

# **BRRI ANNUAL REPORT**

## **2023-2024**



**BANGLADESH RICE RESEARCH INSTITUTE**

# **BRRI ANNUAL REPORT**

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# Preface

The present volume of BRRI Annual Report is a summary of research works carried out by 19 research divisions and 11 regional stations of the institute during July 2023 to June 2024. This document consists of the significant portions of the research covering eight programme areas.

The programme areas such as variety development, crop-soil-water management, rice farming systems, pest management, socio-economics and policy, farm mechanization, technology transfer and regional stations representing the broader conceptual frameworks of BRRI activities.

With a target to sustain Bangladesh's achievements as a rice surplus country, BRRI scientists have been engaged in developing various location specific, climate smart, stress tolerant rice varieties and some nutritionally enriched premium quality ones.

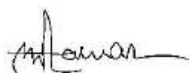
Another group of BRRI scientists dedicated their time to develop and disseminate resource-saving profitable environment friendly technologies along with some management tools such as alternate wetting and drying (AWD) techniques, low cost water distribution system, rice transplanter, low cost machinery like harvester, weeder etc., integrated crop management (ICM) practices, rice based farming systems and popularization of BRRI machinery to the end users.

Furthermore, BRRI developed high yielding rice varieties along with management technologies were demonstrated in different agro-ecological zones of the country.

Above all, the present report includes various research results out of activities that attempted to minimize yield gap. It also includes research initiatives dedicated to finding out coping strategies to face the effects of changing climate like increased flash floods, salinity, excessive heat and drought as well as severe cold.

I acknowledge all the efforts that helped bring out the publication and special thanks for those who contributed with different capacities.

I hope the report will be useful for the scientists, extension agents, policy makers and other partners home and abroad to be updated on continuous research activities at BRRI.



(Dr Mohammad Khalequzzaman)  
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# Weather information

**Introduction:** Weather is an instantaneous state of atmosphere, describing for example the degree to which it is hot or cold, wet or dry, calm or stormy, clear or cloudy. It influences growth and development of crops as well as pest and disease incidences. We present here the available weather parameters viz maximum and minimum temperature (°C), rainfall (mm), pan evaporation (mm), humidity (9 am and 2pm), sunshine hours and solar radiation (gm-cal/cm<sup>2</sup>/day) during the reporting year (July 2023 - June 2024) as recorded from BRRi headquarter-Gazipur and Seven regional stations Rangpur, Cumilla, Bhanga, Habiganj, Barishal, and Sonagazi by Plant Physiology Division.

**Temperature:** Among the weather stations, the highest mean maximum temperature was recorded at Bhanga (44.6°C) in May, followed by Gazipur (37.3°C) in April, Comilla (36.87°C) in April, Sonagazi (35.03°C) in May, Barishal (34.79°C) in April, Habiganj (34.56°C) in April, and Rangpur (33.13°C) in May. The mean maximum temperature was quite high during April and May at most stations. However, the mean minimum temperature was lowest in January across all stations, with the lowest recorded in Rangpur (10.58°C) and the highest in Habiganj (14.5°C) Fig. 1.

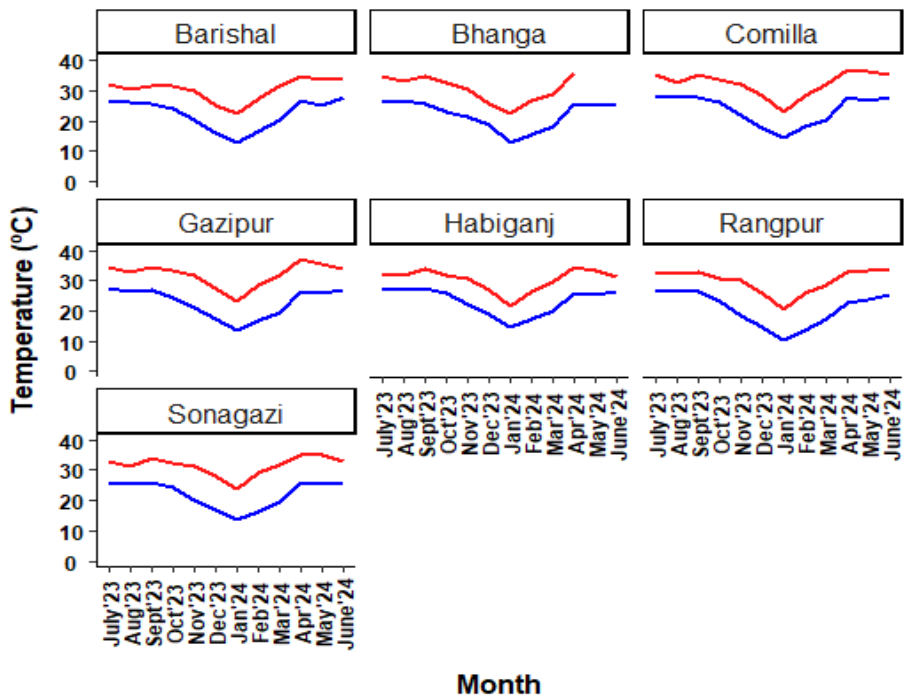


Fig. 1: Monthly mean maximum (T Max) and minimum (T Min) temperature of BRRi Gazipur and six regional stations during July 2023 to June 2024.



**Rainfall:** An unusual monthly trend in the rainfall pattern was observed across all stations, with the highest rainfall recorded in Barishal (3,384 mm),

followed by Habiganj (2,743 mm) during the reporting period, while the lowest amount was recorded in Bhanga (952 mm) Fig. 2.

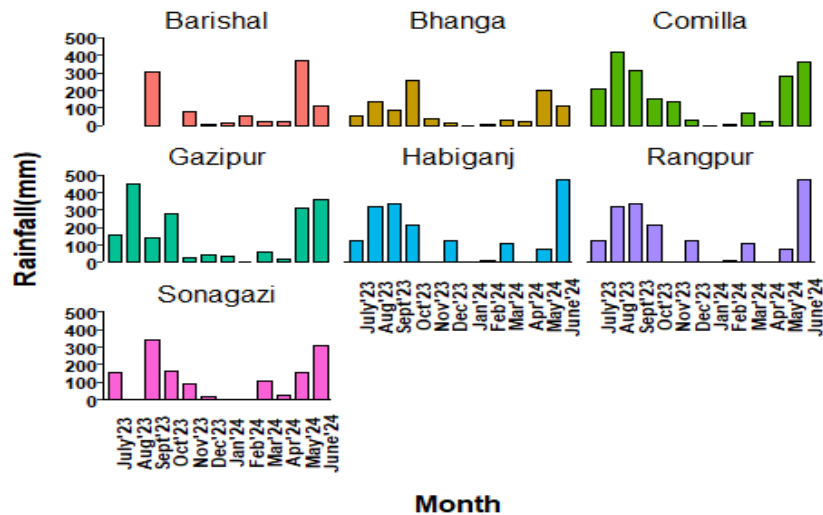


Fig. 2: Monthly total rainfall of BRRI Gazipur and six regional stations during July'2023 to June'2024.

**Relative Humidity (RH):** Relative humidity was higher at morning for all the station of which

highest was observed at June to september and lowest at November to February Fig. 3.

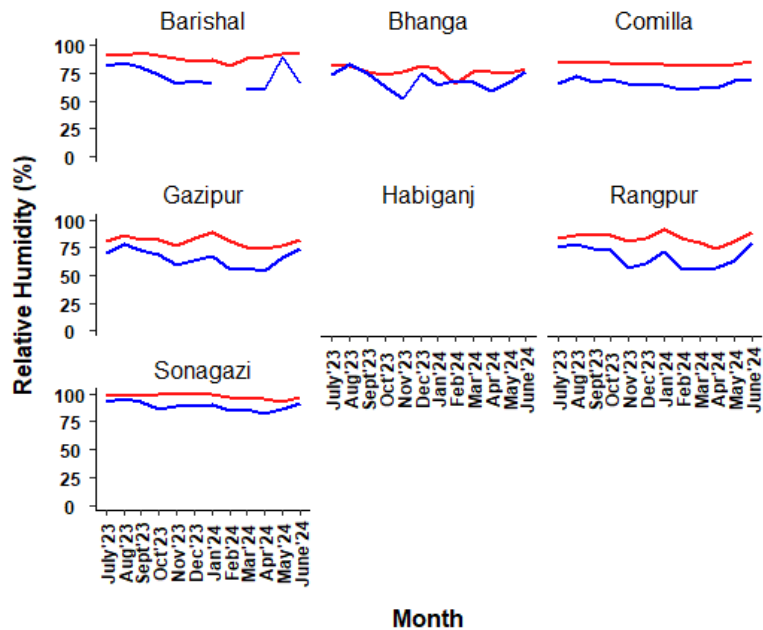


Fig. 3: Monthly mean Relative Humidity (%) of BRRI Gazipur and Seven regional station during July'2023 to June'2024.

**Sunshine hours and Solar radiation:** Among the weather stations, the highest monthly mean sunshine hours per day was recorded at Comilla (7.98 hrs/day) and the lowest was recorded in Rangpur (1.25 hrs/day) in January. The monthly mean solar radiation was relatively low in the rainy

season and also November to February as well. The highest mean solar radiation prevailed at Comilla (723.7 Cal/cm<sup>2</sup>/day) in August and the lowest value was recorded at Sonagazi (138.44 Cal/cm<sup>2</sup>/day) in November Fig. 4.

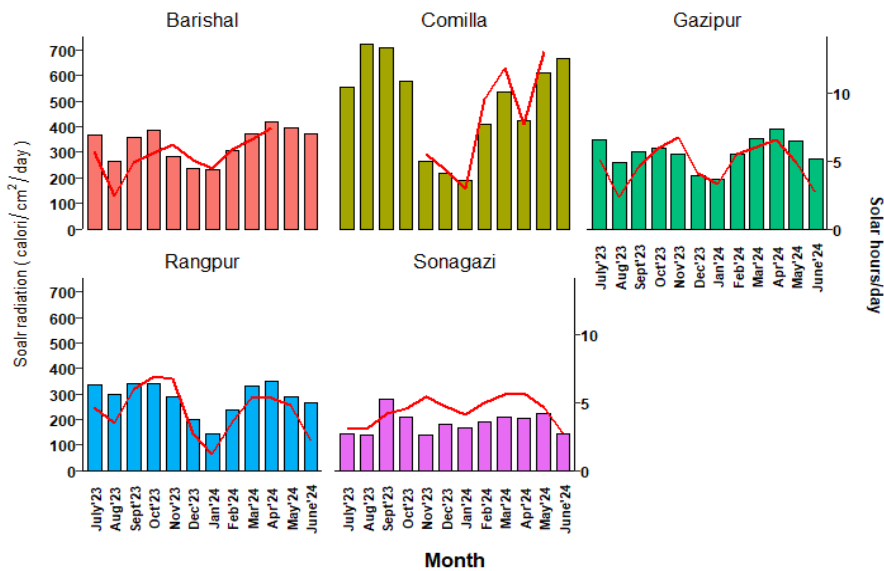


Fig. 4: Monthly mean solar radiation and sunshine hours of BRRI Gazipur and six regional station during July'2023 to June'2024.

## Abbreviation and acronyms

|         |                                                     |
|---------|-----------------------------------------------------|
| AEZ     | = agroecological zone                               |
| ALART   | = advanced line adaptive research trial             |
| ARIMA   | = auto regressive integrated moving average         |
| As      | = arsenic                                           |
| AT      | = active tillering                                  |
| AWD     | = alternate wetting and drying                      |
| AYT     | = advanced yield trial                              |
| B. Aman | = broadcast Aman                                    |
| BADC    | = Bangladesh Agricultural Development Corporation   |
| B. Aus  | = broadcast Aus (upland rice)                       |
| Bak     | = bakanae                                           |
| BARI    | = Bangladesh Agriculture Research Institute         |
| BB      | = bacterial blight                                  |
| B       | = Blast                                             |
| BC      | = back cross                                        |
| BCR     | = benefit-cost-ratio                                |
| BI      | = blast                                             |
| BLB     | = bacterial leaf blight                             |
| BINA    | = Bangladesh Institute of Nuclear Agriculture       |
| BMDA    | = Barind Multi Purpose Development Authority        |
| BPH     | = brown plant hopper                                |
| BR      | = Bangladesh rice                                   |
| BS      | = breeder seed                                      |
| BRRI    | = Bangladesh Rice Research Institute                |
| BWDB    | = Bangladesh Water Development Board                |
| BShB    | = bacterial sheath blight                           |
| CAB     | = Commonwealth Agriculture Bureau                   |
| ck      | = check                                             |
| cm      | = centimetre                                        |
| CDB     | = Carabid beetle                                    |
| CMS     | = cytoplasmic male sterile                          |
| CV      | = common variance, co-efficient of variation        |
| DAE     | = Department of Agricultural Extension (Bangladesh) |
| DAP     | = drought animal power                              |
| DAS     | = days after seeding                                |
| DAT     | = days after transplanting                          |
| DH      | = dead heart                                        |
| DHB     | = dark-headed borer                                 |
| DMRT    | = Duncan's multiple range test                      |
| DNA     | = deoxyribonucleic acid                             |
| DNI     | = Direct normal irradiance                          |
| DHI     | = Diffuse horizontal irradiance                     |
| DTF     | = days to flowering                                 |
| DWSR    | = Direct wet seeded rice                            |
| DWR     | = deepwater rice                                    |
| ET      | = evapotranspiration                                |
| FS      | = foundation seed                                   |

|        |                                                        |
|--------|--------------------------------------------------------|
| FMPHT  | = Farm Machinery and Postharvest Technology            |
| GABA   | = gamma amino buteric acid                             |
| GH     | = grasshopper                                          |
| GM     | = gall midge                                           |
| GMB    | = green mirid bug                                      |
| GLH    | = green leafhopper                                     |
| GoB    | = Government of Bangladesh                             |
| GRS    | = Genetic Resources and Seed                           |
| GSR    | = green super rice                                     |
| GQN    | = Grain Quality and Nutrition                          |
| HA     | = Habiganj Aman                                        |
| HAT    | = hours after treatment                                |
| HB     | = Habiganj Boro                                        |
| HNRP   | = Hill Nerica Rice Productivity                        |
| ht     | = height                                               |
| IIRON  | = International Irrigated Rice Observational Nursery   |
| INGER  | = International Network for Genetic Evaluation of Rice |
| INM    | = integrated nutrient management                       |
| IPM    | = integrated pest management                           |
| IPNS   | = integrated plant nutrition system                    |
| IRRI   | = International Rice Research Institute (Philippines)  |
| IRSSTN | = International Rice Soil Stress Tolerance Nursery     |
| IURON  | = International Upland Rice Observational Nursery      |
| LCC    | = leaf colour chart                                    |
| LBB    | = lady bird beetle                                     |
| LHC    | = long-horned cricket                                  |
| Lit/ha | = litre per hectare                                    |
| LR     | = leaf roller                                          |
| LSc    | = leaf scald                                           |
| LSD    | = least significant difference                         |
| LV     | = local variety                                        |
| LIV    | = local improved variety                               |
| MAS    | = marker assisted selection                            |
| MER    | = micronutrient enriched rice                          |
| ML     | = monogenic line                                       |
| MLT    | = multi-location trial                                 |
| MMT    | = million metric tons                                  |
| MR     | = moderately resistant                                 |
| MT     | = maximum tillering                                    |
| MV     | = modern variety                                       |
| meq    | = milli equivalent                                     |
| NGO    | = non-government organization                          |
| NIL    | = near isogenic line                                   |
| NIR    | = net irrigation requirement                           |
| NSB    | = National Seed Board (Bangladesh)                     |
| OC     | = oil cake                                             |
| OHLH   | = orange headed leafhopper                             |
| OT     | = observational trial                                  |
| OYT    | = observational yield trial                            |
| PACp   | = phenotypic acceptance                                |

|            |   |                                                               |
|------------|---|---------------------------------------------------------------|
| PI         | = | panicle initiation                                            |
| PQR        | = | premium quality rice                                          |
| PVART      | = | proposed variety adaptive research trial                      |
| PVS        | = | participatory varietal selection                              |
| PVT        | = | proposed variety trial                                        |
| PYT        | = | preliminary yield trial                                       |
| QTL        | = | quantitative trait loci                                       |
| RCB design | = | randomized complete block design                              |
| RF         | = | rainfall                                                      |
| RH         | = | rice hispa                                                    |
| RLF        | = | rice leaf folder                                              |
| RLR        | = | rice leaf roller                                              |
| RPT        | = | rice production training                                      |
| RS         | = | Regional station                                              |
| RTV        | = | rice tungro virus                                             |
| RWM        | = | rice whorl maggot                                             |
| RWS        | = | relative water supply                                         |
| RYT        | = | regional yield trial                                          |
| SAAO       | = | Sub Assistant Agricultural Officer                            |
| SB         | = | stem borer                                                    |
| SCA        | = | Seed Certification Agency (Bangladesh)                        |
| SD         | = | standard deviation                                            |
| SES        | = | standard evaluation system                                    |
| ShB        | = | sheath blight                                                 |
| ShR        | = | sheath rot                                                    |
| SPDP       | = | seed production and dissemination trial                       |
| SPIRA      | = | Strengthening Physical Infrastructure and Research Activities |
| SR         | = | solar radiation, stem rot                                     |
| STB        | = | soil test based                                               |
| STPD       | = | staphylinid                                                   |
| SYT        | = | secondary yield trial                                         |
| T. Aman    | = | transplanted Aman                                             |
| T. Aus     | = | transplanted Aus                                              |
| TGW        | = | 1000-grain weight                                             |
| TLS        | = | truthfully labelled seed                                      |
| TOC        | = | Training and operation cell                                   |
| TRB        | = | Transforming Rice Breeding                                    |
| TSP        | = | triple super phosphate                                        |
| USG        | = | urea super granule                                            |
| WMM        | = | Workshop Machinery and Maintenance                            |
| WBPH       | = | white-backed plant hopper                                     |
| WS         | = | wet season                                                    |
| WSR        | = | wet-seeded rice                                               |
| WTR        | = | weed tolerant rice                                            |
| WT         | = | weight                                                        |
| YSB        | = | yellow stem borer                                             |

# **Plant Breeding Division**

**2 Summary**

**2 Variety development**

## SUMMARY

For the development of rice varieties under different ecosystems, 720 crosses were made and 636 crosses were confirmed during 2022-23. A total of 6,19,097 individual plants were advanced from F<sub>2-6</sub> generation following single seed decent (SSD) method under rapid generation advance (RGA) condition. From line-stage testing (LST), 7,413 genotypes were selected based on yield and other agronomic performances. A total of 1,387 genotypes from observational yield trial (OYT) and 7,10 advanced breeding lines were selected from different yield trials (PYT, SYT, AYT, RYT, ALART and PVT). A total of 510 germplasm were maintained during T. Aman and Boro season to use as parents in the breeding programme.

National Seed Board (NSB) of Bangladesh has released two promising genotypes viz Lata Balam and BRH11-9-11-4-5B as BRRI dhan107 and BRRI dhan108 respectively for cultivation throughout the country in Boro season. BRRI dhan107 is a premium quality high protein (10.02 %) with high yielding rice variety. The yield of BRRI dhan107 was 8.19 t/ha whereas, average yield of the check variety BRRI dhan50 was 6.99 t/ha. BRRI dhan107 produced 17.7% higher yield than BRRI dhan50. The size and shape of this newly developed variety was extra-long slender and white coloured grain. The average yield of BRRI dhan108 is 8.52 t/ha with 146 days' growth duration, its potential yield can be up to 10.17 t/ha under favourable environment and appropriate agronomic management.

## VARIETY DEVELOPMENT

**Development of upland rice (B. Aus).** Efforts were made to develop upland rice varieties with multiple traits viz adaptability in drought prone upland ecosystem with earliness (100 days duration), quick

seedling emergence, vigorous growth and plant architecture for lodging tolerance, 4.0-4.5 t/ha grain yield. In 2023-24, in total 39 crosses were made using 26 parents. Eleven crosses were confirmed as true F<sub>1</sub>s through hybridity test. Thirty-four entries were selected considering growth duration, yield, uniformity of morpho-agronomic traits and superiority over the four standard checks from 64 advanced breeding lines in OYT. Sixteen genotypes were selected from 27 tested entries on the basis of yield and short growth duration in PYT. In approach, six genotypes were selected from 13 tested entries. Improvement of jhum rice under upland rice programme was implemented to develop high yielding (3.5 ton/ha or above) rice variety with low (10-19%) to high (>25%) grain amylose content and drought tolerance along with good eating quality for jhum cultivation acceptable to tribal population of Chattogram hill districts. Thirty-nine crosses were made using 26 parental genotypes from local Jhum cultivars, exotic varieties, single BRRI variety, promising advanced breeding lines having low to high level amylose content. Seventeen crosses were confirmed as true F<sub>1</sub>. Six F<sub>2</sub> populations were grown for generation advance through field RGA (Rapid generation advance). Out of 1862 lines, a total of 301 lines comprising 17 crosses were selected from LST based on identical flowering, grain type traits and phenotypic acceptability under field condition. Eight entries from 22 tested genotypes in PYT were selected. Two AYT<sub>s</sub> were conducted in 2023. Among them, eight genotypes were selected from 10 in AYT-1. One hotspot Jhum trial as AYT-2 with nine genotypes was conducted in hill tracts evaluated at six locations (three in Khagrachori, one in Rangamati, two in Bandarban). Among all the entries, despite heterogeneity in climatic condition and topographic architecture, two genotypes, viz, BR12239-5R-93 and BRRI dhan83 were the top yielder genotypes in every trial (Table 1).

**Table 1. Performance of the genotypes in AYT-2, development of Jhum Rice, 2023-24.**

| Genotype            | PH<br>(cm) | GD<br>(day) | L1   | L2   | L3   | L4   | L5   | L6   | Yield<br>(tha <sup>-1</sup> ) |
|---------------------|------------|-------------|------|------|------|------|------|------|-------------------------------|
| Chandranath-3       | 109        | 141         | 1.6  | 2.1  | 1.6  | 1.7  | 1.8  | 1.2  | 1.8                           |
| BR (Bio)10331-AC1-2 | 117        | 89          | 1.6  | 2.3  | 2.0  | 2.1  | 1.5  | 1.7  | 2.1                           |
| Luyin-46            | 119        | 100         | 2.5  | 2.7  | 2.4  | 2.9  | 3.1  | 2.5  | 3.0                           |
| D(R)-6              | 121        | 97          | 1.9  | 2.2  | 2.3  | 1.8  | 2.0  | 2.3  | 2.3                           |
| BR12239-5R-93       | 111        | 107         | 2.7  | 3.5  | 2.9  | 3.3  | 3.1  | 3.2  | 3.4                           |
| BRRI dhan75         | 113        | 93          | 2.9  | 2.5  | 2.1  | 2.1  | 3.2  | 2.5  | 2.8                           |
| BRRI dhan83         | 108        | 106         | 3.1  | 3.5  | 4.2  | 3.7  | 3.7  | 2.8  | 3.8                           |
| BRRI dhan98         | 112        | 93          | 2.6  | 2.5  | 2.6  | 2.1  | 3.2  | 2.8  | 2.9                           |
| BRRI dhan104        | 113        | 99          | 2.3  | 2.5  | 2.1  | 1.7  | 1.8  | 2.1  | 2.3                           |
| LSD<0.05            | 2.32       | 2.90        | 0.12 | 0.23 | 0.21 | 0.11 | 0.08 | 0.14 | 0.26                          |
| H2b                 | 0.91       | 0.78        | 0.70 | 0.79 | 0.76 | 0.91 | 0.78 | 0.90 | 0.95                          |

PH=Plant Height(cm); GD= Growth duration (day); L1=Matiranga, Khagrachori; L2=Sadar, Khagrachori; L3= Sadar, Khagrachori; L4=Sadar, Rangamati; L5=Rowangchori, Bandarban; L6= Rowangchori, Bandarban

Investigators: M Akhlasur Rahman and Nusrat Jahan

### Development of transplanted Aus rice (T. Aus).

The project was aimed to develop short duration (105-110 days), high yield potential genotypes having tolerance to lodging and heat (high temperature) at the reproductive phase, pre-harvest sprouting and good grain quality. In total, 19 crosses were made using 24 parents, and 1702 F<sub>1</sub> seeds were obtained; 32 crosses were confirmed as true F<sub>1</sub>; 35,400 progenies of 77 crosses in T. Aus season were advanced through modified field Rapid Generation Advanced (FRGA). Out of 3,700 lines of 12 crosses, 224 uniform lines were identified from LST based on uniformity in heading, plant height, and acceptable grain type in the field condition. Eighty genotypes were selected from 792 entries from observational yield trial (OYT) and 15 genotypes were selected from AYT#1 on the basis of homogeneity with respect to plant height, phenotypic acceptability at vegetative and maturity stages. Three genotypes were selected from RYT#1 and three genotypes were selected from RYT#2 (BB resistance) along with the check BRRI dhan48 and BRRI dhan98. In addition, three entries were selected from eight in RYT#3 for Bacterial blight (BB) along with BRRI dhan48, BRRI dhan82 and BRRI dhan98.

The genetic trend of 1,794 advanced lines of transplanted Aus rice was estimated which were

conducted from 2020 to 2023 under transplanted Aus (T. Aus) in different locations (Gazipur, Rajshahi, Cumilla, Sonagazi, Kushtia and Rangpur). The result demonstrate that the genetic gain was 1.77% per year with 69.0 kg/ha/year yield advantage for 1794 high yielding promising lines of transplanted Aus rice (Fig. 1).

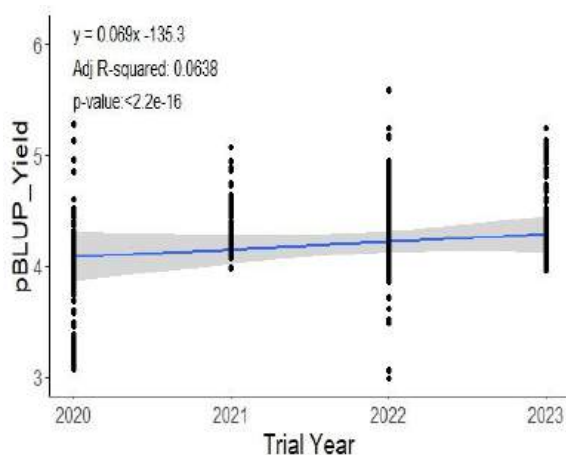


Fig.1. Line graph is showing the genetic gain of BRRI-developed RGA derived transplanted Aus (T. Aus) rice advanced lines.

Investigators: M Khatun, S K Debsharma, J Ferdousy and N Tamanna

**Development of heat tolerant rice (HTR).** The project aims to develop varieties/lines tolerant to



heat stress quality grains into high yielding genotypes in T. Aus season. Nineteen crosses were made using 22 parents for development of heat tolerant rice (HTR) from Boro 2023-24 and 2269 F<sub>1</sub> seeds were collected. Eight F<sub>1</sub>s were confirmed as true crosses for heat tolerance rice development. Development of heat tolerant rice (HTR) programme consists of 10,000 progenies of 20 crosses in Boro season was advanced through modified FRGA. Out of 986 lines of four crosses, 104 uniform lines were selected from LST based on uniformity in heading, plant height and acceptable grain type in the field condition. Selection applied for selecting LST lines was 10%. Ninety-eight entries were evaluated and 32 genotypes selected at Gazipur under observational yield trial (OYT). Two advanced lines from AYT#1 and four from AYT#2 were selected on the basis of homogeneity with respect to plant height, phenotypic acceptability at maturity stages.

Investigators: M Khatun, S K Debsharma, J Ferdousy and Nese Sreenivasulu

### **Evaluation of heat resilient varieties with reduced impact of combined high day and high night temperatures on rice productivity with added premium grain quality for improving livelihoods**

**in South and Southeast Asia under AYT.** The experiment was conducted at five locations namely Gazipur, Rajshahi, Kushtia, Lalpur and Dinajpur during late Boro 2022-23 and T. Aus 2023-24. Fourteen entries along with two check varieties BRRI dhan98 (local check) and N22 (tolerant check) at late Boro and three check varieties BRRI dhan48 (local check), BRRI dhan98 (local check) and N22 (tolerant check) at T. Aus season were evaluated under participatory variety selection (PVS). PVS preference analysis for entries was done by the team consisting of farmers, researchers, DAE personnel, scientific assistant (SA), sub assistant agricultural officer (SAAO), dealers, millers, seed producer, local leaders, local NGOs. A number of male and female participants were chosen to participate in the PVS programme. Each farmer was provided six paper ballots (three with a tick mark for chosen entries and three with a cross mark for worst entries) and they were given necessary instructions on how to cast ballots for best and the worst lines. After casting the votes, these were counted by the scientists and displayed in front of the farmers using the flip chart board.

**Table 2. Performance of the genotypes in AYT#2, high day and high night temperature, Late Boro 2022-23 and T. Aus 2023-24.**

| Designation      | PH (cm) | DM (days) | Yield (t/ha) |       | Spikelet fertility (%) |       | Amylose (%) |
|------------------|---------|-----------|--------------|-------|------------------------|-------|-------------|
|                  |         |           | Late Boro    | T Aus | Late Boro              | T Aus |             |
| IR64             | 90.8    | 113       | 3.04         | 3.50  | 56.44                  | 44.10 | 21.6        |
| IRRI 154         | 101.9   | 118       | 4.60         | 4.69  | 57.99                  | 66.42 | 27.9        |
| IR18C1001        | 91.6    | 108       | 3.82         | 4.18  | 58.32                  | 56.79 | 19.8        |
| IR18C1002        | 87.5    | 111       | 4.11         | 5.03  | 62.30                  | 57.94 | 24.5        |
| IR18C1003        | 92.0    | 111       | 4.04         | 4.46  | 59.76                  | 55.60 | 24.0        |
| IR18C1004        | 88.6    | 110       | 4.15         | 4.62  | 63.43                  | 62.47 | 25.2        |
| IR18C1005        | 99.9    | 112       | 4.03         | 4.18  | 62.10                  | 58.62 | 24.2        |
| IR18C1007        | 98.1    | 110       | 3.70         | 4.48  | 63.48                  | 60.77 | 19.8        |
| IR18C1009        | 98.4    | 112       | 3.99         | 4.77  | 61.54                  | 54.93 | 20.1        |
| IR18C1010        | 95.9    | 108       | 4.01         | 4.55  | 65.04                  | 65.47 | 22.0        |
| IR18C1011        | 95.5    | 110       | 3.89         | 4.66  | 56.80                  | 52.45 | 18.6        |
| IR18C1012        | 97.6    | 111       | 3.90         | 3.38  | 59.23                  | 48.63 | 16.7        |
| IR18C1013        | 97.5    | 110       | 4.13         | 4.14  | 60.43                  | 58.46 | 18.4        |
| BRRI dhan48 (Ck) | -       | -         | -            | 4.88  | -                      | 67.89 | 25.0        |
| BRRI dhan98 (Ck) | 94.2    | 108       | 4.21         | 5.05  | 64.15                  | 71.96 | 27.5        |
| N22 (Tol. Ck)    | 101.5   | 88        | 2.36         | 3.10  | 72.86                  | 72.30 | 23.4        |
| LSD              | 5.72    | 5.57      | 0.97         | 1.34  | -                      | -     | -           |
| H2               | 0.56    | 0.85      | 0.58         | 0.39  | -                      | -     | -           |

From the result of PVS and the yield of different trial sites, the genotypes IR18CI002 and IR18CI004 might be selected for further trial considering late Boro and transplanted (T. Aus) season. Besides, the genotypes IRRI 154 and IR18CI005 can be used as parent because of IRRI 154 has acceptable grain quality and IR18CI005 has the QTL qHTSF4.1 (Table 2).

Investigators: M Khatun, S K Debsharma, J Ferdousy and Nese Sreenivasulu

**Improvement of rice for shallow flooded and deep-water environment.** The major objectives of the project were to develop high yielding (4.0-5.0 t/ha) rice varieties for deep (>1.0 m), shallow flooded areas (up to 1.0 m depth), shallow deep areas (30 cm water) and medium deep areas (50-60 cm water) along with submergence, facultative elongation and hypoxia tolerance. In total, seven crosses were made by using ten parents and produced 206 F<sub>1</sub> seeds. In total 22 F<sub>1</sub> crosses were confirmed through QC SNP panel analysis. A total of 6,601 progenies of 61 crosses (2,465 progenies of 7 F<sub>2</sub> crosses, 1,268 progenies of 15 F<sub>3</sub> crosses, 1,371 progenies of 19 F<sub>4</sub> crosses, 1,497 progenies of 20 F<sub>5</sub> crosses) were advanced through RGA. From LST population, 1,541 lines from 18 crosses were genotyped with trait markers using custom SNP panel among which 358 lines were selected based on uniformity and traits markers. In yield trial, 111 genotypes were tested out of which 20 genotypes were selected based on phenotypic acceptance, growth duration, survivability and higher yield performance. In OYT the genotype BR12950-5R-134 produced the highest yield (3.6 t/ha) which is significantly higher than the check variety BRRI dhan91 (1.9 t/ha) whereas in PYT the genotype BR11686-5R-1 (3.7 t/h) produced the highest yield, which was significantly higher than the check variety BRRI dhan91 (2.2 t/ha). In AYT the genotype BR11186-5R-549 (3.5 t/h) produced the highest grain yield which was significantly higher

than the check variety BRRI dhan91 (2.1 t/ha). The heritability obtained for growth duration was ranging from 82% to 88% and grain yield was ranging from 61% to 74% indicating acceptable level of precision in these experiments. Through maintenance breeding 20 shallow flood tolerant genotypes and land races were grown and maintained for future use.

Investigators: S Maniruzzaman, Sharmistha Ghosal, A S M Masuduzzaman and K M Iftekharuddaula

**Development of rainfed lowland rice (RLR):** The project aims to develop genotypes superior to standard varieties and adaptable to rainfed lowland environment in T. Aman season. In T. Aman 2023-24, 2,892 F<sub>1</sub> seeds were obtained from 30 single crosses. Around 30 crosses were confirmed as true hybrids using 10-SNP *indica* QC panel. A total of 18,920 individual progenies of 59 crosses from F<sub>3</sub> and F<sub>5</sub> generations were harvested from T. Aman season through RGA method. The materials were advanced in Boro 2023-24 season and 11,710 progenies of 36 crosses from F<sub>4</sub> generations were harvested in Boro season at Gazipur through RGA method. A total of 64 genotypes were selected from 606 progenies of line stage testing (LST) trial with a selection intensity of 10.56%. (Fig. 2 and 3) presents selection intensity and trait marker profile of the genotypes of LST. Most of the selected materials from LST contained genes of high amylose and high zinc and some of the materials also showed drought tolerance QTLs. A total of 432 genotypes were evaluated in three observation yield trials (OYT) in Gazipur, Cumilla and Rangpur. Among the tested genotypes 40 genotypes were selected and forwarded in advanced yield trial (AYT). In AYT, 104 genotypes were evaluated in two trials in Gazipur, Cumilla and Rangpur and 20 genotypes were found promising to advance. Among the 16 tested genotypes of regional yield trial (RYT), three was selected for re-trial. Genetic trend of the genotypes from 2019 to 2023 showed the pBLUP (grain yield) in respect of trial year indicated an annual 77.67 kg/ha equivalent to about 1.67% increase in grain yield per year based on yield of 2019.

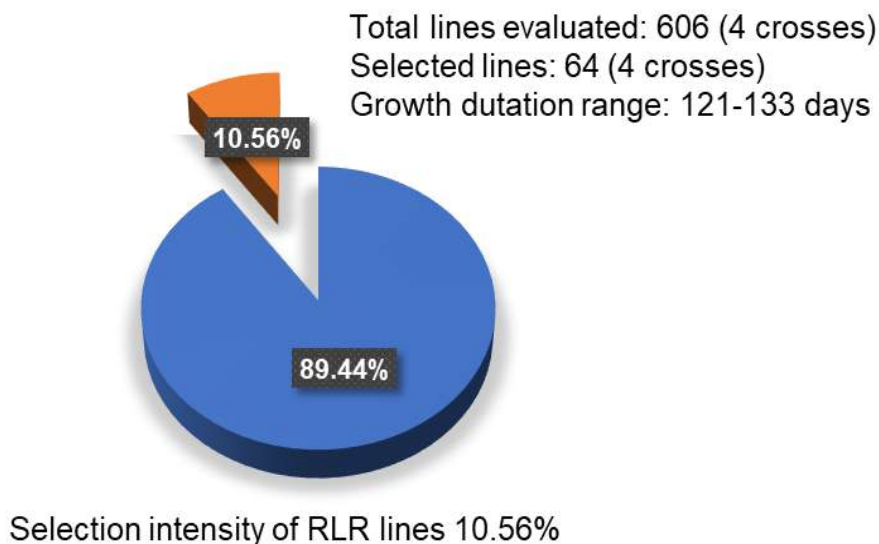


Fig. 2. Selection intensity genotypes of LST, RLR, T. Aman 2023-24

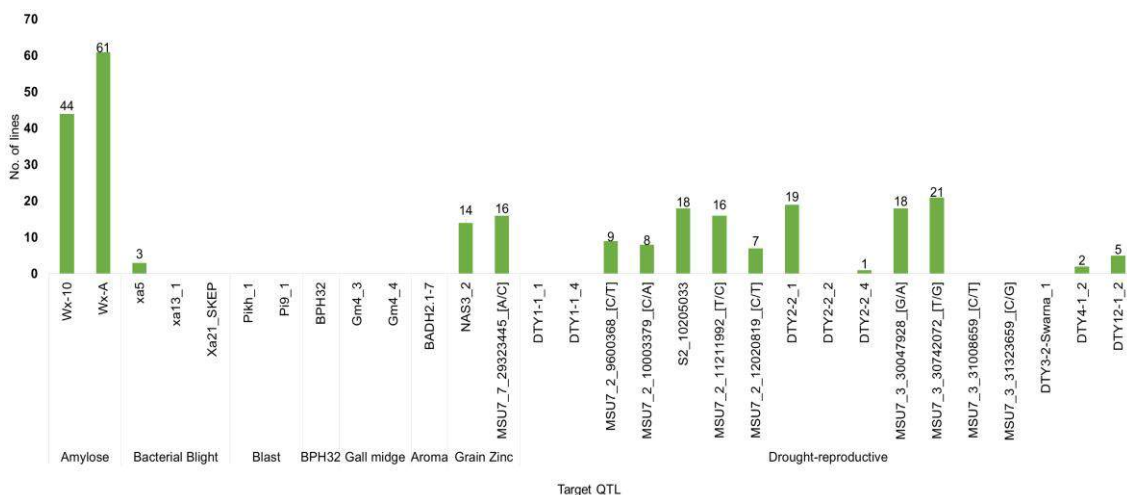


Fig. 3. Trait marker profile of genotypes of LST, RLR, T. Aman 2023-24.

Investigators: M A Kader, R R Majumder, T K Hore, U R Shaha and M I H Joy

**Development of rice varieties for favourable Boro environment:** The aim of this project was to develop improved genotypes with high yield potential ( $\geq 8.0$  t/ha), earliness (135-145 days) and acceptable grain quality for favourable irrigated

ecosystem in Bangladesh. To address the objectives, 29 single crosses and seven backcrosses were made using 37 breeding lines/varieties as parents targeting to develop high yielding breeding lines enriched with favourable alleles of key target traits, viz

disease resistance (blast and BLB), insect resistance (BPH) and acceptable grain quality (amylose, chalkiness, palatability, zinc content, etc.). Seventeen crosses were confirmed as true F<sub>1</sub> through a hybridity test using KASP based QC SNP genotyping. Out of 37,277 segregating progenies of 153 crosses grown in the RGA nurseries, a total of 29,528 individual progenies comprising 2,620 F<sub>2</sub> progenies of 19 crosses, 4,910 F<sub>3</sub> progenies of 31 crosses, 4,817 F<sub>4</sub> progenies of 18 crosses, 10,340 F<sub>5</sub> progenies of 39 crosses, 4,758 F<sub>6</sub> progenies of 32 crosses, 685 BC<sub>1</sub>F<sub>2</sub> of 5 crosses, 1,065 BC<sub>1</sub>F<sub>4</sub> progenies of five crosses and 333 BC<sub>2</sub>F<sub>4</sub> progenies of two crosses were advanced following single seed decent method of breeding. Out of 4,537 lines of 48 crosses tested in LST, 598 uniform lines in terms of plant height, days to flowering, grain size and shape were selected for genotyping to track the favourable alleles of key target genes for BB (*xa5*, *xa13* and *Xa21*), blast (*Pi9*, *Pita*, *Pita2* and *Pb1*) and BPH (*Bph17* and *BPH32*) resistance and grain quality (*Wx-a*, *Wx-10*, *chalk5*, *BADH2*).

Twenty-eight genotypes out of 530 fixed lines tested in OYT at four locations following sparse testing (Fig. 4) model of genomic selection were selected based on genomic BLUP for yield. Genomic BLUP values were estimated using genome-wide

genotyping data and phenotypic values for yield of the training population tested at four locations. The accuracy of the genomic prediction ranged from 0.398 to 0.750 among the sites (Fig. 5). The selected lines yielded 7.3 t/ha to 9.7 t/ha with growth duration of 130 – 150 days. Out of 168 breeding lines tested in an OYT under AGGRiNet trial network, 11 breeding lines showing 7.0 t/ha to 8.16 t/ha yield with 133 – 136 days growth duration across three sites (Cumilla, Habiganj and Rajshali) were selected for further evaluation (Table 3). Eight early maturing lines (141 -145 days) yielding 10.5 % to 37.2% higher than BRRI dhan28 (140-142 days) and four medium maturing lines (147-152 days) yielding 10.8% to 37.4% higher than BRRI dhan102 (146-147 days) were selected from 96 advanced breeding lines tested in three AYT trials (Tables 4 and 5). Four medium maturing lines (150-151 days) and one early maturing line (147 days) yielding at least 0.5 t/ha higher yield over the contemporary check varieties (BRRI dhan28 and BRRI dhan88) were selected from 31 breeding lines tested in four sets of RYT at 10 locations across the country for further advancement (Tables 6 and 7). Two short duration (143-144 days) breeding lines BR11318-5R-63 and BR11337-5R-72 respectively yielded 12.4% and 11.5% higher than the check variety BRRI dhan88 across 10 locations in proposed variety trial (PVT).

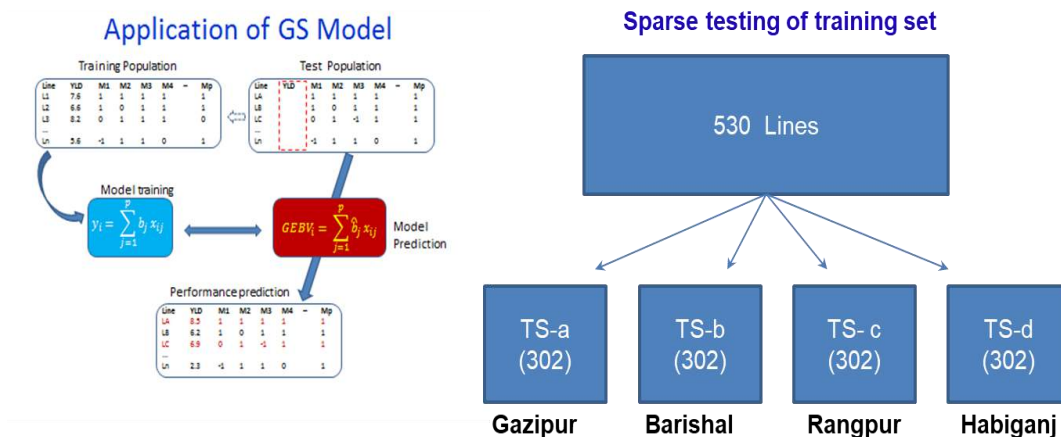


Fig. 4. Sparse testing 530 breeding lines at four locations during Boro 2023-24.

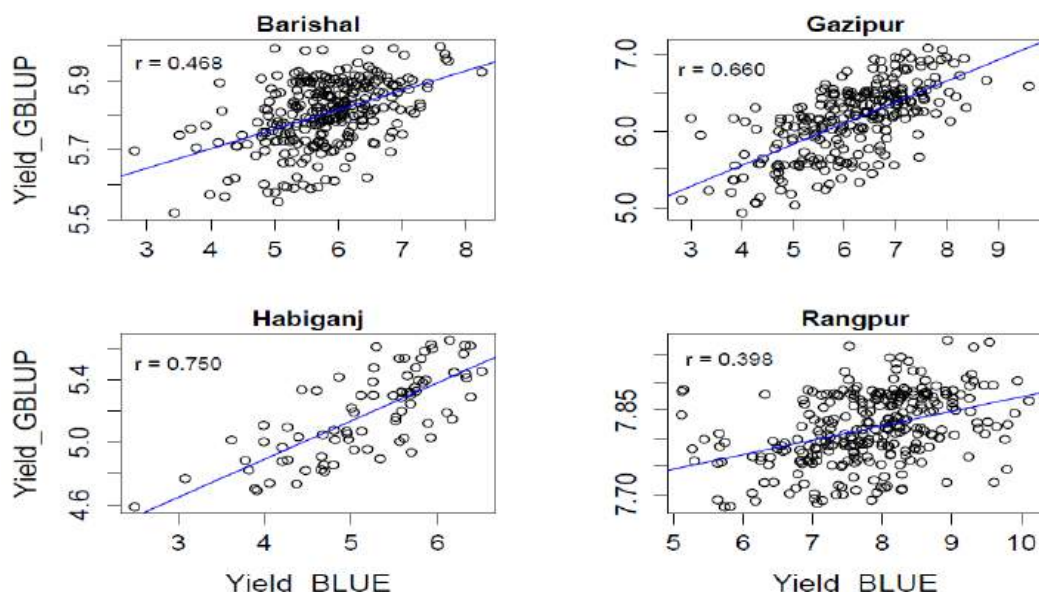


Fig. 5. Accuracy of genomic prediction of 530 breeding lines tested at four locations in OYT during Boro 2023-24

**Table 3. Yield performances of the selected breeding lines from OYT-AGGRiNet trials conducted at different locations under favourable Boro rice during Boro 2023-24.**

| Designation     | Growth duration (day) |             |             |              | Yield (t/h)    |               |                |              |
|-----------------|-----------------------|-------------|-------------|--------------|----------------|---------------|----------------|--------------|
|                 | Cum                   | Hab         | Raj         | Across sites | Cum            | Hab           | Raj            | Across sites |
| IR22MD1637      | 128                   | 135         | 144         | 136          | 4.78           | 2.46          | 9.14           | 8.16         |
| IR20X1015       | 131                   | 132         | 144         | 136          | 6.03           | -             | 9.53           | 8.04         |
| IR22MD3737      | 129                   | 133         | 142         | 135          | 6.15           | 3.88          | 9.18           | 7.91         |
| IR22MD4057      | 131                   | 129         | 146         | 135          | 6.39           | 2.55          | 9.31           | 7.91         |
| IR22MD2048      | 130                   | 130         | 144         | 135          | 7.2            | 2.33          | 8.07           | 7.85         |
| IR22MD2234      | 129                   | 130         | 149         | 136          | 5.57           | 3.76          | 9.24           | 7.40         |
| IR22MD2015      | 130                   | 135         | 140         | 135          | 6.03           | 3.12          | 9.99           | 7.24         |
| IR22MD1319      | 133                   | 125         | 142         | 133          | 5.86           | 3.28          | 9.59           | 7.13         |
| IR22MD1618      | 128                   | 130         | 139         | 132          | 6.45           | -             | 9.24           | 7.09         |
| IR22MD3929      | 134                   | 131         | 143         | 136          | 6.09           | 3.05          | 10.43          | 7.06         |
| IR22MD1405      | 128                   | 136         | 141         | 135          | 6.9            | 2.00          | 7.84           | 7.01         |
| RRI dhan88      | 133                   | 130         | 139         | 134          | 5.52           | 2.13          | 7.11           | 6.31         |
| BRRI dhan89     | 139                   | 139         | 146         | 141          | 5.98           | 3.27          | 10.47          | 6.65         |
| BRRI dhan92     | 138                   | 124         | 147         | 146          | 6.35           | 3.26          | 9.17           | 7.11         |
| Range (N = 168) | 125-<br>139           | 122-<br>146 | 124-<br>150 | 129-141      | 4.17 -<br>7.51 | 0.33-<br>5.64 | 6.07-<br>10.47 | 5.70-9.34    |
| LSD (0.05)      | 1.38                  | 5.18        | 3.04        | 3.20         | 0.301          | 1.04          | 0.375          | 0.55         |

\* 15-20% grain was lost due to shattering with majority of the entries at Habiganj site.

-, indicates value not available due not to be tested or due to missing/excluded plots.

**Table 4. Yield performances of the selected breeding lines from AYT conducted at different locations, Favourable Boro Rice, Boro 2023-24.**

| Designation    | Growth duration<br>(day) | Yield (t/ha) |         |          |         |
|----------------|--------------------------|--------------|---------|----------|---------|
|                |                          | Cumilla      | Gazipur | Habiganj | Average |
| ATY-1          |                          |              |         |          |         |
| BR13418-5R-18  | 153                      | 6.2          | 6.3     | 7.1      | 6.5     |
| BR13141-5R-22  | 144                      | 5.9          | 6.9     | 6.4      | 6.4     |
| BR13137-5R-107 | 149                      | 4.1          | 6.6     | 8.6      | 6.4     |
| BRRi dhan28    | 142                      | 4.7          | 6.9     | 5.9      | 5.8     |
| BRRi dhan88    | 148                      | 4.4          | 6.7     | 5.4      | 5.7     |
| Range (N =39)  | 140-155                  | 3.1-6.4      | 2.6-7.5 | 3.8-7.5  | 3.8-6.4 |
| LSD (0.05)     | 8.2                      | 0.60         | 0.53    | 0.9      | 0.61    |
| H2b (%)        | 82.0                     | 79.0         | 81      | 77.0     | 35.0    |

**Table 5. Yield performances of the selected breeding lines from AYT conducted at different locations, favourable Boro rice, Boro 2023-24 (Contd.).**

| Designation    | Growth duration<br>(day) | Yield (t/ha) |         |          |         |
|----------------|--------------------------|--------------|---------|----------|---------|
|                |                          | Cumilla      | Gazipur | Habiganj | Average |
| <b>ATY-2</b>   |                          |              |         |          |         |
| IR19A8188      | 152                      | 5.3          | 6.3     | 6.8      | 6.6     |
| IR19A8986      | 151                      | 3.0          | 4.7     | 6.9      | 5.8     |
| BRRi dhan58    | 153                      | 4.0          | 5.2     | 5.5      | 5.3     |
| BRRi dhan88    | 146                      | 3.3          | 5.8     | 5.5      | 5.7     |
| BRRi dhan102   | 156                      | 4.4          | 4.7     | 5.2      | 4.9     |
| Range (N =25)  | 144-163                  | 2.4-6.1      | 4.2-6.3 | 3.9-7.2  | 3.5-6.6 |
| LSD (0.05)     | 4.4                      | 0.62         | 0.6     | 0.42     | 0.51    |
| H2b (%)        | 90.0                     | 88.9         | 71.9    | 61.7     | 56.0    |
| <b>AYT-3</b>   |                          |              |         |          |         |
| BR13136-5R-139 | 145                      | 6.3          | 7.3     | 6.6      | 6.7     |
| BR13136-5R-165 | 144                      | 6.3          | 6.4     | 6.8      | 6.5     |
| BR13418-5R-21  | 145                      | 6.4          | 6.6     | 5.5      | 6.2     |
| BR13418-5R-58  | 141                      | 5.2          | 6.1     | 6.3      | 5.9     |
| BR13418-5R-20  | 142                      | 5.1          | 7.0     | 5.5      | 5.9     |
| SVIN109        | 149                      | 6.2          | 6.9     | 4.5      | 5.9     |
| IR12A173       | 146                      | 6.0          | 6.7     | 5.7      | 6.1     |
| BRRi dhan67    | 146                      | 3.9          | 7.0     | 3.8      | 4.9     |
| BRRi dhan88    | 140                      | 4.0          | 6.2     | 3.1      | 4.5     |
| BRRi dhan102   | 146                      | 4.6          | 6.3     | 4.1      | 5.0     |
| Range (N =32)  | 137-157                  | 2.6-6.4      | 3.5-7.5 | 2.0-6.8  | 3.1-6.9 |
| LSD (0.05)     | 4.5                      | 0.59         | 0.7     | 0.42     | 0.56    |
| H2b (%)        | 91.3                     | 82.1         | 87.3    | 73.8     | 62.7    |

**Table 6. Yield performances of the selected breeding lines from RYT\_SD conducted at different locations, favourable Boro rice, Boro 2023-24.**

| Designation   | PH<br>(cm) | DM<br>(day) | Yield BLUE (t/ha) |     |     |     |     |     |     |     |     |     |      |
|---------------|------------|-------------|-------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|
|               |            |             | L1                | L2  | L3  | L4  | L5  | L6  | L7  | L8  | L9  | L10 | Avg. |
| BR12574-5R-52 | 112        | 147         | 6.0               | 7.8 | 6.6 | 7.2 | 5.8 | 7.2 | 7.2 | 7.1 | 6.5 | 7.4 | 6.9  |
| BRRi dhan88   | 92         | 146         | 5.6               | 7.3 | 6.4 | 5.2 | 6.1 | 6.3 | 7.2 | 6.6 | 5.9 | 6.1 | 6.3  |
| BRRi dhan96   | 88         | 144         | 5.2               | 6.6 | 6.5 | 5.0 | 6.1 | 6.5 | 6.3 | 7.1 | 5.9 | 6.5 | 6.1  |

| Designation          | PH<br>(cm) | DM<br>(day) | Yield BLUE (t/ha) |         |         |         |         |         |         |         |         |         |         |
|----------------------|------------|-------------|-------------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
|                      |            |             | L1                | L2      | L3      | L4      | L5      | L6      | L7      | L8      | L9      | L10     | Avg.    |
| Range (N=8)          | 88-120     | 141-157     | 4.7-6.1           | 6.0-7.8 | 5.0-7.1 | 5.4-7.2 | 5.8-7.0 | 5.3-6.4 | 6.3-7.9 | 6.3-7.3 | 5.6-6.8 | 6.1-8.1 | 5.2-6.9 |
| LSD (0.05)           | 5.24       | 0.5         | 0.3               | 0.5     | 0.5     | 0.3     | 0.4     | 0.3     | 0.5     | 0.3     | 0.6     | 0.5     | 0.5     |
| H <sup>2</sup> b (%) | 97.2       | 85.7        | 89.4              | 72.2    | 76.1    | 93.4    | 85.6    | 91.8    | 39.3    | 86.1    | 89.2    | 76.3    | 85.7    |

L1= Barishal, L2= Bhanga, L3= Cumilla, L4= Gazipur, L5= Habiganj, L6= Kushtia, L7= Rajshahi, L8= Rangpur, L9= Satkhira, L10= Sonagazi, Av= Average.

**Table 7. Yield performances of the selected genotypes from RYT (SMD and MD) conducted at different locations, favourable Boro rice, Boro 2023-24.**

| Designation          | PH<br>(cm) | DM<br>(day) | Yield BLUE (t/ha) |         |         |         |         |         |         |         |         |         |         |
|----------------------|------------|-------------|-------------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
|                      |            |             | L1                | L2      | L3      | L4      | L5      | L6      | L7      | L8      | L9      | L10     | Avg.    |
| BR11894-5R-260       | 110        | 151         | 5.7               | 7.5     | 7.2     | 6.5     | 7.2     | 6.7     | 7.4     | 6.3     | 7.1     | 7.1     | 7.0     |
| BR12508-5R-5         | 102        | 150         | 6.3               | 7.4     | 6.5     | 6.5     | 7.9     | 7.0     | 7.7     | 6.8     | 6.6     | 6.7     | 7.0     |
| BR12517-5R-57        | 107        | 150         | 6.6               | 7.3     | 5.5     | 6.2     | 7.3     | 7.2     | 7.7     | 6.6     | 7.0     | 6.6     | 7.0     |
| BR13027-BC1-3R-77    | 107        | 150         | 6.6               | 7.1     | 7.5     | 6.1     | 6.9     | 6.0     | 7.7     | -       | 6.7     | 6.6     | 6.8     |
| BRRI dhan58          | 100        | 151         | 5.9               | 7.4     | 6.5     | 5.1     | 6.7     | 7.1     | 7.1     | 6.1     | 6.0     | 6.8     | 6.4     |
| BRRI dhan89          | 109        | 156         | 6.5               | 7.3     | 6.9     | 5.7     | 6.8     | 6.8     | 8.0     | 6.1     | 7.6     | 7.1     | 7.0     |
| BRRI dhan102         | 110        | 153         | 5.9               | 7.2     | 7.1     | 4.8     | 6.4     | 6.9     | 7.4     | 7.8     | 7.1     | 6.9     | 6.6     |
| Range (N=19)         | 89-113     | 145-158     | 5.0-6.6           | 5.4-7.5 | 5.5-7.5 | 3.5-6.8 | 6.0-7.9 | 5.5-7.2 | 6.2-8.0 | 6.0-8.6 | 4.6-7.7 | 4.2-7.7 | 5.5-7.0 |
| LSD (0.05)           | 0.53       | 1.49        | 0.4               | 0.4     | 0.4     | 0.6     | 0.4     | 0.6     | 0.3     | 0.6     | 0.4     | 0.6     | 0.5     |
| H <sup>2</sup> b (%) | 89.3       | 93.2        | 89.6              | 88.7    | 79.2    | 81.8    | 64.8    | 73.2    | 79.1    | 92.4    | 87.5    | 93.2    | 77.5    |

L1= Barishal, L2= Bhanga, L3= Cumilla, L4= Gazipur, L5= Habiganj, L6= Kushtia, L7= Rajshahi, L8= Rangpur, L9= Satkhira, L10= Sonagazi, Av= Average

**Development of cold tolerant rice:** The major objective of the project was to develop high yielding and short duration (6.0-7.0 t/ha yield and 135-145 days growth duration for haor areas) and high yielding medium duration (6.5-7.5 t/ha yield with 145-150 days growth duration for Northern regions) rice varieties tolerant to cold stress at seedling and reproductive stage. To address the above objectives, 10 single crosses and 22 backcrosses were made using 21 lines/varieties including five cold tolerant donors as parents targeting to develop high yielding and cold tolerant breeding lines enriched with favourable alleles of disease resistance (blast and BLB), insect resistance (BPH) and acceptable grain quality (amylose, chalkiness, palatability, zinc content, etc.). Thirty-seven crosses were confirmed

as true F1 through a hybridity test using KASP based QC SNP genotyping. From segregating RGA nurseries, 30,373 individual plants were harvested from 150 cross combinations of F<sub>2</sub>-F<sub>6</sub>, BC1F<sub>2</sub>, BC1F<sub>4</sub> and BC2F<sub>2</sub> generations following SSD method of breeding. Out of 1,272 lines (647 F<sub>5</sub>:6 and 625 BC1F<sub>4</sub> lines) under 12 crosses tested in LST, 158 uniform lines in terms of plant height, days to flowering, grain size and shape were selected from nine crosses for genotyping with trait markers for cold tolerance (*SCT1*, *qPSST6*, *qPSST3*, *qPSST7* and *qPSST9*), blast resistance (*Pi9*, *Pita*, *Pita2*, *pb1*), BB resistance (*xa5*, *xa13*, *Xa21*) and grain quality traits (*Wx-a*, *Wx-10*).

Out of 474 breeding lines tested under natural cold stress (at booting stage) and non-stress conditions at two locations in OYT-1 and OYT-2, 33 lines showing 20.8 – 133.0 % yield advantage under cold stress condition and seven lines showing 17.0 – 79.6 % yield advantage under non-stress condition over the check varieties of contemporary growth duration were selected for further yield testing. Also, four breeding lines showing 18.9% to 41.3% higher yield over the check variety were selected from 96 IRRI developed breeding lines tested at Habiganj site under non-stress condition. Twelve advanced breeding lines including three short durations (<150 days) and nine medium duration lines (150-154 days) showing 26.1% to 89.6% yield advantage over the contemporary check varieties BRRI dhan28 and BRRI dhan67 under cold stress were selected from 136 breeding lines tested in three AYT trials at three locations (Nikli, Tahirpur and Habiganj). Also, six short duration lines showing 13.5% to 34.7% higher yield over the check varieties (BRRI dhan28 and BRRI dhan88) and four medium duration breeding lines showing 10.7% to 17.9% yield advantage over the check varieties (BRRI dhan67 and BRRI dhan89) were selected from the three AYT non-stress control trials conducted at Gazipur, Nikli, Habiganj and Tahirpur.

Nine advanced breeding lines were evaluated in RYT at 10 locations in the haor areas along with three standard check varieties, BRRI dhan28, BRRI dhan67 and BRRI dhan89 at cold stress under three sowing intervals (CS1: sowing on 23-25 October, CS2: sowing on 1-5 November and NS: sowing during 15-20 November conditions. (Fig. 6) show that the average temperature during 20 January to 6 February was in between 17.5°C – 19.85°C with maximum daily temperature of 19.6°C-22.9°C and from 7 February to 29 February, the average

temperature was 20.25°C-21.85°C with maximum temperature of 21.6°C-25.2°C. The breeding tested under CS1 condition flowered in between 15 February 2024 to 10 March 2024, which suggests that most of the lines materials experienced severe to moderate level of cold shock during PI to booting stage at Nikli site. At Tahirpur site, from 18 January to 9 February, the average temperature during 20 January to 6 February was in between 15.8°C– 19.15°C with maximum daily temperature of 18.3°C-22.4°C and from 10 February to 27 February, the average temperature ranged between 17.5°C – 22.25°C with maximum daily temperature of 20°C-25°C. The breeding tested under CS condition flowered from 20 February to 10 March, indicates that breeding lines experienced moderate level of cold shock during PI to booting stage at this site. At Habiganj site, from 1<sup>st</sup> February to 13 February, the average temperature prevailed between 19.4°C – 22.35°C with maximum daily temperature of 24.1°C-27.7°C. The breeding lines flowered from 6 March to 26 March, which indicates moderate cold shock during PI stage and slight or no cold stress during booting stage.

Out of 9 genotypes, BR11894-R-R-R-R-152, BR11894-R-R-R-R-59 and BR11894-R-R-R-R-59 showed growth duration similar to BRRI dhan67 and yielded 54.2%, 29.5% and 35.2% higher than BRRI dhan67. Considering plant height, lodging tolerance, spikelet fertility rate and yield under cold stress BR11894-R-R-R-R-59 was selected for further evaluation (Table 8).

From an ALART trial conducted at 10 locations in the haor areas with two breeding lines, one breeding line, BR11894-R-R-R-R-169 has been recommended for evaluation in the proposed variety trial.



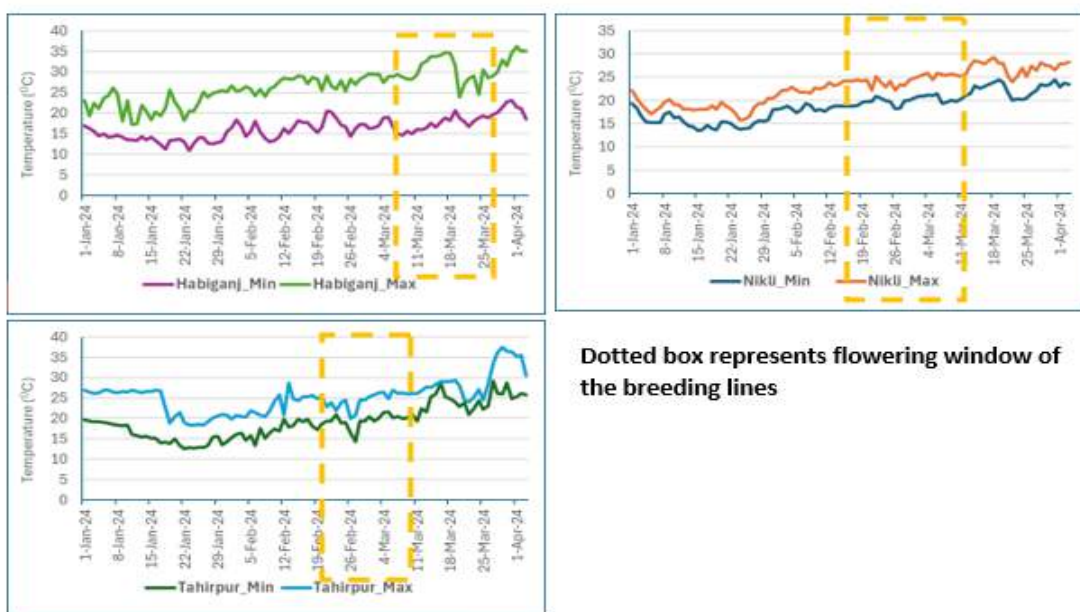


Fig 6. Maximum, minimum, and average temperature at the project sites and the flowering window of the breeding lines tested in RYT during Boro 2023-24.

**Table 8. Yield performance of the advanced breeding lines tested in RYT under three sowing staggers in the haor areas during Boro 2023-24.**

| Designation       | Growth duration (day) |      |      | Plant height (cm) |      |      | Yield (t/ha) |      |      |
|-------------------|-----------------------|------|------|-------------------|------|------|--------------|------|------|
|                   | CS1                   | CS2  | NS   | CS1               | CS2  | NS   | CS1          | CS2  | NS   |
| BR11894-R-R-R-152 | 157                   | 161  | 154  | 102               | 110  | 122  | 3.4          | 4.9  | 5.1  |
| BR11894-R-R-R-59  | 159                   | 163  | 153  | 91                | 100  | 108  | 2.8          | 4.7  | 5.7  |
| BR11894-R-R-R-72  | 156                   | 160  | 156  | 100               | 109  | 119  | 3.0          | 5.1  | 6.1  |
| BR13026-BC1-3R-10 | 162                   | 160  | 152  | 104               | 107  | 119  | 2.3          | 3.9  | 5.3  |
| BR13027-BC1-3R-14 | 155                   | 159  | 153  | 93                | 100  | 111  | 2.4          | 5.3  | 5.8  |
| BRR1 dhan28       | 153                   | 159  | 148  | 80                | 97   | 106  | 1.6          | 3.3  | 4.9  |
| BRR1 dhan67       | 162                   | 162  | 157  | 99                | 103  | 109  | 2.2          | 4.6  | 5.4  |
| BRR1 dhan89       | 165                   | 166  | 159  | 94                | 100  | 106  | 3.3          | 5.3  | 5.6  |
| IR18A1859         | 153                   | 155  | 149  | 77                | 87   | 95   | 2.1          | 2.4  | 4.9  |
| IR19A1473         | 169                   | 170  | 161  | 90                | 98   | 107  | 2.8          | 4.8  | 5.7  |
| IR19A4821         | 160                   | 159  | 153  | 92                | 94   | 103  | 2.7          | 4.0  | 5.4  |
| IR19A5712         | 158                   | 162  | 157  | 89                | 95   | 100  | 2.4          | 3.5  | 5.7  |
| LSD               | 5.5                   | 3.2  | 2.5  | 8.6               | 6.4  | 9.4  | 0.9          | 0.8  | 0.7  |
| H2B (%)           | 92.3                  | 90.1 | 94.6 | 91.5              | 90.9 | 70.3 | 76.5         | 89.8 | 75.1 |

CS1: Mimicked cold stress by sowing seeds on 23-25 October; CS2: Mimicked cold stress by sowing seeds on 5-7 November 2024 and NS: Non-stress by sowing seeds on 15-20 November

**Development of salt tolerant rice (STR).** The objective of this project is to develop high yielding salt tolerant rice cultivars based on product profile. Salinity is one of the major constraints for the rainfed lowland and Boro rice ecosystems in the southern coastal zone of Bangladesh. In T. Aman season, 55 crosses were made using 60 well characterized elite parents with higher genetic merit/breeding values and various alleles of interest. A total of 44 F<sub>1</sub>s were confirmed as true hybrids through hybridity test via F<sub>1</sub> verification by quality check (QC) genotyping with purity SNP panel during T. Aman season. In T. Aman season, 27,186 segregating progenies derived from 115 crosses were advanced from F<sub>2</sub> to F<sub>5</sub> generations using FRGA technique (Fig. 7). Yield trials were carried out in Gazipur, Debhata, Kaliganj and BRRI RS Farm, Satkhira in T. Aman season. In LST, out of 7009 breeding lines derived from 41 crosses, 748 lines were selected on the basis of strong

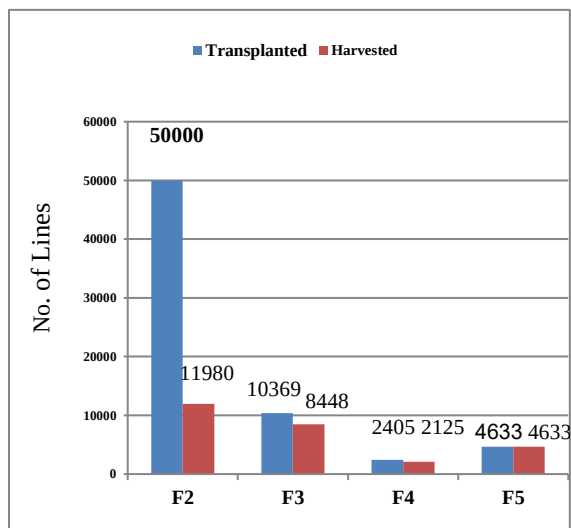


Fig.7. Number of lines of FRGA population, T. Aman 2023-24.

Out of 450 genotypes, 120 genotypes were selected from OYT. Two PYTs (PYT-1 and PYT-2) were conducted using 133 breeding lines following alpha

lattice design. In total 40 genotypes were selected from these trials depending on grain yield, salinity tolerance and phenotypic acceptability.



Fig.8. Field view of salinity tolerant proposed variety (BR11716-4R-102), T Aman, 2023-24.

Out of 106 genotypes, 62 genotypes were selected from AYT-1 and AYT-2. In RYT, out of 28 genotypes, seven entries were selected. In proposed variety trial (PVT), one salinity tolerant advanced line (BR11716-4R-102) was evaluated and the following results were obtained. The proposed genotypes showed yield advantages ranging from

7.17 to 26.53% over the check variety BRRI dhan73 (Table 9). The proposed genotype also showed relatively higher level of salinity tolerance than the check variety BRRI dhan73 and more lodging tolerance in the field whereas the check was lodged as reported in (Fig. 8).

**Table 9. Performance of BR11716-4R-102 in PVT, STR T. Aman 2023**

| Location                 | Yield (kg/ha)                                |                                | Growth duration (day)                        |                                | Yield advantage over check (%) | Remarks                          |
|--------------------------|----------------------------------------------|--------------------------------|----------------------------------------------|--------------------------------|--------------------------------|----------------------------------|
|                          | I-0074<br>(BR11716-4R-102): Proposed variety | I-0073 (BRRI dhan73):<br>Check | I-0074<br>(BR11716-4R-102): Proposed variety | I-0073 (BRRI dhan73):<br>Check |                                |                                  |
| Gazipur                  | 5165                                         | 4082                           | 117                                          | 116                            | 26.53                          | Check Lodging                    |
| Satkhira Farm            | 5986                                         | 4511                           | 118                                          | 119                            | 32.7                           | Check Lodging                    |
| Kaliganj, Satkhira       | 5279                                         | 3383                           | 119                                          | 116                            | 56.04                          | Check Lodging, Salinity affected |
| Dumuria, Khulna          | 4589                                         | 3768                           | 113                                          | 113                            | 21.79                          | Salinity and BPH                 |
| Jashore                  | 3398                                         | 3064                           | 128                                          | 128                            | 10.9                           | Rat, BPH damage                  |
| Patuakhali               | 5163                                         | 3856                           | 122                                          | 119                            | 33.9                           |                                  |
| BRRI Farm                | 4930                                         | 4600                           | 130                                          | 123                            | 7.17                           |                                  |
| Sonagazi, Feni           |                                              |                                |                                              |                                |                                |                                  |
| Sonagazi, Feni (On Farm) | 4773                                         | 4321                           | 118                                          | 115                            | 10.46                          |                                  |
| Companiganj, Noakhali    | 4140                                         | 3691                           | 117                                          | 119                            | 12.164                         | Tide affected                    |
| Gopalganj                | 6126                                         | 5300                           | 118                                          | 115                            | 15.6                           |                                  |
| Mean                     | 5079.5                                       | 4070.5                         | 120                                          | 118                            | 24.79                          |                                  |

\*Source: Seed Certification Agency

In Boro Season, 35 crosses were made using 64 elite parents. A total of 55 F<sub>1</sub>s was confirmed as true hybrid through F<sub>1</sub> verification by quality check (QC) genotyping with purity SNP panel. Total 52553 segregating progenies from 124 crosses (F<sub>2</sub>-F<sub>5</sub> generation) were harvested from FRGA nursery and grown in the subsequent generation. In LST trial, 730 lines out of 3321 lines were selected on the basis of desirable plant type, grain quality and uniformity at flowering under field condition. A total of 146 genotypes selected out of 312 from OYT based on growth duration, grain yield, and homogeneity in different morpho-agronomic traits. Out of 114

genotypes, 31 genotypes were selected from two PYTs. Twenty-four genotypes were selected from two AYT's out of 96 genotypes. Four genotypes were selected from one RYT (Table 10). In ALART (advanced line adaptive research trial), four entries were evaluated and two were selected. One on- farm cum ALART with five entries were evaluated whereas two were selected. (Fig. 9) presents the magnitude of saline level at research field of Kaliganj, Satkhira where the extremities of salinity drives out an absolute unfavourable situation for rice cultivation (EC range: 13.0-20.0 dS/m) during Boro season 2023-24.

**Table 10. Performance of RYT, STR Boro, 2023-24**

| Designation           | PH (cm)    | GD (day)   | Bhanga     | Cum        | Gazi       | Gopal      | Raj        | Rang       | Sat        | Yield (tha <sup>-1</sup> ) |
|-----------------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|----------------------------|
| BR13113-4R-63         | 100        | 151        | 8.5        | 5.2        | 9.1        | 6.6        | 7.8        | 6.9        | 6.1        | 7.2                        |
| <b>BR13125-4R-92</b>  | <b>95</b>  | <b>150</b> | <b>7.4</b> | <b>6.1</b> | <b>9.7</b> | <b>6.2</b> | <b>7.6</b> | <b>6.9</b> | <b>5.2</b> | <b>7.0</b>                 |
| BR131138-4R-76        | 101        | 151        | 8.5        | 6.8        | 8.3        | 7.3        | 7.7        | 6.9        | 5.0        | 7.2                        |
| <b>BR13113-4R-185</b> | <b>95</b>  | <b>153</b> | <b>7.9</b> | <b>7.3</b> | <b>8.9</b> | <b>7.0</b> | <b>8.1</b> | <b>7.1</b> | <b>5.7</b> | <b>7.5</b>                 |
| BR13111-4R-191        | 106        | 158        | 7.8        | 5.9        | 6.2        | 7.1        | 8.3        | 7.3        | 4.4        | 6.7                        |
| BR13106-4R-469        | 112        | 155        | 7.5        | 7.0        | 8.5        | 8.1        | 7.8        | 5.6        | 5.8        | 7.2                        |
| <b>BR13108-4R-232</b> | <b>105</b> | <b>151</b> | <b>7.0</b> | <b>5.7</b> | <b>8.9</b> | <b>7.1</b> | <b>7.9</b> | <b>6.8</b> | <b>5.7</b> | <b>7.0</b>                 |
| BR13106-4R-438        | 104        | 152        | 7.2        | 5.3        | 8.5        | 7.7        | 8.2        | 6.1        | 5.4        | 6.9                        |

| Designation       | PH (cm) | GD (day) | Bhanga | Cum  | Gazi | Gopal | Raj  | Rang | Sat  | Yield (tha <sup>-1</sup> ) |
|-------------------|---------|----------|--------|------|------|-------|------|------|------|----------------------------|
| BR13111-4R-63     | 105     | 152      | 7.5    | 6.9  | 8.5  | 7.4   | 8.2  | 6.3  | 5.7  | 7.2                        |
| BR13106-4R-184    | 94      | 153      | 7.8    | 6.7  | 8.4  | 6.8   | 7.2  | 6.7  | 5.9  | 7.1                        |
| BR13122-4R-136    | 106     | 156      | 8.1    | 7.1  | 9.0  | 5.9   | 8.2  | 6.0  | 5.6  | 7.1                        |
| BR13113-4R-116    | 102     | 150      | 7.5    | 6.6  | 9.1  | 6.4   | 7.6  | 7.4  | 6.2  | 7.3                        |
| BRRRI dhan67 (ck) | 110     | 148      | 7.5    | 5.6  | 7.3  | 6.1   | 7.1  | 6.9  | 6.2  | 6.7                        |
| BRRRI dhan28 (ck) | 103     | 145      | 6.8    | 6.3  | 5.5  | 6.0   | 7.2  | 6.5  | 6.0  | 6.3                        |
| BRRRI dhan88 (ck) | 91      | 146      | 7.0    | 6.6  | 4.1  | 6.7   | 7.2  | 5.9  | 6.1  | 6.2                        |
| LSD (<0.05)       | 5.42    | 3.23     | 0.70   | 0.60 | 0.84 | 0.84  | 0.34 | 0.59 | 0.59 | 0.84                       |
| H <sup>2</sup> b  | 0.90    | 0.88     | 0.83   | 0.91 | 0.60 | 0.56  | 0.63 | 0.87 | 0.86 | 0.43                       |

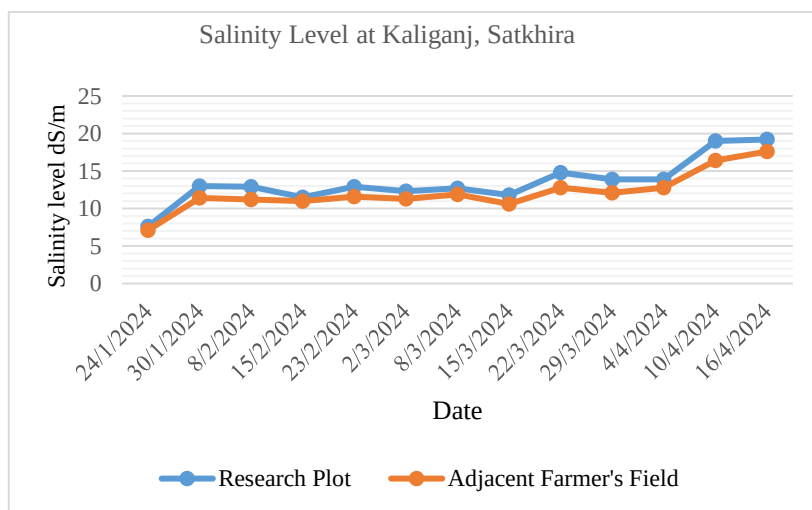


Fig. 9. Salinity level at Kaliganj during Boro season 2023-24.

Most of the trial at Kaliganj was completely damaged immediately after transplanting due to high salinity (EC 13.0-20.0 dS/m) at the seedling stage. Salinity level was the highest 19.2 dS/m recorded at 16<sup>th</sup> April, 2024.

Investigators: M Akhlasur Rahman, Nusrat Jahan and Ribed Farzana Disha

### Development of premium quality rice (PQR)

**T. Aman.** Efforts were made T. Aman to develop aromatic and non-aromatic fine quality rice with national and international standards (Kalizira/Chinigura/Kataribhog/Radhunipagol/Jasmin e type) and photosensitive rice for domestic use and export. In T. Aman 2023-24, a total of 44 crosses (17 single crosses using 18 parents and 14 backcrosses for

PQR and 13 single crosses using nine parents for photosensitive rice) were made. Total 28 crosses (18 for PQR and 10 for photosensitive rice) were confirmed as true hybrids using quality control SNP panel analysis. A total of 36,963 progenies from 120 crosses (20133 progenies of 32 F<sub>2</sub> crosses, 10564 progenies of 43 F<sub>3</sub> crosses, 4,277 progenies of 26 F<sub>4</sub> crosses and 1989 progenies of 19 F<sub>5</sub> crosses) were advanced through RGA under PQR. On the other hand, a total of 14,684 progenies from 48 crosses (10,320 progenies of 23 F<sub>2</sub> crosses, 2,812 progenies from 10 F<sub>3</sub> crosses, 700 progenies from 5 F<sub>4</sub> crosses and 852 progenies from 10 F<sub>5</sub> crosses) were advanced through RGA under photosensitive programme. Under, PQR T. Aman 152 fixed lines were selected from 1,962 fixed lines of 28 crosses from LST based on phenotypic and trait genotyping. A total

of 41 genotypes (24 genotypes out of 90 in OYT#1 and 17 genotypes out of 29 in OYT#2) were selected in OYT based on homogeneity in the population, phenotypic acceptance, plant type, grain type, presence/absence of aroma and yield. On the other hand, eight genotypes out of 21 were selected in OYT of photosensitive breeding programme. From preliminary yield trial (PYT), A total of 4 genotypes were selected out of eight genotypes under PQR breeding programme. In AYT, a total of 14 genotypes were selected (7 out of 14 genotypes in AYT1 and seven out of seven in AYT-special) under PQR programme and seven genotypes were selected out of 21 genotypes under photosensitive rice breeding programme. two genotypes out of 8 were selected from RYT of photosensitive rice breeding programme for next season ALART-photosensitive. In OYT-1 of PQR, the genotype BR13942-5R-53 produced the highest yield (6.97 t/ha) without aroma having BRRI dhan90 type grain quality. In OYT2 of PQR, the genotype BR11811-9-2-2-P2 produced the highest yield (4.60 t/ha) with aroma having BRRI dhan90 type grain quality. In PYT of PQR, the BRRI dhan90 type aromatic genotype BR10812-8-4-3-2-P2 produced the

highest yield of 4.23 t/ha with aroma and 132 days growth duration. Whereas BRRI dhan90 produced 3.89 t/ha grain yield. In AYT (Katary type) under PQR, the genotype BR8845-18-8-45-4-11 having BRRI dhan34 type aromatic grain having stronger plant type produced 5.0 t/ha yield with similar growth duration of BRRI dhan34. Under photosensitive rice programme, the genotypes BR11766-5R-10-2 produced highest grain yield (4.99 t/ha) in OYT. In PYT, the genotype BR8845-21-1-10-3-4 produced significantly higher yield (5.5 t/ha) than the check varieties BR22 (4.1 t/ha) and BR23 (4.8 t/ha) having strong photosensitivity. In RYT-Photosensitive, two advanced genotypes BR10212-17-3-2-2 and BR10212-5-5-3 produced the highest 4.47 t/ha and 4.95 t/ha grain yield whereas BR22 produced 4.27 t/ha grain yield. The heritability obtained for growth duration was ranging from 86% to 92% and grain yield was ranging from 54 % to 82% indicating acceptable level of precision in these experiments (Table 11). Through maintenance breeding, 235 genotypes including 136 aromatic rice landraces were grown as panicle to row method to be maintained as nucleus stock for future use.

**Table 11. RYT materials grown in T. Aman 2023-24; photosensitive rice breeding**

| Designation      | GD (day) | PH (cm) | TN_Ave | Yield (t/ha) |      |      |       |      |       |      |
|------------------|----------|---------|--------|--------------|------|------|-------|------|-------|------|
|                  |          |         |        | Gaz          | Rang | Cum  | Gopal | Sat  | Siraj | Ave  |
| BR10212-17-3-2-2 | 126      | 111     | 10     | 4.33         | 4.05 | 6.21 | 5.10  | 2.40 | 4.05  | 4.37 |
| BR10212-4-3-1    | 125      | 115     | 10     | 5.20         | 4.72 | 6.41 | 3.47  | 3.17 | 3.97  | 4.47 |
| BR10211-30-2-1-4 | 126      | 118     | 10     | 5.63         | 3.63 | 5.12 | 3.13  | 2.53 | 3.29  | 3.90 |
| BR10212-5-5-3    | 125      | 118     | 10     | 4.70         | 5.34 | 5.84 | 3.80  | 2.87 | 5.07  | 4.60 |
| IR13F652-1-P3    | 132      | 111     | 10     | 4.50         | 4.80 | 5.27 | 4.43  | 3.03 | 5.24  | 4.57 |
| IR16F1097-P1     | 131      | 120     | 10     | 6.07         | 3.52 | 6.10 | 3.83  | 2.90 | 3.73  | 4.37 |
| BR11196-5R-5     | 132      | 115     | 10     | 4.03         | 3.97 | 6.06 | 3.53  | 3.07 | 4.66  | 4.23 |
| BR10211-7-5-1    | 125      | 118     | 9      | 5.00         | 4.26 | 5.72 | 3.17  | 3.20 | 4.34  | 4.27 |
| BR22             | 131      | 117     | 10     | 4.20         | 4.68 | 5.11 | 4.03  | 3.27 | 3.33  | 4.10 |
| BR23             | 132      | 117     | 9      | 3.97         | 4.20 | 5.35 | 4.23  | 3.13 | 4.79  | 4.27 |
| H <sup>2</sup> % | 97       | 96      | 70     | 98           | 77   | 91   | 96    | 61   | 65    | 71   |
| LSD              | 1.49     | 1.71    | 0.6    | 0.29         | 0.74 | 0.39 | 0.35  | 0.49 | 1.14  | 0.31 |
| P value          | ***      | ***     | *      | ***          | **   | ***  | ***   | *    | *     | *    |

Investigators: S Maniruzzaman, Sharmistha Ghosal, M M Yasmin and K M Iftekharuddaula.

**Boro.** The project aims to develop of aromatic and non-aromatic fine quality rice with international (Basmati/Banglamati/SoruBalam type) standards in Boro season for domestic use and export quality. Totally 773 F<sub>1</sub> seeds were obtained from 18 crosses.

Forty-four F<sub>1</sub> crosses were confirmed as true hybrid. In total 21,940 progenies of 63 crosses from F<sub>2</sub> to F<sub>4</sub> generations were advanced through RGA method. In total, 370 genotypes were selected from 1,840 progenies of LST trial figures 10 and 11 presents the

selection intensity and trait marker profile of the genotypes of LST. The most of the selected materials from LST contained genes of high amylose and aroma and some of the genotypes had disease and insect tolerant genes. A total of 311 genotypes were evaluated in four OYT in Gazipur, Rajshahi and

Rangpur and among them 44 genotypes were selected to forward in AYT based on the performance. From the three AYT, among the 153 tested genotypes 15 genotypes were selected for RYT. In RYT only two genotypes were selected to forward in ALART.

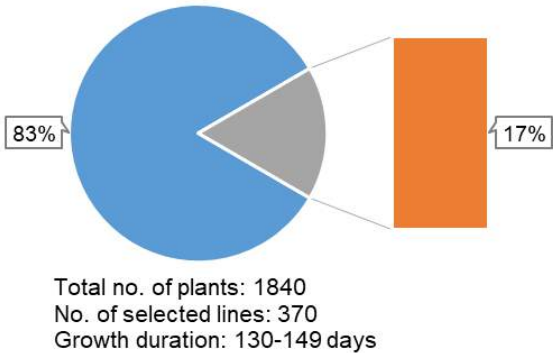


Fig. 10. Selection intensity genotypes of LST, PQR, Boro 2023-24

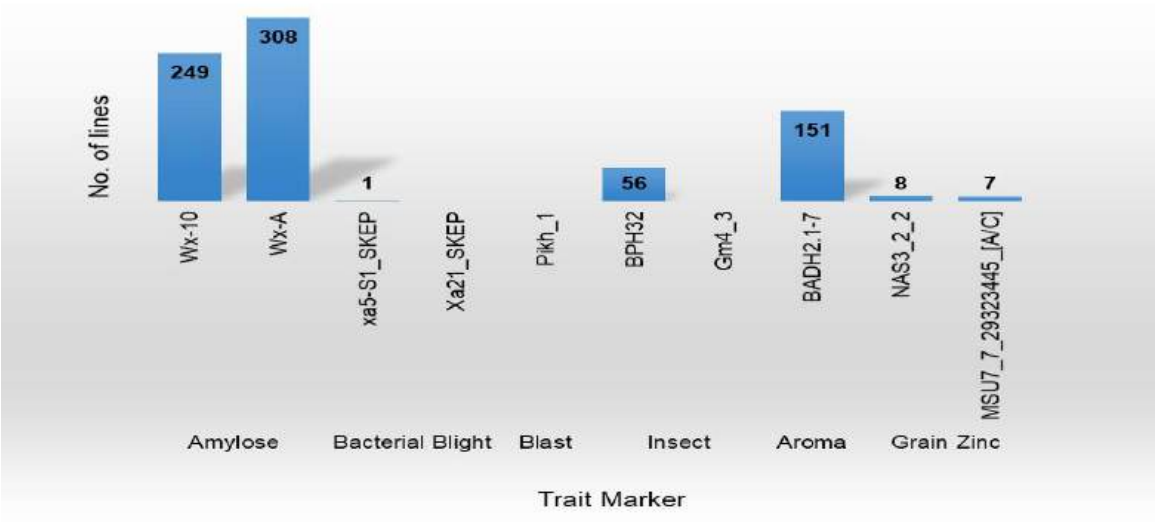


Fig. 11. Trait marker profile of genotypes of LST, PQR, Boro 2023-24.

On-farm evaluation of a new premium quality high protein (10.02%) with high yielding rice variety BRRI dhan107 (Lata Balam) was suitable for Boro season. The yield of BRRI dhan107 was 8.19 t/ha whereas, the average yield of the check variety BRRI dhan50 was 6.99 t/ha (Table 12). BRRI dhan107 produced 17.7% higher yield than the check variety

BRRI dhan50. The size and shape of BRRI dhan107 was extra-long slender white coloured grain. It was recommended to release as BRRI dhan107 for nationwide cultivation at the 111<sup>th</sup> meeting of National Seed Board of Bangladesh (NSB) held on 9 January, 2024.



**Table 12. Grain yield and grain characteristics of BRRI dhan107 (Lata Balam).**

| Designation               | Plant height (cm) | Growth duration (day) * | Grain yield (t/ha) * | Grain characteristics |                             |                              |           |                |                  |             |         |
|---------------------------|-------------------|-------------------------|----------------------|-----------------------|-----------------------------|------------------------------|-----------|----------------|------------------|-------------|---------|
|                           |                   |                         |                      | Head rice yield (%)   | Milled Rice length (L) (mm) | Milled Rice breadth (B) (mm) | L-B ratio | Size and shape | Elongation ratio | Protein (%) | Amy (%) |
| BRRI dhan107 (Lata Balam) | 103               | 143                     | 8.188                | 60.1                  | 7.6                         | 1.8                          | 4.2       | Extra LS       | 1.4              | 10.02       | 29.1    |
| BRRI dhan50 (Ck)          | 81                | 144                     | 6.997                | 59.9                  | 6.6                         | 1.6                          | 4.0       | LS             | 1.2              | 8.2         | 26.8    |

**Field view of BRRI dhan107****Comparative grain picture of BRRI dhan107 with BRRI dhan50**

Investigators: M A Kader, R R Majumder, T K Hore, U R Shaha and M I H Joy

### Development of antioxidant enriched rice variety.

The main objective of the project was to develop anthocyanin enriched value-added rice genotypes with high yield potential for rainfed and irrigated ecosystems in Bangladesh. In T Aman 2023-24, a total of 34 crosses were made using 26 parents and 5,462 F<sub>1</sub> seeds were obtained, and 31 single crosses were selected and confirmed through QC SNP panel analysis. A total of 10,081 progenies were advanced from 41 crosses (5,011 progenies of six F<sub>2</sub> crosses, 8,252 progenies of twenty-three F<sub>3</sub> crosses, 2,038 progenies of eight F<sub>4</sub> crosses and 780 progenies of four F<sub>5</sub> crosses) were advanced through RGA. A total of 44 fixed lines from 291 fixed lines were selected from four crosses of LST. In OYT, 17 genotypes were selected out of 66 in two OYT (OYT1 and OYT2) aromatic and non-aromatic genotypes. A total of 15 genotypes were selected out of 25 in two AYT (AYT1 and AYT2) aromatic and non-aromatic genotypes. A total of six genotypes were selected out of 12 in two RYT (RYT1 and RYT2) aromatic and non-aromatic genotypes. One advanced breeding lines was selected from ALART for PVT. In between two OYTs the

genotype BR12839-4R-138-2 produced the highest yield (5.56 t/ha) with 125 days growth durations whereas standard check BRRI dhan87 produced 5.12 t/ha grain with 126 days growth duration. In AYT, the highest yielder genotype was BR12839-4R-124-2-P1a producing 4.89 t/ha grain yield with 125 days growth duration followed by the genotype BR12837-5R-57 which produced 4.34 t/ha grain yield with 132 days growth duration. In RYT, the highest yielder genotype was BR12836-4R-312 producing 4.12 t/ha grain yield with 123 days growth duration followed by the genotype BR12839-4R-106 which produced 4.76 t/ha grain yield with 131 days growth duration. In ALART, the one genotype BR12836-4R-63 produced 3.1 t/ha grain yield. Based on grain quality and anti-oxidant properties the advanced line BR12836-4R-63 was promoted to PVT (Table 13). In Boro 2023-24, a total of 38 crosses were made using 27 parents and 429 F<sub>1</sub> seeds were obtained, and 28 single crosses among 38 crosses were confirmed and selected through QC SNP panel analysis. panicles of 39,335 progenies from 60 crosses (23,872 progenies of twenty-three

F2 crosses, 5,011 progenies of six F3 crosses, 8,252 progenies of 23 F4 crosses and 2,200 progenies of eight F5 crosses) were advanced through RGA (Table 18.3a and b). Among the advanced 39,335 progenies, panicles of 28,661 progenies from 60 crosses (18,122 progenies of 23 F2 crosses, 2,720 progenies of six F3 crosses, 6,235 progenies of 23 F4 crosses and 1,584 progenies of eight F5 crosses) were harvested for next generation. The harvested panicles were labeled, dried and preserved properly. 153 fixed lines from 1,350 fixed lines were selected from nine crosses of LST based on phenotypic acceptance, uniformity in flowering, plant height, grain size and shape, lodging tolerance and pigmentation and presence higher predicted yield. A total of 23 genotypes were selected out of 45 genotypes in OYT. The highest yield was found in BR13751-5R-50 which gave 6.33 t/ha yields with 135 days growth durations. A total of 9 genotypes were selected out of 23 genotypes in PYT1. The highest yielding genotype BR12839-4R-193

produced 5.98 t/ha yields with duration of 148 days in PYT1. Twelve genotypes were selected out of 18 genotypes based in PYT2. The highest-yielding genotype BR12833-5R-16 produced 6.76 t/ha and growth duration 141 days. Three genotypes were selected out of eight genotypes in AYT1. The genotype BR12838-4R-5a produced the highest yield 6.92 t/ha with a duration of 141 days. The yield range of all-other selected genotypes was 3.34 to 5.5 t/ha. Nine genotypes were selected out of 12 genotypes in AYT2. The genotypes BR12839-4R-93 produced the highest yield of 6.3 t/ha followed by the genotype BR12837-5R-57 having 6.22 t/ha yield. The growth duration of these two genotypes were 117 days and 128 days respectively. These two genotypes were selected for RYT in the next season. The yield range of the other selected genotypes were 4.61 t/ha to 6.18t/ha. The heritability obtained for the plant height, growth duration and yield ranged from 60%-75%, 90%-98% and 50%-77%, respectively, indicating high level of precision in this experiment.

**Table 13. Performance of the proposed variety at different zonal trial i.e., advanced line adaptive research trial (ALART), T. Aman 2023-24.**

| Genotype                          | Location |        |         |          |           |         |          |         |         |         | *Mean |
|-----------------------------------|----------|--------|---------|----------|-----------|---------|----------|---------|---------|---------|-------|
|                                   | Satkhira | Bogura | Cumilla | Sonagazi | Gopalganj | Barisal | Rajshahi | Rangpur | Kushtia | BRR H/Q |       |
| Grain yield (t ha <sup>-1</sup> ) |          |        |         |          |           |         |          |         |         |         |       |
| V1=BR12836-4R-63                  | 3.2      | 3.0    | 3.9     | 3.1      | 3.8       | 1.6     | 3.7      | 3.0     | 3.7     | 1.9     | 3.1   |
| V4=BRRI dhan70 (Ck)               | 4.2      | 3.7    | 3.7     | 3.8      | 5.0       | 3.0     | 3.5      | 2.7     | 3.7     | 2.9     | 3.6   |
| LSD (0.05)                        | 0.69     |        |         |          |           |         |          |         |         |         |       |
| CV                                | 13.24    |        |         |          |           |         |          |         |         |         |       |
| Growth duration (day)             |          |        |         |          |           |         |          |         |         |         |       |
| V1=BR12836-4R-63                  | 134      | 127    | 140     | 140      | 126       | 134     | 139      | 134     | 135     | 123     | 133   |
| V4=BRRI dhan70 (Ck)               | 134      | 120    | 132     | 139      | 130       | 134     | 133      | 129     | 132     | 155     | 134   |
| LSD (0.05)                        | 2.4      |        |         |          |           |         |          |         |         |         |       |
| CV                                | 1.11     |        |         |          |           |         |          |         |         |         |       |
| Plant height (cm)                 |          |        |         |          |           |         |          |         |         |         |       |
| V1=BR12836-4R-63                  | 133      | 106    | 93      | 116      | 109       | 94      | 134      | 130     | 108     | 122     | 115   |
| V4=BRRI dhan70 (Ck)               | 146      | 144    | 117     | 128      | 134       | 122     | 151      | 161     | 135     | 153     | 139   |
| LSD (0.05)                        | 4.69     |        |         |          |           |         |          |         |         |         |       |
| CV                                | 2.33     |        |         |          |           |         |          |         |         |         |       |

\*Mean value of eight locations under stress

Investigators: S Maniruzzaman, Sharmistha Ghosal, M M Yasmin and K M Iftekharuddaula.



**Development of high yielding superior variety (SHR).** In the trial of ALART (zirasail type), the advanced line BRH10-1-14-2-6B was evaluated and

showed 1.47t/ha higher yield than the check variety BRRI dhan81 (5.31 t/ha), which was recommended for PVT (Table 14).

**Table 14. Performance of the proposed lines at advanced line adaptive research trial (ALART), Boro 2022-23.**

| Desig<br>nation  | Growth<br>duration<br>(day) | Plant<br>height<br>(cm) | Grain yield (t ha-1) |      |      |      |      |      |      |      |      |      | Meanyield<br>(t ha-1) |
|------------------|-----------------------------|-------------------------|----------------------|------|------|------|------|------|------|------|------|------|-----------------------|
|                  |                             |                         | Location             |      |      |      |      |      |      |      |      |      |                       |
|                  |                             |                         | L1                   | L2   | L3   | L4   | L5   | L6   | L7   | L8   | L9   | L10  |                       |
| BRH10-1-14-2-6 B | 146                         | 92                      | 5.39                 | 6.57 | 6.38 | 7.63 | 7.43 | 6.03 | 5.66 | 8.01 | 8.01 | 6.67 | 6.78                  |
| BRRI dhan81 (Ck) | 144                         | 92                      | 5.24                 | 4.23 | 5.67 | 6.56 | 7.09 | 1.94 | 3.35 | 5.43 | 6.60 | 6.98 | 5.31                  |
| LSD (0.05)       | 0.26                        | 1.30                    | 0.80                 |      |      |      |      |      |      |      |      |      | 0.25                  |
| CV               | 0.35                        | 2.81                    | 8.02                 |      |      |      |      |      |      |      |      |      |                       |

\*Mean of 10 locations

In PVT (Zira type), the advanced line BRH11-9-11-4-5B was recommended as BRRI dhan108 during Boro 2023-24. The genotype produced 8.52 t/ha which showed 13.18% yield advantage over the check variety Bangabandhu dhan100 (Table 15). Another advanced line BR10260-5-15-21-6B was recommended as BRRI dhan111 during shallow flooded condition 2023-24 in 10 locations. The

genotype produced 4.20 t/ha which showed 32.2% yield advantage over the check variety BRRI dhan91 (Table 16). In T. Aman2023-24, the advanced line BRH13-2-4-7-2B was recommended as BRRI dhan116. The genotype produced 5.30 t/ha, which showed 17.8% yield advantage over the check variety BRRI dhan57 (Table 17).

**Table 15. Performance of proposed variety BRH11-9-11-4-5B (BRRI dhan108) in proposed variety trial (PVT) at ten locations, Boro, 2022-23.**

| Location           | BRH11-9-11-4-5B (Proposed variety) |                    | Bangabandhu dhan100 (Check variety) |              | % yield increase over check |
|--------------------|------------------------------------|--------------------|-------------------------------------|--------------|-----------------------------|
|                    | Duration (day)                     | Grain yield (t/ha) | Duration (day)                      | Yield (t/ha) |                             |
| BRRI,Gazipur       | 150                                | 7.93               | 144                                 | 6.71         | 18.18%                      |
| BINA, Mymensingh   | 146                                | 6.43               | 144                                 | 8.23         | -21.87%                     |
| BRRI,Faridpur      | 155                                | 9.38               | 144                                 | 8.28         | 13.29%                      |
| Sadar Jashore      | 149                                | 10.17              | 145                                 | 8.08         | 25.87%                      |
| Sadar Feni         | 143                                | 8.82               | 142                                 | 7.64         | 15.45%                      |
| Laksham,Cumilla    | 139                                | 8.06               | 134                                 | 6.54         | 23.24%                      |
| Bogura Sadar       | 148                                | 8.08               | 143                                 | 7.44         | 8.60%                       |
| Babuganj, Barishal | 129                                | 7.84               | 129                                 | 6.87         | 14.12%                      |
| BRRI,Rangpur       | 152                                | 9.87               | 145                                 | 8.80         | 12.16%                      |
| Sadar, Dinajpur    | 145                                | 8.63               | 145                                 | 7.03         | 22.76%                      |
| Average            | 146                                | 8.52               | 142                                 | 7.56         | 13.18%                      |

**Table 16. Performance of the BR10260-5-15-21-6B (BRRI dhan111) line at proposed variety trial (PVT) under shallow flooded condition, T. Aman 2023-24.**

| Location            | BR10260-5-15-21-6B<br>(Proposed variety) |                       | BRRI dhan91<br>(Check variety) |                       | % yield<br>increase<br>over<br>check |
|---------------------|------------------------------------------|-----------------------|--------------------------------|-----------------------|--------------------------------------|
|                     | Growth<br>duration (day)                 | Grain yield<br>(t/ha) | Growth<br>duration (day)       | Grain yield<br>(t/ha) |                                      |
| BRRI, Gopalganj     | 162                                      | 4.05                  | 154                            | 2.81                  | 44.13%                               |
| Sylhet              | 150                                      | 4.57                  | 150                            | 3.49                  | 30.95%                               |
| BRRI, Satkhira      | 144                                      | 3.82                  | 147                            | 2.45                  | 55.92%                               |
| Khulna              | 129                                      | 4.00                  | 136                            | 3.28                  | 21.95%                               |
| Sadar, Bagerhat     | 145                                      | 3.97                  | 147                            | 3.05                  | 30.16%                               |
| BRRI, Sonagazi      | 154                                      | 4.05                  | 156                            | 2.57                  | 36.54%                               |
| BRRI, Barishal      | 142                                      | 4.32                  | 147                            | 3.17                  | 36.28%                               |
| Bakerganj, Barishal | 144                                      | 4.24                  | 154                            | 3.52                  | 20.45%                               |
| Patuakhali          | 135                                      | 5.30                  | 141                            | 4.31                  | 22.97%                               |
| Jhalakathi          | 152                                      | 4.05                  | 158                            | 3.25                  | 24.62%                               |
| Average             | 146                                      | 4.20                  | 149.0                          | 3.20                  | 32.4%                                |

**Table 17. Performance of the BRH13-2-4-7-2B (BRRI dhan116) line at proposed variety trial (PVT), T. Aman 2023-24.**

| Location       | BRH13-2-4-7-2B<br>(Proposed variety) |                       | BRRI dhan57<br>(Check variety) |                 | % yield<br>increase over<br>check |
|----------------|--------------------------------------|-----------------------|--------------------------------|-----------------|-----------------------------------|
|                | Duration<br>(day)                    | Grain yield<br>(t/ha) | Duration<br>(day)              | Yield<br>(t/ha) |                                   |
| BRRI, Gazipur  | 117                                  | 5.67                  | 109                            | 4.04            | 40.35%                            |
| BINA           | 117                                  | 5.85                  | 108                            | 5.14            | 13.79%                            |
| BRRI, Faridpur | 121                                  | 5.94                  | 108                            | 5.37            | 10.61%                            |
| Sadar, Jashore | 111                                  | 5.72                  | 107                            | 4.35            | 31.49%                            |
| Sadar, Feni    | 118                                  | 5.15                  | 120                            | 4.57            | 12.69%                            |
| Laksham        | 108                                  | 4.92                  | 107                            | 4.32            | 13.89%                            |
| Bogura Sadar   | 114                                  | 5.27                  | 114                            | 4.79            | 10.02%                            |
| Rajshahi       | 115                                  | 4.12                  | 115                            | 3.12            | 32.05%                            |
| BRRI, Rangpur  | 108                                  | 5.94                  | 107                            | 5.15            | 15.34%                            |
| Sadar Dinajpur | 113                                  | 4.76                  | 113                            | 4.87            | -2.26%                            |
| Average        | 113.7                                | 5.30                  | 110.8                          | 4.60            | 17.8%                             |

Investigators: A S M Masuduzzaman, S Maniruzzaman and Afroza Awal Shoily

**Development of disease resistant rice.** Efforts were made for developing varieties resistant to bacterial blight (BB), rice tungro virus (RTV) and blast diseases. The experiments were conducted in both T. Aman and Boro seasons. Thirty-one crosses for BB and blast in T. Aman and 36 crosses for BB, blast, tungro, sheath blight, false smut and bakanae were

made in Boro season. Thirty-one crosses for BB and blast in T. Aman and 47 for BB, blast, tungro, false smut and bakanae were confirmed in Boro season as true F<sub>1</sub>. A total of 72,650 progenies for BB and 11,700 progenies for blast were advanced from F<sub>2-6</sub> generation through green-house RGA and FRGA. Five hundred seventeen uniform lines were isolated

from 5,400 LST lines in T. Aman and 1,040 out of 6,654 lines were identified from LST in Boro season based on uniformity in heading, plant height, and grain type. Twenty genotypes were selected from observational yield trial (OYT) in T. Aman season whereas 20 entries out of 384 for BB during Boro season showed better yield potential and agronomic performance over the check varieties and tolerance to BB. From AYT, three advanced lines were promoted based on growth duration, grain yield, and BB score compared to the check varieties in T. Aman season and 12 genotypes out of 43 from AYT#1 and nine genotypes out of 48 from AYT#2 for BB were selected in Boro season. In the regional yield trial (RYT), two genotypes from RYT for BB and two genotypes from RYT for false smut were selected in T. Aman season and three genotypes for Boro performed better in yield, growth duration, BB resistance, and better grain

quality characters but yield was not >10% higher than the check varieties. Therefore, the high-yielding background BB-resistant promising lines will be used as a genetic resource to develop high-yielding disease-resistant varieties. Blast resistant genotypes, which were developed by the scientist of Plant Pathology Division, were evaluated in ALART. Considering bacterial blight (BB) resistance, one genotype BR (Path)13784-BC3-63-6-4-HR6 was recommended as short duration variety BRRI dhan112 comparing the check variety BRRI dhan88 (Table 18) and other genotypes BR12452 (Path)-BC6-53-21-11 and BR12454 (Path)-BC2-69-97-39-5-44 were recommended as blast resistance short duration variety BRRI dhan117 and long duration variety BRRI dhan115 comparing the check varieties BRRI dhan88 and BRRI dhan89 respectively (Table 19 and Table 20).

**Table 18. Performance of proposed variety BR(Path)13784-BC3-63-6-4-HR6 in proposed variety trial (PVT) at ten locations, Boro 2023-24.**

| Location         | BR(Path)13784-BC3-63-6-4-HR6<br>(Proposed variety) |                       | BRRI dhan88<br>(Check variety) |                 | % yield<br>increase<br>over check |
|------------------|----------------------------------------------------|-----------------------|--------------------------------|-----------------|-----------------------------------|
|                  | Duration<br>(day)                                  | Grain yield<br>(t/ha) | Duration<br>(day)              | Yield<br>(t/ha) |                                   |
| BRRI, Gazipur    | 129                                                | 6.96                  | 132                            | 6.72            | 3.57                              |
| BINA, Mymensingh | 137                                                | 7.04                  | 139                            | 6.67            | 5.55                              |
| BRRI, Faridpur   | 147                                                | 7.39                  | 149                            | 6.95            | 6.33                              |
| Sadar Jashore    | 128                                                | 6.86                  | 128                            | 7.35            | -6.67                             |
| Sadar Feni       | 133                                                | 9.14                  | 133                            | 8.19            | 11.60                             |
| Laksham, Cumilla | 124                                                | 6.22                  | 124                            | 6.34            | -1.89                             |
| Bogura Sadar     | 129                                                | 7.57                  | 129                            | 6.95            | 8.92                              |
| Rajshahi Sadar   | 131                                                | 7.88                  | 131                            | 6.61            | 19.21                             |
| BRRI, Rangpur    | 148                                                | 9.81                  | 150                            | 8.83            | 11.10                             |
| Sadar, Dinajpur  | 140                                                | 7.54                  | 147                            | 8.08            | -6.68                             |
| Average          | 135                                                | 7.64                  | 136                            | 7.27            | 5.10                              |

**Table 19. Performance of the proposed varieties BR12452 (Path)-BC6-53-21-11 in proposed variety trial (PVT) at ten locations, Boro 2023-24.**

| Location         | BR12452 (Path)-BC6-53-21-11<br>(Proposed variety) |                 | BRRI dhan88<br>(Check variety) |                 |
|------------------|---------------------------------------------------|-----------------|--------------------------------|-----------------|
|                  | Duration<br>(day)                                 | Yield<br>(t/ha) | Duration<br>(day)              | Yield<br>(t/ha) |
| BRRI, Gazipur    | 135                                               | 7.57            | 135                            | 7.30            |
| BINA, Mymensingh | 137                                               | 5.60            | 137                            | 6.58            |
| BRRI, Faridpur   | 154                                               | 7.42            | 154                            | 7.41            |

| Location         | BR12452 (Path)-BC6-53-21-11<br>(Proposed variety) |                 | BRRI dhan88<br>(Check variety) |                 |
|------------------|---------------------------------------------------|-----------------|--------------------------------|-----------------|
|                  | Duration<br>(day)                                 | Yield<br>(t/ha) | Duration<br>(day)              | Yield<br>(t/ha) |
| Sadar Jashore    | 139                                               | 7.07            | 139                            | 6.72            |
| Sadar Feni       | 136                                               | 7.56            | 136                            | 7.31            |
| Laksham, Cumilla | 127                                               | 6.15            | 127                            | 5.98            |
| Bogura Sadar     | 130                                               | 6.95            | 130                            | 7.88            |
| Rajshahi Sadar   | 134                                               | 7.09            | 132                            | 6.64            |
| BRRI, Rangpur    | 154                                               | 7.95            | 152                            | 8.07            |
| Sadar, Dinajpur  | 142                                               | 7.43            | 142                            | 8.53            |
| Average          | 138                                               | 7.08            | 138                            | 7.21            |

**Table 20. Performance of the proposed variety BR12454(Path)-BC2-69-97-39-5-44 in proposed variety trial (PVT) at ten locations, Boro 2023-24.**

| Location         | BR12454(Path)-BC2-69-97-39-5-44<br>(Proposed variety) |                       | BRRI dhan89<br>(Check variety) |                 |
|------------------|-------------------------------------------------------|-----------------------|--------------------------------|-----------------|
|                  | Duration<br>(day)                                     | Grain yield<br>(t/ha) | Duration<br>(day)              | Yield<br>(t/ha) |
| BRRI, Gazipur    | 148                                                   | 6.73                  | 147                            | 7.06            |
| BINA, Mymensingh | 149                                                   | 7.91                  | 147                            | 7.85            |
| BRRI, Faridpur   | 165                                                   | 7.35                  | 165                            | 7.14            |
| Sadar Jashore    | 147                                                   | 8.39                  | 148                            | 8.07            |
| Sadar Feni       | 144                                                   | 10.23                 | 145                            | 9.16            |
| Laksham, Cumilla | 134                                                   | 6.07                  | 135                            | 5.79            |
| Bogura Sadar     | 139                                                   | 7.49                  | 139                            | 8.19            |
| Paba, Rajshahi   | 147                                                   | 6.42                  | 151                            | 7.14            |
| BRRI, Rangpur    | 165                                                   | 8.98                  | 161                            | 8.09            |
| Sadar, Dinajpur  | 149                                                   | 7.99                  | 150                            | 8.28            |
| Average          | 149                                                   | 7.76                  | 149                            | 7.69            |

Investigators: M Khatun, S K Debsharma, J Ferdousy, N Tamanna, T H Ansari and M A Latif

**Development of insect resistant rice:** The main thrust of the project was to develop varieties resistant to gall midge (GM), brown plant hopper (BPH) and white backed plant hopper (WBPH). The experiments were conducted in both T. Aman and Boro seasons. In T. Aman season, 18 crosses for forward breeding, six crosses for pre breeding, two F<sub>1</sub> and three BC<sub>1</sub>F<sub>2</sub> crosses for line augmentation and three back crosses were made, and 27 crosses were confirmed as true hybrids using quality check (QC) genotyping with purity SNP panel. In total 25,149 segregating progenies from 109 crosses of F<sub>2</sub>-F<sub>5</sub> generations were advanced through field rapid

generation advanced (FRGA) technique. Out of 2,886 F<sub>5:6</sub> LST lines derived from 18 different crosses, 387 genotypes were selected based on strong plant architecture, grain type and uniformity in heading under field condition as well as the presence of the favourable alleles of key target genes for BPH (*bph9*, *bph17\_1*, *bph17\_2*, *bph17\_3* and *bph32*), Gm (*Gm4\_3* and *Gm4\_4*) and grain quality (*Wx-A* and *Wx-10*). The yield trials (OYT, PYT and AYT) were conducted at three locations of BRRI, Gazipur, Cumilla and Rangpur. Eighty-one genotypes were selected from 276 breeding lines in OYT. Fourteen genotypes were selected from 49

genotypes in PYT. Eleven genotypes were selected from 36 lines in AYT. In Boro season, 19 crosses for forward breeding, two crosses for pre-breeding and three F<sub>1</sub> crosses for line augmentation were made, and 21 crosses were confirmed as true hybrids through F<sub>1</sub> verification using quality check (QC) genotyping with purity SNP panel. A total of 34,023 individual plants were advanced from 97 crosses in F<sub>2</sub>-F<sub>5</sub> generations by FRGA technique. In LST, 324 lines having strong plant architecture, grain quality, uniformity in heading under field condition were selected from 3,816 F<sub>5:6</sub> breeding lines that are the descendants of 21 crosses. Eighty-three genotypes, out of 348 were selected from OYT#1 that tested in three locations of BRRI, Gazipur, Cumilla and Rangpur. In OYT#2, 97 genotypes were selected from 443 genotypes at BRRI, Bhnaga. Thirty lines were selected from 84 lines in PYT. Out of 45 genotypes, 12 were selected from AYT for further evaluation. Total 65 parental lines were maintained in insect resistant maintenance breeding programme.

Investigators: Md. Ruhul Amin Sarker, Hasina Khatun, Nusrat Jahan, Ribed Farzana Disha and M Akhlasur Rahman

**Development of submergence and water stagnation tolerant rice varieties.** The project aims for the development of high yielding rice varieties tolerant to submergence (flash flooding) and medium stagnant water (MSW) stresses. Totally 44 single crosses were made and 1,737 F<sub>1</sub> seeds were produced. Thirty-seven single crosses were confirmed and selected through QC SNP panel analysis. A total of 17,376 progenies from 78 crosses (4,524 from 10 F<sub>2</sub> crosses, 6,472 from 34 F<sub>3</sub>, 2,152 from 27 F<sub>4</sub> progenies and 4,796 from nine F<sub>5</sub> progenies) were harvested at the time of maturity, processed with proper labels and preserved. The ranges of mortality percentage of different RGA generations were around 18%. From LST population, 2,287 lines from 28 crosses were genotyped with trait markers using custom SNP panel among which 246 lines were selected based on uniformity and traits markers like *Sub1*, *Wx-A group*,

*Wx-A\_NB*, *xa13*, *Xa21* etc. In yield trial, 447 genotypes were tested out of which 182 genotypes were selected based on phenotypic acceptance, growth duration, survivability and higher yield performance. From OYT, 25 genotypes out of 44 from PYT1, 16 genotypes out of 32 from PYT2, 12 genotypes out of 27 from AYT\_Early, 18 genotypes out of 26 from AYT\_Late, 17 genotypes out of 30 from AYT\_Special, four genotypes out of eight from PVS, three genotypes out of eight were selected. One line was evaluated in PVT\_Submergence and the line performed better over the check, one line was evaluated in PVT\_Tidal Submergence and the line performed better over the check. In OYT, the genotype BR12920-5R-4 with 92% survivability produced the highest yield of 7.01 t/ha under stress condition and on average yielded 6.21 t/ha followed by the genotype BR12504-5R-158 produced 6.81 t/ha under controlled stress and on average 5.65 t/ha with 92% survivability. In PYT1, the genotype BR12506-5R-83 produced the highest yield (5.8 t/ha) under control condition where four checks BRRI dhan79 and BRRI dhan95, BINA dhan11 and IR16F1148 yielded lower than stress condition. In PYT2, the genotype SV1586 produced the highest yield (5.7 t/ha) under control condition where three checks BRRI dhan79 and BRRI dhan95, BINA dhan11 yielded lower than stress condition. In AYT\_Early genotype IR15A4029 produced the highest yield of 6.17 t/ha followed by IR13F582 (5.24 t/ha) and BR12162-5R-350-3 (5.15 t/ha) under controlled stress condition. In AYT\_Late, the genotype IR16F1201 produced the highest yield of 6.41 t/ha with 81% survivability in control stress condition followed by the genotype BR9793-13-2-1 (5.35 t/ha) with 80% survivability. In PVS, the genotype IR15F1886 produced significantly higher yield (5.29 t/ha) over both the checks BRRI dhan79 (4.13 t/ha) and BINA dhan11 (2.51 t/ha) with similar growth duration. In PVT\_submergence, the genotype

IR16F1148 yielded 5.29 t/ha, which was 20.50% higher than the check variety BINA dhan11 (4.39 t/ha) (Table 21). In PVT\_tidal submergence, the genotype BR9158-19-9-6-50-2-HR1 yielded 5.49 t/ha, which was 21% higher than the check variety BRRI dhan44 (4.52 t/ha) (Table 22). The heritability obtained for grain yield under stress of all trials conducted was ranging from 44 % to 95%, whereas that for non-stress trials was ranging from 38 % to

83%, indicating acceptable level of precision in these experiments. Through maintenance breeding, 190 genotypes including submergence tolerant land races were grown as panicle to row method to be maintained as nucleus stock for future use.

Investigators: S Maniruzzaman, Sharmistha Ghosal, A Rahman, R Hassan and K M Iftekharuddaula.

**Table 21. Performance of the genotype IR13F1148 in PVT (proposed variety trial) in ten locations to be released as a short duration submergence tolerant variety, submergence and water stagnation tolerant rice, T. Aman 2023-24.**

| Trial Location        | Yield(t/ha) |                  | % Yield advantage | Water depth (cm) | Remark                          |
|-----------------------|-------------|------------------|-------------------|------------------|---------------------------------|
|                       | IR16F1148   | Bina dhan11 (Ck) |                   |                  |                                 |
| BRRI, Gazipur-1       | 6.61        | 5.63             | 17.41             | -                | Rainfed/ non stress             |
| BRRI, Gazipur-2       | 5.02        | 3.74             | 34.22             | 110              | Controlled submergence, 16 days |
| Dewanganj, Jamalpur   | 5.87        | 5.31             | 10.55             | 145              | 26 days flood                   |
| Sadar, Sylhet         | 3.95        | 2.82             | 40.07             | -                | No flood                        |
| Ullapara, Sirajganj   | 5.41        | 4.65             | 16.34             | 70               | 15 days flood                   |
| BRRI-Rangpur-1        | 5.89        | 5.11             | 15.26             | -                | Rainfed/ non stress             |
| BRRI-Rangpur-2        | 4.5         | 4.02             | 11.94             | 100              | Controlled submergence, 15 days |
| Kamarjani, Gaibandha  | 5.1         | 3.9              | 30.77             | 125              | 21 days flood                   |
| Jattarapur, Kurigram  | -           | -                | -                 | 147              | Damaged due to 31 days flood    |
| Mogalhat, Lalmonirhat | -           | -                | -                 | 157              | Damaged due to 45 days flood    |
| Mean                  | 5.29        | 4.39             | 20.5              | -                | -                               |

**Table 22. Performance of the genotype BR9158-19-9-6-50-2-HR1 in PVT (proposed variety trial) in ten locations to be released as a tidal submergence tolerant variety Rice, T. Aman 2023-24.**

| Trial Location   | Yield(t/ha)            |                  | % Yield advantage | Remarks            |
|------------------|------------------------|------------------|-------------------|--------------------|
|                  | BR9158-19-9-6-50-2-HR1 | BRRI dhan44 (CK) |                   |                    |
| BRRI-Gazipur     | 6.32                   | 5.49             | 15                | Rainfed/non-stress |
| Sadar, Gopalganj | 4.56                   | 4.03             | 13                | Tidal ecosystem    |
| BRRI-Gopalganj   | 5.29                   | 4.01             | 32                | Rainfed/non-stress |
| BRRI-Sonagazi    | 4.36                   | 3.94             | 11                | Tidal ecosystem    |
| BRRI-Barishal    | 6.5                    | 5.07             | 28                | Tidal ecosystem    |

| Trial Location     | Yield(t/ha)            |                  | % Yield advantage | Remarks         |
|--------------------|------------------------|------------------|-------------------|-----------------|
|                    | BR9158-19-9-6-50-2-HR1 | BRRI dhan44 (CK) |                   |                 |
| Sadar, Barishal    | 6.19                   | 5.17             | 20                | Tidal ecosystem |
| Sadar, Patuakhali  | 5.4                    | 4.1              | 32                | Tidal ecosystem |
| Sadar, Barguna     | 5.9                    | 5.15             | 15                | Tidal ecosystem |
| Nolcity, Jhalokati | 4.08                   | 3.13             | 30                | Tidal ecosystem |
| Kawkhali, Pirojpur | 6.33                   | 5.2              | 22                | Tidal ecosystem |
| Mean               | 5.49                   | 4.52             | 21                | -               |

**Development of drought tolerant rice (DTR).** The project aims to develop high yielding drought tolerant rice varieties under rainfed lowland rice ecosystem in the T. Aman season. In T. Aman 2023-24, a total of 3,908 F<sub>1</sub> seeds were obtained from 25 crosses using 25 parents and 25 crosses were confirmed as true hybrids using 10-SNP *indica* QC panel. A total of 9,314 individual progenies from 33 crosses from F<sub>3</sub> and F<sub>5</sub> generation were harvested through RGA. The materials were advanced in the Boro 2023-24 season and 4,930 progenies of 14 crosses from F<sub>4</sub> generations were harvested through RGA method. A total of 292 genotypes were evaluated in two OYT<sub>s</sub> in Gazipur, Rajshahi and Rangpur. Among the tested genotypes 43 genotypes were selected and

forwarded in AYT. In AYT, 67 genotypes were evaluated in two trials in Gazipur, Rajshahi and Rangpur and 12 genotypes were found promising and advanced in RYT. During the flowering stage drought stress was observed in Rajshahi (Fig. 12) with moderate drought in Gazipur (Fig. 13) of OYT and AYT. In Rangpur there was not much drought observed. One genotype was forwarded from RYT to ALART due to its grain yield and drought tolerance ability. Genetic trend of the genotypes from 2019 to 2023 showed the pBLUP (grain yield) in respect of trial year an annual 94.49 kg/ha equivalent to about 2.43% increase in grain yield per year based on yield of 2019.

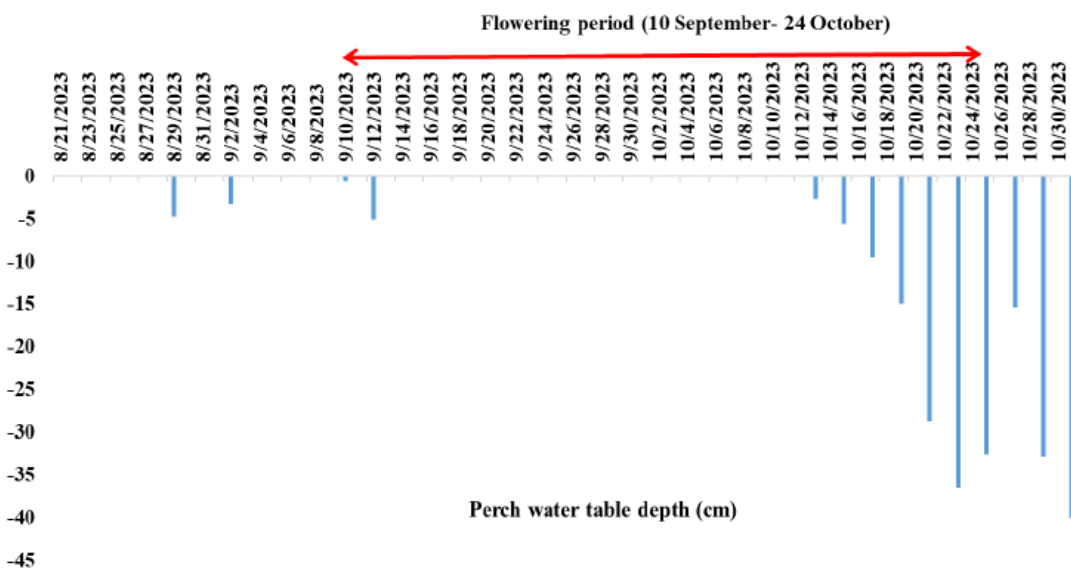


Fig. 12. Perch water table depth in the experimental field of Rajshahi, T. Aman 2023-24.

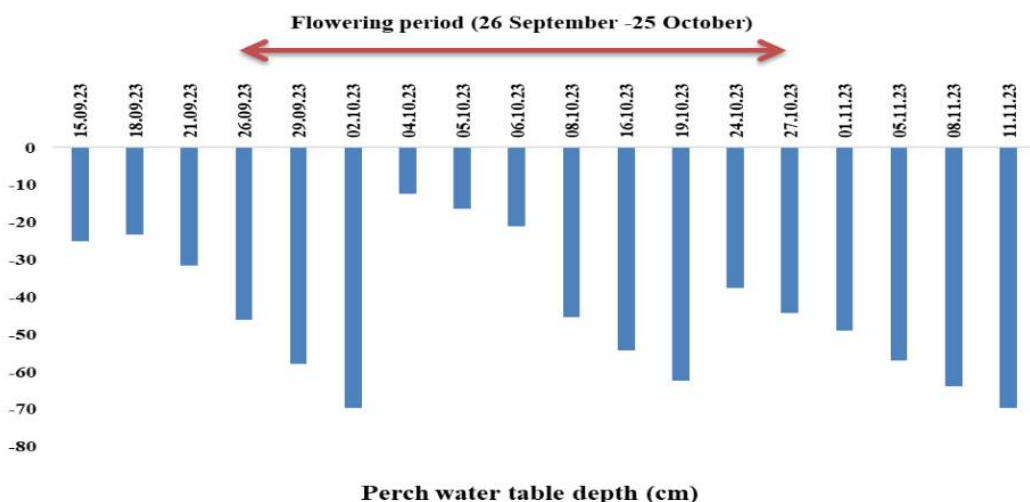


Fig. 13. Perch water table depth in the experimental field of Gazipur, T. Aman 2023-24

Investigators: M A Kader, R R Majumder, T K Hore, U R Shaha and M I H Joy

**Development of water saving and aerobic rice varieties.** The objective of the project was to develop short duration water-use-efficient rice genotypes with 10% more yield than the check varieties under transplanted alternate wetting and drying (AWD) and aerobic conditions. A total of 35 crosses were made using 35 parents and 2,350 F<sub>1</sub> seeds were obtained, and 14 single crosses were selected and confirmed through QC SNP panel analysis. A total of 8,037 individual panicles were selected from 30 crosses (4,430 of 13 crosses from F<sub>2</sub>, 3,315 of 13 crosses from F<sub>3</sub> and 292 of four crosses from F<sub>5</sub>) were harvested through RGA. From yield trial, 37 genotypes were selected out of 143 genotypes. In OYT, 12 genotypes were selected from 63 genotypes. From PYT, 25 genotypes were selected out of 80 genotypes. In OYT, among all selected genotypes the line IR 126999-B-32-2-1-3 produced the highest yield (7.0 t/ha). In PYT#1 the genotype IR16T1009, significantly produced the highest yield (6.7 t/ha) over the check variety BRRI dhan88 (5.6 t/ha). In PYT#2, the genotype BR11690-5R-98-P1 significantly produced the highest yield (7.8 t/ha) over the check variety BRRI dhan88 (6.9 t/ha) and BRRI dhan100 (6.4 t/ha). In

RYT, none of the tested genotypes were selected, both the tested entry BR11206-5B-351 and BR11204-5B-224 produced similar yield (6.6 t/ha) with the check variety BRRI dhan58 (6.8 t/ha). The heritability obtained for growth duration and grain yield of all the trials conducted was ranging from 85 % to 95%, and 44 % to 85% respectively indicating acceptable level of precision in these experiments.

Investigator: Sharmistha Ghosal, S Maniruzzaman, Z A Riyadh and K M Iftekharuddaula.

### Development of zinc enriched rice (ZER)

The project aims to develop high yielding rice varieties with improved nutritional quality with high zinc ( $Zn \geq 24$  mg/kg) in polished grain. The project also prioritizes development of stress tolerant zinc enriched rice varieties in a combination of submergence and zinc, drought and zinc, salinity and zinc along with cold and zinc enriched rice with improved grain yield. The experiments were conducted in both T. Aman and Boro seasons. In T. Aman, 19 single crosses were made that produced 4,437 seeds. A total of 16 crosses were selected and confirmed as true F<sub>1</sub>s. In RGA method, 29,463 segregating progenies were harvested from F<sub>2</sub> to F<sub>5</sub>



generations of 121 crosses. A total of 363 uniform lines out of 6,207 were harvested based on visual observation on homogeneity in flowering, plant height and grain size and shape. (Fig. 14 and 15) present the selection intensity and trait marker profile of the LST genotypes. Most of the selected materials from LST contained genes/QTLs of high

amylose, high zinc content and drought tolerance. From the OYT, 56 genotypes were selected from 220 genotypes. Seven genotypes were selected out of 15 from the PYT based on yield performances. Only two promising genotypes were selected out of eight from the SYT. None of the entries were recommended for promoting from RYT.

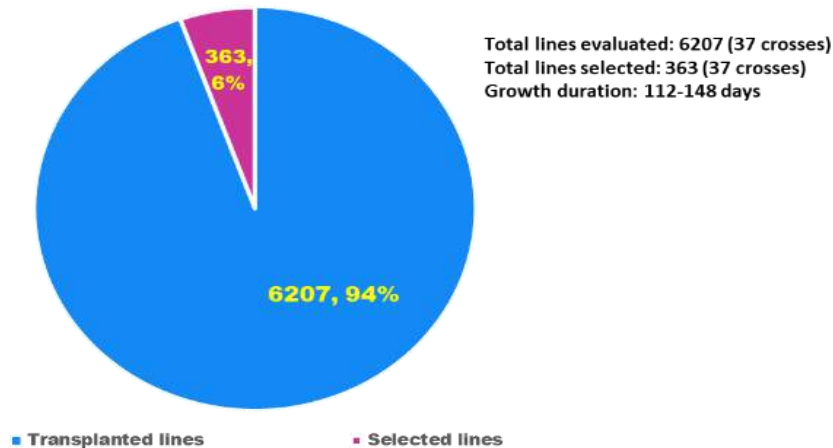


Fig. 14. Selection intensity genotypes of LST, ZER, T. Aman 2023-24

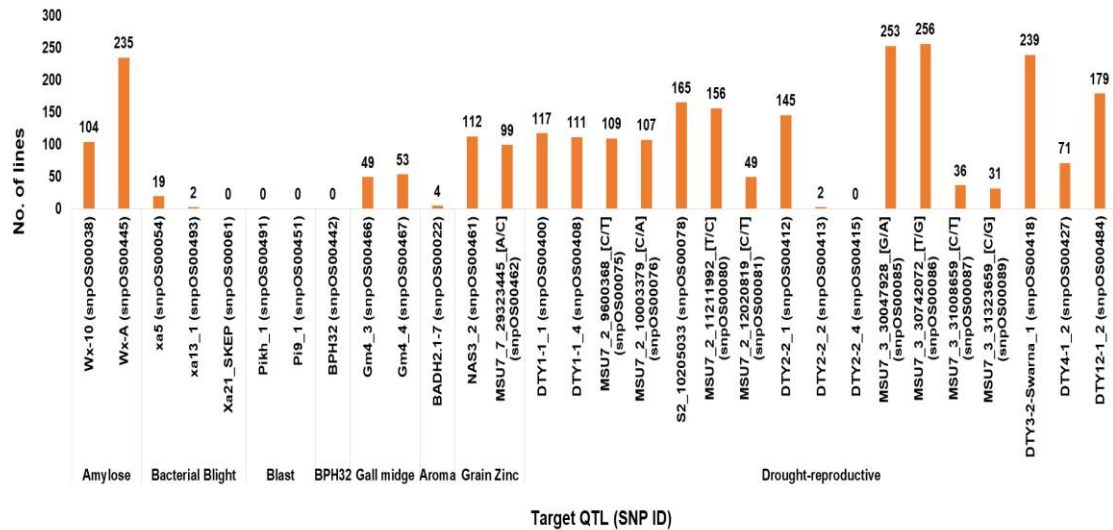


Fig. 15. Trait marker profile of genotypes of LST, ZER, T. Aman 2023-24.

In Boro 2023-24 season, 25 single crosses were made that produced 1,718 seeds. Fourteen crosses were selected and confirmed as true F<sub>1</sub>s. In RGA method, 48,729 segregating progenies were harvested from F<sub>2</sub> to F<sub>5</sub> generations from 156 crosses. From LST, a total of 532 uniform lines out of 6,530 were harvested based on visual observation on homogeneity in flowering, plant height and grain size and shape. (Fig. 16 and 17) present the selection

intensity and trait marker profile of the genotypes of LST in. Most of the selected materials from LST contained genes of high amylose, high zinc content, and some lines contained genes of aroma and few lines had insect resistance genes. From the OYT, 50 genotypes were selected from 471 genotypes. Only three genotypes were selected out of 11 genotypes from the SYT. None of the entries were recommended for promoting from RYT.

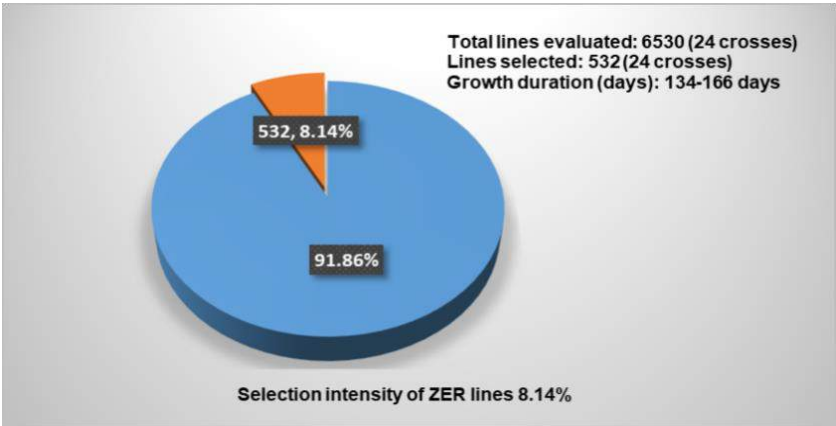


Fig. 16: Selection intensity genotypes of LST, ZER, T. Aman 2023-24.

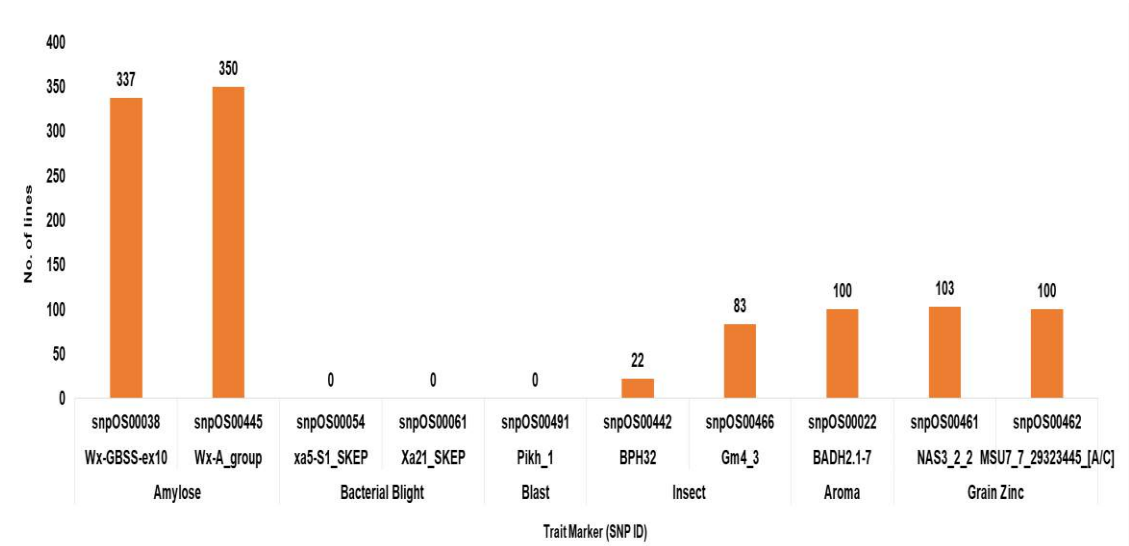


Fig. 17. Trait marker profile of genotypes of LST, ZER, Boro 2023-24.

Investigators: M A Kader, R R Majumder, T K Hore, U R Shaha and M I H Joy

### **Development of transgenic high beta-carotene rice and high iron & zinc rice (Healthier Rice)**

The main objective of the project was to develop high yielding transgenic rice varieties with enhanced provitamin-A, iron and zinc content in polished rice grain. A total of 658 BC<sub>3</sub>F<sub>2</sub> seeds were obtained from two backcrosses. However, in two backcrosses in the background of BRRI dhan71 and BRRI dhan89 six fixed lines (B type) and one hemizygous plant (H type) was identified in T. Aman 2023-24 season to develop high iron and zinc enriched rice (HIZR). With a view to developing provitamin-A enriched

rice, 176 fixed lines were selected from the 567 homozygous plants (B type) for contained trial (CT) in next T. Aman 2024-25 season.

In the Boro season, 129 F<sub>1</sub> seeds were obtained from two backcrosses. However, in two backcrosses in the backgrounds of BRRI dhan71 and BRRI dhan87 a total of 75 BC<sub>1</sub>F<sub>1</sub> seeds were obtained in Boro 2023-24 season with a view to developing high iron and zinc enriched rice (HIZR).

Investigators: M A Kader, R R Majumder, T K Hore, U R Shaha and M I H Joy

# **Biotechnology Division**

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## SUMMARY

A total 31 experiments were conducted during 2023-24 for the development of aromatic, antioxidant enriched black rice, and high yielding Aus, Aman and Boro rice varieties. Thirty-four lines from anther culture derived BRRI dhan50/Bashful (Acc. no. 3954) cross were evaluated in Boro 2023-24 as OT along with check BRRI dhan50. Among them 14 lines were selected for further evaluation. During Boro 2022-23, six and eight lines for antioxidant enriched black rice were selected from PYT and OT respectively. Seven and six lines for antioxidant enriched black rice were also selected from PYT and OT respectively during T. Aman 2022. Three hundred and twenty six somaclonal variants (SCV<sub>3</sub>) of Kalijira were harvested from 126 SCV<sub>2</sub> lines for further evaluation. Forty-seven and 89 homozygous antioxidant enriched black rice lines were selected during T.Aman 2022 and Boro 2022-23 respectively from SC<sub>5</sub> generation. In total, 219 backcross progeny plants (BC<sub>2</sub>F<sub>5</sub>) from wide hybridization were evaluated in Boro 2023-24. Among them 114 plants were selected for generation advancement. For developing high yielding aromatic rice variety 182 lines F<sub>6</sub> progenies derived from a cross between BRRI dhan87 and Kalijira were grown as OT during T. Aman 2023 among them 46 homozygous lines were selected. *AeMDHAR* salt tolerant gene (from mangrove plant) containing transgenic plant was crossed with BRRI dhan28 to introgress *AeMDHAR* salt tolerant gene. A total of 126 BC<sub>2</sub>F<sub>4</sub> plants were confirmed with gene specific primer. To deactivate the Function of *BADH2* gene a construct was prepared and 21day-old calli of BRRI dhan90 were used to transform using *Agrobacterium* mediated transformation. Putative transformed calli are now in selection stage. For fragrance rice development, 168 M<sub>3</sub> Kilijira lines were transplanted in T.Aman 2023 along with check and 273 plants were selected. Thirty-one plants (M<sub>3</sub>) of Tulshimala obtained through mutation by EMS were evaluated during T. Aman

2023. Among them, 47 plants (M<sub>4</sub>) were selected for generation advancement. Seed from seven rice genotype treated with 350Gy and 450Gy Gamma radiation were transplanted in T. Aman 2023. A total of 50 and 41 M<sub>3</sub> plants from 350Gy and 450Gy were selected respectively for further evaluation. Fifty-three M<sub>3</sub> plants of BRRI dhan87 were grown in the field and 117 M<sub>4</sub> plants were selected for further evaluation. During Aus 2023, 24 and 22 fixed lines of EMS treated variants of BRRI dhan48 were evaluated in two OTs with check variety. Among them, ten lines were selected for further evaluation. During T. Aman 2023, 222 fixed mutant lines of BR11 were evaluated as OT with standard check and 20 lines were selected for further evaluation. Besides, during Boro 2023-24, four (4) fixed lines were evaluated as PYT and one line was selected for further evaluation. For C4 rice development, a total of 7,000 M4 lines of Kaoun (*Setaria italica*) were developed. So far, 1100 M4 lines have been screened in low concentration (20 ppm) CO2 chamber for 72 hours and 26 plants, among them, seemed to have lost C4 properties. Photosynthetic properties of rice can be enhanced utilising Uri dhan (*Oryza coarctata*) as it has been reported to be an intermediate towards C4 having Kranz anatomy. It has a larger bundle sheath and denser venation. But its chloroplasts in the bundle sheaths are rudimentary making it less efficient photosynthetically (Chowrasia et al., 2021). This can be improved by editing the hexokinase gene OsHXK1 through CRISPR and making the Uri dhan, even more, closer to the C4 plant. Primers have been designed and synthesized and the vector has been cloned for genome editing

## DEVELOPMENT OF DOUBLED HAPLOID RICE THROUGH ANTHER CULTURE

### Low glycemic index (GI) rice variety

Three doubled haploid lines were grown as RYT in T. Aman 2022. Among them none was selected for further evaluation during T. Aman season. (Table 1).

**Table 1. Agronomic characteristics of selected anther culture derived materials. SYT-1, T. Aman/2022.**

| Designation           | PH (cm) | GD (day) | Kus  | Cum  | Gop  | Rang | YIELD (t/ha) |       |      |      |      |       |      |
|-----------------------|---------|----------|------|------|------|------|--------------|-------|------|------|------|-------|------|
|                       |         |          |      |      |      |      | Bari         | Gazi  | Raj  | Satk | Sona | Siraj | Avg. |
| BR(Bio)10381-AC11-7-1 | 114     | 125      | 6.28 | 6.50 | 4.00 | 6.26 | 4.35         | 5.43  | 4.74 | 4.91 | 4.92 | 6.08  | 5.35 |
| BR(Bio)10381-AC11-8-1 | 96      | 106      | 4.92 | 4.15 | 4.23 | 3.30 | Rat damage   | 2.85  | 2.11 | 4.11 | 4.94 | 1.96  | 3.62 |
| BR(Bio)13031-AC1-2    | 113     | 113      | 4.39 | 6.01 | 3.23 | 3.74 | 3.30         | 3.41  | 5.22 | 3.35 | 4.70 | 3.42  | 4.08 |
| BRRIdhan71(ck)        | 117     | 114      | 4.99 | 5.44 | 5.10 | 4.86 | 3.65         | 5.55  | 5.13 | 4.01 | 4.52 | 5.54  | 4.88 |
| BRRIdhan87(ck)        | 121     | 124      | 6.22 | 6.26 | 6.00 | 5.79 | 4.32         | 4.90  | 5.78 | 4.71 | 5.12 | 5.99  | 5.51 |
| CV (%)                |         |          | 8.17 | 6.94 | 2.48 | 7.58 | 4.23         | 11.56 | 5.41 | 5.1  | 5.34 | 8.94  |      |
| LSD (0.05)            |         |          | 0.82 | 0.74 | 0.21 | 0.68 | 0.25         | 0.94  | 0.45 | 0.41 | NS   | 0.77  |      |

Ph= Plant height, GD= Growth duration, Kus=Kushtia, Cum=Cumilla, Gop=gopalganj, Rang= Rangpur, Bar=Barishal, Gaz=Gazipur, Raj=Rajshahi, Sat=Satkhira Son=Sonagaji, Sir=Sirajgonj,

Investigators: Jannatul Ferdous, Shahanaz Sultana and Md Enamul Hoque.

#### **Premium quality rice variety through anther culture**

Thirty-three doubled haploid plants of BRRIdhan90/Kataribhog (Dinajpur) were evaluated in T. Aman 2023. Among them 65 plants were selected for generation advancement. Eight doubled haploid plants from BRRIdhan38/Bashful (Acc. no. 3954) were evaluated in T. Aman 2023. Among them 48

plants were selected for generation advancement. One hundred and sixty doubled haploid Plants from BRRIdhan50/Bashful (Acc. no. 3954) were evaluated in Boro 2023-24 and 53 lines were selected. Thirty-four lines from anther culture of BRRIdhan50/ Bashful (Acc. No. 3954) cross were evaluated in Boro 2023-24 as OT along with check BRRIdhan50. Among them 14 lines were selected for further evaluation.(Table 2)

**Table 2. Agronomic characteristics of selected lines derived from BRRIdhan50/Bashful (Acc. no. 3954) evaluated as OT in Boro 2023-24.**

| Designation          | PH (cm) | GD  | Yield |
|----------------------|---------|-----|-------|
| BR(Bio)16417-AC2-3-5 | 76      | 142 | 6.26  |
| BR(Bio)16417-AC2-1-6 | 93      | 150 | 6.38  |
| BR(Bio)16417-AC3-1-3 | 85      | 141 | 5.96  |
| BR(Bio)16417-AC3-7-4 | 83      | 141 | 6.24  |
| BR(Bio)16417-AC4-3-2 | 81      | 141 | 6.15  |
| BR(Bio)16417-AC4-1-1 | 86      | 141 | 6.04  |
| BR(Bio)16417-AC6-4-1 | 101     | 144 | 6.33  |
| BR(Bio)16417-AC6-5-3 | 84      | 144 | 6.00  |
| BR(Bio)16417-AC7-1-3 | 80      | 143 | 6.14  |
| BR(Bio)16417-AC7-5-4 | 84      | 143 | 6.12  |
| BR(Bio)16417-AC8-1-1 | 86      | 145 | 6.26  |
| BR(Bio)16417-AC8-3-3 | 88      | 142 | 6.02  |
| BR(Bio)16417-AC9-2-1 | 96      | 144 | 6.14  |
| BR(Bio)16417-AC9-6-5 | 88      | 144 | 6.05  |
| BRRIdhan50 (CK)      | 84      | 153 | 6.15  |

Investigators: Nilufar Yasmin Shaikh, Ripon Kumar Roy, S M Hisam Al Rabbi

### Antioxidant enriched black rice variety

Seven, six and forty-six antioxidant enriched black rice lines were evaluated as SYT, PYT and OT respectively during T.Aman 2023. Among them two lines were selected from OT materials for further evaluation. Besides, 66 somaclonal variants (SCV<sub>5</sub>) of antioxidant enriched black rice were evaluated as pedigree in T. Aman 2023 and 67 SCV plants were selected.

During Boro 2023-24, three antioxidant enriched black rice developed by anther culture were evaluated as ALART by ARD. Moreover, during Boro 2022-23, six, ten and 38 antioxidant enriched black rice lines were evaluated as RYT, PYT and OT respectively. Among them three, six and eight lines were selected (Table 3 and 4).

Investigators: Jannatul Ferdous, Shahana Sultana and Md. Enamul Hoque.

**Table 3. Agronomic characteristics of selected anther culture derived materials. RYT, Boro 2023-24.**

| Designation                 | PH (cm)    | GD (day)   | Gazi        | kush        | cum         | gopal       | Yield (t/ha) |             |             |             |             |             | Avg. |
|-----------------------------|------------|------------|-------------|-------------|-------------|-------------|--------------|-------------|-------------|-------------|-------------|-------------|------|
| BR(Bio)13028-AC1-2-2        | 110        | 143        | 4.7         | 5.44        | 4.26        | 6.24        | 3.91         | 5.12        | 6.68        | 5.57        | 5.95        | 5.32        |      |
| BR(Bio)13028-AC1-2-3        | 115        | 143        | 5.71        | 6.42        | 5.16        | 7.17        | 6.68         | 5.86        | 5.99        | 5.12        | 5.42        | 5.95        |      |
| <b>BR(Bio)13028-AC1-2-4</b> | <b>105</b> | <b>144</b> | <b>6.43</b> | <b>6.6</b>  | <b>6.60</b> | <b>7.30</b> | <b>6.02</b>  | <b>6.08</b> | <b>7.60</b> | <b>5.86</b> | <b>6.62</b> | <b>6.57</b> |      |
| <b>BR(Bio)13028-AC1-2-7</b> | <b>105</b> | <b>146</b> | <b>6.3</b>  | <b>6.35</b> | <b>5.23</b> | <b>7.53</b> | <b>5.90</b>  | <b>6.01</b> | <b>7.69</b> | <b>6.08</b> | <b>4.50</b> | <b>6.18</b> |      |
| BR(Bio)13029-AC6-2-6        | 103        | 146        | 6.1         | 6.22        | 5.5         | 6.57        | 5.72         | 5.57        | 7.28        | 6.01        | 5.74        | 6.08        |      |
| BR(Bio)13030-AC13-2-2       | 100        | 145        | 6.56        | 6.58        | 5.53        | 6.83        | 6.06         | 5.18        | 7.67        | 5.18        | 6.55        | 6.24        |      |
| BRRi dhan86                 | 93         | 141        | 5.7         | 6.28        | 6.21        | 6.11        | 6.07         | 5.4         | 6.51        | 5.40        | 6.37        | 6.01        |      |
| BRRi dhan96                 | 87         | 143        | 5.5         | 6.68        | 6.54        | 6.97        | 5.88         | 5.6         | 6.79        | 5.60        | 6.85        | 6.27        |      |
| CV (%)                      |            |            | 14.59       | 6.17        | 6.31        | 6.93        | 7.04         | 4.31        | 3.01        | 4.314       | 7.64        |             |      |
| LSD(0.5)                    |            |            | ns          | 0.68        | 1.02        | 1.36        | 1.17         | 0.69        | 0.42        | 0.37        | 0.80        |             |      |

Bold = Selected

Ph= Plant height, GD= Growth duration, Gaz=Gazipur, Cum=Cumilla, Bar=Barishal, Gop=gopalganj, Son=Sonagaji, Sir=Sirajgonj, Raj=Rajshahi, Kus=Kushtia, Sat=Satkhira

**Table 4. Agronomic characteristics of selected anther culture derived materials. PYT, Boro 2023-24**

| Designation                    | PH (cm)    | GD         | Yield       |
|--------------------------------|------------|------------|-------------|
| <b>BR(Bio)13028-AC11-2-1-1</b> | <b>115</b> | <b>148</b> | <b>5.33</b> |
| <b>BR(Bio)13028-AC11-2-2-3</b> | <b>102</b> | <b>150</b> | <b>5.83</b> |
| BR(Bio)13028-AC15-1-1-1        | 96         | 148        | 4.95        |
| <b>BR(Bio)13028-AC15-3-1-2</b> | <b>116</b> | <b>152</b> | <b>5.30</b> |
| <b>BR(Bio)13028-AC24-3-5-1</b> | <b>113</b> | <b>148</b> | <b>5.31</b> |
| <b>BR(Bio)13028-AC24-4-2-2</b> | <b>96</b>  | <b>146</b> | <b>5.91</b> |
| BR(Bio)13028-AC24-4-3-3        | 104        | 145        | 4.82        |
| <b>BR(Bio)13028-AC24-5-2-4</b> | <b>93</b>  | <b>149</b> | <b>5.33</b> |
| BR(Bio)13030-AC 1-2-3          | 95         | 146        | 5.12        |
| BR(Bio)13030-AC 6-4-1          | 102        | 149        | 4.12        |
| BRRi dhan86 (ck)               | 90         | 145        | 5.23        |
| BRRi dhan96 (ck)               | 80         | 146        | 5.17        |
| CV (%)                         |            |            | 11.98       |
| LSD (0.5)                      |            |            | ns          |

Bold = Selected

### Development of high-yielding colored and low-amylose content rice for hill ecosystem

During Boro 2023-24, eighteen antioxidant enriched black rice were developed using anther

culture were evaluated as PYT at Khagrachari. Among them eight lines were selected for RYT (Table 5).

**Table 5. Agronomic characteristics of selected anther culture derived materials. PYT, Boro 2023-24.**

| Line                          | PH         | GD         | Yield ( t/h) | % Amylose   | SS        |
|-------------------------------|------------|------------|--------------|-------------|-----------|
| <b>BR(Bio)13028-AC24-1-2</b>  | <b>114</b> | <b>139</b> | <b>6.45</b>  | <b>21.0</b> | <b>LS</b> |
| BR(Bio)13028-AC24-2-3         | 107        | 137        | 4.78         | 22.0        | MS        |
| BR(Bio)13028-AC24-2-4         | 101        | 135        | 5.50         | 22.0        | LS        |
| BR(Bio)13028-AC24-3-3         | 109        | 144        | 5.71         | 22.0        | LS        |
| BR(Bio)13029- AC2-2-2         | 122        | 144        | 3.06         | 26.5        | MB        |
| <b>BR(Bio)13029-AC6-2-6</b>   | <b>104</b> | <b>137</b> | <b>6.42</b>  | <b>20.1</b> | <b>LB</b> |
| BR(Bio)13029-AC6-3-2          | 130        | 142        | 5.90         | 25.1        | LB        |
| BR(Bio)13028-AC1-2-2          | 126        | 135        | 5.59         | 24.7        | MS        |
| <b>BR(Bio)13028-AC1-2-3</b>   | <b>111</b> | <b>139</b> | <b>6.19</b>  | <b>24.9</b> | <b>MS</b> |
| <b>BR(Bio)13028-AC1-2-4</b>   | <b>107</b> | <b>137</b> | <b>6.80</b>  | <b>25.2</b> | <b>MB</b> |
| <b>BR(Bio)13028-AC1-2-7</b>   | <b>111</b> | <b>137</b> | <b>6.36</b>  | <b>24.6</b> | <b>MB</b> |
| <b>BR(Bio)13028-AC2-2-2-3</b> | <b>120</b> | <b>137</b> | <b>6.15</b>  | <b>25.2</b> | <b>MS</b> |
| BR(Bio)13030-AC5-2-1          | 124        | 136        | 5.84         | 24.8        | MS        |
| <b>BR(Bio)13030-AC13-2-2</b>  | <b>100</b> | <b>137</b> | <b>6.25</b>  | <b>25.6</b> | <b>LS</b> |
| BR(Bio)10368-AC6-1-1          | 117        | 147        | 4.66         | 22.0        | LS        |
| BR(Bio)10368-AC17-2-2         | 116        | 148        | 4.72         | 23.2        | LS        |
| BR(Bio)10368-AC22-2-2         | 111        | 150        | 5.49         | 22.9        | LS        |
| <b>BR(Bio)10368-AC30-2-3</b>  | <b>123</b> | <b>151</b> | <b>6.08</b>  | <b>23.9</b> | <b>LS</b> |
| BRRI dhan86                   | 102        | 136        | 6.85         | 25.0        | LS        |
| BRRI dhan96                   | 96         | 137        | 7.00         | 27.0        | MB        |

Bold = Selected

### Development of Aus rice variety through anther culture

Fifteen (15) advanced lines were grown in a preliminary yield trial (PYT-1) in Aus 2023.

Among them, five lines were selected (Table 6) based on plant type, yield, and growth duration for the secondary yield trial (SYT).

**Table 6. Agronomic characteristics of selected anther culture derived lines in PYT-1, Aus 2023.**

| Designation         | PH (cm) | GD (day) | Yield (t/ha) |
|---------------------|---------|----------|--------------|
| BR(Bio)15085-AC2-9  | 112     | 104      | 5.41         |
| BR(Bio)15086-AC11-5 | 108     | 100      | 5.52         |
| BR(Bio)15086-AC11-7 | 108     | 100      | 5.54         |
| BR(Bio)15086-AC51-7 | 107     | 101      | 5.18         |
| BR(Bio)15086-AC51-6 | 103     | 101      | 5.12         |
| BRRI dhan48 (ck)    | 100     | 107      | 4.72         |
| BRRI dhan98 (ck)    | 104     | 111      | 5.60         |
| CV (%)              | 1.11    | 0.75     | 3.28         |
| LSD (0.5)           | 2.5     | 2.25     | 0.38         |

Investigators: Ripon Kumar Roy, SM Hisam Al Rabbi, Nilufar Yasmin Shaikh, Md Arafat Hossain, Shampa Das Joya, Sentu Rahman, M A Monsur, M N Islam, M M Rana, T Halder, T K Roy



### Development of photosensitive rice through anther culture

Seventy-four advanced lines having taller seedling capabilities were grown in Aman 2023. Among them, 30 homozygous advanced were selected for further evaluation.

One preliminary yield trial (PYT) was done in Aman 2023, where six advanced lines were grown. Four lines were selected (Table 7) for further evaluation.

**Table 7. Agronomic characteristics of selected anther culture derived lines inPYT-1, Aman 2023.**

| Designation              | PH   | GD   | Yield (t/ha) | TW (g) |
|--------------------------|------|------|--------------|--------|
| BR (Bio)8033-AC5-1-1-HR1 | 119  | 143  | 5.79         | 27.51  |
| BR (Bio)8033-AC5-1-1-HR2 | 118  | 142  | 5.51         | 29.91  |
| BR (Bio)8033-AC5-1-2-HR1 | 119  | 142  | 5.60         | 28.72  |
| BR (Bio)8033-AC7-1-1-HR2 | 118  | 142  | 5.43         | 29.14  |
| Gainja (ck)              | 158  | 146  | 4.48         | 24.63  |
| CV (%)                   | 3.13 | 2.78 | 4.21         |        |
| LSD (0.5)                | 2.56 | 1.97 | 0.41         |        |

Investigators: Ripon Kumar Roy, S M Hisam Al Rabbi, Nilufar Yasmin Shaikh, Md Arafat Hossain, Shampa Das Joya, Sentu Rahman, M A Monsur, M N Islam, M M Rana, T Halder, T K Roy

### Development of Aman rice for the favourable ecosystem through anther culture

Twelve advanced lines were grown in a preliminary yield trial (PYT) in Aman 2023. Three

promising advanced lines were selected (Table 8) for further evaluation.

**Table 8. Agronomic characteristics of selected anther culture derived lines in PYT-1, Aman/2023.**

| Designation            | PH (cm) | GD (day) | Yield (t/ha) |
|------------------------|---------|----------|--------------|
| BR(Bio)15086-AC114-8-1 | 113     | 117      | 6.38         |
| BR(Bio)15086-AC119-16  | 112     | 118      | 6.36         |
| BR(Bio)15086-AC120-18  | 114     | 121      | 6.59         |
| BBRI dhan75 (ck)       | 112     | 113      | 5.46         |
| BRRI dhan95 (ck)       | 120     | 134      | 4.98         |
| BRRI dhan71 (ck)       | 113     | 118      | 5.35         |
| CV                     | 2.61    | 0.98     | 4.18         |
| LSD                    | 2.5     | 1.69     | 0.33         |

Investigators: Ripon Kumar Roy, S M Hisam Al Rabbi, Nilufar Yasmin Shaikh, Md Arafat Hossain, Shampa Das Joya, Sentu Rahman, M A Monsur, M N Islam, M M Rana, T Halder, T K Roy

### Development of Boro Rice for the favourable ecosystem using anther culture techniques

Twenty-one advanced lines were evaluated in an observational yield trial (OT-1) in Boro 2023-24.

Eleven lines were selected (Table 9) for further evaluation.

**Table 9. Agronomic characteristics of selected anther culture derived lines in OT-1, Boro 2023-24.**

| Designation          | PH (cm) | GD (day) | Yield (t/ha) |
|----------------------|---------|----------|--------------|
| BR(Bio)15085-AC3-10  | 103     | 147      | 7.07         |
| BR(Bio)15085-AC19-2  | 123     | 151      | 6.84         |
| BR(Bio)15085-AC20-4  | 117     | 151      | 6.60         |
| BR(Bio)15085-AC25-6  | 116     | 144      | 7.41         |
| BR(Bio)15085-AC28-10 | 119     | 144      | 7.54         |
| BR(Bio)15085-AC35-3  | 101     | 142      | 7.27         |
| BR(Bio)15085-AC36-2  | 117     | 142      | 7.37         |
| BR(Bio)15085-AC37-1  | 104     | 146      | 7.46         |
| BR(Bio)15085-AC37-4  | 103     | 145      | 6.98         |
| BR(Bio)15085-AC38-3  | 102     | 145      | 7.15         |
| BR(Bio)15085-AC38-5  | 104     | 145      | 7.93         |
| BRRI dhan58 (ck)     | 101     | 146      | 6.71         |
| BRRI dhan88 (ck)     | 90      | 138      | 6.15         |

Besides, 17 advanced lines were evaluated in an observational yield trial (PYT-1) in Boro 2023-24. Ten lines were selected (Table 10) for further evaluation.

**Table 10. Agronomic characteristics of selected anther culture derived lines in PYT-1, Boro 2023-24.**

| Designation            | PH (cm) | GD (day) | Yield (t/ha) |
|------------------------|---------|----------|--------------|
| BR (Bio)15086-AC67-1   | 100     | 151      | 7.81         |
| BR (Bio)15086-AC67-3-1 | 117     | 149      | 7.99         |
| BR (Bio)15086-AC67-3-2 | 104     | 149      | 7.88         |
| BR (Bio)15086-AC68-4   | 107     | 151      | 7.91         |
| BR (Bio)15086-AC69-1   | 114     | 149      | 7.95         |
| BR (Bio)15086-AC69-2   | 97      | 148      | 7.78         |
| BR (Bio)15086-AC70-1   | 101     | 153      | 7.89         |
| BR (Bio)15086-AC73-1   | 112     | 149      | 7.85         |
| BR (Bio)15086-AC74-1   | 103     | 152      | 7.96         |
| BR (Bio)15086-AC74-2   | 108     | 149      | 7.77         |
| BRRI dhan89 (ck)       | 107     | 156      | 7.68         |
| CV (%)                 | 2.09    | 0.73     | 3.12         |
| LSD (0.5)              | 4.69    | 2.3      | 0.49         |

Investigators: Ripon Kumar Roy, SM Hisam Al Rabbi, Nilufar Yasmin Shaikh, Md Arafat Hossain, Shampa Das Joya, Sentu Rahman, M A Monsur, M N Islam, M M Rana, T Halder, T K Roy

Moreover, 11 advanced lines were evaluated in a secondary yield trial (SYT-1) in Boro 2023-24 for the development of medium-growth duration rice. Nine lines were selected (Table. 11) for further evaluation.

**Table 11. Agronomic characteristics of selected anther culture derived lines in SYT-1, Boro/2023-24.**

| Designation          | PH (cm) | GD (day) | Yield (t/ha) |
|----------------------|---------|----------|--------------|
| BR (Bio)15086-AC11-1 | 105     | 150      | 7.78         |
| BR (Bio)15086-AC12-1 | 107     | 150      | 7.68         |
| BR (Bio)15086-AC13-2 | 108     | 150      | 7.71         |
| BR (Bio)15086-AC14-6 | 102     | 149      | 7.79         |
| BR (Bio)15086-AC16-4 | 109     | 150      | 7.75         |
| BR (Bio)15085-AC27-2 | 102     | 151      | 7.84         |
| BR (Bio)15085-AC28-2 | 103     | 151      | 7.74         |

| Designation          | PH (cm) | GD (day) | Yield (t/ha) |
|----------------------|---------|----------|--------------|
| BR (Bio)15085-AC38-1 | 103     | 148      | 7.85         |
| BR (Bio)15085-AC62-1 | 107     | 150      | 7.73         |
| BRRI dhan58(ck)      | 101     | 153      | 7.23         |
| BRRI dhan89(ck)      | 104     | 157      | 7.73         |
| CV (%)               | 1.0     | 0.68     | 1.53         |
| LSD (0.5)            | 2.26    | 2.23     | 0.25         |

Investigators: Ripon Kumar Roy, S M Hisam Al Rabbi, Nilufar Yasmin Shaikh, Md Arafat Hossain, Shampa Das Joya, Sentu Rahman, M A Monsur, M N Islam, M M Rana, T Halder, T K Roy

Ten advanced lines were evaluated in a secondary yield trial (SYT-2) in Boro 2023-24 for the development of long-duration rice. Eight lines were selected (Table. 12) for further evaluation.

**Table 12. Agronomic characteristics of selected anther culture derived lines in SYT-1, Boro/2023-24.**

| Designation          | PH (cm) | GD (day) | Yield (t/ha) |
|----------------------|---------|----------|--------------|
| BR (Bio)15085-AC1-4  | 113     | 163      | 7.82         |
| BR (Bio)15086-AC13-6 | 110     | 161      | 7.93         |
| BR (Bio)15086-AC16-1 | 111     | 163      | 7.86         |
| BR (Bio)15085-AC29-5 | 108     | 161      | 7.98         |
| BR (Bio)15086-AC58-1 | 110     | 159      | 7.89         |
| BR (Bio)15086-AC58-3 | 107     | 159      | 7.89         |
| BR (Bio)15086-AC59-6 | 113     | 159      | 7.95         |
| BR (Bio)15086-AC59-8 | 110     | 164      | 7.93         |
| BRRI dhan89 (ck)     | 108     | 159      | 7.60         |
| BRRI dhan92 (ck)     | 110     | 163      | 7.66         |
| CV (%)               | 0.39    | 0.20     | 1.19         |
| LSD (0.5)            | 0.96    | 0.70     | 0.20         |

Investigators: Ripon Kumar Roy, S M Hisam Al Rabbi, Nilufar Yasmin Shaikh, Md Arafat Hossain, Shampa Das Joya, Sentu Rahman, M A Monsur, M N Islam, M M Rana, T Halder, T K Roy

## DEVELOPMENT OF RICE VARIETY THROUGH SOMACLONAL VARIATION

### Development of premium quality rice (Kalijira type) through somaclonal variation

In total 326 lines somaclonal variants (SCV<sub>3</sub>) of Kalijira were grown in T. Aman 2022. In total of 441 plants were selected for further evaluation.

Investigators: Shahanaz Sultana, Jannatul Ferdous and Md Enamul Hoque

### Premium quality rice variety through somaclonal variation

Seeds of Kataribhog, Tulshimala, Radhunipagol and Shakkhorkhana (Local varieties) were used in this experiment. Seed culture was done to create somaclonal variations during T. Aman 2022. Thirty-one SC<sub>1</sub> plants derived from seed culture of Kataribhog, Tulshimala, Radhunipagol and Shakkhorkhana was evaluated as pedigree during the T. Aman 2023. In total, 42 plants (SC<sub>2</sub>) were selected from Kataribhog (13), Tulshimala (2), Radhunipagal (16) and Sakkarkhana (11) for generation advancement.

Investigators: Nilufar Yasmin Shaikh, Ripon Kumar Roy, S M Hisam Al Rabbi

## DEVELOPMENT OF RICE VARIETY THROUGH WIDE HYBRIDIZATION

### Wide hybridization followed by embryo rescue

Three lines from BRRI dhan28/*O. nivara* (IRGC 103821) along with check BRRI dhan96 were field evaluated as SYT during Boro 2023-24. None of the lines were selected for further evaluation.

These lines will be sent to plant Pathology Division for screening of BB, sheath blight, blast and tungro resistant traits and GQN Division for physicochemical properties. In total, 219 backcross progeny plants (BC<sub>2</sub>F<sub>5</sub>) from wide hybridization were evaluated in T. Aman 2023. Among them 114 plants were selected for generation advancement (Table 13).

**Table 13. Pedigree selection from wide hybridization.**

| Designation<br>(Generation: BC <sub>2</sub> F <sub>5</sub> ) | Cross<br>number | No. of plant<br>evaluated | No. of plant selected<br>in Boro 2023-24 |
|--------------------------------------------------------------|-----------------|---------------------------|------------------------------------------|
| BRRI dhan28/ <i>O. glaberrima</i> IRGC105190                 | BR (Bio)13037   | 104                       | 70                                       |
| BRRI dhan87/ <i>O. glaberrima</i> IRGC105190                 | BR (Bio)13040   | 41                        | 26                                       |
| BRRI dhan48/ <i>O. glaberrima</i> IRGC105190                 | BR (Bio)13036   | 74                        | 18                                       |
| Total                                                        |                 | 219                       | 114                                      |

Investigators: Nilufar Yasmin Shaikh, Ripon Kumar Roy, S M Hisam Al Rabbi

### Development of Aman rice through wide hybridization

Five embryo-rescued BC<sub>2</sub>F<sub>3</sub> populations

were grown in T. Aman 2023. Among them, 1,111 plants were selected (Table 14).

**Table 14. List of wide crosses and their status.**

| Designation                            | Generation | Selected plant (No.) |
|----------------------------------------|------------|----------------------|
| BR33*2/ <i>O. rufipogon</i> (103404)   | ERBC2F3    | 491                  |
| BR11*2/ <i>O. rufipogon</i> (103404)   | ERBC2F3    | 157                  |
| BR52*2/ <i>O. rufipogon</i> (103404)   | ERBC2F3    | 117                  |
| BR66*2/ <i>O. rufipogon</i> (105190)   | ERBC2F3    | 96                   |
| BR39*2/ <i>O. officinalis</i> (106174) | ERBC2F3    | 250                  |
| Total                                  |            | 1111                 |

Investigators: Ripon Kumar Roy, S M Hisam Al Rabbi, Nilufar Yasmin Shaikh, Md Arafat Hossain, Shampa Das Joya

## DEVELOPMENT OF RICE VARIETY THROUGH MUTATION BREEDING

### Development of high yielding Aus rice variants using EMS

During Aus 2023, 24 and 22 fixed lines of EMS treated variants of BRRI dhan48 were evaluated in two OTs with check variety. Among them, ten lines were selected for further evaluation.

Investigators: Shahanaz Sultana, Jannatul Ferdous, Shampa Das Joya and Md Enamul Hoque

### Development of high yielding rice variants using EMS for Boro season

During T. Aman 2023, a total of 222 fixed mutant lines of BR11 lines were evaluated as OT with standard check and 20 lines were selected for further evaluation (Fig.1, Table15). Besides, during Boro 2023-24, four fixed lines were evaluated as PYT and one lines were selected for further evaluation (Table 16).

Investigators: Shahanaz Sultana, Jannatul Ferdous, Md Sentu Rahman, Shampa Das Joya and Md Enamul Hoque

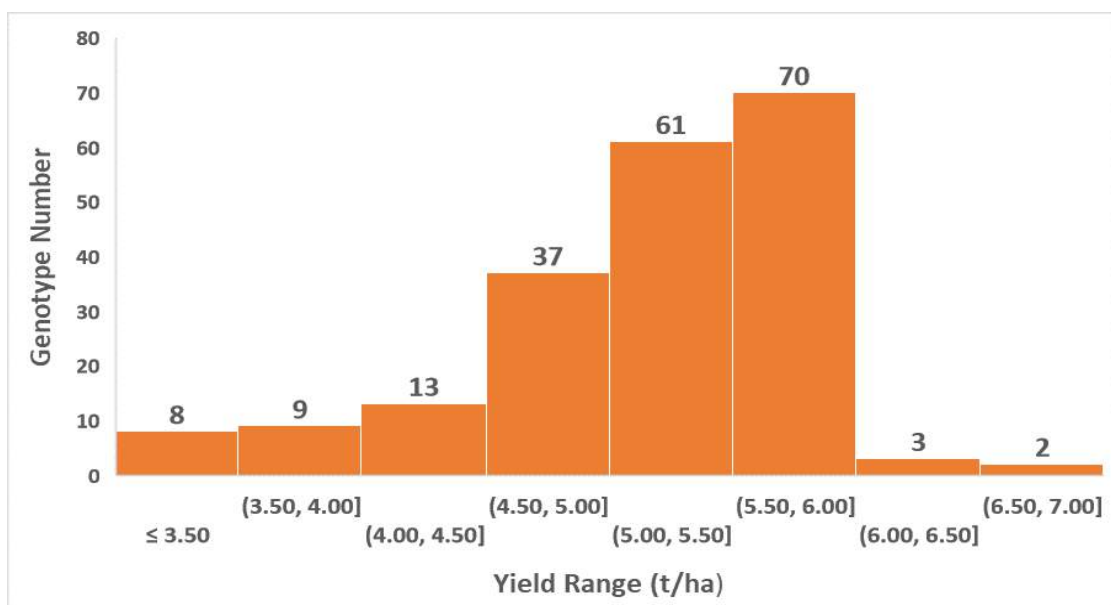


Fig. 1. Yield of 222 fixed mutant lines of BR11 during T. Aman 2023.

**Table 15. Agronomic characteristics of selected top 20 lines as OT, T. Aman /2023-24.**

| Designation        | Yield<br>t/ha | PH  | GD  |
|--------------------|---------------|-----|-----|
| T4-BR11-26-1-1     | 7.00          | 138 | 132 |
| T4-BR11-104-23-8-1 | 6.99          | 125 | 128 |
| BR11 -M-1          | 6.24          | 120 | 132 |
| T4-BR11-13-1-1     | 6.18          | 120 | 136 |
| T4-BR11-112-1-1    | 6.02          | 133 | 133 |
| T4-BR11-103-1-3    | 5.99          | 137 | 134 |
| T4-BR11-49-1-2     | 5.98          | 135 | 129 |
| T4-BR11-58-1-1     | 5.97          | 132 | 129 |
| T4-BR11-12-1-1     | 5.95          | 118 | 132 |
| BR11-M-3           | 5.93          | 123 | 132 |
| T4-BR11-4-1-1      | 5.91          | 131 | 135 |
| T4-BR11-16-1-1     | 5.91          | 113 | 136 |
| T4-BR11-33-1-3     | 5.90          | 121 | 133 |
| T4-BR11-35-1-2     | 5.87          | 121 | 132 |
| T4-BR11-24-1-1     | 5.87          | 133 | 132 |
| T4-BR11-18-1-1     | 5.86          | 120 | 132 |
| T4-BR11-91-120-4-1 | 5.85          | 130 | 134 |
| T4-BR11-38-1-2     | 5.84          | 127 | 132 |
| T4-BR11-59-1-2     | 5.83          | 130 | 133 |
| T4-BR11-52-1-1     | 5.83          | 136 | 135 |
| BRRI dhan103 (ck)  | 5.65          | 128 | 132 |
| BRRI dhan71 (ck)   | 5.00          | 125 | 116 |
| BRRI dhan87 (ck)   | 4.34          | 130 | 127 |

**Table 16. Agronomic characteristics of selected lines in PYT, Boro /2023-24**

| Designation               | PH (cm)    | GD (days)  | Yield (t/ha) |
|---------------------------|------------|------------|--------------|
| T4-BR11-17-1-3            | 103        | 151        | 5.90         |
| T4-BR11-53-1-1            | 113        | 160        | 4.93         |
| T4-BR11-53-1-2            | 117        | 154        | 5.99         |
| <b>T4-BR11-104-23-8-4</b> | <b>115</b> | <b>149</b> | <b>7.28</b>  |
| BRR1 dhan74(ck)           | 97         | 142        | 6.46         |
| BRR1 dhan96(ck)           | 87         | 140        | 6.31         |
| CV (%)                    |            |            | 11.42        |
| LSD (0.5)                 |            |            | 1.28         |

Bold = selected

#### **Development of Kilijira type rice vareity through mutation by NMU**

Seed from 168 M<sub>3</sub> Kilijira lines were transplanted in T. Aman 2023 along with check. 273 plants were selected during T. Aman 2023 for further evaluation.

Investigators: Shahanaz Sultana, Jannatul Ferdous, S M Hisham Al Rabbi, Shampa Das Joya and Md Enamul Hoque.

#### **High yielding sheath blight resistant rice variety**

Fifty-three M<sub>3</sub> plants were grown in the field to observe the yield and disease reaction. One hundred and seventeen M<sub>4</sub> plants were selected for further evaluation.

Investigators: Md Arafat Hossain, S M Hisam Al Rabbi, Ripon Kumar Roy, Shamima Akter

#### **Premium quality rice through mutation by EMS**

EMS treated seeds of local variety (Tulshimala) were used in this experiment. Thirty-one plants (M<sub>3</sub>) of Tulshimala obtained through mutation by EMS were evaluated during T. Aman 2023. Among them 47 plants (M<sub>4</sub>) were selected for generation advancement.

Investigators: Nilufar Yasmin Shaikh, Ripon Kumar Roy, S M Hisam Al Rabbi and Md Arafat Hossain

#### **Development of premium quality rice variety using gamma radiations**

Seed from seven rice genotype treated with 350Gy and 450Gy Gamma radiation were transplanted in T. Aman 2023. A total of 50 and 41 M<sub>3</sub> plants from 350Gy and 450Gy were selected respectively, for further evaluation

Investigators: Shahanaz Sultana, Jannatul Ferdous, Md Sentu Rahman

#### **DEVELOPMENT OF RICE VARIETY THROUGH MARKER ASSISTED SELECTION**

#### **Marker assisted selection for fragrance gene *BADH2***

In total of 154 pedigree lines developed from a cross between BRR1 dhan87 and Kalijira were evaluated. Among them 46 homozygous lines were selected on the basis of aroma, growth duration and plant height. All the tested aromatic lines were confirmed by using functional marker of fragrance gene BADH2 Development of (Fig. 2). The primers combination of ESP and IFAP amplified the fragrance specific allele at 257 bp. On the other hand, the primers combination of INSP and EAP amplified the expected non-fragrance-specific allele (355 bp).

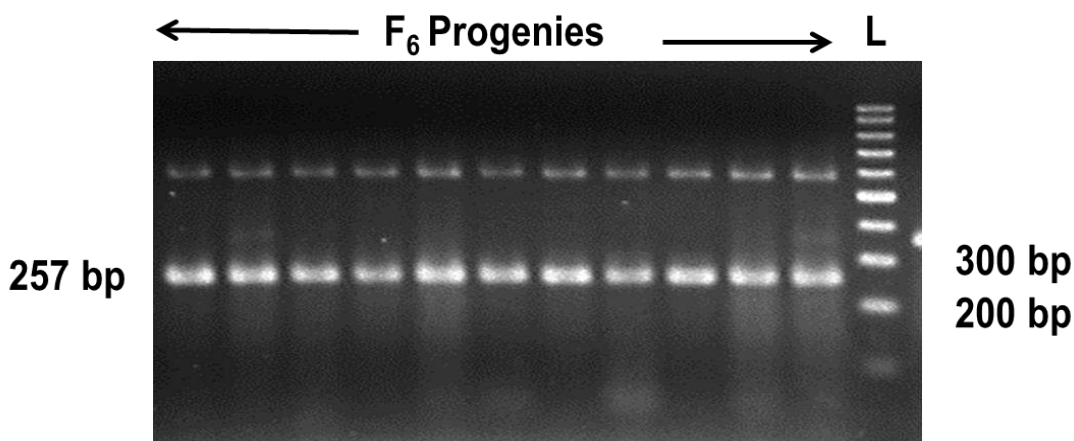


Fig. 2. Marker assisted selection with functional marker of *BADH2* gene in F<sub>6</sub> Population of BRRI dhan87 and Kalijira.

Investigators: Jannatul Ferdous, Shahanaz Sultana and Md Enamul Hoque.

**Marker assisted selection for aromatic and tidal submergence tolerant rice genotype**

A three way cross, two double crosses and six crosses were done. Aromatic progenies were

identified with Functional Marker of *BADH2* gene (Fig. 3). Thirty-eight lines of different crosses were harvested from F<sub>2</sub> generation

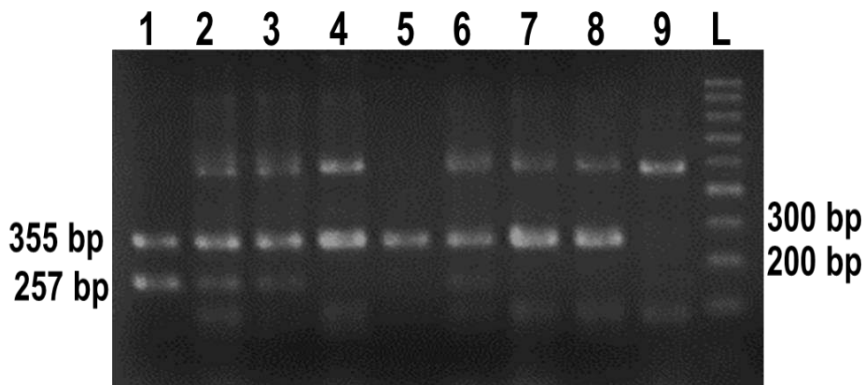


Fig 3. Identification of aromatic progenies with Functional Marker of *BADH2* gene

1-3=BRRI dhan90/Kalijira// BRRI dhan52/Kalijira 4-9= BRRI dhan90//BRRI dhan52/Kalijira.

Investigators: Jannatul Ferdous, Shahanaz Sultana and Md Enamul Hoque.

**Development of multiple disease resistant (blast and bacterial blight) rice varieties using marker assisted selection**

To develop multiple disease resistant (blast and bacterial blight) rice varieties F<sub>3</sub> plants of four crosses such as BR (Bio)11447-1-28-14-

3/IR64Pi9 (L), BR (Bio)11447-1-28-14-3/IR64Pi9 (E), BR (Bio)11447-3-10-7-1/IR64Pi9 (L), BR (Bio)11447-3-10-7-1/IR64Pi9 (E) were screened with *Xa21* and *xa13* primer and F<sub>4</sub> seeds were harvested from confirmed plants (Fig. 4).

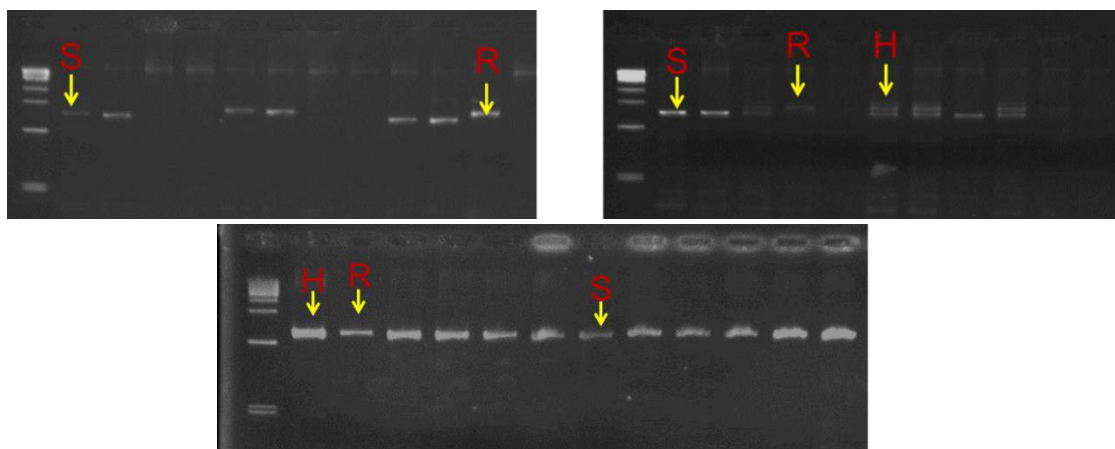


Fig. 4. BB resistance gene were confirmed with gene specific primer Xa21, xa13.

Investigators: Jannatul Ferdous, Shahanaz Sultana and Md Enamul Hoque, Ashik Ikbal Khan.

### Genome wide association mapping for photosensitivity of rice

An association mapping panel of 158 accessions comprised of varieties, landraces, and advanced breeding lines of the T. Aman season were used for the study. Heading data were taken in the short-day conditions for two years and long-day conditions for two years. They were raised in the shading facility under the Plant Physiology Division of BRRI in the current year and data taking is being continued on the photosensitivity.

Investigators: S M Hisam Al Rabbi, Ripon Kumar Roy, Md Arafat Hossain, Md Sentu Rahman, and Sadia Ahmed Shupta

### RICE TRANSFORMATION

#### Introgression of salt tolerant gene

*AeMDHAR* salt tolerant gene (from mangrove plant) containing transgenic plant was crossed with BRRI dhan28 to introgress *AeMDHAR* salt tolerant gene. A total of 126 BC<sub>2</sub>F<sub>4</sub> plants of BRRI dhan28 were confirmed with gene specific primer (Fig. 5) and seeds were harvested for further evaluation.

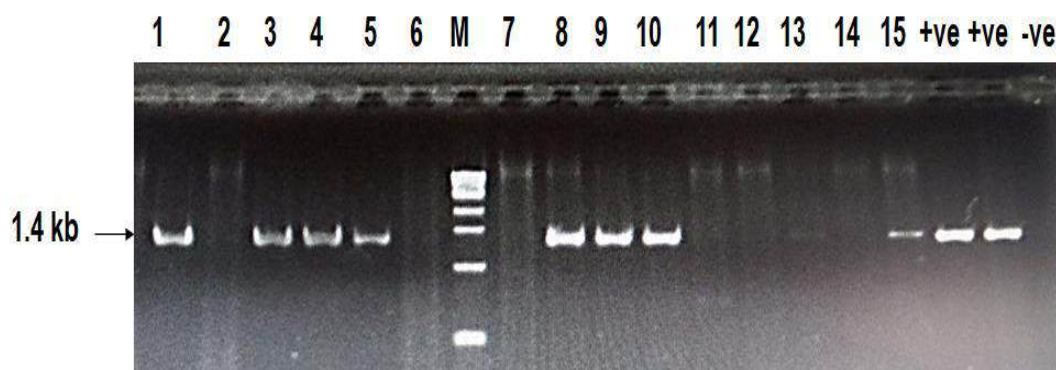


Fig. 5. Confirmation of transgenic plant with gene specific primer.

Investigators: Shahanaz Sultana, Jannatul Ferdous, Shampa Das Joya and Md Enamul Hoque.



## GENOME EDITING THROUGH CRISPR

### **Development of high yielding aromatic rice lines through genome editing**

To deactivate the Function of *BADH2* gene construct was prepared and 21 day-old calli of BRR1 dhan90 were used to transform a through *Agrobacterium* mediated transformation. Putative transformed calli are now in selection stage.

Investigators: Shahanaz Sultana, Jannatul Ferdous, Shampa Das Joya, Md Sentu Rahman Md Enamul Hoque, Hirendro Nath Barman.

## C4 RICE DEVELOPMENT

### **Identification of *Setaria* mutants losing C4 properties**

A number of 7000 M<sub>4</sub> lines of Kaoun (*Setaria italica*) have been developed for further study. These lines are gradually being raised and subjected to CO<sub>2</sub> stress in low concentration (20 ppm) CO<sub>2</sub> chamber for 72 hours and high-throughput screened for loss of C4 functions. High throughput screening of 1100 mutant lines detected 26 lines losing C4 properties, which are being maintained for future studies.

Investigators: S M Hisam Al Rabbi, Ripon Kumar Roy, Munnujan Khanam, Sazzadur Rahman

### **Redesigning photosynthesis to enhance sustainable rice yield potential under climate change**

Photosynthetic properties of rice can be enhanced utilising Uri dhan (*Oryza coarctata*) as it has been

reported to be an intermediate towards C4 having Kranz anatomy. It has a larger bundle sheath and denser venation. But its chloroplasts in the bundle sheaths are rudimentary making it less efficient photosynthetically (Chowrasia et al., 2021). This can be improved by editing the hexokinase gene OsHXK1 through CRISPR and making the Uri dhan, even more, closer to the C4 plant. Primers have been designed and synthesized and the vector has been cloned for genome editing.

Investigators: S M Hisam Al Rabbi, Ripon Kumar Roy, Munnujan Khanam, Sazzadur Rahman, and Hirendra Nath Barman

## Basic Research

### **Study on Kernel elongation of rice for the development of high elongation ratio (>1.7) variety through anther culture**

Sixty-four selected genotypes were grown in T. Aman 2023 and the seeds were harvested from single plant. Seeds from 10 genotypes were used for physic-chemical properties analysis. Kernel length varied from 3.6 to 7.1. The highest kernel elongation was observed in GulTepi (1.6). The highest amylose content was found in Bashmati PARDNR442(IRGC-27792) (AC-4497) (22.22%) and lowest in Bashmati (IRGC-3647)(AC-4488)(7.5%)

Investigators: Shahanaz Sultana, Jannatul Ferdous, Shampa Das Joya, Md Enamul Hoque, Habibul Bari Sojib

## **Genetic Resources and Seed Division**

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## SUMMARY

In total, 753 rice germplasm of which 274 in Aus, 373 in T. Aman, 59 in B. Aman, 46 in Boro seasons and one wild rice entry were collected from different districts of Bangladesh. One hundred and sixty-three germplasm accessions and new collections (NC) of which 36 in T. Aus 2023, 80 in T. Aman 2023 and 50 in Boro 2023-24 were morphologically characterized using Rice Germplasm Descriptors and Evaluation Form.

Rejuvenation of 2,532 accessions including 526 accessions in T. Aus 2023, 1357 in T. Aman 2023 and 649 in Boro 2023-24 seasons was completed. In total 2,922 entries comprising 589 entries/samples of Aus 2023 season, 1,594 entries of T. Aman 2023 and 775 entries of Boro 2023-24 were processed and stored in short term storage. At the same time, 246 entries including 20 entries of Aus 2023, 131 entries of T. Aman 2023 and 95 entries of Boro 2023-24 were processed and stored in medium term storage. Similarly, 180 entries comprising 43 entries of Aus 2023, 106 entries of T. Aman and 31 entries of Boro season were processed and stored in long-term storage. Besides, 138 new germplasm were registered as new accessions (from accession number 8,869 to 9,006) in the BRRI Genebank. As a germplasm sharing activity, a total of 3,872 samples were supplied to 30 different users in the reporting year. Besides, 383 rice germplasm accessions have been purified based on GBS profiling (97% homology) and selected for downstream analysis.

One hundred nineteen BRRI developed and recommended rice varieties were maintained and nucleus seed was produced. Besides, nucleus seeds of 71 BRRI varieties were produced as the source of breeder seed. In total 294.07 tons of breeder seed with tags (193.65 tons of 20 Boro varieties, 16.72 tons of seven Aus varieties and 83.70 tons of 35 T. Aman varieties) were produced during 2023-24. At the same time, 249.08 tons of breeder seed including 158.50 tons of 20 Boro varieties, 11.86 tons of seven Aus varieties and 78.73 tons of 35 T. Aman varieties) were distributed among 645 partners (GO, NGO and PS) of 'BRRI Rice Seed Network'. Besides, BS production plots and foundation seed (FS) production farms were visited to observe the varietal purity and performance of the respective classes of seeds.

## RICE GERMPLASM CONSERVATION AND MANAGEMENT

**Germplasm collection and acquisition.** Two collection missions were accomplished during the reporting year and in total 753 rice germplasm including 274 in Aus, 373 in T. Aman, 59 in B. Aman, 46 in Boro and one wild rice germplasm were collected from different districts of Bangladesh.

Investigators: Partha Sarathi Biswas (PI), Md Abubakar Siddique, Armin Bhuiya, Nashirum Monir and Md Ashiqur Rahman

**Germplasm rejuvenation, purification, processing and storage.** A total of 2,532 rice germplasm were rejuvenated to increase the seed for safe storage in the Genebank. The experiment was carried out under transplanted conditions using double rows of 5.4 m long plots per accession with 20 × 20 cm spacing between rows and plants respectively. Fertilizers were applied @ 60:20:40 kg NPK/ha in T. Aus and T. Aman and @ 80:20:40 kg NPK/ha in Boro seasons.

During 2023-24, a total of 2,532 germplasm comprising 526 accessions (between Acc. 2601 to 6000) in T. Aus; 1,357 accessions (between Acc. 01 to 2000) in T. Aman and 649 accessions (between Acc. 1 to 5000) in Boro were rejuvenated in field for obtaining fresh seed and on average 500 g of seeds per accession were produced.

Besides, 2,922 entries of germplasm were processed and conserved with respective accession number in different storages of BRRI Genebank during the reporting year. The germplasm were cleaned and dried with a seed moisture content of less than 9% for short-term storage. A total of 589 entries/samples from Aus 2023 season, 1,594 entries from T. Aman 2023 and 775 entries from Boro 2023-24 were processed and stored in short term storage. At the same time, 246 entries including 20 entries of Aus 2023, 131 entries of T. Aman 2023 and 95 entries of Boro 2023-24 were processed and stored in medium term storage. Similarly, 180 entries comprising 43 entries of Aus 2023, 106 entries of T. Aman season and 31 entries of Boro season were processed and stored in the long-term storage. Besides, a total of 138 new germplasm was registered as new accessions (from accession number 8,869 to 9,006) in the BRRI Genebank.

Investigators. Partha Sarathi Biswas (PI), Armin Bhuiya (Co-PI), Mir Sharf Uddin Ahmed, Ebna Syod Md Harunur Rashid, Md Abubakar Siddique, Armin Bhuiya, Md Humyun Kabir Baktia, Tonmoy Chakrabarty, Nashirum Monir and Md Ashiqur Rahman

### **Morphological characterization of germplasm.**

Three experiments were conducted to characterize 163 rice germplasm (accessions as well as new collections). Thirty-six germplasm were characterized in T. Aus 2023, 80 in T. Aman 2023 and 47 in Boro 2023-24. Using Rice Germplasm Descriptors and Evaluation Form of BRRI. The experiments were conducted using a single row of 5.4 m long plot for each entry/accession with 20 × 20 cm spacing between rows and plants respectively. Fertilizers were applied @ 60:20:40 kg NPK/ha in T. Aus and T. Aman and @ 80:20:40 kg NPK/ha in Boro seasons. Appropriate control measures were taken for insect, pests, diseases and weeds when necessary.

In Aus 2023, among the 36 germplasm accessions, all the germplasm were of duration short (<135 days) (Table 1). Twenty-six germplasm were found with short (<110 cm), 9 medium (110-130 cm) and one with long (>130 cm) plant height. In case of panicle length (cm), eight had short (≤20), sixteen had medium long (21-25), 11 had long (26-30) and one had extra-long (>30) panicles. For 1000-grain weight (TGW), two germplasm had low (16-19 g), eight had medium (20-23 g), twenty-two had high (24-27 g) and four had very high (>27 g) grain weights. For yield, 12 germplasm had medium (5-10 g) and 24 germplasm had higher (>10 g) yield per hill. The shortest growth duration (108 days) was observed in PANDAY. The shortest plant height (65.8 cm) was observed in HULIGAMBIR and the longest (132.1cm) in KUMRI BORO. Binni Dhan had the lowest (15.0 g) and KHAIR MONI had the highest (32 g) TGW. The highest yield per hill (27.59 g) was observed in ABDULLAH.

Investigators: Armin Bhuiya (PI), Mohammad Abubakar Siddique

In T. Aman 2023, all the accession had long (>130 days) growth duration (Table 2). Twenty-one germplasm were found with short (<110 cm), 45 with moderate (110-130 cm) and the rest (14) with long (>130 cm) plant height. Twenty-six germplasm were found with long (>25 cm), 48 with moderate (20-25 cm) and the rest (26) with short (<20 cm)

panicle length. Maximum (75) varieties possessed low (<10) and five varieties possessed moderate (10-15) number of effective tillers. A total of 38 varieties were found having low (<25 g), 36 varieties with moderate (25-30 g) and rest (06) of the varieties/accessions with high (>30 g) TGW. Fifteen varieties possessed moderate (5-10 g) and rest (65) of the varieties/accessions had higher (>10 g) yield/hill. The shortest growth duration (135 days) was observed in Tilok kochuri (Acc. 758) and the longest (151 days) in Paijong and Pajam (Acc. 786 and 787). The shortest plant height (83.4 cm) was observed in Jhinga sali (Acc. 1394) and the longest (154.6 cm) in Dudh moni (Acc. 1156). Hana chikon (Acc. 749) was found to have the highest number of effective tillers (14) and Pajam (Acc. 787) with the lowest (4). The highest grain length breadth ratio (3.6) was observed in Boshi raj (Acc. 1402) and the lowest (1.6) in Ghunshi (Acc. 991). Begon bichi (Acc. 986) had the lowest (10.29 g) and the Patnai (Balam, Acc. 1027) had the highest (33.1 g) TGW. The highest yield per hill (32 g) was observed in Patnai (Balam, Acc. 1027) and the lowest (6 g) in Begon bichi (Acc. 986).

Investigators: Md Abubakar Siddique (PI), Ibna Syod Harunur Rashid, Tonmoy Chakraborti, Md Ashiqur Rahman.

In Boro 2023-24, among the 47 germplasm accessions, 34 had short (107-134 days), one had medium (139 days) and 12 had long (>145) growth duration (Table 3). Similarly, in case of panicle length, one germplasm had short (<20 cm), 20 had medium (20-25 cm) and 26 germplasm had long (>25 cm) panicle. Again, 45 germplasm possessed intermediate (<10) and rest two had high (11) number of tillers per hill. For TGW, five had very low (<15 g), 15 had medium (15-19 g) and 27 had high (19.5-31g) grain weights. Twenty-eight germplasm possessed moderate (5-10 g/hill) and 16 had higher (>10 g/hill) grain yield. Twenty-three germplasm had <3.0 and rest 24 had LB ratio.

The shortest growth duration (107 days) was observed in Boro (Acc. 4970). Jaguli (Acc. 4553) had the lowest (13.0 g) and MTL-241 had the highest (31.0 g) TGW. The highest yield (19.6g) per hill was observed in Anamia (Acc. 4552).

Investigators: Md Humyun Kabir Baktiar (PI), Nashirum Monir, Mir Sharf Uddin Ahmed.

**Table 1. Important features of characterized germplasm in T. Aus 2023.**

| Growth duration (day) |                        | Plant height (cm) |                   | Panicle length (cm) |                                                                    | No. of effective tiller |                                            | TGW          |                                  | Yield/hill (g)  |                   |
|-----------------------|------------------------|-------------------|-------------------|---------------------|--------------------------------------------------------------------|-------------------------|--------------------------------------------|--------------|----------------------------------|-----------------|-------------------|
| Range                 | No. of entries         | Range             | No. of entries    | Range               | No. of entries                                                     | Range                   | No. of entries                             | Range        | No. of entries                   | Range           | No. of entries    |
| <100                  | 0                      | <110              | 26                | ≤20                 | 8                                                                  | <6                      | 3                                          | ≤15          | 0                                | <5              | 0                 |
| 101-115               | 5                      | 110-130           | 9                 | 21-25               | 16                                                                 | 6-10                    | 33                                         | 16-19        | 2                                | 5-10            | 12                |
| 116-135               | 31                     | >130              | 1                 | 26-30               | 11                                                                 | >10                     | 0                                          | 20-23        | 8                                | >10             | 24                |
| 136-150               | 0                      |                   |                   | >30                 | 1                                                                  |                         |                                            | 24-27        | 22                               |                 |                   |
| >150                  | 0                      |                   |                   |                     |                                                                    |                         |                                            | >27          | 4                                |                 |                   |
| Shortest (108)        | PAN DAY (8810)         | Shortest (65.8)   | HULIGAMBIR (8193) | Shortest (17)       | GORCHU (8243), Khumal-7 (8807), ABDULLAH (8240), HULIGAMBIR (8193) | Lowest (4)              | DHORIA (8200), GORCHU (8243), ATLAI (8359) | Lowest (18)  | PAITA (8239), KUMRI BORO- (8363) | Lowest (5.4)    | IKRAHAITTA (8241) |
| Longest (133)         | NATURAL (STRAW) (8195) | Longest (132.1)   | KUMRI BORO (8363) | Longest (30.8)      | NATUL (AWNED LAL) (8194)                                           | Highest (9)             | MUK BADAL (8368)                           | Highest (32) | KHAIR MONI (8198)                | Highest (27.59) | ABDULLAH (8240)   |
| Mean                  | 123                    |                   | 104               |                     | 23                                                                 |                         | 6                                          |              | 24                               |                 | 13                |
| S. Dev.               | 6.94                   |                   | 18.91             |                     | 4.09                                                               |                         | 1.30                                       |              | 3.56                             |                 | 5.88              |
| CV                    | 5.64                   |                   | 18.24             |                     | 17.78                                                              |                         | 20.97                                      |              | 15.08                            |                 | 43.60             |
| LSD                   | 2                      |                   | 6                 |                     | 1                                                                  |                         | 0                                          |              | 1                                |                 | 2                 |

**Table 2. Important features of characterized germplasm during T. Aman 2023.**

| Growth duration     |                      | Plant height    |                    | Panicle length  |                    | No. of tiller |                   | No. of effective tiller |                    | Grain LB ratio |                  | 1000-grain wt. |                      | Yield/hill   |                       |
|---------------------|----------------------|-----------------|--------------------|-----------------|--------------------|---------------|-------------------|-------------------------|--------------------|----------------|------------------|----------------|----------------------|--------------|-----------------------|
| Range               | No. of entries       | Range (cm)      | No. of entries     | Range (cm)      | No. of entries     | Range         | No. of entries    | Range                   | No. of entries     | Range          | No. of entries   | Range (g)      | No. of entries       | Range (g)    | No. of entries        |
| <120 days           | -                    | <110            | 21                 | <20             | 6                  | <10           | 71                | <10                     | 75                 | <3             | 72               | <25            | 38                   | <5           | -                     |
| 120-130 days        | -                    | 110-130         | 45                 | 20-25           | 48                 | 10-15         | 7                 | 10-15                   | 5                  | 3-5            | 8                | 25-30          | 36                   | 5-10         | 15                    |
| >130 days           | 80                   | >130            | 14                 | >25             | 26                 | >15           | 2                 | >15                     | -                  | >5             | -                | >30            | 6                    | >10          | 65                    |
| Shortest (135 days) | Tilok Kochuri (758)  | Shortest (83.4) | Jhinga Sali (1394) | Shortest (17.4) | Kajol gouri (1308) | Lowest (4)    | Pajam (787)       | Lowest (4)              | Pajam (787)        | lowest (1.6)   | Ghunshi (991)    | Lowest (10.29) | Begon bichi (986)    | Lowest (6)   | Begon bichi (986)     |
| Longest (151 days)  | Paijong, Pajam (786, | Longest (154.6) | Dudh moni (1156)   | Longest (30.6)  | Kala bokri (1209)  | highest (19)  | Kola nocha (1119) | Highest (14)            | Hasna chikon (749) | highest (3.6)  | Boshi raj (1402) | Highest (33.1) | Patnai (Balam)(1027) | Highest (32) | Patnai (Balam) (1027) |

**Table 3. Important features of characterized germplasm during Boro 2023-24.**

| Parameters | Growth duration (day)     | Panicle length (cm)                  | Effective (Tille /hill)     | Filled G/P                | 1000 GW (g)             | L/B ratio                    | Yield/hill (g)           |
|------------|---------------------------|--------------------------------------|-----------------------------|---------------------------|-------------------------|------------------------------|--------------------------|
| Range      | 107~179                   | 19.8~34.2                            | 4~11                        | 26~137                    | 13~31                   | 2.28~4.33                    | 3.6~19.6                 |
| Highest    | 107 (Boro, Acc. 4970)     | 19.8 (Topa Boro, Acc. 4983)          | 4 (Begun Bitchi, Acc. 4563) | 26 (Topa Boro, Acc. 4983) | 13 (Jaguli, Acc. 4980)  | 2.28 (Rahman Dhan, Acc.5047) | 3.6 (Begun Bitchi)       |
| Lowest     | 179 (kali Boro, Acc 4961) | 34.2(Atmisail/ Artiksail, Acc. 4562) | 11(Kali Boro, Acc. 4961)    | 137 (Anamia, Acc. 4552)   | 31 (MTL-241, Acc. 5171) | 4.33 (Rata, Acc.4965)        | 19.6 (Anamia, Acc. 4552) |

In conclusion, the variety having higher yield could be utilized in a crossing programme, if other characters satisfy the breeder's objectives.

**Germplasm distribution and exchange.** A total of 3,872 samples were supplied to 30 different requestors in the reporting year. Among the samples, 3,751 germplasm accessions were supplied to 26 users for research purpose and 121 samples of BRRi developed rice varieties were supplied to the researchers, Department of Agricultural Extension (DAE) personnel and university students for research, demonstration as well as other purposes.

Investigators: Partha Sarathi Biswas and Armin Bhuiyan.

## SEED PRODUCTION AND VARIETY MAINTENANCE

**Nucleus seed production and variety maintenance.** One hundred and twenty-five BRRi developed and recommended rice varieties including 18 locally improved varieties (LIVs) were maintained using panicle to row method, maintaining temporal isolation and performing thorough roguing (Table 4 and Fig. 1). After harvest, both the intact panicles and nucleus seed of each variety were stored (20°C with 40% RH) for variety maintenance and distribution to researchers, DAE personnel and students respectively.

Investigators: Ebna Syod Md Harunur Rashid (PI), Md Humayun Kabir Baktiar, Partha Sarathi Biswas.

**Table 4. List of BRRi developed and recommended rice varieties maintained during 2023-24.**

| Season  | Type | Number | Variety                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|---------|------|--------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| T. Aman | MV   | 56     | BR4, BR5, BR10, BR11, BR21, BR22, BR23, BR24, BR25, BRRi dhan27, BRRi dhan30, BRRi dhan31, BRRi dhan32, BRRi dhan33, BRRi dhan34, BRRi dhan37, BRRi dhan38, BRRi dhan39, BRRi dhan40, BRRi dhan41, BRRi dhan42, BRRi dhan43, BRRi dhan44, BRRi dhan46, BRRi dhan48, BRRi dhan49, BRRi dhan51, BRRi dhan52, BRRi dhan53, BRRi dhan54, BRRi dhan56, BRRi dhan57, BRRi dhan62, BRRi dhan66, BRRi dhan70, BRRi dhan71, BRRi dhan72, BRRi dhan73, BRRi dhan75, BRRi dhan76, BRRi dhan77, BRRi dhan78, BRRi dhan79, BRRi dhan80, BRRi dhan82, BRRi dhan83, BRRi dhan85, BRRi dhan87, BRRi dhan90, BRRi dhan91, BRRi dhan93, BRRi dhan94, BRRi dhan95, BRRi dhan98, BRRi dhan103 |
|         | LIV  | 10     | Nizersail, Latisail, Rajasail, Kalijira, Kataribhog, Basmati-D, Patnai23, Tilockkachari, DA29, DA31                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Boro    | MV   | 51     | BR1, BR2, BR3, BR6, BR7, BR8, BR9, BR12, BR14, BR15, BR16, BR17, BR18, BR19, BR26, BRRi dhan28, BRRi dhan29, BRRi dhan35, BRRi dhan36, BRRi dhan45, BRRi dhan47, BRRi dhan50, BRRi dhan55, BRRi dhan58, BRRi dhan59, BRRi dhan60, BRRi dhan61, BRRi dhan63, BRRi dhan64, BRRi dhan65, BRRi dhan67, BRRi dhan68, BRRi dhan69, BRRi dhan74, BRRi dhan81, BRRi dhan84, BRRi dhan86, BRRi dhan88, BRRi dhan89, BRRi dhan92, BRRi dhan96, BRRi dhan97, BRRi dhan98, BRRi dhan99, Bangabandhu dhan100, BRRi dhan101, BRRi dhan102, BRRi dhan104, BRRi dhan105, BRRi dhan107, BRRi dhan108.                                                                                      |
|         | LIV  | 8      | Hbj Boro II, Hbj Boro IV, Hbj Boro VI, Hbj Boro VIII, Purbachi, IR8, IR20, IR64                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Total   |      | 125    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |



Fig. 1. Pictorial view of variety maintenance and nucleus seed production at *West Baid*, BRRI HQ in Boro 2023-24 season.

**Production of Nucleus seed stock.** Seventy-three BRRI developed rice varieties comprising 46 in T. Aman and 27 in Boro were grown following panicle to row method to produce nucleus seed stocks. The objective for nucleus seed production was to maintain genetic purity and homogeneity of morphological characteristics of each variety and subsequently to produce and maintain the seed standard of breeder seed.

‘Panicle to row’ method was used to maintain nucleus seed stock, where the intact panicles were sown instead of threshed seeds of each variety. If off-type plant was identified in a row, then the whole row was discarded or rogued out for maintaining the varietal purity. At maturity, 500 to 50,000 panicles from the ‘true to type’ plants of all the varieties were harvested dried and stored at controlled temperature (20°C with 40% RH).

Investigators: Md Abubakar Siddique (PI), Mir Sharf Uddin Ahmed, Ebna Syod Md Harunur Rashid, Md Abubakar Siddique, Armin Bhuiya, Md Humyun Kabir Baktiar, Tonmoy Chakrabarty, Nashirum Monir and Md Ashiqur Rahman

**Breeder seed and Foundation production and distribution.** GRS Division, Farm Management Division and 11 regional stations of BRRI were engaged in breeder seed production. ‘Panicle to row’ method was also used to produce all breeder seed, where the intact panicles were sown instead of threshed seeds for each variety. Off-type plants were identified and rogued out in every growth stage. The quality of the breeder seed was maintained through 2-3 times visits of the breeder seeds plots of

eleven BRRI regional stations (RS) throughout whole growth stage by the assigned scientists of GRS Division (Table 5).

The foundation seed production farms of BADC at Dattanagar, Jhenaidah (Fig. 2) was also visited upon request for inspection. During the visit, no major insect-pest damage, varietal impurity (<1%) and no obnoxious weeds were observed. Isolation distances and crop conditions were satisfactory. The seed producers were advised for thorough roguing by themselves for one more time before harvesting.

After harvesting of a variety, the seeds were separately threshed, dried, cleaned and stored in controlled temperature (20°C with about 40% RH) at BRRI HQ and other BRRI RS. Seeds from RSs were transported to HQ after pre-processing and necessary documentation. The processed seeds were then offered as seed lot for securing green ‘breeder seed tag’ from the Seed Certification Agency (SCA) for its distribution.

In total 294.07 tons of breeder seed with tags in which 193.65 tons of 20 Boro varieties, 16.72 tons of seven Aus varieties and 83.70 tons of 35 T. Aman varieties were certified breeder seed during 2023-24 (Tables 6, 7, 8).

A total of 249.08 tons of breeder seed in which 158.50 tons of 20 Boro varieties, 11.86 tons of seven Aus varieties and 78.73 tons of 35 T. Aman varieties were distributed among 645 partners (GO, NGO and PS) of ‘BRRI Rice Seed Network’ upon approval by the BRRI authority. Text message (SMS) with variety name, allotted quantity of breeder seed, date

of BS collection from GRS Division, amount of money need to be deposited and bank account number was sent through mobile apps to 433, 32 and 245 SeedNet partners before commencing of Boro 2023-24, Aus 2024 and T. Aman 2024 seasons for distributing allocated amount of breeder seed.

Investigators. Ebna Syod Md Harunur Rashid (PI), Md Sirajul Islam (CSO and Head, FMD), Head and Assigned Scientists of All BRRI RS.

**Table 5. List of scientists for monitoring breeder seed plot at different BRRI RSs.**

| Responsible scientist        | Name of BRRI RS             |
|------------------------------|-----------------------------|
| Mir Sharf Uddin Ahmed        | Cumilla, Kushtia            |
| Ebna Syod Md. Harunur rashid | Rajshahi, Rangpur, Satkhira |
| Md Abubakar Siddique         | Barishal, Sonagazi          |
| Armin Bhuiyan                | Gopalganj, Rangpur          |
| Md Humayun Kabir Baktiar     | Habiganj, Cumilla           |
| Tonmoy Chakraborti           | Bhanga, Sirajganj           |
| Nasirum Monir                | Kushtia                     |
| Md Ashiqur Rahman            | Gopalganj, Rangpur          |

**Table 6. Production and distribution of rice breeder seed on Boro 2023-24.**

| Variety      | Production (with tag) (kg) |                         | Distribution (kg)  |                         |
|--------------|----------------------------|-------------------------|--------------------|-------------------------|
|              | Favourable Variety         | Stress Tolerant Variety | Favourable Variety | Stress Tolerant Variety |
| BR16         | 1140                       |                         | 1140               |                         |
| BR26         | 2280                       |                         | 20                 |                         |
| BRRI dhan28  | 27440                      |                         | 18019              |                         |
| BRRI dhan29  | 21630                      |                         | 21643              |                         |
| BRRI dhan36  |                            | 200                     |                    | 200                     |
| BRRI dhan47  |                            | 1360                    |                    | 30                      |
| BRRI dhan50  | 3630                       |                         | 2887               |                         |
| BRRI dhan58  | 5410                       |                         | 5411               |                         |
| BRRI dhan63  | 3520                       |                         | 3124               |                         |
| BRRI dhan67  |                            | 6240                    |                    | 3044                    |
| BRRI dhan74  | 12800                      |                         | 13296              |                         |
| BRRI dhan81  | 10490                      |                         | 5053               |                         |
| BRRI dhan84  | 4200                       |                         | 3357               |                         |
| BRRI dhan86  | 240                        |                         | 40                 |                         |
| BRRI dhan88  | 7310                       |                         | 7370               |                         |
| BRRI dhan89  | 36560                      |                         | 34159              |                         |
| BRRI dhan92  | 25980                      |                         | 25055              |                         |
| BRRI dhan96  | 4790                       |                         | 1291               |                         |
| BRRI dhan97  |                            | 5160                    |                    | 430                     |
| BRRI dhan99  |                            | 740                     |                    | 650                     |
| BRRI dhan100 | 11800                      |                         | 12001              |                         |
| BRRI dhan101 | 210                        |                         | 157                |                         |
| BRRI dhan102 | 240                        |                         | 239                |                         |
| BRRI dhan104 | 280                        |                         | 256                |                         |
| Total        | 179,950                    | 13,700                  | 154,518            | 4,354                   |
| Grand total  | 193,650                    |                         | 158,872            |                         |



**Table 7. Production and distribution of rice breeder seed on Aus 2023.**

| Variety      | Production (with tag) (kg) | Distribution (kg) |
|--------------|----------------------------|-------------------|
| BRRi dhan 48 | 5770                       | 2667              |
| BRRi dhan 65 | 220                        | 212               |
| BRRi dhan 82 | 100                        | 112               |
| BRRi dhan 83 | 120                        | 05                |
| BRRi dhan85  | 1680                       | 467               |
| BRRi dhan98  | 882                        | 8387              |
| BRRi dhan106 | 10                         | 10                |
| Total        | 16,720                     | 11,860            |

**Table 8. Production and distribution of rice breeder seed on T. Aman 2023.**

| Variety      | Production (with tag) (kg) |                         | Distribution (kg)  |                         |
|--------------|----------------------------|-------------------------|--------------------|-------------------------|
|              | Favourable Variety         | Stress tolerant Variety | Favourable Variety | Stress Tolerant Variety |
| BR10         | 4290                       | -                       | 3360               | -                       |
| BR11         | 4470                       | -                       | 4483               | -                       |
| BR22         | 2260                       | -                       | 2293               | -                       |
| BR23         | 6740                       | -                       | 6801               | -                       |
| BRRi dhan30  | 800                        | -                       | 655                | -                       |
| BRRi dhan32  | 0                          | -                       | 0                  | -                       |
| BRRi dhan33  | 640                        | -                       | 241                | -                       |
| BRRi dhan34  | 4160                       | -                       | 4185               | -                       |
| BRRi dhan39  | 620                        | -                       | 590                | -                       |
| BRRi dhan41  | -                          | 80                      | -                  | 70                      |
| BRRi dhan44  | 110                        | -                       | 60                 | -                       |
| BRRi dhan46  | 120                        | -                       | 125                | -                       |
| BRRi dhan49  | 11380                      | -                       | 10925              | -                       |
| BRRi dhan51  | -                          | 4560                    | -                  | 4465                    |
| BRRi dhan52  | -                          | 5440                    | -                  | 4880                    |
| BRRi dhan56  | -                          | 70                      | -                  | 20                      |
| BRRi dhan57  | -                          | 230                     | -                  | 131                     |
| BRRi dhan62  | 150                        | -                       | 53                 | -                       |
| BRRi dhan66  | -                          | 80                      | -                  | 12                      |
| BRRi dhan70  | -                          | -                       | 15                 | -                       |
| BRRi dhan71  | -                          | 460                     | -                  | 447                     |
| BRRi dhan72  | 350                        | -                       | 42                 | -                       |
| BRRi dhan73  | -                          | 120                     | -                  | 60                      |
| BRRi dhan75  | 6920                       | -                       | 6792               | -                       |
| BRRi dhan76  | 930                        | -                       | 917                | -                       |
| BRRi dhan77  | 10                         | -                       | 15                 | -                       |
| BRRi dhan78  | -                          | 140                     | -                  | 5                       |
| BRRi dhan79  | 50                         | -                       | 30                 | -                       |
| BRRi dhan80  | 160                        | -                       | 50                 | -                       |
| BRRi dhan87  | 14120                      | -                       | 13835              | -                       |
| BRRi dhan90  | 4240                       | -                       | 3414               | -                       |
| BRRi dhan91  | -                          | 120                     | -                  | 101                     |
| BRRi dhan93  | 2360                       | -                       | 2368               | -                       |
| BRRi dhan94  | 740                        | -                       | 776                | -                       |
| BRRi dhan95  | 4700                       | -                       | 3979               | -                       |
| BRRi dhan103 | 2040                       | -                       | 2125               | -                       |
| Nizersail    | 40                         | -                       | 20                 | -                       |
| Total        | 72,400                     | 11,300                  | 68,139             | 10,191                  |
| Grand total  | 83,700                     |                         | 78,330             |                         |



Fig. 2. Pictorial views of monitoring the BS plots in BRRRI regional stations at Satkhira, Rajshahi and FS plots of BADC at Dattnagar, Jhenaidah during 2023-24.

#### EXPLORATORY AND GENETIC STUDIES

##### **Evaluation of photosensitive rice germplasm collected from Northern districts of Bangladesh.**

A total of 12 photosensitive germplasm along with three checks were grown late (transplanting 15 September) in T. Aman 2023-24 season to identify germplasm suitable for late transplanting after flood in northern region of Bangladesh (Bogura, Kurigram, Lalmonirhat, Gaibandha, Rangpur and Jamalpur). One Rosul Bhog (Acc. 338), one Joysail (Acc. 5969) and, one Ganjia (Acc. 284) accession showed better performance on the basis of their

morpho-agronomic traits among the tested entries (Table 9). Grain weights per hill of Rosul Bhog (Acc. 338), Joysail (Acc. 5969) and Ganjia (Acc. 284) germplasm were 10.88 g, 10.08 g and 9.95 g, respectively. L/B ratio of Rosul Bhog was very high (3.70). Longer panicle length (20 to 32 cm), higher number of filled grain per panicle (126 to 151) and medium growth duration (131 to 134 days) were observed in selected three local germplasm.

Investigators: Ebna Syod Md Harunur Rashid (PI), Nasirum Monir.

**Table 9. Performance of twelve photosensitive T. Aman rice germplasm from BRRRI Genebank.**

| Acc. | Name        | Eff/ Tiller | Plant Height (cm) | PL (cm) | DTM | 1000 GW (g) | Yield/ Hill (g) | DGL (mm) | DGW (mm) | L/B ratio |
|------|-------------|-------------|-------------------|---------|-----|-------------|-----------------|----------|----------|-----------|
| 285  | Bindi Pakri | 4.4         | 76.2              | 19.2    | 135 | 15          | 8.2             | 5.79     | 2.01     | 2.9       |
| 284  | Ganjia      | 6.4         | 82                | 20.6    | 134 | 17          | 9.95            | 5.8      | 2.08     | 2.8       |
| 299  | Malshira    | 5.6         | 70.4              | 15      | 135 | 15          | 8.1             | 5.25     | 2.22     | 2.4       |
| 360  | Malshira    | 4           | 57.6              | 14.8    | 132 | 15          | 7.35            | 5.72     | 2.31     | 2.5       |
| 520  | Ganjia      | 7.4         | 77.8              | 21      | 134 | 17          | 9.56            | 5.55     | 2.2      | 2.5       |
| 531  | Ganjia      | 6.4         | 84.2              | 21.4    | 131 | 17          | 8.1             | 5.74     | 2.58     | 2.2       |

| Acc. | Name        | Eff/ Tiller | Plant Height (cm) | PL (cm) | DTM | 1000 GW (g) | Yield/ Hill (g) | DGL (mm) | DGW (mm) | L/B ratio |
|------|-------------|-------------|-------------------|---------|-----|-------------|-----------------|----------|----------|-----------|
| 545  | Malshira    | 4           | 75.2              | 19      | 132 | 18          | 3.04            | 5.68     | 2.21     | 2.6       |
| 3661 | Indur Sail  | 5.4         | 64                | 21.2    | 131 | 18          | 9.35            | 5.74     | 2.72     | 2.1       |
| 4810 | Bindi Pakri | 6           | 70.8              | 17.4    | 133 | 18          | 8.47            | 5.65     | 2.11     | 2.7       |
| 5969 | Joy Sail    | 6.6         | 100.6             | 32      | 133 | 20          | 10.08           | 6.01     | 2.3      | 2.6       |
| 338  | Rosul Bhog  | 5.2         | 72.8              | 11      | 131 | 22          | 10.88           | 5.81     | 2.11     | 2.8       |
| 5071 | Rosul Bhog  | 5.4         | 96.8              | 23.2    | 133 | 14          | 9.45            | 6.6      | 1.8      | 3.7       |
|      | BR22        | 7.6         | 82.2              | 25      | 135 | 19          | 10.6            | 6.09     | 2.18     | 2.8       |
|      | BR23        | 6.8         | 89.6              | 18.6    | 133 | 26          | 11.6            | 6.79     | 2.21     | 3.1       |
|      | Nizersail   | 6.4         | 94.2              | 22.4    | 135 | 18          | 9.85            | 5.28     | 2.09     | 2.5       |
|      | CV          | 19.3        | 15.2              | 36.0    | 1.3 | 17.0        | 22.5            | 7.1      | 9.9      | 13.9      |
|      | LSD (5%)    |             | 6.13              | 3.82    |     | 1.54        | 1.02            | 0.21     | 0.11     | 0.18      |

**Characterization of similar named Jhoshua, Mal Shira, Shailla and Shapahar groups of germplasm.** Twenty-six Jhoshua, Mal shira, Shailla and Shapahar rice germplasm of T. Aman were morphologically characterized using 53 morpho-agronomic characters of BRRI rice descriptor.

Investigators: Md Ashiqur Rahman (PI), Md Abubakar Siddique, Armin Bhuiyan, Tonmoy Chakraborty and Nasirum Monir.

**Identification and selection of low amylose content rice varieties.** Fifty-one Biruin rice germplasm were studied during Aus 2023. The seeds of the best performing Biruin rice germplasm were dehusked manually with a dehusker and sent to GQN Division for evaluation of amylose content. A total of 20 Biruin rice germplasm viz. Biruin (2), Biruin (Tola), Biruin Kalarmur, Biroin(Makri), Biroin (Hawai), Biroin (Habai), Makri Biroin, Biroin, Aikkabiroid, Kalo Biroin, Pakh Biroin, Khara Biroin, Kala Biruin, Modhu Berun, Pak Biruin, Mikal Biruin, Deshi Biruin, Kaila Biruin (Sada), Kala Biruin, Kala Boron, Biruin were found containing very low amylose % (4 -7.8).

Investigators: Armin Bhuiya (PI), Tonmoy Chakraborty, Ebna Syod Md Harunur Rashid, Habibul Bari Shozib (RAL).

**Trait-based selection and agronomic performance analysis of Aus rice germplasm from all over Bangladesh.** A total of 100 Aus rice germplasm were characterized through agronomic characters viz plant height (cm), panicle length (cm), effective tiller (no/hill), growth duration (day), grain length (mm), grain breadth (mm), dehulled rice ratio, grain yield (g/hill). Among them, KALA BOYEI (2) had the shortest (80.42 cm) whereas SENTU four had the highest (129.31 cm) plant height (Table 10). Panicle length was found longest (30.35 cm) for LAITHA JHARA and shortest (14.76 cm) for BRRI JHUM DHAN LOWAS. Highest effective tiller number per hill was found for TEPU DHAN (11) and lowest (3) for SIRAMPURI HATIA. The lowest (100 days) growth duration was found for KALA BOYEI (1) whereas longest (132 days) for BOSHAKHI AUS/20. The shortest (5.08 mm) grain length was found for FAIJOR IRRI whereas longest (10.47 mm) for KANIHATI-1. The shortest (2.16 mm) grain breadth was found for MINIKIT whereas longest (5.53 mm) for JAI MORI. Dehulled rice ratio was found lowest (2.07) for GOTA IRRI and highest (4.44) for KANIHATI-6. In case of grain yield, BRRI JHUM DHAN LOWAS yielded the lowest (2.59 g/hill) number of seeds whereas the highest (21.29 g/hill) amount was yielded by KHATO MALA.

**Table 10. Trait based agronomic performance of Aus germplasm.**

| Trait                      | Range        | Mean   | StDev | CV    | LSD  | Lowest                   | Highest             |
|----------------------------|--------------|--------|-------|-------|------|--------------------------|---------------------|
| Plant height (cm)          | 80.42-129.31 | 107.94 | 10.08 | 9.34  | 1.98 | G4 KALA BOYEI (2)        | G93 SENTU 4         |
| Panicle length (cm)        | 14.76-30.35  | 22.70  | 3.07  | 13.52 | 0.60 | G96 BRRI JHUM DHAN LOWAS | G37 LAITHA JHARA    |
| Effective tiller (no/hill) | 3-11         | 6.86   | 9.66  | 11.79 | 1.89 | G31 SIRAMPURI HATIA      | G44 TEPU DHAN       |
| Growth duration (day)      | 100-132      | 117.97 | 7.08  | 6.00  | 1.39 | G2 KALA BOYEI (1)        | G95 BOSHAKHI AUS/20 |
| Grain length (mm)          | 5.08-10.47   | 8.56   | 0.81  | 9.43  | 0.16 | G22 FAIJOR IRRI          | G80 KANIHATI-1      |
| Grain breadth (mm)         | 2.16-5.53    | 2.76   | 0.40  | 14.35 | 0.08 | G10 MINIKIT              | G53 JAI MORI        |
| Dehulled rice Ratio        | 2.07-4.44    | 2.60   | 0.42  | 16.27 | 0.08 | G47 GOTA IRRI            | G84 KANIHATI-6      |
| Grain yield (g/hill)       | 2.59-21.29   | 9.72   | 4.59  | 47.16 | 0.90 | G96 BRRI JHUM DHAN LOWAS | G5 KHATO MALA       |

Germplasms were screened against Brown Plant Hopper (BPH) under the supervision of Entomology Division of BRRI. Most of the entries showed susceptible reaction (score 7 & 9) against BPH, only 4 germplasm viz GODA IRRI DHAN, MUNSUR, DIGHI BAUAL and KALOSAITTA showed moderately susceptible (score 5) reaction against BPH.

Germplasms were screened against Bacterial Leaf Blight (BLB) under the supervision of Pathology Division of BRRI. Most of the entries showed susceptible (score 7) to highly susceptible (score 9) reaction against BLB, only one germplasm viz. MINIKIT responded moderately resistant (score 3) whereas MOSAIR AUS, AUS (REDDISH), BENASURI and KARDIDET showed moderately susceptible (score 5) reaction against BLB.

Investigators: Tonmoy Chakrabarty (PI), Md Abubakar Siddique, Ebna Syod Md Harunur Rashid, Armin Bhuiya, Nashirum Monir, Md Ashiqur Rahman, Sheikh Arafat Islam Nihad (Path) and Tapon Kumer Roy (Ento).

### **Morphological characterization of Aus rice germplasm collected from greater Kushtia region of Bangladesh.**

In total 58 Aus rice germplasm were morphologically characterized at BRRI HQ farm, Gazipur (Table 11). Table 9 showed that V-2 (UNKNOWN) had the shortest (79.8 cm) whereas BATUL SHI had the highest (136.2 cm) plant height. Panicle length was found longest (28.7 cm) for BATUL SHI and shortest (17.2 cm) for MANIK MODU(2). Highest effective tiller number per hill was found for MANIK MUNDU (9) and lowest (4) for AUS BA. The lowest (99 days) growth duration was found for AUS BAKI whereas longest (115 days) for KADA MONI. SADA AUS had the lowest (30) and KAIKA had the highest (92) number of filled grain/panicle. KALA NOROI had the lowest (17 g) and KADAMONI had the highest (30 g) TGW. Brown rice LB ratio was found lowest (1.67) for KADA MONI(2) and highest (3.33) for HANUMAN JOTA. For grain yield, ZAMIR SAITA yielded the lowest (7.16 g/hill) number of seeds whereas the highest (20.65 g/hill) amount was yielded by HANUMAN JOTA.

Investigators: Nashirum Monir (PI), Md Abubakar Siddique, Tonmoy Chakrabarty and Armin Bhuiya

**Table 11. Some important features of characterized 58 Aus rice germplasm.**

| Traits         | Range      | Mean  | StDev | CV (%) | LSD (0.05) | Lowest               | Highest              |
|----------------|------------|-------|-------|--------|------------|----------------------|----------------------|
| PH (cm)        | 79.8~136.2 | 112   | 12.28 | 10.99  | 3.16       | 79.8 (V-2: UNKNOWN)  | 136.2 (BATUL SHI)    |
| PL (cm)        | 17.2~28.7  | 22.76 | 2.57  | 11.29  | 0.66       | 17.2 (MANIK MODU(2)) | 28.7 (BATUL SHI)     |
| CD (mm)        | 3.1~5.12   | 4.14  | 0.43  | 10.50  | 0.11       | 3.1 (HIDI(2))        | 5.12 (JABAHUL)       |
| TN/hill        | 4~10       | 6.72  | 1.15  | 17.13  | 0.30       | 4 (AUS BA)           | 10 (MANIK MUNDU)     |
| ETN/hill       | 4~9        | 6.40  | 0.95  | 14.91  | 0.25       | 4 (AUS BA)           | 9 (MANIK MUNDU)      |
| DFF            | 70~87      | 76.36 | 3.66  | 4.79   | 0.94       | 70 (AUS BAKI)        | 87 (KADA MONI)       |
| GD (days)      | 99~115     | 105   | 3.60  | 3.43   | 0.93       | 99 (AUS BAKI)        | 115 (KADA MONI)      |
| FG/panicle     | 30~92      | 58.90 | 15.66 | 26.60  | 4.03       | 30 (SADA AUS)        | 92 (KAIKA)           |
| TGW (g)        | 17~30      | 23.76 | 3.78  | 15.89  | 0.97       | 17 (KALO NOROI)      | 30 (KADAMONI)        |
| GLB ratio      | 2.13~3.93  | 2.96  | 0.39  | 13.12  | 0.10       | 2.13 (SADA HIJILI)   | 3.93 (AUS BA)        |
| BR LB ratio    | 1.67~3.33  | 2.46  | 0.37  | 14.96  | 0.09       | 1.67 (KADA MONI(2))  | 3.33 (HANUNAN JOTA)  |
| Yield/hill (g) | 7.16~20.65 | 12.05 | 2.45  | 20.34  | 0.10       | 7.16 (ZAMIR SAITA)   | 20.65 (HANUNAN JOTA) |

Note: PH = Plant height, PL = Panicle length, CD = Culm diameter, TN = Tiller number, ETN = Effective tiller number, DFF = Days to 50% flowering, GD = Growth duration, FG = Filled grain, TGW = Thousand grain weight, GLB = Grain length breadth, BR = Brown rice

**Morphological characterization of Red rice germplasm of Bangladesh.** A total of 50 Aus rice germplasm were characterized through agronomic characters viz plant height (cm), panicle length (cm), effective tiller (no/hill), growth duration (day), grain length (mm), grain breadth (mm), dehulled rice ratio, grain yield (g/hill). Average effective tiller was about 7 ranged from 3 (Manik Mandal) to 11 (Kali Mughi) where average panicle length was 25.10 cm ranged from 18.33 cm (Kali Boro) to 33.00 cm. (Katak Tara) Average filled grain per panicle was 87 ranged from 37 (Ashina) to 188 (Balam) where average 1000 grain weight was 21.40 g ranged from 11.00 g (Modhu Malati) to 32 g. (Manik Modhu) In addition, average grain length was 8.28 mm ranged from 6.18 mm (Mary Saita) to 10.24 mm (Batulshi) where average grain breadth was 2.92 mm ranged from 2.02 mm (Benaful) to 3.79 mm (Manik Mondal). Average dehulled grain length was 5.90 mm ranged from 4.25 mm (Pathar) to 8.35 mm (Batulshi) where average dehulled grain breadth was 2.54 mm ranged from 1.82 mm (Benaful) to 4.66 mm (Bathuri).

Investigators: Md Humayun Kabir Baktiar, Mir Sharf Uddin Ahmed, Ebna Syod Md Harunur Rashid and Md Abubakar Siddique

**Purification and duplicate sorting of genebank accessions through GBS profiling.** To construct a duplicate free core set of rice accessions of BRRI

Genebank, DNA of 460 accessions each with four sample plants (206 Boro accessions and 254 T. Aman accessions were extracted and sent to the University of Saskatchewan, Canada for genotyping by sequencing (GBS). The GBS library pools were subjected for DNA sequencing on the NovaSeq 6000 sequencing platform at GIFS. Sequence data from the NovaSeq6000 for all libraries underwent sequence processing and quality filtering before being de-multiplexed based on the unique barcodes for each sample. The readings for each sample were then aligned against the rice RefSeq genome and then underwent SNP identification using a developed pipeline by the Data Management and Analytics (DMA) team at GIFS. Large numbers of SNPs and indels variation were identified for each sample but to get an initial idea about the relatedness of samples, especially those representing the 5/4 different plants grown from each accession we carried out a phylogeny analysis to develop a dendrogram tree (Fig. 3). This revealed that the 5 different from each accession were indeed mainly clustering together confirming their high degree of relatedness. A total of 383 rice germplasm accessions based on GBS profiling (97% homology) were selected and seeds of those accessions have been multiplied for further phenotyping and evaluation.

Investigators: Md Abubakar Siddique, Armin Bhuiyan and Partha Sarathi Biswas.

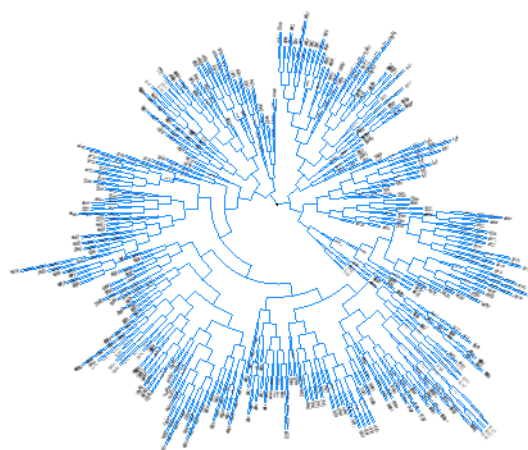


Fig. 3. Phylogenetic analysis of 885 rice samples: The detected SNPs and indels detected in each sample were compared against each other using software (VCF2PopTree) which provides a ‘phylogram’ graphical representation of the clustering. From this output it was possible to identify that the five plants for each of the 177 accessions usually clustered closely together.



# **Grain Quality and Nutrition Division**

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## SUMMARY

In Rice breeding programme, 2,069 breeding lines were analyzed, among them 989 had more than 70% milling outturn, 148 had more than 60% head rice recovery, 222 had more than 3.0 L/B ratio, 238 had more than 25.0% amylose content, 482 had more than 9.0% protein content, 603 had more than 1.5 elongation ratio, 554 had between the range of (4.0-5.0) volume expansion ratio. Some of the promising lines were identified for higher milling and head rice recovery, size and shape, amylose content, protein content, elongation ratio and acceptable other physicochemical properties.

In Transforming Rice Breeding programme, 4,117 transforming breeding (TRB) lines were evaluated for grain quality properties for superior quality. Based on the performance on grain quality, we recommend (52) lines, among them six from salinity tolerant (BR11910-4R-167; BR11919-4R-59; BR11919-4R-86; BR11921-4R-13; BR11925-4R-32; BR11940-4R-171), nine from disease desistant rice (BR11607-4R-6; BR11604-4R-24; BR11869-5R-51; BR11868-5R-122; BR11869-5R-119; BR11866-5R-277; BR11866-5R-5; BR12096-4R-103-1; BR9942-1-2-1-1-B1), five from submergence tolerance (IR16F1243; IR15F1869; IR19L1046a; IR20LT2294; IR 126957-B-48-5-1-3), eight from salt tolerant rice (BR11718-4R-178; BR11276-4R-152; BR11276-4R-132; BR11718-4R-92; BR12274-4R-110; BR12274-4R-9; BR11712-4R-328; BR11712-4R-82), three (3) lines from insect resistant rice (BR 12675-4 R-125; BR 12675-4 R-216; BR 12676-4 R-125), five from favourable Boro rice (BR7528-2R-19-16-RIL-55; IR18A2427; IR19A3799; BR11630-5R-39; BR7528-2R-19-16-RIL-59), three from Favourable Boro and cold tolerant rice (BR12520-5R-67; BR12554-5R-128; IR19A7004), eight from insect resistant rice (BPH) (BR13094-4 R-123; BR13094-4 R-82; BR13099-4 R-166; BR12229-5 R-162; BR12216-5 R-31; BR12296-4 R-74; BR11052-4 R-234; BR11040-4 R-137) and five from salt tolerant rice (BR13105-4R-232; BR12459-4R-103; BR12459-4R-209; BR12459-4R-106; BR12462-4R-283) for further advancement.

Based on cluster analysis of physicochemical properties to identify brand name of paddy the findings of this study ‘Classification of

rice samples collected from farmer’s field’ are taken when millers purchase paddy for sell. They consider paddy length, breadth and thousand grain wt. whereas, when consumer purchases rice for consumption. They prefer well milled rice length, breadth and L/B ratio (10% degree of milling). On the basis of miller and consumer, when they will buy Katari brand they will get, may be, Katari type rice like Katari, Shampakatari and Minijira as well as Minikit brand; Minikit type rice like Jira, Jirasail, Minikit, BRRI dhan28 and Hajarijira. Other findings of this study are Jira, Minikit, Minijira, Jirasail and Hajarijira, which are replaced by BRRI dhan81 as well as Katari and Shampakatari, which are replaced by BRRI dhan28.

The purpose of this work ‘Antiproliferative activity of traditional Black rice cultivars of Bangladesh’ is to examine the apoptotic activity of a local extract and fractions obtained from Bangladeshi black rice bran on human cervical cancer cells (HeLa cells) and Vero cell line. Bran extract of black rice can produce healthier alternative to artificial food colourants. Black rice should be developed in food applications as health products, food industry and pharmaceutical to value add rice. Thus, BK-10 and BK-11 can further be utilized as a superior crossing parent in the molecular breeding of indica type black HYV rice research programme.

Validation of baseline dietary survey questionnaire (6 months to 2 years’ child) of middle and low-income families in rural and urban populations for weaning practices in Bangladesh. In different areas of Gazipur city corporation baseline dietary survey questionnaire has been finalized for quantitative dietary data collection on current weaning practices of Bangladesh.

The study ‘Dietary Habits and Preferences for Unparboiled Rice in Khulna’ focused on rice consumption in Botiaghata and Dakop upazilas of Khulna district. Despite sharing a common cultural identity, its residents exhibit diverse rice preferences. The survey revealed that about 90% of the population regularly consumes unparboiled rice, mainly due to tradition and taste, with local varieties such as Rani Sylhet, Kachra, Juto Balam, and Morich Shail being widely preferred. High-yielding varieties (HYV) and hybrid rice are less popular, with fewer than 10% of respondents consuming

these types. The nutritional awareness of rice is low, with most people unaware of the benefits of parboiled rice. While some reported digestive issues, particularly those in sedentary jobs, physical labourers were less likely to face such problems. The study also observed a shift toward HYV and hybrid rice, particularly among migrants and urban residents.

The survey on 'Dietary Habit and Preferences for Unparboiled Rice in Sylhet' was conducted in four districts named Moulvibazar, Habiganj, Sunamganj and Sylhet under Sylhet Division. The survey area was selected on the basis of literature review. A semi-structured questionnaire was prepared with active consultation of key information. Data were collected on present status of unparboiled consumption area by personal interview through semi-structured questionnaire. The survey was conducted in 28 individuals covering four districts. The result revealed that on average more than 90% respondents were consumed parboiled rice as they follow doctors' advice except Sylhet district (UPB 90%) may reason of their heredity. Additionally, the survey stated that most of the respondents are not much concerned about the nutrition benefit of parboiled or unparboiled rice as well as the health implication due to consumption of unparboiled rice.

Rice contains health-promoting phenolic components such as anthocyanins, which act as antioxidants. Anthocyanin-rich rice varieties are aimed to utilize for the formulation of rice-based value-added food products. Black rice extract (BK11) was found to be effective as anti-cancerous at the dose-dependent application of 2 mg/ml. Anti-proliferative activity of black rice (BK11) was validated in human breast cancer cell lines MCF-7. We have formulated our rice-based products with several ingredients including anthocyanin-enriched black rice (BK11) rice flour (2.0 mg/mL or mg/g), fermented anthocyanin-enriched rice bran, sugar, milk, egg, vanilla essence, sagu powder (natural lubricating agent available in Bangladesh), corn powder, butter, baking powder and rice bran oil (RBO). The rice-based products are resulted in preferable texture and crispiness.

Puffed, popped and flattened rice were produced from BRRI varieties to evaluate the quality

of products. Comparing a few parameters (fully puffed rice, length, and breadth increased percentage) with BR16 (Std), it is ascertained from the results that Bangabandhu dhan100, BRRI dhan80 and BRRI dhan81 are better in producing fully puffed rice followed by BRRI dhan95 and BRRI dhan99 in terms of weight of fully puffed rice. Considering physical parameters of popped rice, BR11, BRRI dhan58 and BRRI dhan67 showed excellent performance followed by BR23 and BRRI dhan52 considering total popped rice percent, fully popped rice percent, partial and broken popped rice percent. On the other hand, BRRI dhan96 showed the best performance followed by BRRI dhan84, BRRI dhan95 and BRRI dhan99 have been found highly promising in producing flattened rice. BRRI dhan95 showed higher potential in producing flattened rice considering the flattened rice length increased percent, the thickness of the flattened rice, 1000 flattened rice weight and the volume of the 50 g sample comparing with other varieties.

## GRAIN QUALITY CHARACTER

### Determination of physicochemical and cooking properties of breeding lines

PI: M A H; CI: S S D, N F, T K S, H B S, S H and M R A  
A total of 2,069 samples were provided from different BRRI divisions and outside of BRRI to find out the desirable characteristics. In Bangladesh, long slender type translucent grains preferred by consumers as premium quality rice with higher price. But medium bold type grains are most suitable for milling. Out of 1,870 samples, 989 had more than 70% milling outturn, 577 had between the range of (68.0-70.0)% milling outturn but 148 had more than 60% head rice recovery and 515 had between the range of (50.0-60.0)% head rice recovery. Out of 1,839 samples, 597 had long grain, 1,138 had medium grain and 104 had short grain. Among these samples 222 had more than 3.0 L/B ratio, whereas 1,467 had between the range of (2.1-3.0) L/B ratio. Out of 1,874 samples, 41 samples had more than 30.0 g 1000-grain wt., 1,255 had between the range of 20.0-30.0 g 1000-grain wt. and 578 had less than 20 g 1000-grain wt. (Table 1).

Amylose is the most important trait for eating quality, which indicates the texture of cooked rice and also volume expansion. Out of 1,698 samples, 238 had more than 25.0% amylose content, 1,013

had between the range of 20-25)% amylose content, and 447 had less than 20% amylose content. Out of 1,698 samples, 482 had more than 9% protein content, 849 had between the range of (7-9)% protein content but only 430 had less than 7% protein content. Less than 7% protein content in brown rice, which is not normally recommended for variety release. Grain with high gelatinization temperature is not desirable. Out of 1,422 samples, 69 had more than 20 min. cooking time, 723 had between the range of 15-20 minute. cooking time but only 630 had less than 15minute cooking time. The samples, having more than 20minute cooking time may give comparatively hard cooked rice. Among 1,839 samples, 603 had between the range of more than 1.5 elongation ratio, 458 had between the range of 1.3-1.5 elongation ratio and 778 had less than 1.3 elongation ratio. More than 1.5 elongation ratio, which are desirable. High volume expansion of cooking is still considered to be a good quality for the working-class people who do not care whether the expansion is lengthwise or crosswise. Among these samples, 47 had more than 5.0 volume expansion ratio, 554 had between the range of 4.0-5.0 volume expansion ratio and 818 had less than 4.0 volume expansion ratio (Table 2).

Some of the promising samples were identified for higher milling outturn, head rice recovery, amylose content, protein content, elongation ratio and acceptable other physicochemical properties.

### **Determination of physicochemical and cooking properties of transforming rice breeding (TRB) lines**

PI: S S D; CI: M A H

Grain quality is an important component for consumer's preference and profitability. For the transforming rice breeding project on rice grain quality screening, 4,117 lines were received, processed and analyzed for grain quality parameter. Data presented in the tables are the mean of three replications.

Among them, 3,045 OYT (Favourable and cold tolerant Boro, insect resistant rice, salinity tolerance, Boro, Submergence tolerant, disease

resistant rice, salinity tolerant T. Aman) lines, 80 were long slender (LS), followed by 948 long bold, four were medium slender, 1,958 were medium bold, seven were medium round, 39 were short bold, eight were short round and one was short. Most of the lines were more than 20 % chalk.

Apparent amylose content 3,446 of OYT lines, 2,689 were high followed by 336 intermediate and 20 was low (Table 3).

Among 1,072 PYT, SYT and AYT lines, 550 lines had more than 70% and 372 had 68-70% total milled rice percentage. One hundred fifty had less than 68% milling outturn which is not desirable. Two hundred five lines had more than 60% followed by 517 had within 50-60%, 350 had less than 30% head rice recovery percentage. Out of 1,072 lines, none were translucent (Table 2). Appearance or colour of milled rice is one of the important physical properties to attract consumer's attention. All of the lines were brown in colour. The consumers in our country prefer long and medium slender grain. Grain length and length to breadth ratio determine the grain size and shape. Out of 1,072 lines, 72 were long slender, followed by 312 were long bold, 156 were medium slender, 528 were medium bold. In Bangladesh, medium slender and medium bold grains are suitable for milling. But long slender rice is sold at high price in the market (Table 4).

Rice contains two types of starch namely-amylose and amylopectin. Amylose content of rice grain determines the hardness and stickiness of cooked rice. More than 25% amylose content provides non sticky cooked rice; 20-25% amylose containing rice provides soft and comparatively sticky cooked rice. Out of 1,072 lines, 756 had more than 25% amylose, 261 lines had amylose content between the range of 20-25% and 55 lines had less than 20 amylose (Table 3). Protein content is measuring the nutritional value of rice. Four hundred fifty-one lines had high (>9%) and 602 lines had intermediate (7-9%) protein content. Generally, a variety having less than 7% protein content in brown

rice, is not recommended for release as a variety (Table 3). 987 lines had cooking time between the range of 15-20 minutes. Imbibition ratio (Volume expansion) is one of the important parameters for rice quality. It shows the value of expansion of rice after cooking. Hard working people of our country prefer rice having more volume expansion. Among 1,072, eight hundred forty-nine lines had than 3.5 volume expansion ratio (Table 5). The elongation ratio is one of the important parameters for cooked rice. Elongation ratio is responsible for fine or coarse cooked it rice. If rice elongation is more in length, it gives a finer appearance, but if it expands in breadth, it gives a coarse look. Long slender and medium slender rice should elongate more in length, as they are consumed mostly by people having comparatively a higher income. The elongation ratio of most of the lines (913) varied between 1.3-1.5 (Table 8). Among the 1,072 breeding lines 72 had alkali spreading value ranging 6-7 and 689 had 3.1-5.9. Grain with high gelatinization temperature is not desirable. This study identified 52 of the promising lines for high milling and acceptable other physicochemical properties.

#### **Classification of rice samples collected from farmer's field based on cluster analysis of physicochemical properties**

PI: N F; CI: M A H

Now a days, consumers prefer specific rice from specific paddy name but it is not possible due to mechanisms of millers. Initially, different types of paddy with similar type of paddy length, breadth and 1000 grain wt were collected in mills from different farmer's field. After that, rice with almost similar types of length and breadth are collected in mills by most of the millers. To determine physicochemical and cooking properties for comparing grain quality among the collected rice samples from farmer's field. To identify brand name of rice and replace local cultivars by BRRI varieties. Sixty rice samples such as Katari (5), Jira (7), Jirasail (10), BRRI dhan28 (1), BRRI dhan81 (9), Minikit (14), Minijira

(5), Shampakatari (8) and Hajarijira (1) were collected from Bogura district (Upazila: Adamdighi and Nandigram) as well as Naogaon district (Upazila: Mahadevpur) at Boro season. All parameters are analyzed by GQN and AOAC standard protocols of cereal products. **Note:** B, A= Bogura, Adamdighi; B, N= Bogura, Nandigram and N, M= Naogaon, Mahadevpur

Among 60 rice samples of nine categories, BRRI dhan81 has shown the highest number of milling outturn (73%) while Shampakatari has shown the lowest number of milling outturn (69.6%); Katari has shown the highest number of head rice recovery (64.4%) while BRRI dhan81 has shown the lowest number of head rice recovery (42.6%); BRRI dhan81 has shown the highest number of paddy length (9.7 mm) while Minijira has shown the lowest number of paddy length (7.7 mm); BRRI dhan28 and Hajarijira both have shown the highest number of paddy breadth (2.2 mm) while Katari, Jira, Jirasail and Minikit all have shown the lowest number of paddy length (2.0 mm) as well as BRRI dhan81 has shown the highest number of 1000 grain wt. (22.4g) while Katari and Shampakatari both have shown the lowest number of 1000 grain wt. (14.3g) (Table 6).

Among 60 rice samples of nine categories, BRRI dhan81 has shown the highest number of milled rice length (6.7mm) while Katari and Shampakatari both have shown the lowest number of milled rice length (5.1mm); BRRI dhan28 has shown the highest number of milled rice breadth (2.0mm) while Katari, Jira and Shampakatari all have shown the lowest number of milled rice length (1.8mm) as well as BRRI dhan81 has shown the highest number of L/B ratio (3.6) while Minijira has shown the lowest number of L/B ratio (2.7). Among these samples, 36 were long slender (LS) types grain size and shape, it were medium slender types grain size and shape (MS) and 18 were medium bold types grain size and shape (MB). Most of the rice samples have good appearance except Minijira (Table 7).

Among 60 rice samples of nine categories, BRRI dhan28 has shown the highest number of Alkali spreading value (5.5) while Jira and Hajarijira both have shown the lowest number of Alkali spreading value (3.1); Jirasail and Hajarijira both have shown the highest number of amylose content (27.1%) while BRRI dhan81 has shown the lowest number of amylose content (26.1%); Shampakatari has shown the highest number of protein content (8.5%) while Jira has shown the lowest number of protein content (6.9%) as well as Jirasail and BRRI dhan28 both have shown the highest number of moisture content (13.1%) while Minijira and Hajarijira both have shown the lowest number of moisture content (11.6%) (Table 8).

Among 60 rice samples of nine categories, cooking time varies from 15:30 to 16:27; elongation ratio (ER) varies from 1.3 to 1.5 as well as Imbibition ratio varies from 4.0 to 4.9 (Table 9).

**Cluster analysis.** Sixty rice samples such as Katari (5), Jira (7), Jirasail (10), BRRI dhan28 (1), BRRI dhan81 (9), Minikit (14), Minijira (5), Shampakatari (8) and Hajarijira (1) were collected from farmers field. All the rice cultivars have formed six dendrograms (such as dendrogram-1, dendrogram-2, dendrogram-3, dendrogram-4, dendrogram-5 and dendrogram-6) based on different properties of rice at level 5.

**Dendrogram-1.** It has provided only two clusters (Cluster-1 and Cluster-2) based on paddy length (PL) and paddy breadth (PB) at level-5. Cluster-1 consists of six rice cultivars, such as Jirasail, Minikit, Jira, BRRI dhan28, BRRI dhan81 and Hajarijira. On the other hand of cluster-2 consists of three rice cultivars, such as Katari, Shampakatari and Minijira (Fig. 1).

**Dendrogram-2.** It has provided three clusters (Cluster-1, Cluster-2 and Cluster-3) based on paddy length (PL), paddy breadth (PB) and 1000 grains weight (TGW) at level-5. Cluster-1 consists of five rice cultivars, such as Jira, Jirasail, Minikit, BRRI

dhan28 and Hajarijira. Cluster-2 consists of only one rice cultivar, such as BRRI dhan81. Cluster-3 consists of three rice cultivars, such as Katari, Shampakatari and Minijira (Fig.1).

**Dendrogram-3.** It has provided three clusters (Cluster-1, Cluster-2 and Cluster-3) based on milled rice length (ML) and milled rice breadth (MB) at level-5. Cluster-1 consists of three rice cultivars, such as Katari, Shampakatari and Minijira. Cluster-2 consists of five rice cultivars, such as Minikit, Hajarijira, Jira, BRRI dhan28 and Jirasail. Cluster-3 consists of only one rice cultivar, such as BRRI dhan81 (Fig.1).

**Dendrogram-4.** It has provided three clusters (Cluster-1, Cluster-2 and Cluster-3) based on milled rice length (ML), milled rice breadth (MB) and length/breadth ratio (L/B) at level-5. Cluster-1 consists of three rice cultivars, such as Katari, Shampakatari and Minijira. Cluster-2 consists of five rice cultivars, such as Jira, Minikit, Hajarijira, Jirasail and BRRI dhan28. Cluster-3 consists of only one rice cultivar, such as BRRI dhan81 (Fig.1).

**Dendrogram-5.** It has provided three clusters (Cluster-1, Cluster-2 and Cluster-3) based on paddy length (PL), paddy breadth (PB), TGW, ML, MB and L/B at level-5. Cluster-1 consists of three rice cultivars, such as Katari, Shampakatari and Minijira. Cluster-2 consists of five rice cultivars, such as Jira, Jirasail, Minikit, BRRI dhan28 and Hajarijira. Cluster-3 consists of only one rice cultivar, such as BRRI dhan81. Three clusters have shown similar clustering in Dendrogram-2, Dendrogram-3, Dendrogram-4, and Dendrogram-5 (Fig.1).

**Dendrogram-6.** It has provided four clusters (Cluster-1, Cluster-2, Cluster-3 and Cluster-4) at level-5. Cluster-1 consists of five rice cultivars, such as Jira, Minikit, Minijira, Jirasail and Hajarijira. Cluster-2 consists of only one rice cultivar, such as BRRI dhan81. Cluster-3 consists of two rice cultivars, such as Katari and Shampakatari. Again,

cluster-4 consists of only one rice cultivar, such as BRRI dhan28 (Fig.1).

On the other hand, another dendrogram has also provided two clusters (Cluster-A and Cluster-B) based on all physicochemical properties of rice at level-15.

**Cluster-A and Cluster-B.** Cluster-A consists of six rice cultivars, such as Jira, Minikit, Minijira, Jirasail, Hajarijira and BRRI dhan81. Cluster-B consists of three rice cultivars, such as Katari, Shampakatari and BRRI dhan28 (Fig. 2).

**Conclusion.** Sixty samples such as Katari (5), Jira (7), Jirasail (10), BRRI dhan28 (1), BRRI dhan81 (9), Minikit (14), Minijira (5), Shampakatari (8) and Hajarijira (1) were collected from Bogura district (Upazila: Adamdighi and Nandigram) and Naogaon (Upazila: Mahadevpur) at Boro season.

Among six dendrograms at level 5, Dendrogram-2 based on paddy length (PL), paddy breadth (PB) and TGW; Dendrogram-3 based on milled rice length (ML) and milled rice breadth (MB); Dendrogram-4 based on ML, MB and L/B ratio and Dendrogram-5 based on paddy length (PL), paddy breadth (PB) and TGW, ML, MB and L/B ratio all have shown the similar three clusters whereas Dendrogram-1 has shown the two clusters based on paddy length (PL) and paddy breadth (PB) but Dendrogram-6 has shown the 4 clusters based on all physicochemical parameters.

Cluster-1 consists of three rice cultivars, such as Katari, Shampakatari and Minijira. Cluster-2 consists of five rice cultivars, such as Jira, Jirasail, Minikit, BRRI dhan28 and Hajarijira. Cluster-3 consists of only one rice cultivar, such as BRRI dhan81. Three clusters have shown similar clustering in Dendrogram-2, Dendrogram-3, Dendrogram-4, and Dendrogram-5.

The findings of this study are taken when millers purchase paddy for sell. They consider paddy length, breadth and thousand grain wt whereas, when

consumer purchases rice for consumption they prefer well milled rice length, breadth and L/B ratio (10% degree of milling). On the basis of miller and consumer, when they will buy Katari brand. They will get may be Katari type rice like Katari, Shampakatari and Minijira as well as Minikit brand; Minikit type rice like Jira, Jirasail, Minikit, BRRI dhan28 and Hajarijira (Fig.1).

Cluster-A consists of six rice cultivars, such as Jira, Minikit, Minijira, Jirasail, Hajarijira and BRRI dhan81. Cluster-B consists of three rice cultivars, such as Katari, Shampakatari and BRRI dhan28. The findings of this study are the local rice cultivars such as Jira, Minikit, Minijira, Jirasail and Hajarijira, which have very close relationship among them. These local rice cultivars also have a relationship with BRRI dhan81. Other local rice cultivars such as Katari and Shampakatari, which have very close relationship among them. These local rice cultivars also have a relationship with BRRI dhan28.

The findings of this study are Jira, Minikit, Minijira, Jirasail and Hajarijira, which are replaced by BRRI dhan81 as well as Katari and Shampakatari, which are replaced by BRRI dhan28 (Fig. 2).

## NUTRITIONAL QUALITY ASSESSMENT OF RICE

### Antiproliferative activity of traditional Black rice cultivars of Bangladesh

PI: S H; CI: H B S; M A H and A H M Nurun Nabi (DU)

Increasing evidence from animal, epidemiological and clinical investigations suggest that dietary anthocyanins have potential to prevent chronic diseases, including cancers. The phytochemical compounds found in pigmented rice can trigger apoptosis in cancer cells and effectively treat metabolic disorders and bioactive compounds derived from rice bran possess the ability to directly safeguard DNA from harm (*Deng et al., 2013*).

Two types of cell used in this study. Hela (Cancer cell line) and Vero (Non cancer cell line) Hela cell line was used as a model to observe

anticancer effect and Vero cell line was used to assess toxic effect of rice extracts. DMEM (Dulbecco's modified eagles's medium) containing 1% penicillin: streptomycin (1:1) and 0.2% gentamycin and 10% fetal bovine serum (FBS). cultured for 48 h. Cells ( $8.0 \times 10^4$ /400 $\mu$ l) used for Hela cell line and ( $6.0 \times 10^4$ /400 $\mu$ l) used for Vero cell line. Further cells were seeded onto 24 well plate and incubated at 37% +5% CO<sub>2</sub>. Next day, 100  $\mu$ l sample (filtered) was added to each well. Then the wells were washed and cell condition were analyzed under the microscope. Here trypan blue was used to differentiate between live and dead cells. Extracts of the rice grain collected from Black rice cultivars Bk-9 (from Sylhet), Bk-10 (from Khagrachari), Bk-11 (from Bandarban) along with BRRI dhan28, BRRI dhan34 and Balam. Black rice extracts from Bk-9, Bk-10 and Bk-11 exhibit antiproliferative activity on Hela cell line (Fig. 3) and did not exhibit any cytotoxic impact on the non-cancerous Vero cell line (Fig. 4). This analysis revealed that white rice extract from BRRI dhan28, BRRI dhan34, and Balam did not exhibit any as a result, these findings suggest that black rice bran extracts are safe to eat because they had no negative effects on Vero cells, which are non-cancerous cells. The purpose of this work is to examine the apoptotic activity of a local extract and fractions obtained from Bangladeshi black rice bran on human cervical cancer cells (Hela cells) and Vero cell line. The findings of our study support the previous research conducted by *RM Rukmana et al., 2016*, who investigated the cytotoxic properties of four indigenous Indonesian black rice bran varieties on cancer cell lines—Raji and HepG2. Bran extract of black rice can produce healthier alternative to artificial food colourants. Black rice should be developed in food applications as health products, food industry and pharmaceutical to add value to rice. Thus, BK-10 and BK-11 can further be utilized as a superior crossing parent in the molecular breeding of indica type black HYV rice research programme.

#### **Cytotoxic effects on malignant Hela and non-cancerous Vero cell lines.**

#### **GRAIN QUALITY PARAMETERS FOR CONSUMER PREFERENCE**

#### **Validation of baseline survey questionnaire for quantitative dietary data collection on current weaning practices**

PI: M R A; CI: S H, H B S, T K S, N F, S S D, M A I (Agri. Eco.), S S (I N F S, D U) and M A H

Breast milk is the best food for infants and supports them with all the necessary nutrients for babies' normal mental and physical growth. It provides polyunsaturated fatty acids, proteins, immunological and bioactive compositions, and all essential minerals in a readily absorbable form. Human milk alone is no longer sufficient to meet the nutritional needs of the growing babies after six months of their age. So, they need additional foods to support their growing nutritional demands besides mother's milk, which is known as weaning or complementary feeding, and begins from six months and continues to 24 months of age or beyond. It is the transitional period from exclusive breastfeeding to the regular family foods of the children. Weaning foods should be rich in calories and good-quality protein, vitamins, and minerals. These foods should be precooked or well-processed and low in indigestible fiber content so that babies can easily swallow and digest.

Rice is the first solid food fed to infants in many cultures because of its availability and cheaper rate than milk, soy products, legumes, etc. Milk-based infant formula contains gluten, which causes allergic reactions in child mainly after one year of birth. Rice is hypoallergenic due to lack of gluten and can be used to develop gluten-free hypoallergenic formula food. Besides rice-based formula can be the best solution to treat lactose intolerance because rice-based formulas do not contain lactose. Cow's milk cannot be replaced by milk from sheep, goats, or buffalo due to a high cross-reactivity between milk proteins from mammals. Cow's milk cannot be replaced by milk from sheep, goats, or buffalo due to a high cross-reactivity between milk proteins from mammals. Extensively hydrolyzed cow's milk formulas (eHF) with documented hypoallergenicity can be recommended as the first choice for the treatment of cow milk allergenicity (CMA), especially in infants and young children. But extensive hydrolysis of cow's milk turns the formula beyond the financial capacity of common people. Amino acid-based

formulas (AAF) can also be recommended, especially for patients with more severe symptoms or in patients not responding to the eHF. Soy and hydrolyzed rice-based formulas (HRFs) are a suitable alternative for infants with CMA that cannot tolerate or do not work like eHF. Soy formula contains significant amounts of phytoestrogens such as isoflavones, and it is to be avoided in the first six months of life as indicated by the European Society for Pediatric.

In addition to being considered hypoallergenic, rice protein contained in the caryopsis has a higher biological value and digestibility than that of other grains such as wheat, barley, and corn, but lower than proteins derived from animal sources, legumes, and oil crops. The nutritional value of a protein is influenced not only by its amino acid composition but also by its digestibility coefficient (DC). The DC of rice proteins is lower than that of cow milk protein (CMP) (93 vs 100%). Slightly higher protein content in infant formulas (1.4 g/100 mL), follow-on formulas (1.5 g/100 mL), and growing-up formula (1.7 g/100 mL) was suggested by French Association of Ambulatory Pediatrics (AFPA), which solved the lower digestibility problem.

Bangladesh Rice Research Institute (BRRI) has released several nutrients (Fe, Zn, Protein) enriched, high-yielding varieties (HYVs). Using these varieties in the formulation of weaning foods can minimize the current scenario of double-burden child malnutrition. This weaning formula can target the middle to low-income families as the formulated weaning item will be cheap due to using rice as principal ingredient along with other locally available sources of nutrients. Addition of nutrient-rich sources to the rice will make the formula protein, vitamin and mineral rich and immune booster. Besides, prebiotics and probiotics will help the baby to have an enriched gut microflora.

Baseline dietary survey questionnaire (six months to two years' child) of middle and low-income families in rural and urban populations for weaning practices in Bangladesh has been validated. In different areas of Gazipur city corporation baseline dietary survey questionnaire has been finalized for quantitative dietary data collection on current weaning practices of Bangladesh.

## **Dietary Habits and Preferences for Unparboiled Rice in Khulna**

PI: T K S; CI: M A H

**Rice varieties cultivated in Khulna.** The study identified that local rice varieties, such as Rani Sylhet, Kachra, Morich Shail, Juto Balam, Chap Shail, and Kumri, dominate the cultivation in Botiaghata and Dakop upazilas. Additionally, high-yielding varieties like BR11, BR23, BRRI dhan28, BRRI dhan29, and hybrid varieties like Hira and Chokka are also cultivated.

**Consumption preferences and market availability.** Approximately 90% of the population consumes unparboiled rice, a hereditary habit. Local markets sell both parboiled and unparboiled rice, with local varieties being favoured for their taste. Only 10% of respondents consume high-yielding or hybrid rice varieties, and about 60% grow their rice.

**Cultivation and purchasing patterns.** Around 27% of respondents consume a mix of local and HYV rice, primarily the rice they grow themselves. Thirty percent do not cultivate rice but purchase it from markets or stockpile paddy after harvest. Despite its higher price, local rice is preferred for its taste.

**Awareness and health implications.** The survey revealed that 90% of respondents were unaware of the nutritional differences between parboiled and unparboiled rice. While some reported digestive issues, particularly those with sitting jobs, physical labourers experienced fewer health problems. Migrants and urban dwellers increasingly prefer parboiled rice due to its availability.

## **A Survey on Dietary Habits and Preferences for Unparboiled Rice in Sylhet**

PI: S S D; CI: M A H

Rice is the staple food in Bangladesh; with an average per capita consumption rate 144.5 kg/year, that accounts for 67.5 percent of the daily calorie intake (FAOSTAT, 2021). Most rice consumed in Bangladesh is parboiled (PB), although unparboiled (UPB) milled rice is preferred in some areas. So, this survey intended to determine the area of people are consuming UPB rice and behind the reason. The survey was conducted in four districts



such as Moulvibazar, Habiganj, Sunamganj and Sylhet under Sylhet Division. The survey area was selected on the basis of review literature. A semi-structured questionnaire was prepared with active consultation of key informants (Q 1). Data were collected on present status of unparboiled consumption area by personal interview through semi-structured questionnaire. The survey was conducted in 28 individuals covering four districts such as Sylhet (5), Habiganj (10), Sunamganj (3) and Moulvibazar (10).

**Rice varieties cultivated in Sylhet.** In Sylhet division including four districts, the cultivated varieties are BR22, BRRi dhan28, BRRi dhan29, BRRi dhan49, BRRi dhan52, BRRi dhan76, BRRi dhan78, BRRi dhan88, BRRi dhan89, BRRi dhan92, BRRi dhan96, Bongobondhu dhan100, Hira, Muktasail, Ranjit, CMG, Poshusail, Beruin, Katari, Swarna-5, Nazirsail, Chinigura, Shompakatari, Kataribhog, Mota IRRI, Zirasail, Gazi, Mukta IRRI and Mala. These rice varieties are also available in the market.

**Rice consumption and preferences.** The majority of the people of Moulvibazar, Habiganj, Sunamganj are shifting UBR to PB rice, very few are still eating UPB rice. In Sylhet district most of the people (95%) prefer UPB rice. The majority of the population from Sylhet division prefer long to medium slender grain. The study observed that parboiled rice is high prior than UPB rice may due to the processing cost of parboiled rice.

**Reason of shifting UPB to PB rice.** In Bangladesh a high prevalence of diabetes was observed and in has been steadily increasing over time. Studies suggest that parboiled rice has a lower impact on blood sugar levels, making it a safer choice for people with diabetes then other rice. Majority (96%) of the populations answer that doctors' advise them to eat parboiled rice instead UPB due to the diabetes concern.

**Cultivation and Purchasing Patterns.** Majority (Habiganj, Sunamganj and Sylhet) of the population are buying rice from the market, very few (10-20%) are eating rice from their own production.

**Preferences of unparboiled (UPB) rice.** Majority of the unparboiled consumer opinioned that

UPB rice is tasty, easily digestible, takes less cooking time and extends heredity.

**Nutrition awareness and health Implication.** The majority of the respondents (95%) are not aware of the nutritional benefits of parboiled or unparboiled rice. The common belief is that UPB rice may cause constipation or problem of digestion. During the survey we did not find any information from anyone regarding long term digestive or constipation problems information.

**Conclusion.** Findings from this study revealed that majority of the respondent from Habiganj, Sunamganj, Moulvibazar are consuming parboiled rice because of awareness about diabetes. On the other hand, people from Sylhet district are still consuming unparboiled rice due to their heredity concern. Most of the people purchase rice from the market instead of the fact that their own production may provide higher level of incomes, demand shifts from village to town and substitute market. They are unaware about the nutritional benefit of PB or UPB rice as well as the health implication due to consuming UPB rice.

## COMMERCIAL RICE BASED PRODUCT

### Formulation of rice-based foods supplemented with anthocyanin-enriched fermented rice bran

PI: H B S; CI: M A H

Rice contains health-promoting phenolic components such as anthocyanins, which act as antioxidants. Anthocyanin-rich rice varieties are aimed to utilize for the formulation of rice-based value-added food products. Black rice (BK11) has an extra long (7.6 mm) type of rice grain with the highest Cyanidin-3-Glucoside (C3G) content of 806.15 ppm and high protein enriched (10.7%) which seems to be very suitable for manufacturing rice-based bakery products. BK11 rice extract was found to be effective as anti-cancerous at the dose-dependent application of two mg/ml. Anti-proliferative activity of BK11 was validated in human breast cancer cell lines MCF-7 (Fig. 6).

In preparation of fermented rice bran (FRB), we have optimized the protocol as described below.

Distilled water is taken in 500 ml duran bottle, measured MRS broth powder (27.5gm) and dissolved water. Sterilized this solution (media), cooled this media and took the next step for making culture, *Lactobacillus acidophilus*, *Lactobacillus bulgaricus*, *bifidobacterium bifidum* probiotic powder (1gm) weighted and dissolved in cooled sterile water. Liquid media has taken to a conical flask (probiotic solution  $12 \times 10^6$  per mL) Inoculation ( $36^\circ\text{C}$ , 48 hours, 130 rpm in shaking incubator). Culture is prepared. Sucrose (1%), pectin (1%) and alpha-amylase (1%) (All ingredients are previously dissolved in 10 ml sterilized water separately). Rice bran (200 gm), wrapped a container with pure cotton cloth. Incubation at  $36^\circ\text{C}$ , 48 hours. Add previously prepared *Lactobacillus* culture (250ml). Incubation at  $36^\circ\text{C}$ , 48 hours. Continued incubation up to 72 hours for fermentation. Drying ( $65^\circ\text{C}$ , 48 hours). grinding and blending of fermented sample. Preserved at  $4^\circ\text{C}$  for future test or use.

We have formulated our rice-based products with several ingredients including anthocyanin-enriched black rice (BK11) rice flour (2.0 mg/mL or mg/g), fermented anthocyanin-enriched rice bran, sugar, milk, egg, vanilla essence, sagu powder (natural lubricating agent available in Bangladesh), corn powder, butter, baking powder and rice bran oil (RBO). Since rice does not have gluten protein and it's very fragile in texture, we applied combination of sagu and corn powder to make the food dough compatible for uses in terms of softer, thicker and gaining elasticity. It resulted in preferable texture and crispiness (Fig. 7).

### **Determination of physicochemical properties and quality of puffed, popped and flattened rice from newly released BRRI varieties**

PI: M A H; CI: N F, T K S and H B S

Physical properties viz length, breadth, thickness, increased length and breadth, and volume of rice products such as puffed, popped and flattened rice were determined. This study aims to screen out the BRRI-released varieties that are suitable for popular snack food products: puffed, popped, and flattened rice for instance. BR16 is used as the standard for all the products of puffed, popped, and flattened rice.

Comparing with the standard variety, it is ascertained from the results that Bangabandhu dhan100, BRRI dhan80 and BRRI dhan81 are better in producing fully puffed rice 77.07%, 50.83% and 53.99% respectively followed by BRRI dhan95 (45.34%) and BRRI dhan99 (37.54%) in terms of weight of fully puffed rice. Considering overall parameters, BRRI dhan80 and BRRI dhan81 yielded better results: puffed rice length = 13.68 mm and 13.41 mm; increased percentage of puffed rice length = 94.54% and 98.42%; increased percent of puffed rice breadth = 124.80% and 136.67%, and 50 g puffed rice volume = 553.33 ml and 500.00 ml followed BRRI dhan99 (puffed rice length = 12.80 mm, increased percentage of length = 103.33%, volume = 540.00 ml), Bangabandhu dhan100 (puffed rice length = 11.97 mm, increased percentage of length = 129.69%, volume = 550.00 ml) and BRRI dhan95 (puffed rice length = 10.30 mm, increased percentage of length = 98.14%, volume = 473.33 ml) respectively (Table 10). Results of correlation matrix for relationships ascertained that puffed rice length is highly significant and positively correlated with milled rice length ( $r=0.803$ ,  $p<0.1$ ) as well as fifty g puffed rice volume is also highly significant and positively correlated with fully puffed rice ( $r=0.772$ ,  $p<0.1$ ). Puffed rice breadth is significant and positively correlated with milled rice length ( $r=0.670$ ,  $p<0.5$ ). Puffed rice breadth increase is significant and positively correlated with milled rice length ( $r=0.639$ ,  $p<0.5$ ) as well as it is also significant and positively correlated with puffed rice breadth ( $r=0.678$ ,  $p<0.5$ ). Similarly, thousand puffed rice weight is significant and positively correlated with milled rice length ( $r=0.761$ ,  $p<0.5$ ) as well as it is also significant and positively correlated with puffed rice breadth ( $r=0.749$ ,  $p<0.5$ ) (Table 11).

In the case of popped rice, BR11, BRRI dhan58 and BRRI dhan67 showed excellent performance followed by BR23 and BRRI dhan52 considering total popped rice percent, fully popped rice percent, partial and broken popped rice percent. On the other hand, in terms of increased popped rice length and volume of 50 g popped rice, BRRI dhan67 (122.72% and 850 ml) performed better than BR11 (119.07% and 783 ml) and BRRI dhan58 (100.54 and 820 ml). However, BRRI dhan32 (137.65%), BRRI dhan55 (134.93%) and BRRI dhan60 (134.95%) showed the highest potential in

increasing breadth percent respectively after being popped (Table 12). Results of the correlation matrix for relationships ascertained that the popped rice length is highly significant and positively correlated with the brown rice length ( $r=0.815$ ,  $p<0.01$ ). Thousand popped rice wt is significant and positively correlated with brown rice breadth ( $r=0.710$ ,  $p<0.05$ ) as well as partially popped rice is also significant and positively correlated with total waste ( $r=0.682$ ,  $p<0.05$ ) (Table 13).

Similarly, physical properties such as whole, partial, and broken flattened rice were considered. Comparing the varieties selected from screening, it is revealed from the results that in terms of weight of whole, partial, and broken flattened rice, BRRI dhan96 showed the best performance followed by BRRI dhan84, BRRI dhan95 and BRRI dhan99 (Table 14). However, the results demonstrated that BRRI dhan95 showed higher

potential in producing flattened rice considering the flattened rice length increased percent, the thickness of the flattened rice, 1000 flattened rice weight, and the volume of the 50 g sample. It is ascertained from the study that brown rice length and breadth are not or insignificantly correlated with the flattened rice length and breadth. Results of correlation matrix for relationships ascertained that flattened rice breadth increased is highly significant and positively correlated with flattened rice breadth ( $r=0.863$ ,  $p<0.1$ ) as well as thousand flattened rice wt is also highly significant and positively correlated with brown rice length ( $r=0.884$ ,  $p<0.1$ ) as well as it is also significant and positively correlated with broken flattened rice ( $r=0.826$ ,  $p<0.5$ ). Similarly, brown rice length is significant and positively correlated with broken flattened rice ( $r=0.728$ ,  $p<0.5$ ) (Table 15).

Table 1. Physical properties of rice samples

| Range                | Properties and Sample number               |
|----------------------|--------------------------------------------|
|                      | Milling Outturn (%) (Total sample 1874)    |
| >70.0                | 989                                        |
| 68.0-70.0            | 577                                        |
| <68.0                | 308                                        |
|                      | Head rice recovery (%) (Total sample 1870) |
| >60.0                | 148                                        |
| 50.0-60.0            | 515                                        |
| <50.0                | 1207                                       |
|                      | Length (mm) (Total sample 1839)            |
| >6.0                 | 597                                        |
| 5.0-6.0              | 1138                                       |
| <5.0                 | 104                                        |
|                      | L/B ratio (Total sample 1839)              |
| >3.0                 | 222                                        |
| 2.1-3.0              | 1467                                       |
| <2.0                 | 150                                        |
|                      | Size & Shape (Total sample 1721)           |
| >6.0 mm ; >3.0       | 0                                          |
| >6.0 mm ; 2.1-3.0    | 530                                        |
| 5.0-6.0 mm ; >3.0    | 1                                          |
| 5.0-6.0 mm ; 2.1-3.0 | 1093                                       |
| <5.0 mm ; 2.1-3.0    | 92                                         |
| <5.0 mm ; <2.0       | 5                                          |
|                      | 1000-grain wt. (g) (Total sample 1874)     |
| >30.0                | 41                                         |
| 20-30                | 1255                                       |
| <20                  | 578                                        |

Table 2. Chemical and cooking properties of rice samples

| Range     | Properties and Sample number               |
|-----------|--------------------------------------------|
|           | Alkali spreading Value (Total sample 751)  |
| >6        | 199                                        |
| 4.1-5.9   | 599                                        |
| <4        | 33                                         |
|           | Amylose content (%) (Total sample 1698)    |
| >25.0     | 238                                        |
| 20.0-25.0 | 1013                                       |
| <20.0     | 447                                        |
|           | Protein content (%) (Total sample 1698)    |
| >9.0      | 482                                        |
| 7.0-9.0   | 849                                        |
| <7.0      | 430                                        |
|           | Cooking time (min.) (Total sample 1422)    |
| >20       | 69                                         |
| 15.0-20   | 723                                        |
| <15.0     | 630                                        |
|           | Elongation ratio (Total sample 1839)       |
| >1.5      | 603                                        |
| 1.3-1.5   | 458                                        |
| <1.4      | 778                                        |
|           | Volume expansion ratio (Total sample 1419) |
| >5.0      | 47                                         |
| 4.0-5.0   | 554                                        |
| <4.0      | 818                                        |

**Table 3: Physicochemical properties of Transforming Rice Breeding (OYT) rice lines**

| Parameter & Total number of sample | Classification         | Number of Sample |
|------------------------------------|------------------------|------------------|
| Size & Shape (Milled Rice)         | Long Slender           | 80               |
| (Total sample no. 3045)            | Long Bold              | 948              |
|                                    | Medium Slender         | 4                |
|                                    | Medium Bold            | 1958             |
|                                    | Medium Round           | 7                |
|                                    | Short Bold             | 39               |
|                                    | Short Round            | 8                |
|                                    | Short <del>Short</del> | 1                |
| Amylose Content (%)                | High                   | 2689             |
| (Total sample no. 3045)            | Intermediate           | 336              |
|                                    | Low                    | 20               |

Table 4: Physical properties of promising PYT, SYT and AYT genotypes

| Range     | Properties and Sample number               |
|-----------|--------------------------------------------|
|           | Milling Outturn (%) (Total sample 1072)    |
| >70.0     | 550                                        |
| 68.0-70.0 | 372                                        |
| <68.0     | 150                                        |
|           | Head rice recovery (%) (Total sample 1072) |
| >60.0     | 205                                        |
| 50.0-60.0 | 517                                        |
| <50.0     | 350                                        |
|           | Length (mm.) (Total sample 1072)           |
| >6.0      | 597                                        |
| 5.0-6.0   | 371                                        |
| <5.0      | 104                                        |
|           | L/B ratio (Total sample 1072)              |
| >3.0      | 222                                        |
| 2.1-3.0   | 700                                        |
| <2.0      | 150                                        |
|           | Size & Shape (Total sample 1072)           |
| LS        | 72                                         |
| LB        | 312                                        |
| MS        | 156                                        |
| MB        | 528                                        |
| MR        | 4                                          |
|           | Chalk (%) (Total sample 1072)              |
| 0 (Gr)    | -                                          |
| <10       | 112                                        |
| 10-20     | 156                                        |
| >20       | 804                                        |

Table 5: Chemical and cooking properties of Transforming Rice Breeding (PYT, SYT, and AYT) rice samples

| Range     | Properties & Sample no.                        |
|-----------|------------------------------------------------|
|           | Amlylose content (%) (Total sample No. 1072)   |
| >25.0     | 756                                            |
| 20.0-25.0 | 261                                            |
| <20.0     | 55                                             |
|           | Protein content (%) (Total sample No. 1072)    |
| >9.0      | 451                                            |
| 7.0-9.0   | 602                                            |
| <7.0      | 19                                             |
|           | Alkali Spreading Value (Total sample No. 1072) |
| 1.0-3.0   | 311                                            |
| 3.1- 5.9  | 689                                            |
| >6.0      | 72                                             |
|           | Cooking time (min.) (Total sample No. 1072)    |
| >20       | 23                                             |
| 15-20     | 987                                            |
| <15       | 62                                             |
|           | Elongation ratio (Total sample No. 1072)       |
| >1.5      | 74                                             |
| 1.3-1.5   | 913                                            |
| <1.3      | 85                                             |
|           | Volume expansion ratio (Total sample No. 1072) |
| >4.0      | -                                              |
| 3.4-4.0   | 223                                            |
| <3.5      | 849                                            |

Table 6. Milling properties of rice samples collected from Baidya and Nauyas district (Boro)

[illegible]

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| Turbine     | Wibber<br>scatter (%) | SE, CTV %<br>LSD | Dead<br>loss | SE, CTV %<br>LSD | Peak<br>load loss | SE, CTV %<br>LSD | Health<br>loss | SE, CTV %<br>LSD | Wibber<br>scatter (%) | SE, CTV %<br>LSD |
|-------------|-----------------------|------------------|--------------|------------------|-------------------|------------------|----------------|------------------|-----------------------|------------------|
| Wibber 3.3  | 7.7                   |                  |              |                  | 3.7               |                  |                |                  | 7.7                   |                  |
| Wibber 3.7  | 7.7                   |                  |              |                  | 3.7               |                  |                |                  | 7.7                   |                  |
| Wibber 4.0  | 7.7                   |                  |              |                  | 3.7               |                  |                |                  | 7.7                   |                  |
| Wibber 4.3  | 7.7                   | 1.2 (4.1)        | 1.1*         | 1.1 (4.2)        | 1.1*              | 7.7 (3.1)        | 2.1*           | 1.1 (4.1)        | 7.7 (3.1)             |                  |
| Wibber 4.6  | 7.7                   | 1.0 (3.1)        | 1.1*         | 1.0 (3.1)        | 1.1*              | 3.6 (1.1)        | 2.1*           | 2.1*             | 3.6 (1.1)             |                  |
| Wibber 4.9  | 7.7                   | 1.1 (3.1)        | 1.1*         | 1.1 (3.1)        | 1.1*              | 1.1 (3.1)        | 2.1*           | 1.1*             | 1.1 (3.1)             |                  |
| Wibber 5.1  | 7.7                   |                  |              |                  | 3.7               |                  |                |                  | 3.7                   |                  |
| Wibber 5.4  | 7.7                   |                  |              |                  | 3.7               |                  |                |                  | 3.7                   |                  |
| Wibber 5.7  | 7.7                   |                  |              |                  | 3.7               |                  |                |                  | 3.7                   |                  |
| Wibber 6.0  | 7.7                   |                  |              |                  | 3.7               |                  |                |                  | 3.7                   |                  |
| Wibber 6.3  | 7.7                   | 1.0 (3.1)        | 1.1*         | 1.0 (3.1)        | 1.1*              | 7.7 (3.1)        | 2.1*           | 1.0 (3.1)        | 7.7 (3.1)             |                  |
| Wibber 6.6  | 7.7                   | 1.0 (3.1)        | 1.1*         | 1.0 (3.1)        | 1.1*              | 3.6 (1.1)        | 2.1*           | 1.0 (3.1)        | 3.6 (1.1)             |                  |
| Wibber 6.9  | 7.7                   | 1.1 (3.1)        | 1.1*         | 1.1 (3.1)        | 1.1*              | 1.1 (3.1)        | 2.1*           | 1.1 (3.1)        | 1.1 (3.1)             |                  |
| Wibber 7.2  | 7.7                   |                  |              |                  | 3.7               |                  |                |                  | 3.7                   |                  |
| Wibber 7.5  | 7.7                   |                  |              |                  | 3.7               |                  |                |                  | 3.7                   |                  |
| Wibber 7.8  | 7.7                   |                  |              |                  | 3.7               |                  |                |                  | 3.7                   |                  |
| Wibber 8.1  | 7.7                   |                  |              |                  | 3.7               |                  |                |                  | 3.7                   |                  |
| Wibber 8.4  | 7.7                   |                  |              |                  | 3.7               |                  |                |                  | 3.7                   |                  |
| Wibber 8.7  | 7.7                   |                  |              |                  | 3.7               |                  |                |                  | 3.7                   |                  |
| Wibber 9.0  | 7.7                   |                  |              |                  | 3.7               |                  |                |                  | 3.7                   |                  |
| Wibber 9.3  | 7.7                   |                  |              |                  | 3.7               |                  |                |                  | 3.7                   |                  |
| Wibber 9.6  | 7.7                   |                  |              |                  | 3.7               |                  |                |                  | 3.7                   |                  |
| Wibber 9.9  | 7.7                   |                  |              |                  | 3.7               |                  |                |                  | 3.7                   |                  |
| Wibber 10.2 | 7.7                   |                  |              |                  | 3.7               |                  |                |                  | 3.7                   |                  |
| Wibber 10.5 | 7.7                   |                  |              |                  | 3.7               |                  |                |                  | 3.7                   |                  |
| Wibber 10.8 | 7.7                   |                  |              |                  | 3.7               |                  |                |                  | 3.7                   |                  |
| Wibber 11.1 | 7.7                   |                  |              |                  | 3.7               |                  |                |                  | 3.7                   |                  |
| Wibber 11.4 | 7.7                   |                  |              |                  | 3.7               |                  |                |                  | 3.7                   |                  |
| Wibber 11.7 | 7.7                   |                  |              |                  | 3.7               |                  |                |                  | 3.7                   |                  |
| Wibber 12.0 | 7.7                   |                  |              |                  | 3.7               |                  |                |                  | 3.7                   |                  |
| Wibber 12.3 | 7.7                   |                  |              |                  | 3.7               |                  |                |                  | 3.7                   |                  |
| Wibber 12.6 | 7.7                   |                  |              |                  | 3.7               |                  |                |                  | 3.7                   |                  |
| Wibber 12.9 | 7.7                   |                  |              |                  | 3.7               |                  |                |                  | 3.7                   |                  |
| Wibber 13.2 | 7.7                   |                  |              |                  | 3.7               |                  |                |                  | 3.7                   |                  |
| Wibber 13.5 | 7.7                   |                  |              |                  | 3.7               |                  |                |                  | 3.7                   |                  |
| Wibber 13.8 | 7.7                   |                  |              |                  | 3.7               |                  |                |                  | 3.7                   |                  |
| Wibber 14.1 | 7.7                   |                  |              |                  | 3.7               |                  |                |                  | 3.7                   |                  |
| Wibber 14.4 | 7.7                   |                  |              |                  | 3.7               |                  |                |                  | 3.7                   |                  |
| Wibber 14.7 | 7.7                   |                  |              |                  | 3.7               |                  |                |                  | 3.7                   |                  |
| Wibber 15.0 | 7.7                   |                  |              |                  | 3.7               |                  |                |                  | 3.7                   |                  |
| Wibber 15.3 | 7.7                   |                  |              |                  | 3.7               |                  |                |                  | 3.7                   |                  |
| Wibber 15.6 | 7.7                   |                  |              |                  | 3.7               |                  |                |                  | 3.7                   |                  |
| Wibber 15.9 | 7.7                   |                  |              |                  | 3.7               |                  |                |                  | 3.7                   |                  |
| Wibber 16.2 | 7.7                   |                  |              |                  | 3.7               |                  |                |                  | 3.7                   |                  |
| Wibber 16.5 | 7.7                   |                  |              |                  | 3.7               |                  |                |                  | 3.7                   |                  |
| Wibber 16.8 | 7.7                   |                  |              |                  | 3.7               |                  |                |                  | 3.7                   |                  |
| Wibber 17.1 | 7.7                   |                  |              |                  | 3.7               |                  |                |                  | 3.7                   |                  |
| Wibber 17.4 | 7.7                   |                  |              |                  | 3.7               |                  |                |                  | 3.7                   |                  |
| Wibber 17.7 | 7.7                   |                  |              |                  | 3.7               |                  |                |                  | 3.7                   |                  |
| Wibber 18.0 | 7.7                   |                  |              |                  | 3.7               |                  |                |                  | 3.7                   |                  |
| Wibber 18.3 | 7.7                   |                  |              |                  | 3.7               |                  |                |                  | 3.7                   |                  |
| Wibber 18.6 | 7.7                   |                  |              |                  | 3.7               |                  |                |                  | 3.7                   |                  |
| Wibber 18.9 | 7.7                   |                  |              |                  | 3.7               |                  |                |                  | 3.7                   |                  |
| Wibber 19.2 | 7.7                   |                  |              |                  | 3.7               |                  |                |                  | 3.7                   |                  |
| Wibber 19.5 | 7.7                   |                  |              |                  | 3.7               |                  |                |                  | 3.7                   |                  |
| Wibber 19.8 | 7.7                   |                  |              |                  | 3.7               |                  |                |                  | 3.7                   |                  |
| Wibber 20.1 | 7.7                   |                  |              |                  | 3.7               |                  |                |                  | 3.7                   |                  |
| Wibber 20.4 | 7.7                   |                  |              |                  | 3.7               |                  |                |                  | 3.7                   |                  |

Table 1. Physical properties of test samples collected from *Regia* and *Monaca* turbine (B&B).

| Turbine     | Wibber<br>scatter (%) | SE, CTV %<br>LSD | Dead<br>loss | SE, CTV %<br>LSD | Peak<br>load loss | SE, CTV %<br>LSD | Health<br>loss | SE, CTV %<br>LSD | Wibber<br>scatter (%) | SE, CTV %<br>LSD |
|-------------|-----------------------|------------------|--------------|------------------|-------------------|------------------|----------------|------------------|-----------------------|------------------|
| Wibber 3.3  | 7.7                   |                  |              |                  | 3.7               |                  |                |                  | 7.7                   |                  |
| Wibber 3.7  | 7.7                   | 1.2 (4.1)        | 1.1*         | 1.1 (4.2)        | 1.1*              | 7.7 (3.1)        | 2.1*           | 1.1 (4.1)        | 7.7 (3.1)             |                  |
| Wibber 4.0  | 7.7                   | 1.0 (3.1)        | 1.1*         | 1.0 (3.1)        | 1.1*              | 3.6 (1.1)        | 2.1*           | 2.1*             | 3.6 (1.1)             |                  |
| Wibber 4.3  | 7.7                   | 1.1 (3.1)        | 1.1*         | 1.1 (3.1)        | 1.1*              | 1.1 (3.1)        | 2.1*           | 1.1*             | 1.1 (3.1)             |                  |
| Wibber 4.6  | 7.7                   |                  |              |                  | 3.7               |                  |                |                  | 3.7                   |                  |
| Wibber 4.9  | 7.7                   |                  |              |                  | 3.7               |                  |                |                  | 3.7                   |                  |
| Wibber 5.1  | 7.7                   |                  |              |                  | 3.7               |                  |                |                  | 3.7                   |                  |
| Wibber 5.4  | 7.7                   |                  |              |                  | 3.7               |                  |                |                  | 3.7                   |                  |
| Wibber 5.7  | 7.7                   |                  |              |                  | 3.7               |                  |                |                  | 3.7                   |                  |
| Wibber 6.0  | 7.7                   |                  |              |                  | 3.7               |                  |                |                  | 3.7                   |                  |
| Wibber 6.3  | 7.7                   | 1.0 (3.1)        | 1.1*         | 1.0 (3.1)        | 1.1*              | 7.7 (3.1)        | 2.1*           | 1.0 (3.1)        | 7.7 (3.1)             |                  |
| Wibber 6.6  | 7.7                   | 1.0 (3.1)        | 1.1*         | 1.0 (3.1)        | 1.1*              | 3.6 (1.1)        | 2.1*           | 1.0 (3.1)        | 3.6 (1.1)             |                  |
| Wibber 6.9  | 7.7                   | 1.1 (3.1)        | 1.1*         | 1.1 (3.1)        | 1.1*              | 1.1 (3.1)        | 2.1*           | 1.1 (3.1)        | 1.1 (3.1)             |                  |
| Wibber 7.2  | 7.7                   |                  |              |                  | 3.7               |                  |                |                  | 3.7                   |                  |
| Wibber 7.5  | 7.7                   |                  |              |                  | 3.7               |                  |                |                  | 3.7                   |                  |
| Wibber 7.8  | 7.7                   |                  |              |                  | 3.7               |                  |                |                  | 3.7                   |                  |
| Wibber 8.1  | 7.7                   |                  |              |                  | 3.7               |                  |                |                  | 3.7                   |                  |
| Wibber 8.4  | 7.7                   |                  |              |                  | 3.7               |                  |                |                  | 3.7                   |                  |
| Wibber 8.7  | 7.7                   |                  |              |                  | 3.7               |                  |                |                  | 3.7                   |                  |
| Wibber 9.0  | 7.7                   |                  |              |                  | 3.7               |                  |                |                  | 3.7                   |                  |
| Wibber 9.3  | 7.7                   |                  |              |                  | 3.7               |                  |                |                  | 3.7                   |                  |
| Wibber 9.6  | 7.7                   |                  |              |                  | 3.7               |                  |                |                  | 3.7                   |                  |
| Wibber 9.9  | 7.7                   |                  |              |                  | 3.7               |                  |                |                  | 3.7                   |                  |
| Wibber 10.2 | 7.7                   |                  |              |                  | 3.7               |                  |                |                  | 3.7                   |                  |
| Wibber 10.5 | 7.7                   |                  |              |                  | 3.7               |                  |                |                  | 3.7                   |                  |
| Wibber 10.8 | 7.7                   |                  |              |                  | 3.7               |                  |                |                  | 3.7                   |                  |
| Wibber 11.1 | 7.7                   |                  |              |                  | 3.7               |                  |                |                  | 3.7                   |                  |
| Wibber 11.4 | 7.7                   |                  |              |                  | 3.7               |                  |                |                  | 3.7                   |                  |
| Wibber 11.7 | 7.7                   |                  |              |                  | 3.7               |                  |                |                  | 3.7                   |                  |
| Wibber 12.0 | 7.7                   |                  |              |                  | 3.7               |                  |                |                  | 3.7                   |                  |
| Wibber 12.3 | 7.7                   |                  |              |                  | 3.7               |                  |                |                  | 3.7                   |                  |
| Wibber 12.6 | 7.7                   |                  |              |                  | 3.7               |                  |                |                  | 3.7                   |                  |
| Wibber 12.9 | 7.7                   |                  |              |                  | 3.7               |                  |                |                  | 3.7                   |                  |
| Wibber 13.2 | 7.7                   |                  |              |                  | 3.7               |                  |                |                  | 3.7                   |                  |
| Wibber 13.5 | 7.7                   |                  |              |                  | 3.7               |                  |                |                  | 3.7                   |                  |
| Wibber 13.8 | 7.7                   |                  |              |                  | 3.7               |                  |                |                  | 3.7                   |                  |
| Wibber 14.1 | 7.7                   |                  |              |                  | 3.7               |                  |                |                  | 3.7                   |                  |
| Wibber 14.4 | 7.7                   |                  |              |                  | 3.7               |                  |                |                  | 3.7                   |                  |
| Wibber 14.7 | 7.7                   |                  |              |                  | 3.7               |                  |                |                  | 3.7                   |                  |
| Wibber 15.0 | 7.7                   |                  |              |                  | 3.7               |                  |                |                  | 3.7                   |                  |
| Wibber 15.3 | 7.7                   |                  |              |                  | 3.7               |                  |                |                  | 3.7                   |                  |
| Wibber 15.6 | 7.7                   |                  |              |                  | 3.7               |                  |                |                  | 3.7                   |                  |
| Wibber 15.9 | 7.7                   |                  |              |                  | 3.7               |                  |                |                  | 3.7                   |                  |
| Wibber 16.2 | 7.7                   |                  |              |                  | 3.7               |                  |                |                  | 3.7                   |                  |
| Wibber 16.5 | 7.7                   |                  |              |                  | 3.7               |                  |                |                  | 3.7                   |                  |
| Wibber 16.8 | 7.7                   |                  |              |                  | 3.7               |                  |                |                  | 3.7                   |                  |
| Wibber 17.1 | 7.7                   |                  |              |                  | 3.7               |                  |                |                  | 3.7                   |                  |
| Wibber 17.4 | 7.7                   |                  |              |                  | 3.7               |                  |                |                  | 3.7                   |                  |
| Wibber 17.7 | 7.7                   |                  |              |                  | 3.7               |                  |                |                  | 3.7                   |                  |
| Wibber 18.0 | 7.7                   |                  |              |                  | 3.7               |                  |                |                  | 3.7                   |                  |
| Wibber 18.3 | 7.7                   |                  |              |                  | 3.7               |                  |                |                  | 3.7                   |                  |
| Wibber 18.6 | 7.7                   |                  |              |                  | 3.7               |                  |                |                  | 3.7                   |                  |
| Wibber 18.9 | 7.7                   |                  |              |                  | 3.7               |                  |                |                  | 3.7                   |                  |
| Wibber 19.2 | 7.7                   |                  |              |                  | 3.7               |                  |                |                  | 3.7                   |                  |
| Wibber 19.5 | 7.7                   |                  |              |                  | 3.7               |                  |                |                  | 3.7                   |                  |
| Wibber 19.8 | 7.7                   |                  |              |                  | 3.7               |                  |                |                  | 3.7                   |                  |
| Wibber 20.1 | 7.7                   |                  |              |                  | 3.7               |                  |                |                  | 3.7                   |                  |
| Wibber 20.4 | 7.7                   |                  |              |                  | 3.7               |                  |                |                  | 3.7                   |                  |

| IC   | Variety         | Mildew<br>(mg/L) | HexS-GC<br>C70:4.13 | Mildew<br>(mg/L) | HexS-GC<br>C70:4.13 | LS<br>res | HexS-LC<br>C70:4.13 | Test<br>Day | Cookies     | Appearance |
|------|-----------------|------------------|---------------------|------------------|---------------------|-----------|---------------------|-------------|-------------|------------|
| 1033 | EPD final (3.0) | 4.0              | 1.02E-02            | 1.0              | 102.100E-1          | 5.7       | 0.75E-14            | 13          | 100000000   | 1.600      |
| 1034 | EPD final (3.0) | 4.0              | 2.04E-02            | 1.0              | 2.039E-01           | 5.6       | 0.07                | 13          | 100000000   | 1.600      |
| 1035 | EPD final (3.0) | 4.0              | 1.0                 | 1.0              | 1.0                 | 5.6       | 1.0                 | 13          | 0.000000000 | 1.600      |
| 1036 | EPD final (3.0) | 4.0              | 1.0                 | 1.0              | 1.0                 | 5.6       | 1.0                 | 13          | 0.000000000 | 1.600      |
| 1037 | EPD final (3.0) | 4.0              | 1.0                 | 1.0              | 1.0                 | 5.6       | 1.0                 | 13          | 0.000000000 | 1.600      |
| 1038 | EPD final (3.0) | 4.0              | 1.0                 | 1.0              | 1.0                 | 5.6       | 1.0                 | 13          | 0.000000000 | 1.600      |
| 1039 | EPD final (3.0) | 4.0              | 1.0                 | 1.0              | 1.0                 | 5.6       | 1.0                 | 13          | 0.000000000 | 1.600      |
| 1040 | EPD final (3.0) | 4.0              | 1.0                 | 1.0              | 1.0                 | 5.6       | 1.0                 | 13          | 0.000000000 | 1.600      |
| 1041 | EPD final (3.0) | 4.0              | 1.0                 | 1.0              | 1.0                 | 5.6       | 1.0                 | 13          | 0.000000000 | 1.600      |
| 1042 | EPD final (3.0) | 4.0              | 1.0                 | 1.0              | 1.0                 | 5.6       | 1.0                 | 13          | 0.000000000 | 1.600      |
| 1043 | EPD final (3.0) | 4.0              | 1.0                 | 1.0              | 1.0                 | 5.6       | 1.0                 | 13          | 0.000000000 | 1.600      |
| 1044 | EPD final (3.0) | 4.0              | 1.0                 | 1.0              | 1.0                 | 5.6       | 1.0                 | 13          | 0.000000000 | 1.600      |
| 1045 | EPD final (3.0) | 4.0              | 1.0                 | 1.0              | 1.0                 | 5.6       | 1.0                 | 13          | 0.000000000 | 1.600      |
| 1046 | EPD final (3.0) | 4.0              | 1.0                 | 1.0              | 1.0                 | 5.6       | 1.0                 | 13          | 0.000000000 | 1.600      |
| 1047 | EPD final (3.0) | 4.0              | 1.0                 | 1.0              | 1.0                 | 5.6       | 1.0                 | 13          | 0.000000000 | 1.600      |
| 1048 | EPD final (3.0) | 4.0              | 1.0                 | 1.0              | 1.0                 | 5.6       | 1.0                 | 13          | 0.000000000 | 1.600      |
| 1049 | EPD final (3.0) | 4.0              | 1.0                 | 1.0              | 1.0                 | 5.6       | 1.0                 | 13          | 0.000000000 | 1.600      |
| 1050 | EPD final (3.0) | 4.0              | 1.0                 | 1.0              | 1.0                 | 5.6       | 1.0                 | 13          | 0.000000000 | 1.600      |
| 1051 | EPD final (3.0) | 4.0              | 1.0                 | 1.0              | 1.0                 | 5.6       | 1.0                 | 13          | 0.000000000 | 1.600      |
| 1052 | EPD final (3.0) | 4.0              | 1.0                 | 1.0              | 1.0                 | 5.6       | 1.0                 | 13          | 0.000000000 | 1.600      |
| 1053 | EPD final (3.0) | 4.0              | 1.0                 | 1.0              | 1.0                 | 5.6       | 1.0                 | 13          | 0.000000000 | 1.600      |
| 1054 | EPD final (3.0) | 4.0              | 1.0                 | 1.0              | 1.0                 | 5.6       | 1.0                 | 13          | 0.000000000 | 1.600      |
| 1055 | EPD final (3.0) | 4.0              | 1.0                 | 1.0              | 1.0                 | 5.6       | 1.0                 | 13          | 0.000000000 | 1.600      |
| 1056 | EPD final (3.0) | 4.0              | 1.0                 | 1.0              | 1.0                 | 5.6       | 1.0                 | 13          | 0.000000000 | 1.600      |
| 1057 | EPD final (3.0) | 4.0              | 1.0                 | 1.0              | 1.0                 | 5.6       | 1.0                 | 13          | 0.000000000 | 1.600      |
| 1058 | EPD final (3.0) | 4.0              | 1.0                 | 1.0              | 1.0                 | 5.6       | 1.0                 | 13          | 0.000000000 | 1.600      |
| 1059 | EPD final (3.0) | 4.0              | 1.0                 | 1.0              | 1.0                 | 5.6       | 1.0                 | 13          | 0.000000000 | 1.600      |
| 1060 | EPD final (3.0) | 4.0              | 1.0                 | 1.0              | 1.0                 | 5.6       | 1.0                 | 13          | 0.000000000 | 1.600      |
| 1061 | EPD final (3.0) | 4.0              | 1.0                 | 1.0              | 1.0                 | 5.6       | 1.0                 | 13          | 0.000000000 | 1.600      |
| 1062 | EPD final (3.0) | 4.0              | 1.0                 | 1.0              | 1.0                 | 5.6       | 1.0                 | 13          | 0.000000000 | 1.600      |
| 1063 | EPD final (3.0) | 4.0              | 1.0                 | 1.0              | 1.0                 | 5.6       | 1.0                 | 13          | 0.000000000 | 1.600      |
| 1064 | EPD final (3.0) | 4.0              | 1.0                 | 1.0              | 1.0                 | 5.6       | 1.0                 | 13          | 0.000000000 | 1.600      |
| 1065 | EPD final (3.0) | 4.0              | 1.0                 | 1.0              | 1.0                 | 5.6       | 1.0                 | 13          | 0.000000000 | 1.600      |
| 1066 | EPD final (3.0) | 4.0              | 1.0                 | 1.0              | 1.0                 | 5.6       | 1.0                 | 13          | 0.000000000 | 1.600      |
| 1067 | EPD final (3.0) | 4.0              | 1.0                 | 1.0              | 1.0                 | 5.6       | 1.0                 | 13          | 0.000000000 | 1.600      |
| 1068 | EPD final (3.0) | 4.0              | 1.0                 | 1.0              | 1.0                 | 5.6       | 1.0                 | 13          | 0.000000000 | 1.600      |
| 1069 | EPD final (3.0) | 4.0              | 1.0                 | 1.0              | 1.0                 | 5.6       | 1.0                 | 13          | 0.000000000 | 1.600      |
| 1070 | EPD final (3.0) | 4.0              | 1.0                 | 1.0              | 1.0                 | 5.6       | 1.0                 | 13          | 0.000000000 | 1.600      |
| 1071 | EPD final (3.0) | 4.0              | 1.0                 | 1.0              | 1.0                 | 5.6       | 1.0                 | 13          | 0.000000000 | 1.600      |
| 1072 | EPD final (3.0) | 4.0              | 1.0                 | 1.0              | 1.0                 | 5.6       | 1.0                 | 13          | 0.000000000 | 1.600      |
| 1073 | EPD final (3.0) | 4.0              | 1.0                 | 1.0              | 1.0                 | 5.6       | 1.0                 | 13          | 0.000000000 | 1.600      |
| 1074 | EPD final (3.0) | 4.0              | 1.0                 | 1.0              | 1.0                 | 5.6       | 1.0                 | 13          | 0.000000000 | 1.600      |
| 1075 | EPD final (3.0) | 4.0              | 1.0                 | 1.0              | 1.0                 | 5.6       | 1.0                 | 13          | 0.000000000 | 1.600      |
| 1076 | EPD final (3.0) | 4.0              | 1.0                 | 1.0              | 1.0                 | 5.6       | 1.0                 | 13          | 0.000000000 | 1.600      |
| 1077 | EPD final (3.0) | 4.0              | 1.0                 | 1.0              | 1.0                 | 5.6       | 1.0                 | 13          | 0.000000000 | 1.600      |
| 1078 | EPD final (3.0) | 4.0              | 1.0                 | 1.0              | 1.0                 | 5.6       | 1.0                 | 13          | 0.000000000 | 1.600      |
| 1079 | EPD final (3.0) | 4.0              | 1.0                 | 1.0              | 1.0                 | 5.6       | 1.0                 | 13          | 0.000000000 | 1.600      |
| 1080 | EPD final (3.0) | 4.0              | 1.0                 | 1.0              | 1.0                 | 5.6       | 1.0                 | 13          | 0.000000000 | 1.600      |
| 1081 | EPD final (3.0) | 4.0              | 1.0                 | 1.0              | 1.0                 | 5.6       | 1.0                 | 13          | 0.000000000 | 1.600      |
| 1082 | EPD final (3.0) | 4.0              | 1.0                 | 1.0              | 1.0                 | 5.6       | 1.0                 | 13          | 0.000000000 | 1.600      |
| 1083 | EPD final (3.0) | 4.0              | 1.0                 | 1.0              | 1.0                 | 5.6       | 1.0                 | 13          | 0.000000000 | 1.600      |
| 1084 | EPD final (3.0) | 4.0              | 1.0                 | 1.0              | 1.0                 | 5.6       | 1.0                 | 13          | 0.000000000 | 1.600      |
| 1085 | EPD final (3.0) | 4.0              | 1.0                 | 1.0              | 1.0                 | 5.6       | 1.0                 | 13          | 0.000000000 | 1.600      |
| 1086 | EPD final (3.0) | 4.0              | 1.0                 | 1.0              | 1.0                 | 5.6       | 1.0                 | 13          | 0.000000000 | 1.600      |
| 1087 | EPD final (3.0) | 4.0              | 1.0                 | 1.0              | 1.0                 | 5.6       | 1.0                 | 13          | 0.000000000 | 1.600      |
| 1088 | EPD final (3.0) | 4.0              | 1.0                 | 1.0              | 1.0                 | 5.6       | 1.0                 | 13          | 0.000000000 | 1.600      |
| 1089 | EPD final (3.0) | 4.0              | 1.0                 | 1.0              | 1.0                 | 5.6       | 1.0                 | 13          | 0.000000000 | 1.600      |
| 1090 | EPD final (3.0) | 4.0              | 1.0                 | 1.0              | 1.0                 | 5.6       | 1.0                 | 13          | 0.000000000 | 1.600      |
| 1091 | EPD final (3.0) | 4.0              | 1.0                 | 1.0              | 1.0                 | 5.6       | 1.0                 | 13          | 0.000000000 | 1.600      |
| 1092 | EPD final (3.0) | 4.0              | 1.0                 | 1.0              | 1.0                 | 5.6       | 1.0                 | 13          | 0.000000000 | 1.600      |
| 1093 | EPD final (3.0) | 4.0              | 1.0                 | 1.0              | 1.0                 | 5.6       | 1.0                 | 13          | 0.000000000 | 1.600      |
| 1094 | EPD final (3.0) | 4.0              | 1.0                 | 1.0              | 1.0                 | 5.6       | 1.0                 | 13          | 0.000000000 | 1.600      |
| 1095 | EPD final (3.0) | 4.0              | 1.0                 | 1.0              | 1.0                 | 5.6       | 1.0                 | 13          | 0.000000000 | 1.600      |
| 1096 | EPD final (3.0) | 4.0              | 1.0                 | 1.0              | 1.0                 | 5.6       | 1.0                 | 13          | 0.000000000 | 1.600      |
| 1097 | EPD final (3.0) | 4.0              | 1.0                 | 1.0              | 1.0                 | 5.6       | 1.0                 | 13          | 0.000000000 | 1.600      |
| 1098 | EPD final (3.0) | 4.0              | 1.0                 | 1.0              | 1.0                 | 5.6       | 1.0                 | 13          | 0.000000000 | 1.600      |
| 1099 | EPD final (3.0) | 4.0              | 1.0                 | 1.0              | 1.0                 | 5.6       | 1.0                 | 13          | 0.000000000 | 1.600      |
| 1100 | EPD final (3.0) | 4.0              | 1.0                 | 1.0              | 1.0                 | 5.6       | 1.0                 | 13          | 0.000000000 | 1.600      |
| 1101 | EPD final (3.0) | 4.0              | 1.0                 | 1.0              | 1.0                 | 5.6       | 1.0                 | 13          | 0.000000000 | 1.600      |
| 1102 | EPD final (3.0) | 4.0              | 1.0                 | 1.0              | 1.0                 | 5.6       | 1.0                 | 13          | 0.000000000 | 1.600      |
| 1103 | EPD final (3.0) | 4.0              | 1.0                 | 1.0              | 1.0                 | 5.6       | 1.0                 | 13          | 0.000000000 | 1.600      |
| 1104 | EPD final (3.0) | 4.0              | 1.0                 | 1.0              | 1.0                 | 5.6       | 1.0                 | 13          | 0.000000000 | 1.600      |
| 1105 | EPD final (3.0) | 4.0              | 1.0                 | 1.0              | 1.0                 | 5.6       | 1.0                 | 13          | 0.000000000 | 1.600      |
| 1106 | EPD final (3.0) | 4.0              | 1.0                 | 1.0              | 1.0                 | 5.6       | 1.0                 | 13          | 0.000000000 | 1.600      |
| 1107 | EPD final (3.0) | 4.0              | 1.0                 | 1.0              | 1.0                 | 5.6       | 1.0                 | 13          | 0.000000000 | 1.600      |
| 1108 | EPD final (3.0) | 4.0              | 1.0                 | 1.0              | 1.0                 | 5.6       | 1.0                 | 13          | 0.000000000 | 1.600      |
| 1109 | EPD final (3.0) | 4.0              | 1.0                 | 1.0              | 1.0                 | 5.6       | 1.0                 | 13          | 0.000000000 | 1.600      |
| 1110 | EPD final (3.0) | 4.0              | 1.0                 | 1.0              | 1.0                 | 5.6       | 1.0                 | 13          | 0.000000000 | 1.600      |
| 1111 | EPD final (3.0) | 4.0              | 1.0                 | 1.0              | 1.0                 | 5.6       | 1.0                 | 13          | 0.000000000 | 1.600      |
| 1112 | EPD final (3.0) | 4.0              | 1.0                 | 1.0              | 1.0                 | 5.6       | 1.0                 | 13          | 0.000000000 | 1.600      |
| 1113 | EPD final (3.0) | 4.0              | 1.0                 | 1.0              | 1.0                 | 5.6       | 1.0                 | 13          | 0.000000000 | 1.600      |
| 1114 | EPD final (3.0) | 4.0              | 1.0                 | 1.0              | 1.0                 | 5.6       | 1.0                 | 13          | 0.000000000 | 1.600      |
| 1115 | EPD final (3.0) | 4.0              | 1.0                 | 1.0              | 1.0                 | 5.6       | 1.0                 | 13          | 0.000000000 | 1.600      |
| 1116 | EPD final (3.0) | 4.0              | 1.0                 | 1.0              | 1.0                 | 5.6       | 1.0                 | 13          | 0.000000000 | 1.600      |
| 1117 | EPD final (3.0) | 4.0              | 1.0                 | 1.0              | 1.0                 | 5.6       | 1.0                 | 13          | 0.000000000 | 1.600      |
| 1118 | EPD final (3.0) | 4.0              | 1.0                 | 1.0              | 1.0                 | 5.6       | 1.0                 | 13          | 0.000000000 | 1.600      |
| 1119 | EPD final (3.0) | 4.0              | 1.0                 | 1.0              | 1.0                 | 5.6       | 1.0                 | 13          | 0.000000000 | 1.600      |
| 1120 | EPD final (3.0) | 4.0              | 1.0                 | 1.0              | 1.0                 | 5.6       | 1.0                 | 13          | 0.000000000 | 1.600      |
| 1121 | EPD final (3.0) | 4.0              | 1.0                 | 1.0              | 1.0                 | 5.6       | 1.0                 | 13          | 0.000000000 | 1.600      |
| 1122 | EPD final (3.0) | 4.0              | 1.0                 | 1.0              | 1.0                 | 5.6       | 1.0                 | 13          | 0.000000000 | 1.600      |
| 1123 | EPD final (3.0) | 4.0              | 1.0                 | 1.0              | 1.0                 | 5.6       | 1.0                 | 13          | 0.000000000 | 1.600      |
| 1124 | EPD final (3.0) | 4.0              | 1.0                 | 1.0              | 1.0                 | 5.6       | 1.0                 | 13          | 0.000000000 | 1.600      |
| 1125 | EPD final (3.0) | 4.0              | 1.0                 | 1.0              | 1.0                 | 5.6       | 1.0                 | 13          | 0.000000000 | 1.600      |
| 1126 | EPD final (3.0) | 4.0              | 1.0                 | 1.0              | 1.0                 | 5.6       | 1.0                 | 13          | 0.000000000 | 1.600      |
| 1127 | EPD final (3.0) | 4.0              | 1.0                 | 1.0              | 1.0                 | 5.6       | 1.0                 | 13          | 0.000000000 | 1.600      |
| 1128 | EPD final (3.0) | 4.0              | 1.0                 | 1.0              | 1.0                 | 5.6       | 1.0                 | 13          | 0.000000000 | 1.600      |
| 1129 | EPD final (3.0) | 4.0              | 1.0                 | 1.0              | 1.0                 | 5.6       | 1.0                 | 13          | 0.000000000 | 1.600      |
| 1130 | EPD final (3.0) | 4.0              | 1.0                 | 1.0              | 1.0                 | 5.6       | 1.0                 | 13          | 0.000000000 | 1.600      |
| 1131 | EPD final (3.0) | 4.0              | 1.0                 | 1.0              | 1.0                 | 5.6       | 1.0                 | 13          | 0.000000000 | 1.600      |
| 1132 | EPD final (3.0) | 4.0              | 1.0                 | 1.0              | 1.0                 | 5.6       | 1.0                 | 13          | 0.000000000 | 1.600      |
| 1133 | EPD final (3.0) | 4.0              | 1.0                 | 1.0              | 1.0                 | 5.6       | 1.0                 | 13          | 0.000000000 | 1.600      |
| 1134 | EPD final (3.0) | 4.0              | 1.0                 | 1.0              | 1.0                 | 5.6       | 1.0                 | 13          | 0.000000000 | 1.600      |
| 1135 | EPD final (3.0) | 4.0              | 1.0                 | 1.0              | 1.0                 | 5.6       | 1.0                 | 13          | 0.000000000 | 1.600      |
| 1136 | EPD final (3.0) | 4.0              | 1.0                 | 1.0              | 1.0                 | 5.6       | 1.0                 | 13          | 0.000000000 | 1.600      |
| 1137 | EPD final (3.0) | 4.0              | 1.0                 | 1.0              | 1.0                 | 5.6       | 1.0                 | 13          | 0.000000000 | 1.600      |
| 1138 | EPD final (3.0) | 4.0              | 1.0                 | 1.0              | 1.0                 | 5.6       | 1.0                 | 13          | 0.000000000 | 1.600      |
| 1139 | EPD final (3.0) | 4.0              | 1.0                 | 1.0              | 1.0                 | 5.6       | 1.0                 | 13          | 0.000000000 | 1.600      |
| 1140 | EPD final (3.0) | 4.0              | 1.0                 | 1.0              | 1.0                 | 5.6       | 1.0                 | 13          | 0.000000000 | 1.600      |
| 1141 | EPD final (3.0) | 4.0              | 1.0                 | 1.0              | 1.0                 | 5.6       | 1.0                 | 13          | 0.000000000 | 1.600      |
| 1142 | EPD final (3.0) | 4.0              | 1.0                 | 1.0              | 1.0                 | 5.6       | 1.0                 | 13          | 0.000000000 | 1.600      |
| 1143 | EPD final (3.0) | 4.0              | 1.0                 | 1.0              | 1.0                 | 5.6       | 1.0                 | 13          | 0.000000000 | 1.600      |
| 1144 | EPD final (3.0) | 4.0              | 1.0                 | 1.0              | 1.0                 | 5.6       | 1.0                 | 13          | 0.000000000 | 1.600      |
| 1145 | EPD final (3.0) | 4.0              | 1.0                 | 1.0              | 1.0                 | 5.6       | 1.0                 | 13          | 0.000000000 | 1.600      |
| 1146 | EPD final (3.0) | 4.0              | 1.0                 | 1.0              | 1.0                 | 5.6       | 1.0                 | 13          | 0.000000000 | 1.600      |
| 1147 | EPD final (3.0) | 4.0              | 1.0                 | 1.0              | 1.0                 | 5.6       | 1.0                 | 13          | 0.000000000 | 1.600      |
| 1148 | EPD final (3.0) | 4.0              | 1.0                 |                  |                     |           |                     |             |             |            |

Table 8. Chemical properties of rice samples collected from Beggi and Yaurae district (Bey)

| AC#  | Entity     | Asset Secured<br>Tolco | Monetized ST,<br>CVA & LSO | Arrears<br>(%)    | Monetized ST,<br>CVA & LSO | Revised<br>(%)   | Monetized ST,<br>CVA & LSO | Monitors          | Monetized ST,<br>CVA & LSO |
|------|------------|------------------------|----------------------------|-------------------|----------------------------|------------------|----------------------------|-------------------|----------------------------|
| 1410 | Enbridge A | 1.0 <sup>1</sup>       | 13.614.014.5               | 34.4 <sup>2</sup> | 36.561.001.012             | 7.6 <sup>3</sup> | 7.661.001.010              | 11.8 <sup>4</sup> | 12.614.012                 |
| 1411 | Enbridge B | 1.0 <sup>1</sup>       | 1.614.01                   | 22.8 <sup>2</sup> | 1.611.011                  | 1.2 <sup>3</sup> | 1.611.012                  | 11.8 <sup>4</sup> | 2.012.012.011              |

| Alt  | Target        | Coolest member    | Mass:St. CV% ± 1SD | IR              | Mass:St. CV% ± 1SD | IR              | Mass:St. CV% ± 1SD |
|------|---------------|-------------------|--------------------|-----------------|--------------------|-----------------|--------------------|
| 1039 | WZ Cen II (3) | 1557 <sup>a</sup> |                    | 15 <sup>a</sup> |                    | 45 <sup>a</sup> |                    |
| 1040 | WZ Cen II (3) | 1557 <sup>a</sup> |                    | 15 <sup>a</sup> |                    | 45 <sup>a</sup> |                    |
| 1041 | WZ Cen II (3) | 1557 <sup>a</sup> |                    | 15 <sup>a</sup> |                    | 45 <sup>a</sup> |                    |
| 1042 | WZ Cen II (3) | 1557 <sup>a</sup> |                    | 15 <sup>a</sup> |                    | 45 <sup>a</sup> |                    |
| 1043 | WZ Cen II (3) | 1557 <sup>a</sup> |                    | 15 <sup>a</sup> |                    | 45 <sup>a</sup> |                    |
| 1044 | WZ Cen II (3) | 1557 <sup>a</sup> |                    | 15 <sup>a</sup> |                    | 45 <sup>a</sup> |                    |
| 1045 | WZ Cen II (3) | 1557 <sup>a</sup> |                    | 15 <sup>a</sup> |                    | 45 <sup>a</sup> |                    |
| 1046 | WZ Cen II (3) | 1557 <sup>a</sup> |                    | 15 <sup>a</sup> |                    | 45 <sup>a</sup> |                    |
| 1047 | WZ Cen II (3) | 1557 <sup>a</sup> |                    | 15 <sup>a</sup> |                    | 45 <sup>a</sup> |                    |
| 1048 | WZ Cen II (3) | 1557 <sup>a</sup> | 36.7 ± 0.92        | 14 <sup>a</sup> | 1.6 ± 0.02         | 45 <sup>a</sup> | 4.6 ± 0.1          |
| 1049 | WZ Cen II (3) | 1557 <sup>a</sup> | 0.038              | 15 <sup>a</sup> | 0.03               | 45 <sup>a</sup> | 0.035              |
| 1048 | WZ Cen II (3) | 1557 <sup>a</sup> | 1.6 ± 0.73         | 15 <sup>a</sup> | 9.6 ± 0.94         | 45 <sup>a</sup> | 9.6 ± 0.7          |
| 1050 | WZ Cen II (3) | 1557 <sup>a</sup> |                    | 14 <sup>a</sup> |                    | 45 <sup>a</sup> |                    |
| 1051 | WZ Cen II (3) | 1557 <sup>a</sup> |                    | 14 <sup>a</sup> |                    | 45 <sup>a</sup> |                    |
| 1052 | WZ Cen II (3) | 1557 <sup>a</sup> |                    | 15 <sup>a</sup> |                    | 45 <sup>a</sup> |                    |
| 1053 | WZ Cen II (3) | 1557 <sup>a</sup> |                    | 15 <sup>a</sup> |                    | 45 <sup>a</sup> |                    |
| 1054 | WZ Cen II (3) | 1557 <sup>a</sup> |                    | 15 <sup>a</sup> |                    | 45 <sup>a</sup> |                    |
| 1055 | WZ Cen II (3) | 1557 <sup>a</sup> |                    | 15 <sup>a</sup> |                    | 45 <sup>a</sup> |                    |
| 1056 | WZ Cen II (3) | 1557 <sup>a</sup> |                    | 15 <sup>a</sup> |                    | 45 <sup>a</sup> |                    |
| 1057 | WZ Cen II (3) | 1557 <sup>a</sup> | 15.6 ± 0.47        | 15 <sup>a</sup> | 1.6 ± 0.04         | 45 <sup>a</sup> | 4.6 ± 0.05         |
| 1058 | WZ Cen II (3) | 1557 <sup>a</sup> | 0.065              | 15 <sup>a</sup> | 0.06               | 50 <sup>a</sup> | 0.065              |
| 1059 | WZ Cen II (3) | 1557 <sup>a</sup> | 4.8 ± 0.02         | 14 <sup>a</sup> | 4.8 ± 0.01         | 45 <sup>a</sup> | 4.8 ± 0.01         |
| 1060 | WZ Cen II (3) | 1557 <sup>a</sup> |                    | 15 <sup>a</sup> |                    | 50 <sup>a</sup> |                    |
| 1061 | WZ Cen II (3) | 1557 <sup>a</sup> |                    | 15 <sup>a</sup> |                    | 50 <sup>a</sup> |                    |
| 1062 | WZ Cen II (3) | 1557 <sup>a</sup> |                    | 14 <sup>a</sup> |                    | 45 <sup>a</sup> |                    |
| 1063 | WZ Cen II (3) | 1557 <sup>a</sup> | 10.1 ± 0.11        | 14 <sup>a</sup> | 1.6 ± 0.03         | 35 <sup>a</sup> | 4.6 ± 0.01         |
| 1064 | WZ Cen II (3) | 1557 <sup>a</sup> | 0.146              | 15 <sup>a</sup> | 0.048              | 47 <sup>a</sup> | 0.05               |
| 1065 | WZ Cen II (3) | 1557 <sup>a</sup> | 1.6 ± 0.01         | 14 <sup>a</sup> | 4.8 ± 0.009        | 45 <sup>a</sup> | 4.8 ± 0.005        |
| 1066 | WZ Cen II (3) | 1557 <sup>a</sup> |                    | 14 <sup>a</sup> |                    | 50 <sup>a</sup> |                    |
| 1067 | WZ Cen II (3) | 1557 <sup>a</sup> |                    | 15 <sup>a</sup> |                    | 50 <sup>a</sup> |                    |
| 1068 | WZ Cen II (3) | 1557 <sup>a</sup> |                    | 15 <sup>a</sup> |                    | 45 <sup>a</sup> |                    |
| 1069 | WZ Cen II (3) | 1557 <sup>a</sup> | 5.0                | 15 <sup>a</sup> | 5                  | 45 <sup>a</sup> | 4.0                |

[illegible]

Table 9. Cooking properties of rice samples collected from Betsu and Nagaon district (Boc)

| NCs   | Varies         | Casting time (min) | Monolith II, C19.4 L18 | ER               | Monolith II, C19.4 L18 | H                | Monolith II, C19.4 L18 |
|-------|----------------|--------------------|------------------------|------------------|------------------------|------------------|------------------------|
| 18113 | Expo. (3.4)    | 1500 <sup>a</sup>  |                        | 1.0 <sup>a</sup> |                        | 4.0 <sup>a</sup> |                        |
| 18211 | Expo. (3.4)    | 1500 <sup>a</sup>  |                        | 1.0 <sup>a</sup> | 1.64 (0.109713)        | 4.0 <sup>a</sup> | 4.64 (1.1173)          |
| 18212 | Expo. (3.4)    | 1500 <sup>a</sup>  |                        | 1.0 <sup>a</sup> | 4.0 (1.08)             | 4.0 <sup>a</sup> | 5.8 (3.82)             |
| 18213 | Expo. (3.4)    | 1500 <sup>a</sup>  |                        | 1.0 <sup>a</sup> |                        | 4.0 <sup>a</sup> |                        |
| 18214 | Expo. (3.4)    | 1500 <sup>a</sup>  |                        | 1.0 <sup>a</sup> |                        | 4.0 <sup>a</sup> |                        |
| 18215 | Tim (3.4)      | 1600 <sup>a</sup>  |                        | 1.0 <sup>a</sup> |                        | 4.0 <sup>a</sup> |                        |
| 18216 | Tim (3.7)      | 1600 <sup>a</sup>  |                        | 1.0 <sup>a</sup> |                        | 4.0 <sup>a</sup> |                        |
| 18217 | Tim (3.9)      | 1600 <sup>a</sup>  |                        | 1.0 <sup>a</sup> |                        | 4.0 <sup>a</sup> |                        |
| 18218 | Tim (3.7)      | 1600 <sup>a</sup>  | 10.26 (1.5)            | 1.0 <sup>a</sup> | 1.64 (1)               | 4.0 <sup>a</sup> | 4.64 (10.1007)         |
| 18219 | Tim (3.7)      | 1600 <sup>a</sup>  | 1.6 (1.54)             | 1.0 <sup>a</sup> |                        | 4.0 <sup>a</sup> | 5.8 (2.55)             |
| 18220 | Tim (3.7)      | 1600 <sup>a</sup>  |                        | 1.0 <sup>a</sup> |                        | 4.0 <sup>a</sup> |                        |
| 18221 | Tim (5.10)     | 1600 <sup>a</sup>  |                        | 1.0 <sup>a</sup> |                        | 4.0 <sup>a</sup> |                        |
| 18222 | Expo. (3.4)    | 1600 <sup>a</sup>  |                        | 1.0 <sup>a</sup> |                        | 4.0 <sup>a</sup> |                        |
| 18223 | Expo. (3.4)    | 1600 <sup>a</sup>  |                        | 1.0 <sup>a</sup> |                        | 4.0 <sup>a</sup> |                        |
| 18224 | Expo. (3.4)    | 1600 <sup>a</sup>  |                        | 1.0 <sup>a</sup> |                        | 4.0 <sup>a</sup> |                        |
| 18225 | Expo. (3.4)    | 1600 <sup>a</sup>  | 10.26 (1.5)            | 1.0 <sup>a</sup> | 1.64 (1)               | 4.0 <sup>a</sup> | 4.64 (10)              |
| 18226 | Expo. (3.4)    | 1600 <sup>a</sup>  | 0.25 (1)               | 1.0 <sup>a</sup> | 1.64 (1)               | 4.0 <sup>a</sup> | 4.64 (5)               |
| 18227 | Expo. (3.4)    | 1500 <sup>a</sup>  | 1.6 (1.54)             | 1.0 <sup>a</sup> | 1.64 (1.02)            | 4.0 <sup>a</sup> | 5.8 (4.01159)          |
| 18228 | Expo. (3.4)    | 1600 <sup>a</sup>  |                        | 1.0 <sup>a</sup> |                        | 4.0 <sup>a</sup> |                        |
| 18229 | Expo. (3.4)    | 1600 <sup>a</sup>  |                        | 1.0 <sup>a</sup> |                        | 4.0 <sup>a</sup> |                        |
| 18230 | Expo. (3.4)    | 1600 <sup>a</sup>  |                        | 1.0 <sup>a</sup> |                        | 4.0 <sup>a</sup> |                        |
| 18231 | Expo. (3.4)    | 1600 <sup>a</sup>  |                        | 1.0 <sup>a</sup> |                        | 4.0 <sup>a</sup> |                        |
| 18232 | Expo. (3.4)    | 1600 <sup>a</sup>  |                        | 1.0 <sup>a</sup> |                        | 4.0 <sup>a</sup> |                        |
| 18233 | ER (3.4) (1.5) | 1500 <sup>a</sup>  | 1.6 (1)                | 1.0 <sup>a</sup> | 1.6                    | 4.0 <sup>a</sup> | 4.2                    |
| 18234 | ER (3.4) (1.5) | 1500 <sup>a</sup>  | 1.6 (1.5)              | 1.0 <sup>a</sup> |                        | 4.0 <sup>a</sup> |                        |
| 18235 | ER (3.4) (1.5) | 1500 <sup>a</sup>  | 1.6 (1.5)              | 1.0 <sup>a</sup> |                        | 4.0 <sup>a</sup> |                        |
| 18236 | ER (3.4) (1.5) | 1500 <sup>a</sup>  | 1.6 (1.5)              | 1.0 <sup>a</sup> |                        | 4.0 <sup>a</sup> |                        |
| 18237 | ER (3.4) (1.5) | 1500 <sup>a</sup>  | 1.6 (1.5)              | 1.0 <sup>a</sup> |                        | 4.0 <sup>a</sup> |                        |
| 18238 | ER (3.4) (1.5) | 1500 <sup>a</sup>  | 1.6 (1.5)              | 1.0 <sup>a</sup> |                        | 4.0 <sup>a</sup> |                        |
| 18239 | ER (3.4) (1.5) | 1500 <sup>a</sup>  | 1.6 (1.5)              | 1.0 <sup>a</sup> |                        | 4.0 <sup>a</sup> |                        |
| 18240 | ER (3.4) (1.5) | 1500 <sup>a</sup>  | 1.6 (1.5)              | 1.0 <sup>a</sup> |                        | 4.0 <sup>a</sup> |                        |
| 18241 | ER (3.4) (1.5) | 1500 <sup>a</sup>  | 1.6 (1.5)              | 1.0 <sup>a</sup> |                        | 4.0 <sup>a</sup> |                        |
| 18242 | ER (3.4) (1.5) | 1500 <sup>a</sup>  | 1.6 (1.5)              | 1.0 <sup>a</sup> |                        | 4.0 <sup>a</sup> |                        |
| 18243 | ER (3.4) (1.5) | 1500 <sup>a</sup>  | 1.6 (1.5)              | 1.0 <sup>a</sup> |                        | 4.0 <sup>a</sup> |                        |
| 18244 | ER (3.4) (1.5) | 1500 <sup>a</sup>  | 1.6 (1.5)              | 1.0 <sup>a</sup> |                        | 4.0 <sup>a</sup> |                        |
| 18245 | ER (3.4) (1.5) | 1500 <sup>a</sup>  | 1.6 (1.5)              | 1.0 <sup>a</sup> |                        | 4.0 <sup>a</sup> |                        |
| 18246 | ER (3.4) (1.5) | 1500 <sup>a</sup>  | 1.6 (1.5)              | 1.0 <sup>a</sup> |                        | 4.0 <sup>a</sup> |                        |
| 18247 | ER (3.4) (1.5) | 1500 <sup>a</sup>  | 1.6 (1.5)              | 1.0 <sup>a</sup> |                        | 4.0 <sup>a</sup> |                        |
| 18248 | ER (3.4) (1.5) | 1500 <sup>a</sup>  | 1.6 (1.5)              | 1.0 <sup>a</sup> |                        | 4.0 <sup>a</sup> |                        |
| 18249 | ER (3.4) (1.5) | 1500 <sup>a</sup>  | 1.6 (1.5)              | 1.0 <sup>a</sup> |                        | 4.0 <sup>a</sup> |                        |
| 18250 | ER (3.4) (1.5) | 1500 <sup>a</sup>  | 1.6 (1.5)              | 1.0 <sup>a</sup> |                        | 4.0 <sup>a</sup> |                        |
| 18251 | ER (3.4) (1.5) | 1500 <sup>a</sup>  | 1.6 (1.5)              | 1.0 <sup>a</sup> |                        | 4.0 <sup>a</sup> |                        |
| 18252 | ER (3.4) (1.5) | 1500 <sup>a</sup>  | 1.6 (1.5)              | 1.0 <sup>a</sup> |                        | 4.0 <sup>a</sup> |                        |
| 18253 | ER (3.4) (1.5) | 1500 <sup>a</sup>  | 1.6 (1.5)              | 1.0 <sup>a</sup> |                        | 4.0 <sup>a</sup> |                        |
| 18254 | ER (3.4) (1.5) | 1500 <sup>a</sup>  | 1.6 (1.5)              | 1.0 <sup>a</sup> |                        | 4.0 <sup>a</sup> |                        |

[illegible]

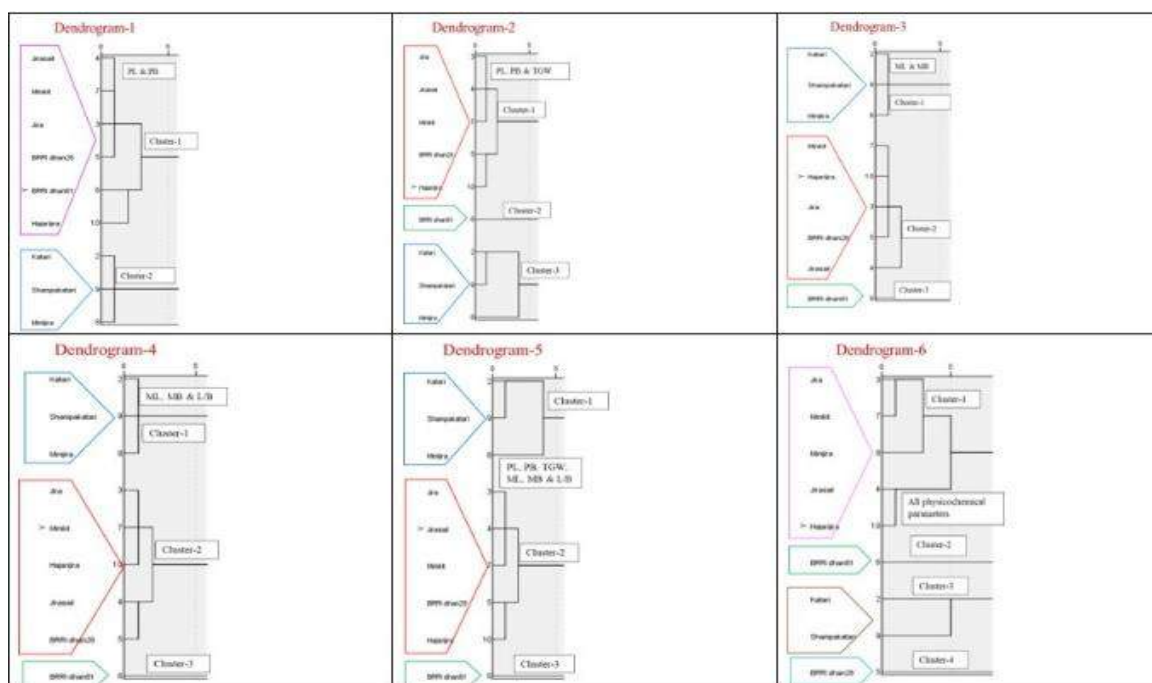


Figure 1. Different dendrogram of rice cultivars (Boro) based on different physicochemical properties collected from Bogura and Naogaon district

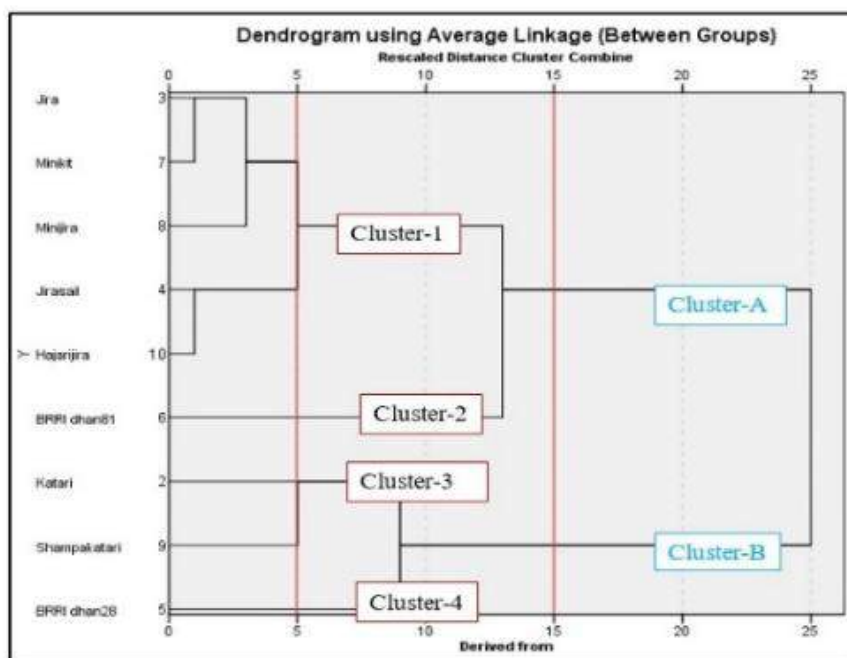


Figure 2. Dendrogram of rice cultivars (Boro) based on physicochemical properties collected from Bogura and Naogaon district



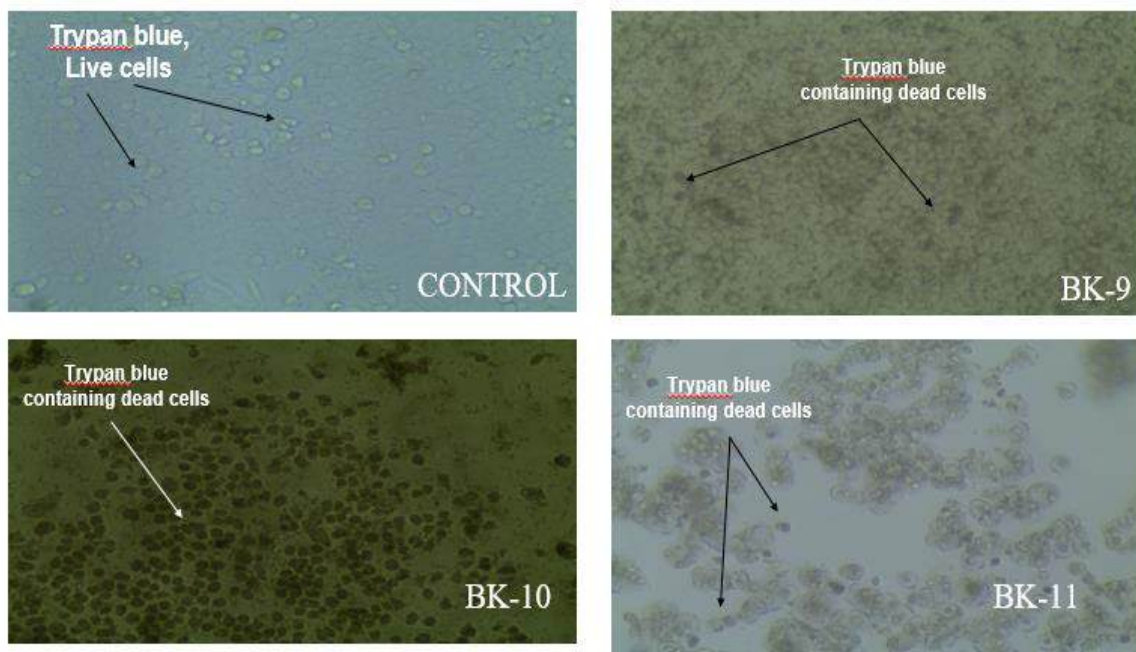


Fig.3. Antiproliferative activity of Black rice extracts on HeLa cell line.

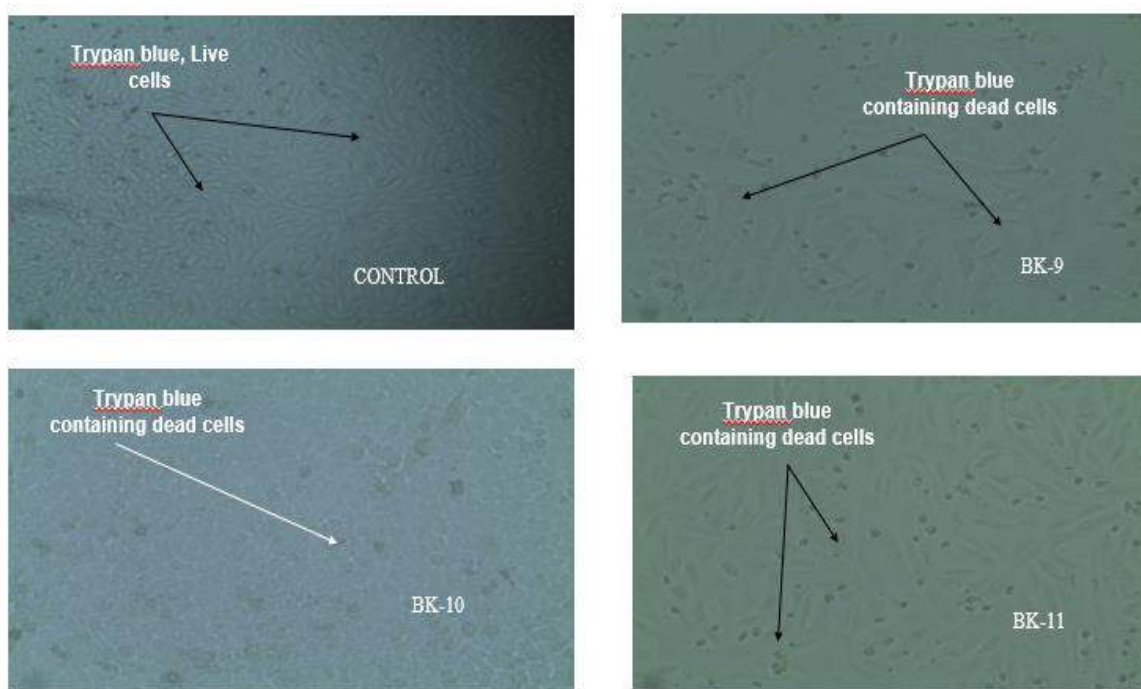


Fig. 4. Antiproliferative activity of Black rice extracts on Vero cell line.

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### Q1. Survey Questioner Dietary Habits and Preferences for Unparboiled Rice

১। তথ্য প্রদানকারীর নাম ও পূর্ণাঙ্গ ঠিকানা

|          |         |        |
|----------|---------|--------|
| নামঃ     | মোবাইলঃ | গ্রামঃ |
| ইউনিয়নঃ | উপজেলাঃ | জেলাঃ  |

২। স্থানীয়ভাবে কোন কোন ধান চাষ হয়?

৩। কোন কোন জাতের ধানের চাল স্থানীয় বাজারে পাওয়া যায়?

৪। কোন জাতের চালের ভাত খান?

৫। উক্ত জাতের ধানের চাল কি মোটা/চিকন? ১. মোটা ২. মাঝারি চিকন ৩. চিকন

৬। মোটা/চিকন কোন ধরনের চালের দাম বেশি? ১. মোটা ২. মাঝারি চিকন ৩. চিকন

৭। যে জাতের চালের ভাত খান তা কি নিজের উৎপাদিত/ বাজার থেকে কেনা?  
১. নিজের উৎপাদিত ২. বাজার থেকে কেনা ৩. অন্যান্য

৮। আতপ/সিদ্ধ কোন ধরনের চাল খান? ১. আতপ ২. অর্ধ-সিদ্ধ ৩. সিদ্ধ

৯। কেন আতপ চাল খান?  
১. খেতে সুস্বাদু ২. সহজে হজম হয় ৩. সিদ্ধ করা সমসময়সাপেক্ষ ৪. রাান্না করতে কম সময় লাগে  
৫. বংশগতভাবে অভ্যস্ত ৬. অন্যান্য

১০। সবাই আতপ চাল খান? ১. হ্যাঁ ২. না ৩. অধিকাংশ আতপ খায়, কেউ কেউ সিদ্ধ খায় ৪. অধিকাংশ সিদ্ধ খায়, কেউ কেউ আতপ খায়

১১। বাজারে আতপ ছাড়া সিদ্ধ চাল পাওয়া যায়? ১. হ্যাঁ ২. না

১২। হ্যাঁ হলে, কি জাতের সিদ্ধ চাল বাজারে পাওয়া যায়?

১৩। উক্ত জাতের ধানের সিদ্ধ চাল কি মোটা/চিকন? ১. মোটা ২. মাঝারি চিকন ৩. চিকন

১৪। আতপ/ সিদ্ধ চাল কোনটার দাম বেশি? ১. আতপ ২. সিদ্ধ

১৫। আতপ/ সিদ্ধ চালের পুষ্টিগুণ সম্বন্ধে জানা আছে কিনা? ১. হ্যাঁ ২. না

১৬। যদি জানা থাকে তাও আতপ চাল কেন খান?  
১. খেতে সুস্বাদু ২. সহজে হজম হয় ৩. চাল সিদ্ধ করা সমসময়সাপেক্ষ ৪. রাান্না করতে কম সময় লাগে ৫. বংশগতভাবে অভ্যস্ত  
৬. অন্যান্য

১৭। হজমে সমস্যা আছে কিনা? ১. হ্যাঁ ২. না

১৮। কোষ্ঠকাঠিন্য হয় কিনা? ১. হ্যাঁ ২. না

১৯। উক্তর হ্যাঁ হলে, কতদিন যাবৎ কোষ্ঠকাঠিন্যে ভুগছে? দিন / মাস

২০। কত পুরুষ যাবৎ আতপ চাল খান?

Fig. 6. MTT assay of anti-carcinogenic effects of anthocyanin by observing the antiproliferative activity in cancer cells (MCF-7, human breast cancer cell).



Fig. 7. Formulation of rice biscuit and rice cake by anthocyanin-enriched fermented rice bran (BK11) at GQN Bakery Laboratory, GQN Division, BRRI.

Table 10. Physical properties of puffed rice of BRRI developed modern varieties

| Variety name       | Fully Puffed rice (%) | Partial Puffed rice (%) | Milled rice Length (mm) | Milled rice Breadth (mm) | Puffed rice Length (mm) | Puffed rice Length Increased (%) | Puffed rice Breadth (mm) | Puffed rice Breadth Increased (%) | Thousand Puffed rice wt. (g) | Fifty g Puffed rice volume (ml) |
|--------------------|-----------------------|-------------------------|-------------------------|--------------------------|-------------------------|----------------------------------|--------------------------|-----------------------------------|------------------------------|---------------------------------|
| BR16               | 59.03 <sup>7b</sup>   | 40.91 <sup>c</sup>      | 6.24                    | 2.18                     | 13.35 <sup>a</sup>      | 117.20 <sup>c</sup>              | 4.37 <sup>a</sup>        | 100.45 <sup>c</sup>               | 18.27 <sup>a</sup>           | 550.00 <sup>a</sup>             |
| BRRI dhan80        | 50.83 <sup>b</sup>    | 49.14 <sup>c</sup>      | 7.03                    | 1.92                     | 13.68 <sup>a</sup>      | 94.54 <sup>d</sup>               | 4.317 <sup>ab</sup>      | 124.80 <sup>b</sup>               | 18.16 <sup>a</sup>           | 553.33 <sup>a</sup>             |
| BRRI dhan81        | 53.99                 | 46.66 <sup>f</sup>      | 6.76                    | 1.79                     | 13.41 <sup>a</sup>      | 98.42 <sup>bc</sup>              | 4.24 <sup>ab</sup>       | 126.67 <sup>a</sup>               | 16.59 <sup>b</sup>           | 500.00 <sup>c</sup>             |
| BRRI dhan84        | 17.46 <sup>de</sup>   | 82.49 <sup>ab</sup>     | 6.18                    | 1.83                     | 13.69 <sup>a</sup>      | 118.33 <sup>c</sup>              | 4.213 <sup>ab</sup>      | 130.23 <sup>ab</sup>              | 15.51 <sup>c</sup>           | 472.33 <sup>b</sup>             |
| BRRI dhan92        | 15.94 <sup>d</sup>    | 84.03 <sup>a</sup>      | 6.38                    | 1.87                     | 12.87 <sup>ab</sup>     | 101.67 <sup>cd</sup>             | 4.17 <sup>ab</sup>       | 123.00 <sup>ab</sup>              | 15.52 <sup>c</sup>           | 417.00 <sup>f</sup>             |
| BRRI dhan95        | 45.54 <sup>e</sup>    | 54.63 <sup>e</sup>      | 5.20                    | 2.12                     | 10.30 <sup>f</sup>      | 98.14 <sup>d</sup>               | 4.19 <sup>a</sup>        | 97.64 <sup>c</sup>                | 13.86 <sup>b</sup>           | 473.33 <sup>b</sup>             |
| BRRI dhan96        | 28.00 <sup>d</sup>    | 71.97 <sup>e</sup>      | 5.26                    | 1.91                     | 12.39 <sup>c</sup>      | 135.55 <sup>b</sup>              | 3.38 <sup>b</sup>        | 76.79 <sup>d</sup>                | 12.47 <sup>e</sup>           | 500.00 <sup>e</sup>             |
| BRRI dhan97        | 18.78 <sup>d</sup>    | 81.18 <sup>ab</sup>     | 5.79                    | 2.61                     | 11.97 <sup>cd</sup>     | 106.74 <sup>de</sup>             | 3.89 <sup>c</sup>        | 49.17 <sup>e</sup>                | 17.63 <sup>a</sup>           | 461.33 <sup>e</sup>             |
| BRRI dhan99        | 37.34 <sup>e</sup>    | 62.43 <sup>de</sup>     | 6.30                    | 2.12                     | 12.80 <sup>ab</sup>     | 103.33 <sup>de</sup>             | 3.81 <sup>c</sup>        | 79.56 <sup>d</sup>                | 13.08 <sup>b</sup>           | 540.00 <sup>d</sup>             |
| Bangladesh dhan100 | 77.07 <sup>a</sup>    | 22.90 <sup>f</sup>      | 5.21                    | 1.95                     | 11.97 <sup>cd</sup>     | 129.69 <sup>de</sup>             | 3.52 <sup>d</sup>        | 80.51 <sup>d</sup>                | 12.56 <sup>f</sup>           | 550.00 <sup>a</sup>             |
| Range              | 15.9-77.1             | 22.9-84.03              | 5.2-7.03                | 1.95-2.18                | 10.30-13.68             | 94.5-135.6                       | 3.38-4.37                | 49.17-136.67                      | 12.47-18.27                  | 417.0-553.33                    |
| Mean±SD            | 40.40±20.45           | 59.63±20.40             | 6.04±0.650              | 2.03±0.249               | 12.64±1.040             | 110.4±14.137                     | 4.01±0.3449              | 99.88±28.535                      | 15.567±2.139                 | 501.73±46.279                   |
| SE                 | 1.1094                | 1.2054                  | 0                       | 0                        | 0.1475                  | 2.3755                           | 0.0844                   | 3.7982                            | 0.3152                       | 4.0689                          |
| CV%                | 3.36                  | 2.48                    | 0                       | 0                        | 1.43                    | 2.64                             | 2.58                     | 4.66                              | 2.48                         | 0.99                            |

Table 11. Correlation among the physical properties of puffed rice of BRRI developed modern varieties

| Parameters                        | Fully Puffed rice (%) | Partial Puffed rice (%) | Milled rice Length (mm) | Milled rice Breadth (mm) | Puffed rice Length (mm) | Puffed rice Length Increased (%) | Puffed rice Breadth (mm) | Puffed rice Breadth Increased (%) | Thousand Puffed rice wt. (g) |
|-----------------------------------|-----------------------|-------------------------|-------------------------|--------------------------|-------------------------|----------------------------------|--------------------------|-----------------------------------|------------------------------|
| Partial Puffed rice (%)           | -1.000 <sup>**</sup>  |                         |                         |                          |                         |                                  |                          |                                   |                              |
| Milled rice Length (mm)           | -0.06                 | 0.71                    |                         |                          |                         |                                  |                          |                                   |                              |
| Milled rice Breadth (mm)          | -0.153                | 1.51                    | -0.261                  |                          |                         |                                  |                          |                                   |                              |
| Puffed rice Length (mm)           | -0.030                | 0.033                   | 0.803 <sup>**</sup>     | -0.383                   |                         |                                  |                          |                                   |                              |
| Puffed rice Length Increased (%)  | 1.02                  | -1.05                   | -0.617                  | -0.096                   | -0.030                  |                                  |                          |                                   |                              |
| Puffed rice Breadth (mm)          | -0.024                | 0.027                   | 0.670                   | -0.076                   | 0.356                   | -0.700 <sup>*</sup>              |                          |                                   |                              |
| Puffed rice Breadth Increased (%) | 0.044                 | -0.039                  | 0.639 <sup>*</sup>      | -0.775 <sup>**</sup>     | 0.526                   | -0.383                           | 0.678 <sup>*</sup>       |                                   |                              |
| Thousand Puffed rice wt. (g)      | -0.076                | 0.077                   | 0.761 <sup>*</sup>      | 0.322                    | 0.560                   | -0.567                           | 0.749 <sup>*</sup>       | 255                               |                              |
| Fifty g Puffed rice volume (ml)   | 0.772 <sup>**</sup>   | -0.774 <sup>**</sup>    | 0.117                   | -0.047                   | 0.276                   | 0.195                            | -0.118                   | -0.098                            | 0.084                        |

\*\* Correlation is significant at the 0.01 level (2-tailed). \* Correlation is significant at the 0.05 level (2-tailed).

Table 12. Physical properties of popped rice of BRRI developed modern varieties

| Variety name | Total Popped rice (%) | Total waste (%)     | Fully Popped rice (%) | Partially Popped rice (%) | Broken Popped rice (%) | Brown rice Length (mm) | Brown rice Breadth (mm) | Popped rice Length (mm) | Popped rice Length Increased (%) | Popped rice Breadth (mm) | Popped rice Breadth Increased (%) | Thousand Popped rice wt. (g) | Fifty g Popped rice volume (ml) |
|--------------|-----------------------|---------------------|-----------------------|---------------------------|------------------------|------------------------|-------------------------|-------------------------|----------------------------------|--------------------------|-----------------------------------|------------------------------|---------------------------------|
| BR11         | 51.12 <sup>a</sup>    | 38 <sup>e</sup>     | 86.80 <sup>b</sup>    | 12.05 <sup>d</sup>        | 1.75 <sup>d</sup>      | 6.17                   | 2.66                    | 13.52 <sup>f</sup>      | 119.07 <sup>b</sup>              | 5.06 <sup>f</sup>        | 91.48 <sup>e</sup>                | 19.59 <sup>e</sup>           | 783.00 <sup>e</sup>             |
| BRRI dhan23  | 42.52 <sup>b</sup>    | 43.86 <sup>c</sup>  | 87.81 <sup>b</sup>    | 9.01 <sup>cd</sup>        | 3.09 <sup>b</sup>      | 7.28                   | 2.50                    | 15.04 <sup>h</sup>      | 106.55 <sup>d</sup>              | 5.24 <sup>d</sup>        | 109.60 <sup>d</sup>               | 19.23 <sup>d</sup>           | 750.00 <sup>d</sup>             |
| BRRI dhan28  | 48.38 <sup>a</sup>    | 39.47 <sup>cd</sup> | 78.92 <sup>cd</sup>   | 18.35 <sup>a</sup>        | 2.67 <sup>ab</sup>     | 6.90                   | 2.20                    | 14.28 <sup>g</sup>      | 106.96 <sup>d</sup>              | 4.93 <sup>d</sup>        | 123.94 <sup>h</sup>               | 16.53 <sup>d</sup>           | 730.00 <sup>d</sup>             |
| BRRI dhan32  | 43.55 <sup>b</sup>    | 43.42 <sup>c</sup>  | 82.60 <sup>c</sup>    | 14.80 <sup>bc</sup>       | 2.35 <sup>bc</sup>     | 6.20                   | 2.24                    | 12.64 <sup>h</sup>      | 103.81 <sup>de</sup>             | 5.35 <sup>cd</sup>       | 137.65 <sup>i</sup>               | 16.23 <sup>d</sup>           | 773.00 <sup>d</sup>             |
| BRRI dhan31  | 37.21 <sup>c</sup>    | 49.10 <sup>d</sup>  | 89.39 <sup>ab</sup>   | 7.85 <sup>c</sup>         | 2.72 <sup>ab</sup>     | 6.11                   | 2.37                    | 12.90 <sup>h</sup>      | 111.07 <sup>c</sup>              | 5.35 <sup>cd</sup>       | 125.88 <sup>i</sup>               | 15.12 <sup>d</sup>           | 900.00 <sup>d</sup>             |
| BRRI dhan2   | 44.44 <sup>b</sup>    | 41.84 <sup>cd</sup> | 86.70 <sup>b</sup>    | 14.14 <sup>d</sup>        | 0.76 <sup>a</sup>      | 6.22                   | 2.80                    | 13.76 <sup>f</sup>      | 121.27 <sup>ab</sup>             | 5.86 <sup>a</sup>        | 109.16 <sup>d</sup>               | 21.40 <sup>a</sup>           | 710.00 <sup>d</sup>             |
| BRRI dhan5   | 28.36 <sup>d</sup>    | 35.34 <sup>d</sup>  | 76.82 <sup>d</sup>    | 12.31 <sup>cd</sup>       | 11.17 <sup>a</sup>     | 7.57                   | 2.30                    | 14.64 <sup>e</sup>      | 93.35 <sup>f</sup>               | 5.40 <sup>a</sup>        | 134.93 <sup>a</sup>               | 20.05 <sup>a</sup>           | 900.00 <sup>a</sup>             |
| BRRI dhan58  | 50.31 <sup>a</sup>    | 36.64 <sup>c</sup>  | 91.66 <sup>a</sup>    | 6.87 <sup>ab</sup>        | 1.41 <sup>de</sup>     | 6.84                   | 2.21                    | 13.72 <sup>ff</sup>     | 100.54 <sup>f</sup>              | 4.95 <sup>d</sup>        | 123.98 <sup>h</sup>               | 15.86 <sup>d</sup>           | 820.00 <sup>d</sup>             |
| BRRI dhan60  | 33.57 <sup>d</sup>    | 51.30 <sup>d</sup>  | 80.74 <sup>c</sup>    | 17.67 <sup>ab</sup>       | 1.57 <sup>de</sup>     | 7.23                   | 2.27                    | 15.38 <sup>a</sup>      | 112.72 <sup>c</sup>              | 5.33 <sup>c</sup>        | 134.93 <sup>a</sup>               | 18.92 <sup>a</sup>           | 880.00 <sup>d</sup>             |
| BRRI dhan67  | 48.87 <sup>a</sup>    | 37.07 <sup>c</sup>  | 90.25 <sup>ab</sup>   | 9.54 <sup>cd</sup>        | 1.25 <sup>de</sup>     | 6.60                   | 2.26                    | 14.70 <sup>e</sup>      | 122.72 <sup>a</sup>              | 4.97 <sup>d</sup>        | 119.91 <sup>c</sup>               | 17.13 <sup>d</sup>           | 850.00 <sup>d</sup>             |
| Range        | 28.36-51.12           | 36.64-55.34         | 76.82-91.66           | 6.87-18.35                | 0.76-11.17             | 6.11-7.57              | 2.20-2.80               | 12.64-15.38             | 93.35-122.72                     | 4.93-5.86                | 91.48-137.65                      | 15.12-21.40                  | 710-900                         |
| Mean±SD      | 42.85±7.63            | 43.60±6.41          | 85.13±5.08            | 12.27±4.29                | 2.87±7.3.0             | 6.71±0.5               | 2.38±0.20               | 14.05±0.90              | 109.81±9.46                      | 5.24±7.0.2               | 121.15±4.33                       | 18.00±0.29                   | 809.67±70.59                    |
| SE           | 0                     | 2                   | 5                     | 78                        | 08                     | 325                    | 6                       | 5                       | 83                               | 6                        | 7                                 | 7                            | 7                               |
| CV%          | 1.5542                | 1.6604              | 1.8655                | 1.5771                    | 0.4103                 | 0                      | 0                       | 0.1065                  | 1.7093                           | 0.0246                   | 1.3312                            | 0.1006                       | 2.1082                          |
|              | 4.44                  | 4.66                | 2.68                  | 15.74                     | 17.48                  | 0                      | 0                       | 0.93                    | 1.91                             | 0.58                     | 1.37                              | 0.68                         | 0.32                            |

Table 13. Correlation among the physical properties of popped rice of BRRI developed modern varieties

| Parameters                        | Total Popped rice (%) | Total waste (%)     | Fully Popped rice (%) | Partially Popped rice (%) | Partially Popped rice (%) | Brown rice Length (mm) | Brown rice Breadth (mm) | Popped rice Length (mm) | Popped rice Length Increased (%) | Popped rice Breadth (mm) | Popped rice Breadth Increased (%) | Thousand Popped rice wt. (g) | Thousand Popped rice wt. (g) |
|-----------------------------------|-----------------------|---------------------|-----------------------|---------------------------|---------------------------|------------------------|-------------------------|-------------------------|----------------------------------|--------------------------|-----------------------------------|------------------------------|------------------------------|
| Total waste (%)                   | -0.92 <sup>**</sup>   | -0.587              | -0.790 <sup>**</sup>  | -0.010                    | 0.592                     | -0.385                 | -0.119                  | 0.007                   | -0.117                           | 0.050                    | -0.418                            | -0.255                       |                              |
| Fully Popped rice (%)             | 0.538                 | 0.203               | 0.682 <sup>*</sup>    | 0.128                     | 0.592                     | -0.385                 | -0.119                  | 0.007                   | -0.117                           | 0.050                    | -0.418                            | -0.255                       |                              |
| Partially Popped rice (%)         | -0.169                | -0.688 <sup>*</sup> | -0.609                | 0.010                     | 0.592                     | -0.385                 | -0.119                  | 0.007                   | -0.117                           | 0.050                    | -0.418                            | -0.255                       |                              |
| Partially Popped rice (%)         | -0.500                | 0.454               | -0.482                | 0.128                     | 0.592                     | -0.385                 | -0.119                  | 0.007                   | -0.117                           | 0.050                    | -0.418                            | -0.255                       |                              |
| Brown rice Length (mm)            | -0.145                | -0.116              | -0.244                | -0.059                    | -0.204                    | -0.385                 | -0.119                  | 0.007                   | -0.117                           | 0.050                    | -0.418                            | -0.255                       |                              |
| Brown rice Breadth (mm)           | -0.287                | -0.229              | -0.266                | 0.202                     | 0.199                     | -0.385                 | -0.119                  | 0.007                   | -0.117                           | 0.050                    | -0.418                            | -0.255                       |                              |
| Popped rice Length Increased (%)  | 0.444                 | -0.446              | -0.445                | -0.054                    | -0.701 <sup>*</sup>       | -0.385                 | -0.119                  | 0.007                   | -0.117                           | 0.050                    | -0.418                            | -0.255                       |                              |
| Popped rice Breadth (mm)          | -0.503                | -0.498              | -0.165                | 0.183                     | 0.126                     | -0.385                 | -0.119                  | 0.007                   | -0.117                           | 0.050                    | -0.418                            | -0.255                       |                              |
| Popped rice Breadth Increased (%) | -0.383                | -0.547              | -0.459                | -0.243                    | 0.362                     | -0.385                 | -0.119                  | 0.007                   | -0.117                           | 0.050                    | -0.418                            | -0.255                       |                              |
| Thousand Popped rice wt. (g)      | -0.241                | 0.229               | -0.280                | 0.275                     | 0.235                     | -0.385                 | -0.119                  | 0.007                   | -0.117                           | 0.050                    | -0.418                            | -0.255                       |                              |
| Fifty g Popped rice volume (ml)   | -0.617                | -0.591              | -0.054                | -0.389                    | 0.432                     | -0.385                 | -0.119                  | 0.007                   | -0.117                           | 0.050                    | -0.418                            | -0.255                       |                              |

\*\* Correlation is significant at the 0.01 level (2-tailed).

\* Correlation is significant at the 0.05 level (2-tailed).



**Table 14. Physical properties of flattened rice of BRRI developed modern varieties**

| Variety Name | Fully Flattened rice (%) | Partial Flattened rice wt. (%) | Broken flattened rice wt. (%) | Brown rice length (mm) | Brown rice breadth (mm) | Flattened rice length (mm) | Flattened rice length increased (%) | Flattened rice breadth (mm) | Flattened rice breadth increased (%) | Flattened rice thickness (mm) | Thousand Flattened rice wt. (g) | Fifty g Flattened rice volume (ml) |
|--------------|--------------------------|--------------------------------|-------------------------------|------------------------|-------------------------|----------------------------|-------------------------------------|-----------------------------|--------------------------------------|-------------------------------|---------------------------------|------------------------------------|
| BR16         | 76.81 <sup>1b</sup>      | 4.52 <sup>1bc</sup>            | 18.65 <sup>1a</sup>           | 7.00                   | 2.28                    | 11.93 <sup>b</sup>         | 70.38 <sup>c</sup>                  | 3.53 <sup>1a</sup>          | 54.82 <sup>c</sup>                   | 0.54 <sup>1b</sup>            | 19.22 <sup>b</sup>              | 120.00 <sup>f</sup>                |
| BRRI dhan80  | 79.88 <sup>a</sup>       | 4.40 <sup>1bc</sup>            | 15.70 <sup>1b</sup>           | 7.34                   | 2.09                    | 11.97 <sup>1b</sup>        | 61.08 <sup>1b</sup>                 | 3.33 <sup>1b</sup>          | 59.33 <sup>1bc</sup>                 | 0.76 <sup>1a</sup>            | 20.04 <sup>1a</sup>             | 130.00 <sup>1b</sup>               |
| BRRI dhan81  | 80.18 <sup>a</sup>       | 2.79 <sup>1ef</sup>            | 17.01 <sup>1ab</sup>          | 7.39                   | 1.93                    | 11.51 <sup>c</sup>         | 55.70 <sup>f</sup>                  | 3.24 <sup>1b</sup>          | 67.87 <sup>1a</sup>                  | 0.54 <sup>1b</sup>            | 18.90 <sup>1</sup>              | 150.00 <sup>1b</sup>               |
| BRRI dhan84  | 84.98 <sup>a</sup>       | 2.36 <sup>1f</sup>             | 12.63 <sup>1c</sup>           | 6.63                   | 2.04                    | 11.47 <sup>1c</sup>        | 73.05 <sup>1</sup>                  | 2.55 <sup>1c</sup>          | 24.84 <sup>1d</sup>                  | 0.54 <sup>1b</sup>            | 16.71 <sup>1c</sup>             | 130.00 <sup>1b</sup>               |
| BRRI dhan92  | 80.00 <sup>a</sup>       | 1.26 <sup>1g</sup>             | 18.89 <sup>1a</sup>           | 6.76                   | 2.09                    | 11.81 <sup>1bc</sup>       | 74.70 <sup>1</sup>                  | 3.32 <sup>1b</sup>          | 58.70 <sup>1bc</sup>                 | 0.72 <sup>1a</sup>            | 17.82 <sup>1b</sup>             | 136.67 <sup>1c</sup>               |
| BRRI dhan95  | 87.22 <sup>1a</sup>      | 3.49 <sup>1d</sup>             | 9.26 <sup>1d</sup>            | 5.74                   | 2.14                    | 12.49 <sup>1a</sup>        | 117.54 <sup>1</sup>                 | 3.54 <sup>1a</sup>          | 65.42 <sup>1ab</sup>                 | 0.72 <sup>1a</sup>            | 16.38 <sup>1c</sup>             | 170.00 <sup>1a</sup>               |
| BRRI dhan96  | 90.12 <sup>1a</sup>      | 7.83 <sup>1a</sup>             | 2.02 <sup>1f</sup>            | 5.93                   | 2.08                    | 11.74 <sup>1bc</sup>       | 98.03 <sup>1b</sup>                 | 3.27 <sup>1b</sup>          | 57.05 <sup>1c</sup>                  | 0.68 <sup>1a</sup>            | 14.66 <sup>1d</sup>             | 120.00 <sup>1f</sup>               |
| BRRI dhan99  | 86.06 <sup>1a</sup>      | 5.23 <sup>1b</sup>             | 8.70 <sup>1e</sup>            | 6.84                   | 2.07                    | 11.66 <sup>1bc</sup>       | 70.52 <sup>1c</sup>                 | 3.28 <sup>1b</sup>          | 58.61 <sup>1bc</sup>                 | 0.76 <sup>1a</sup>            | 17.65 <sup>1b</sup>             | 100.00 <sup>1g</sup>               |
| Range        | 76.81-90.12              | 1.26-7.82                      | 2.03-18.89                    | 5.74-7.39              | 1.93-2.28               | 11.473-12.487              | 55.7-117.54                         | 2.547-3.54                  | 24.84-67.87                          | 0.54-0.76                     | 14.66-20.04                     | 100-170                            |
| Mean±SD      | 83.157±4.57              | 3.983±2.01                     | 12.83±5.89                    | 6.703±0.59             | 2.09±0.098              | 11.82±0.522                | 77.875±20.12                        | 3.256±0.309                 | 55.83±13.24                          | 0.6579±0.098                  | 17.67±1.741                     | 132.08±21.0                        |
| SE           | 7                        | 7                              | 1                             | 9                      | 0                       | 0.1802                     | 0                                   | 0.0633                      | 6                                    | 9                             | 0.0531                          | 77                                 |
| CV%          | 1.66                     | 15.42                          | 12.1                          | 0                      | 0                       | 1.87                       | 4.76                                | 2.45                        | 7.08                                 | 8.24                          | 0.37                            | 1.55                               |

**Table 15. Correlation among the physical properties of flattened rice of BRRI developed modern varieties**

| Parameters                           | Correlations             |                                |                               |                        |                         |                            |                                     |                             |                                      |                               |                                 |
|--------------------------------------|--------------------------|--------------------------------|-------------------------------|------------------------|-------------------------|----------------------------|-------------------------------------|-----------------------------|--------------------------------------|-------------------------------|---------------------------------|
|                                      | Fully Flattened rice (%) | Partial Flattened rice wt. (%) | Broken flattened rice wt. (%) | Brown rice length (mm) | Brown rice breadth (mm) | Flattened rice length (mm) | Flattened rice length increased (%) | Flattened rice breadth (mm) | Flattened rice breadth increased (%) | Flattened rice thickness (mm) | Thousand Flattened rice wt. (g) |
| Partial Flattened rice wt. (%)       | .507                     |                                |                               |                        |                         |                            |                                     |                             |                                      |                               |                                 |
| Broken Flattened rice wt. (%)        | -.954**                  | -.742*                         |                               |                        |                         |                            |                                     |                             |                                      |                               |                                 |
| Brown rice length (mm)               | -.793*                   | -.325                          | .728*                         |                        |                         |                            |                                     |                             |                                      |                               |                                 |
| Brown rice breadth (mm)              | -.237                    | .207                           | .114                          | .226                   |                         |                            |                                     |                             |                                      |                               |                                 |
| Flattened rice length (mm)           | .080                     | .055                           | -.081                         | -.489                  | .565                    |                            |                                     |                             |                                      |                               |                                 |
| Flattened rice length increased (%)  | .688                     | .286                           | -.634                         | -.965**                | .311                    | .695                       |                                     |                             |                                      |                               |                                 |
| Flattened rice breadth (mm)          | -.213                    | .256                           | .079                          | -.084                  | .490                    | .684                       | .271                                |                             |                                      |                               |                                 |
| Flattened rice breadth increased (%) | -.120                    | .174                           | .035                          | .051                   | -.017                   | .446                       | .115                                | .865**                      |                                      |                               |                                 |
| Flattened rice thickness (mm)        | .328                     | .228                           | -.330                         | -.241                  | .046                    | .452                       | .319                                | .391                        | .407                                 |                               |                                 |
| Thousand Flattened rice wt. (g)      | -.892**                  | -.384                          | .826*                         | .884*                  | .094                    | -.036                      | -.740*                              | .229                        | .221                                 | -.091                         |                                 |
| Fifty g Flattened rice volume (ml)   | -.017                    | -.480                          | .178                          | -.269                  | -.166                   | .523                       | .410                                | .172                        | .286                                 | -.105                         | -.042                           |

\*\* Correlation is significant at the 0.01 level (2-tailed). \* Correlation is significant at the 0.05 level (2-tailed).

# Hybrid Rice Division

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## SUMMARY

In T. Aman season 2023, a total of 95 test crosses and 696 ( $A \times R$ ) crosses were made from source nursery. Seventy-four test crosses ( $F_1$ s) were evaluated for their pollen fertility status of which three entries have been found heterotic over the check varieties. Pollen parent of this combination was regarded as suspected restorer and was selected for fertility restoration ability with other CMS lines in the next season. One entry was found completely sterile and their corresponding male parent was regarded as suspected maintainer line. Ten backcross entries were advanced as new CMS lines. Other backcross generations were advanced to next generations except one  $BC_1$  generation, which was found unstable in terms of pollen sterility and hence discarded. One hundred-eleven CMS lines along with their respective maintainer lines were maintained by hand crossing.

A total of 124 test crosses and 321 ( $A \times R$ ) crosses were made using 13 CMS lines in Boro season 2023-24. Ninety-one test crosses ( $F_1$ s) were evaluated for their pollen fertility status. Among them, eleven entries showed complete sterility and immediately backcrossed with their corresponding male parents for conversion. On the other hand, four entries have been selected for their high yielding ability compared to the check varieties. Six  $BC_6$  generations were advanced as new CMS lines and shifted to CMS maintenance and evaluation nursery. Other entries were advanced for next generations except one  $BC_1$  generation was discarded due to pollen fertility fluctuation. One hundred fifty-six CMS lines along with their respective maintainer lines were maintained by hand crossing in CMS maintenance and evaluation nursery for their genetic purity.

In T. Aman, out of 430 test hybrids under observational trials, twelve hybrid combinations were selected based on yield, duration and grain type and expressed more than 24-34% yield advantage over the check variety BRRI hybrid dhan6, 13-22% over AZ7006 and 20-30 % over Dhanny Gold. The heritability obtained from growth duration and grain yield were 92%, and 74% respectively, indicating high level of

precision in this experiment. In Boro, out of 489 test hybrids eleven hybrid combinations were selected based on yield, duration and grain type. The selected hybrid combinations expressed 4.2-10.8 % yield advantage over BRRI hybrid dhan8, 19-27% over SL8H, 19-27% over Heera and 28-37% over the check variety Tej Gold. The heritability obtained from growth duration and grain yield was 84% and 82% respectively, indicating high level of precision in this experiment. Under parental line improvement programme ( $B \times B$  and  $R \times R$ ) fourteen  $B \times B$  and 20  $R \times R$  crosses were confirmed based on different cyto-sources and amylose content and eleven  $B \times B$  and 18  $R \times R$  crosses were made based on different cyto-sources, grain type and amylose content in T Aman 23. Under field rapid generation advancement programme 58,618  $F_2$ ,  $F_3$ ,  $F_5$  and  $F_6$  progenies of  $B \times B$ ,  $R \times R$  and  $A \times R$  were advanced in T. Aman 23. In Boro, eleven  $B \times B$  and 18  $R \times R$  crosses were confirmed based on growth duration, grain type, cyto-sources and amylose content and 29  $R \times R$  and 13  $B \times B$  crosses were made depending on grain type, growth duration, cyto-sources and amylose content in Boro 2023-24. A total of 42,331 progenies of  $F_2$ ,  $F_3$ ,  $F_4$  and  $F_6$  generations of  $B \times B$ ,  $R \times R$  and  $A \times R$  crosses were advanced in Boro 2023-24.

In T. Aman preliminary yield trials, two hybrids were selected out of 15 and showed yield advantage 16-19 % over BRRI hybrid dhan6, 21-24 % over AZ7006 and 16-19 % over Dhanny Gold. Under multi-location trials three hybrids were selected and expressed yield advantage 16-19% over BRRI hybrid dhan6, 21-24 % over AZ7006 and 16-19 % over check variety Dhanny Gold. In Boro, under preliminary yield trials, 13 hybrids were evaluated along with four hybrids as check variety. Out of 13 hybrids three hybrids were selected and produced 5-10 % yield advantage over BRRI hybrid dhan8, 15-20 % over SL8H, 13-18% over Heera-2 and 18-23% over check variety Tej Gold. In Boro, multi-location yield trials comprised of 15 hybrids with four checks. Three hybrids were selected based on average yield of five locations over the check varieties and expressed 6-11% yield advantage over BRRI hybrid dhan8, 18-24 % over SL8H, 12-17% over Heera-2 and 18-24 % over Tej Gold.

Adaptability under saline condition of BRRI developed and popular company hybrids along with popular saline tolerant inbred checks BRRI dhan67, local rice variety IT, Bina dhan-10 were cultivated at three coastal locations of Satkhira. We observed that the salinity levels of Debhata varies from 1.3 ds/m to 1.8 ds/m, which is very low level whereas the salinity levels of Dumuria varies from 4.1 ds/m to 6.1 ds/m which remains at medium level. On the other hand, salinity levels of Kaliganj varies from 7.3 ds/m to 21.9 ds/m, which is very high hence yield is very poor. We found that the highest yielding genotypes of pooled (Debhata and Dumuria) were BRRI hybrid dhan8 (7.52 t ha<sup>-1</sup>), BRRI hybrid dhan3 (6.14 t ha<sup>-1</sup>), Heera-2 (6.02 t ha<sup>-1</sup>) followed by check variety BRRI hybrid dhan6 (5.64 t ha<sup>-1</sup>), IT (5.47 t ha<sup>-1</sup>) and Bina dhan-10 (5.42 t ha<sup>-1</sup>) respectively.

Twelve CMS lines including promising and released hybrids were multiplied during Boro 2023-24 and got total seed yield of 5.9 metric tons. It was ranging from 9.5 kg to 1897 kg/plot equivalent to 1.0 to 2.8 t/ha. Experimental F<sub>1</sub> seed production was made using 13 CMS with six different restorer lines and seed yield was ranging 0.4 to 44 kg/plot from selected promising hybrid combinations during T. Aman 2023, which was equivalent to 0.08 to 1.5 t/ha. Sixty experimental hybrids were evaluated in augmented design during T. Aman 2023 and selected three hybrids expressed around 20 % yield advantages over the highest yielding check variety. In Boro 2023-24,

## DEVELOPMENT OF PARENTAL MATERIALS

**Source nursery.** Ninety-five test crosses and 696 (A × R) crosses were made during T. Aman season 2023. One hundred and twenty-for test crosses and 321 (A × R) crosses were made using 13 CMS lines during Boro season 2023-24.

**Test cross nursery.** In. Aman 2023, seventy-four test crosses (F<sub>1</sub>s) were evaluated for their pollen fertility status of which three entries have been found heterotic over the check varieties. Pollen parents of those combinations were regarded as suspected restorers and selected for fertility restoration ability with other CMS lines in the next season. One entry was found completely

sixty-nine experimental hybrids were evaluated in augmented design and selected six hybrids based on yield, growth duration and grain quality and showed at least 7% yield advantage over the best yielding check variety. In Boro 2023-24, a total of 500 kg (1.3 t/ha) from BRRI hybrid dhan5 and 581 kg (2.2 t/ha) from BRRI hybrid dhan6, 650 kg (2.2 t/ha) from BRRI hybrid dhan7 and 425 kg (1.7 t/ha) from BRRI hybrid dhan8 were obtained. From production side (Ishwardi and Barishal) 490 kg (1.2 t/ha) from BRRI hybrid dhan2, 4,750 kg (1.7 t/ha) from BRRI hybrid dhna3, 2,750 kg (1.7 t/ha) from BRRI hybrid dhan4, 4,300 kg (1.3 t/ha) from BRRI hybrid dhan5, 6,800 kg (2.4 t/ha) from BRRI hybrid dhan6, 6,650 kg (2.4 t/ha) from BRRI hybrid dhan7 and 8,920 kg (1.3 t/ha) of BRRI hybrid dhan8 F<sub>1</sub> seeds was obtained.

In T. Aman 2023, Hybrid Rice Division (HRD) supplied 7,117 kg F<sub>1</sub> seeds to 80 farmers, 12 seed companies, scientists, extension people, projects and staffs of BRRI. In Boro 2023-24, HRD supplied 19878 kg F<sub>1</sub> seeds to 135 farmers, 24 seed companies, scientists, extension people, projects and staffs of BRRI. In T Aus 2024, 4,229 kg F<sub>1</sub> seeds of BRRI hybrid dhan7 was distributed free of cost among farmers through different regional stations of BRRI and department of agricultural extension. Thirty-five stake holders produced more than 500 MT F<sub>1</sub> seeds using BRRI developed hybrid rice parental lines during Boro 2023-24.

sterile and their corresponding male parents were regarded as suspected maintainer lines.

In Boro 2023-24, ninety-one test crosses (F<sub>1</sub>s) were evaluated for their pollen fertility status. Among them 11 entries showed complete sterility and immediately backcrossed with their corresponding male parents for conversion. On the other hand, four entries have been selected for their high yielding ability compared with check varieties.

**Back cross nursery.** In T. Aman 2023, ten backcross entries were advanced as new CMS lines. Other backcross generations were advanced to next generations except one BC<sub>1</sub> generation which was found unstable in terms of pollen

sterility and hence discarded. In Boro 2023-24, six BC<sub>6</sub> generations were advanced as new CMS lines and shifted to CMS maintenance and evaluation nursery. Other entries were advanced for next generations except one BC<sub>1</sub> generation due to pollen fertility fluctuation.

#### CMS maintenance and evaluation nursery.

One hundred and eleven CMS lines were maintained by hand crossing for seed increase and genetic purity in T. Aman 2023 and in Boro 2023-24, 156 CMS lines were maintained through hand crossing for seed increase and genetic purity.

#### EVALUATION OF PARENTAL LINES AND HYBRIDS

In T Aman 2023, out of 430 test hybrids under observational trials, 12 hybrid combinations were selected based on yield, duration and grain type expressed more than 24-34% yield advantage over check variety BRRI hybrid dhan6, 13-22% over AZ7006 and 20-30 % over Dhanny Gold.

The heritability obtained from growth duration and grain yield were 92%, and 74% respectively, indicating high level of precision in this experiment (Table 1).

Upon commercial seed production feasibility of these selected hybrid combinations and grain quality assessment it will be tested under preliminary yield trial (PYT), multi-location yield trials (MLT) and ALART. Upon satisfactory yield advantage over check variety it is subjected to registration under national hybrid rice yield trial (NHRYT) for releasing as new hybrid rice of BRRI. In Boro, out of 489 test hybrids 11 hybrid combinations were selected based on yield, duration and grain type. The selected hybrid combinations expressed 4.2-10.8 % yield advantage over BRRI hybrid dhan8, 19-27% over SL8H, 19-27% over Heera and 28-37% over check variety Tej Gold. The heritability obtained from growth duration and grain yield was 84% and 82% respectively, indicating high level of precision in this experiment (Table 2).

**Table 1. List of experimental hybrids found heterotic over check variety during T. Aman 2023.**

| Trial no. | Designation                        | DTM  | GSS | Plot yield (kg/plot) | Yield (t/h) | Heterosis (%) |      |      |
|-----------|------------------------------------|------|-----|----------------------|-------------|---------------|------|------|
|           |                                    |      |     |                      |             | Ck-1          | Ck-2 | Ck-3 |
| OT-104    | BRRI99A/BRRI32R                    | 108  | LS  | 1.58                 | 7.9         | 27            | 16   | 23   |
| OT-147    | BRRI109A/BRRI32R                   | 106  | LS  | 1.54                 | 7.7         | 24            | 13   | 20   |
| OT-166    | BRRI109A/CHH6R                     | 107  | LS  | 1.64                 | 8.2         | 32            | 21   | 28   |
| OT-247    | BRRI125A/EL168R                    | 114  | MS  | 1.64                 | 8.2         | 32            | 21   | 28   |
| OT-306    | BRRI125A/IR86522-15-2-1-1-1-1-1R   | 121  | MS  | 1.66                 | 8.3         | 34            | 22   | 30   |
| OT-307    | BRRI125A/IR86612-31-3-2-1-1-1-1-1R | 119  | MS  | 1.66                 | 8.3         | 34            | 22   | 30   |
| OT-310    | BRRI125A/IR98206-4-2-2-1-1-1-1-1R  | 117  | MS  | 1.64                 | 8.2         | 32            | 21   | 28   |
| OT-327    | BRRI125A/IR86526-15-10-1-1-2-1-1R  | 120  | MS  | 1.6                  | 8.0         | 29            | 18   | 25   |
| OT-357    | IR79156A/EL220R                    | 126  | LS  | 1.64                 | 8.2         | 32            | 21   | 28   |
| OT-365    | IR79125A/BRRI33R                   | 125  | LS  | 1.58                 | 7.9         | 27            | 16   | 23   |
| OT-375    | IR79125A/KashempurR                | 126  | MS  | 1.62                 | 8.1         | 31            | 19   | 27   |
| OT-378    | IR79125A/IR86526-10-6-1-1-1-1-1-1  | 126  | LS  | 1.56                 | 7.8         | 26            | 15   | 22   |
| ck-1      | BRRI hybrid dhan6                  | 110  | MS  | 1.24                 | 6.2         |               |      |      |
| cK-2      | AZ7006                             | 119  | MS  | 1.36                 | 6.8         |               |      |      |
| cK-3      | Dhanny Gold                        | 118  | MS  | 1.28                 | 6.4         |               |      |      |
|           | Heritability                       | 0.92 | -   |                      | 0.74        |               |      |      |
|           | LSD <sub>(0.05)</sub>              | 15.9 | -   |                      | 2.09        |               |      |      |



Yield data counted from 30 hills per entry, **Legend:** DTM = Days to maturity; GSS= Grain spacing was 20 cm×15 cm (R × P) size and shape

DS: 14 Jul 2023; DT: 6 Aug 2023

**Table 2. List of the hybrid combinations found heterotic from observational nursery during Boro season 2023-24.**

| Trial no | Designation                        | DTM  | GSS | Plot yield (kg/plot) | Yield (t/ha) | Yield adv over cks |      |      |      |
|----------|------------------------------------|------|-----|----------------------|--------------|--------------------|------|------|------|
|          |                                    |      |     |                      |              | ck-1               | ck-2 | ck-3 | ck-4 |
| 20       | BRRI74A/BRRI49R                    | 144  | MB  | 1.94                 | 9.7          | 4.3                | 19.8 | 19.8 | 29.3 |
| 112      | BRRI99A/BRRI50R                    | 145  | MS  | 1.96                 | 9.8          | 5.4                | 20.8 | 20.8 | 30.3 |
| 147      | BRRI109A/BRRI32R                   | 140  | LS  | 1.92                 | 9.6          | 4.2                | 18.5 | 18.5 | 28.3 |
| 149      | BRRI109A/BRRI36R                   | 143  | MS  | 1.94                 | 9.7          | 4.3                | 19.8 | 19.8 | 29.3 |
| 178      | BRRI109A/IR85503-3-3-A-1-1-1-1-1R  | 149  | MS  | 2.06                 | 10.3         | 10.8               | 27.2 | 27.2 | 37.3 |
| 284      | BRRI125A/BRRI20R                   | 155  | MB  | 1.96                 | 9.8          | 5.4                | 20.8 | 20.8 | 30.3 |
| 298      | BRRI125A/BRRI44R                   | 156  | MS  | 1.96                 | 9.8          | 5.4                | 20.8 | 20.8 | 30.3 |
| 361      | IR105687A /Bayer R New             | 138  | LS  | 1.92                 | 9.6          | 4.2                | 18.5 | 18.5 | 28.3 |
| 369      | IR105687A /IR98184-27-1-1-1-1-1-1R | 146  | LS  | 1.92                 | 9.6          | 4.2                | 18.5 | 18.5 | 28.3 |
| 433      | IR102758A /BRRI41R                 | 152  | LS  | 1.98                 | 9.9          | 6.5                | 22.2 | 22.2 | 32.0 |
| 456      | IR102758A /IR101999-31-1-2R        | 150  | LS  | 1.92                 | 9.6          | 4.2                | 18.5 | 18.5 | 28.3 |
| ck-1     | BRRI hybrid dhan8                  | 150  | LS  | 1.86                 | 9.3          |                    |      |      |      |
| ck-2     | SL8H                               | 151  | MS  | 1.62                 | 8.1          |                    |      |      |      |
| ck-3     | Heera-2                            | 152  | MB  | 1.62                 | 8.1          |                    |      |      |      |
| ck -4    | Tej Gold                           | 148  | LS  | 1.5                  | 7.5          |                    |      |      |      |
|          | Heritability                       | 0.84 |     | 0.82                 |              |                    |      |      |      |
|          | LSD (0.05)                         | 8.05 |     | 2.09                 |              |                    |      |      |      |

DS: 10 Dec 2023; DT: 10 Jan 2024; Plot size: 2 m<sup>2</sup>

Legend: DTM = Days to maturity; GSS= Grain size and shape

Preliminary yield trials of promising hybrids

In T. Aman 2023, under preliminary yield trials, two hybrids were selected out of 13 and showed yield advantage 16-19 % over BRRI hybrid

dhan6, 21-24 % over AZ7006 and 16-19 % over Dhanny Gold (Table 3). In Boro, under preliminary yield trials, 13 hybrids were evaluated along with four hybrids as check variety. Out of 13 hybrids three hybrids were selected and produced 5-10 % yield advantage over BRRI hybrid dhan8, 15-20 % over SL8H, 13-18% over Heera-2 and 18-23% over check variety Tej Gold (Table 4).

**Table 3. Results of preliminary yield trials in T. Aman 2023.**

| Designation      | PHT (cm) | GD (day) | GSS | SF (%) | Amy (%) | Yield (t/h) | Heterosis (%) |      |      |
|------------------|----------|----------|-----|--------|---------|-------------|---------------|------|------|
|                  |          |          |     |        |         |             | ck-1          | ck-2 | ck-3 |
| IR58025A/BRRI32R | 112      | 116      | MS  | 78.3   | 23.4    | 7.8         | 13            | 18   | 13   |
| BRRI11A/BRRI38R  | 110      | 121      | S   | 82.2   | 23.6    | 8.2         | 19            | 24   | 19   |
| BRRI99A/BRRI38R  | 105      | 123      | S   | 80.5   | 23.5    | 8.0         | 16            | 21   | 16   |
| IR79125A/BRRI38R | 107      | 105      | S   | 77.6   | 24.1    | 7.4         | 7.0           | 12   | 7.0  |
| IR79156A/BRRI42R | 111      | 107      | S   | 76.5   | 23.7    | 7.2         | 4.0           | 9.0  | 4.0  |

| Designation                            | PHT<br>(cm) | GD<br>(day) | GSS | SF<br>(%) | Amy<br>(%) | Yield (t/h) | Heterosis (%) |      |      |
|----------------------------------------|-------------|-------------|-----|-----------|------------|-------------|---------------|------|------|
|                                        |             |             |     |           |            |             | ck-1          | ck-2 | ck-3 |
| IR79156A/BRR143R                       | 110         | 110         | S   | 83.3      | 23.7       | 6.6         | -             | -    | -    |
| BRR1109A/BRR146R                       | 115         | 118         | S   | 77.6      | 23.5       | 7.4         | 7.0           | 12   | 7.0  |
| IR105688A/BRR146R                      | 112         | 120         | S   | 80.2      | 22.8       | 7.5         | 9.0           | 14   | 9.0  |
| IR102758A/BRR153R                      | 106         | 104         | S   | 76.3      | 23.6       | 6.6         | -             | -    | -    |
| BRR148A/BRR154R                        | 113         | 112         | S   | 75.4      | 23.3       | 6.8         | -             | 3.0  | -    |
| BRR1109A/IR85551-<br>9-1-1-1-2-1-1-1R  | 111         | 111         | S   | 74.4      | 22.8       | 6.1         | -             | -    | -    |
| BRR1110A/IR85551-<br>9-1-1-1-2-1-1-1R  | 115         | 110         | S   | 74.0      | 24.0       | 5.8         | -             | -    | -    |
| IR102758A/IR85551-<br>9-1-1-1-2-1-1-1R | 104         | 106         | S   | 73.6      | 23.3       | 5.8         | -             | -    | -    |
| BRR1 hybrid dhan6                      | 109         | 118         | S   | 76.0      | 24.0       | 6.9         |               |      |      |
| AZ7006                                 | 112         | 131         | S   | 76.5      | -          | 6.6         |               |      |      |
| Dhanny Gold                            | 108         | 135         | MS  | 77.1      | -          | 6.9         |               |      |      |
| Mean                                   | 110         | 115.4       |     | 77.5      | 23.5       | 7.0         |               |      |      |
| CV (%)                                 | 3.0         | 7.9         |     | 3.7       | 1.7        | 10.4        |               |      |      |
| LSD (0.05%)                            | 2.1         | 5.9         |     | 1.8       | 0.3        | 0.5         |               |      |      |

DS: 14 Jul 2023; DT: 4Aug 2023; Plot size=10 m<sup>2</sup>; PHT (cm) = Plant height (cm); GD = Growth duration; GSS= Grain shape and size; S=Slender, MS=Medium slender; SF (%) = Spikelet fertility; Amy (%) = Amylose.

#### 4. Result of Preliminary Yield Trial (PYT) during Boro 2023-24.

| Designation            | PHT<br>(cm) | GD<br>(day) | GSS | Yield<br>(t/h) | AC%  | Heterosis (%) |      |      |      |
|------------------------|-------------|-------------|-----|----------------|------|---------------|------|------|------|
|                        |             |             |     |                |      | ck-1          | ck-2 | ck-3 | ck-4 |
| BRR197A/BRR132R        | 110         | 145         | MS  | 9.10           | 23.5 | -             | -    | -    | -    |
| BRR199A/BRR132R        | 115         | 143         | MS  | 9.20           | 23.3 | -             | -    | -    | 1.1  |
| BRR1110A/BRR138R       | 118         | 144         | MS  | 8.10           | 24.1 | -             | -    | -    | -    |
| IR102758A/BRR138R      | 118         | 143         | S   | 8.60           | 23.7 | -             | -    | -    | -    |
| BRR1125A/BRR142R       | 115         | 139         | S   | 8.80           | 23.2 | -             | -    | -    | -    |
| BRR197A/BRR154R        | 109         | 142         | S   | 10.70          | 23.5 | 4.9           | 15.1 | 12.6 | 17.6 |
| BRR199A/BRR154R        | 112         | 142         | S   | 11.20          | 23.6 | 9.8           | 20.4 | 17.9 | 23.1 |
| BRR1109A/BRR154R       | 113         | 140         | S   | 10.90          | 23.7 | 6.9           | 17.2 | 14.7 | 19.8 |
| BRR111A/BRR155R        | 108         | 140         | M   | 8.63           | 24.0 |               |      |      |      |
| BRR199A/BRR155R        | 115         | 143         | S   | 8.80           | 23.3 |               |      |      |      |
| BRR1109A/BRR155R       | 116         | 142         | S   | 8.60           | 23.4 |               |      |      |      |
| BRR199A/BRR156R        | 117         | 142         | S   | 8.43           | 23.5 |               |      |      |      |
| BRR1120A/BRR156R       | 105         | 141         | M   | 9.70           | 23.5 | -             | 4.3  | 2.1  | 6.6  |
| ck-1 BRR1 hybrid dhan8 | 115         | 142         | S   | 10.2           | 23.3 |               |      |      |      |
| ck-2 SL-8H             | 118         | 141         | S   | 9.30           |      |               |      |      |      |
| ck-3 Heera-2           | 105         | 139         | M   | 9.50           |      |               |      |      |      |
| ck-4 Tej Gold          | 104         | 140         | S   | 9.10           |      |               |      |      |      |
| Mean                   | 112.5       | 141.6       |     | 9.3            |      |               |      |      |      |
| CV (%)                 | 4.3         | 1.2         |     | 9.8            |      |               |      |      |      |
| LSD (0.05%)            | 3.0         | 1.1         |     | 0.6            |      |               |      |      |      |
| Heritability           | 0.93        | 0.78        |     | 0.83           |      |               |      |      |      |

DS: 08 Dec 2023; DT: 16 Jan 2024; Plot size: 20 m<sup>2</sup>

Legend: PH=Plant height (cm), GD= Growth duration (day), AC (%) = Amylose content, GSS= Grain size and shape, MS= Medium slender, S = Slender, M = Medium

### Multi-location yield trials of promising hybrids

In T. Aman 2023, under multi-location yield trials, three hybrids were selected based on yield, grain type and growth duration. The selected entries expressed yield advantage 16-19 % over BRRI hybrid dhan6, 21-24 % over AZ7006 and 16-19 % over Dhanny Gold (Table 5). In Boro 2023-24, multi-location yield trials comprised 15

hybrids with four checks. Three hybrids were selected based on stable yield performance and yield advantage over checks across the locations. All the selected hybrids showed yield advantage ranging from 6-11 % over BRRI hybrid dhan8, 18-24 % over SL8H, 12-17 % over Heera-2 and 18-24 % over Tej Gold (Table 6).

**Table 5. Results of multi-location yield trials during T. Aman 2023.**

| Hybrid                  | PH<br>(cm) | DTM   | Yield (t/ha) |     |      |     |      |     |      | SF<br>(%) | GT   | Amy<br>(%) | Aver yield<br>advantage over ck<br>(%) |      |  |
|-------------------------|------------|-------|--------------|-----|------|-----|------|-----|------|-----------|------|------------|----------------------------------------|------|--|
|                         |            |       | Gaz          | Ish | Bari | Ran | Son  | Av  | ck-1 |           |      |            | ck-2                                   | ck-3 |  |
|                         |            |       |              |     |      |     |      |     |      |           |      |            |                                        |      |  |
| IR79156A/BRRI32R        | 108        | 111   | 7.4          | 7.6 | 5.8  | 6.4 | 5.8  | 6.6 | 76.3 | S         | -    | -          | -                                      | -    |  |
| BRR1109A/BRRI37R        | 110        | 110   | 7.2          | 7.0 | 8.9  | 6.1 | 5.6  | 7.0 | 78.6 | MS        | 23.4 | 1.4        | 6.1                                    | 1.4  |  |
| BRR148A/BRRI38R         | 106        | 113   | 5.9          | 7.3 | 7.4  | 6.4 | 6.3  | 6.7 | 76.0 | S         | 23.2 | -          | 1.5                                    | -    |  |
| BRR1109A/BRRI38R        | 108        | 114   | 8.6          | 8.8 | 8.7  | 6.5 | 7.9  | 8.1 | 75.2 | S         | 23.5 | 17.4       | 22.7                                   | 17.4 |  |
| BRR197A/BRRI38R         | 107        | 114   | 6.8          | 7.7 | 6.9  | 6.0 | 6.7  | 6.8 | 80.3 | MS        | 23.6 | -          | 3.0                                    | -    |  |
| BRR1109A/BRRI42R        | 111        | 115   | 8.4          | 8.5 | 8.3  | 7.1 | 7.8  | 8.0 | 82.5 | MS        | 24.2 | 15.9       | 21.2                                   | 15.9 |  |
| IR79156A/BRRI42R        | 110        | 110   | 6.0          | 7.9 | 6.9  | 6.5 | 6.3  | 6.7 | 77.8 | MS        | 23.4 | -          | 1.5                                    | -    |  |
| IR58025A/BRRI42R        | 107        | 114   | 6.5          | 7.1 | 6.12 | 6.1 | 5.8  | 6.3 | 75.0 | MS        | 23.4 | -          | -                                      | -    |  |
| BRR197A/BRRI42R         | 103        | 110   | 6.8          | 7.5 | 7.3  | 6.6 | 6.3  | 6.9 | 77.6 | S         | 24.0 | -          | 4.5                                    | -    |  |
| IR102758A/BRRI54R       | 111        | 118   | 7.4          | 7.1 | 7.8  | 5.8 | 7.0  | 7.0 | 79.8 | S         | 23.7 | 1.4        | 6.1                                    | 1.4  |  |
| BRR199A/BRRI54R         | 113        | 119   | 6.7          | 6.8 | 7.2  | 5.5 | 6.8  | 6.6 | 78.7 | MS        | 23.6 | -          | -                                      | -    |  |
| BRR111A/BRRI54R         | 109        | 116   | 8.6          | 8.8 | 8.5  | 7.1 | 8    | 8.2 | 83.3 | M         | 24.0 | 18.8       | 24.2                                   | 18.8 |  |
| IR79156A/BRRI54R        | 115        | 118   | 6.4          | 6.7 | 6.2  | 5.8 | 6.6  | 6.3 | 75.2 | MS        | 23.6 | -          | -                                      | -    |  |
| IR58025A/BRRI54R        | 112        | 121   | 6.6          | 7.0 | 6.8  | 6.3 | 6.7  | 6.7 | 76.8 | MS        | 23.0 | -          | 1.5                                    | -    |  |
| Ck-1 BRRI hybrid dhan6  | 112        | 116   | 5.8          | 7.3 | 5.8  | 6.1 | 6.2  | 6.9 | 75.0 | S         | 24.0 |            |                                        |      |  |
| Ck-2 AZ 7006 (ck-2)     | 116        | 123   | 5.6          | 7.8 | 6.2  | 6.4 | 5.4  | 6.6 | 75.1 | S         |      |            |                                        |      |  |
| Ck-3 Dhanny Gold (ck-3) | 118        | 127   | 6.3          | 7.0 | 7.8  | 6.5 | 5.6  | 6.9 | 75.8 | S         |      |            |                                        |      |  |
| Mean                    | 110.4      | 115.8 | 6.9          | 7.5 | 7.2  | 6.3 | 6.5  | 7.0 | 77.6 |           |      |            |                                        |      |  |
| CV (%)                  | 3.5        | 4.1   | 13.7         | 8.8 | 14.0 | 6.7 | 12.3 | 8.4 | 3.4  |           |      |            |                                        |      |  |
| LSD (0.05%)             | 2.4        | 3.0   | 0.6          | 0.4 | 0.6  | 0.3 | 0.5  | 0.4 | 1.6  |           |      |            |                                        |      |  |

DS: 17 Jul 2023; DT: 8 Aug 2023; Unit plot size: 30 m<sup>2</sup>

Legend: PH (cm) = Plant height; DTM= Days to maturity; SF (%) = Spikelet fertility; GSS= Grain size and shape; Amy (%) = Content of amylose in percentage; Gaz = Gazipur; Ish = Ishwardi; Bari = Barishal; Ran = Rangpur; Son = Sonagazi

**Table 6. Results of multi-location yield trials during Boro 2023-24.**

| Hybrid                 | PH<br>(cm) | DTM   | Yield (t/ha) |      |      |     |      |      | SF<br>(%) | GSS | Amy<br>(%) | Aver yield advantage<br>over ck (%) |      |      |      |
|------------------------|------------|-------|--------------|------|------|-----|------|------|-----------|-----|------------|-------------------------------------|------|------|------|
|                        |            |       | Gaz          | Ish  | Bari | Ran | Son  | Av   |           |     |            | Ck-1                                | Ck-2 | Ck-3 | Ck-4 |
| BRR111A/BRR132R        | 108        | 146   | 8.7          | 9.5  | 10.5 | 7.9 | 8.5  | 9.02 | 83.3      | S   | 23.6       | -                                   | 2.5  | -    | 2.5  |
| BRR1125A/BRR132R       | 110        | 139   | 9.2          | 9.6  | 8.9  | 8.5 | 8.3  | 8.9  | 82.6      | MS  | 23.4       | -                                   | 1.1  | -    | 1.1  |
| BRR199A/BRR138R        | 108        | 113   | 11.5         | 11.4 | 11.4 | 9.5 | 10.6 | 10.9 | 87.6      | S   | 23.6       | 11.2                                | 23.7 | 17.2 | 23.7 |
| BRR1109A/BRR138R       | 104        | 147   | 10.1         | 10.6 | 10.3 | 8.7 | 9.6  | 9.9  | 85.2      | S   | 24.0       | -                                   | 1.1  | 6.5  | 1.1  |
| BRR1120A/BRR138R       | 107        | 144   | 11.4         | 11.5 | 10.8 | 9.4 | 10.7 | 10.8 | 86.3      | M   | 24.0       | 10.2                                | 22.7 | 16.1 | 22.7 |
| BRR1125A/BRR138R       | 111        | 145   | 10.7         | 10.3 | 9.8  | 8.5 | 9.4  | 9.7  | 84.5      | S   | 24.2       | -                                   | 10.2 | 4.3  | 10.2 |
| BRR174A/BRR142R        | 110        | 146   | 10.8         | 10.5 | 10.8 | 9.2 | 10.6 | 10.4 | 84.8      | M   | 23.5       | 6.1                                 | 18.2 | 11.8 | 18.2 |
| BRR1109A/BRR142R       | 109        | 144   | 8.9          | 10.1 | 9.7  | 8.5 | 8.8  | 9.2  | 83.0      | S   | 23.4       | -                                   | 4.5  | -    | 4.5  |
| BRR1120A/BRR142R       | 107        | 140   | 8.1          | 8.5  | 9.3  | 8.1 | 8.3  | 8.5  | 77.6      | S   | 24.0       | -                                   | -    | -    | -    |
| BRR111A/BRR154R        | 111        | 143   | 8.4          | 8.8  | 9.7  | 8.1 | 9.0  | 8.8  | 79.8      | S   | 23.7       | -                                   | -    | -    | -    |
| BRR148A/BRR154R        | 113        | 147   | 9.7          | 9.4  | 10.2 | 7.4 | 7.8  | 8.9  | 80.7      | MS  | 23.6       | -                                   | 1.1  | -    | 1.1  |
| BRR174A/BRR154R        | 112        | 144   | 8.5          | 9.1  | 9.2  | 8.2 | 7.8  | 8.6  | 78.1      | M   | 23.3       | -                                   | -    | -    | -    |
| BRR1120A/BRR154R       | 107        | 139   | 8.7          | 9.5  | 9.3  | 8.4 | 8.7  | 8.9  | 81.0      | MS  | 23.4       | -                                   | 1.1  | -    | 1.1  |
| BRR1120A/BRR155R       | 110        | 144   | 9.6          | 10.0 | 10.3 | 8.6 | 8.9  | 9.5  | 84.6      | M   | 23.6       | -                                   | 7.9  | 2.2  | 7.9  |
| BRR174A/BRR156R        | 113        | 145   | 8.9          | 9.3  | 9.5  | 8.2 | 8.8  | 8.9  | 80.5      | M   | 23.4       | -                                   | 1.1  | -    | 1.1  |
| Ck-1 BRR1 hybrid dhan8 | 108        | 145   | 10.3         | 10.5 | 9.7  | 9.4 | 9.3  | 9.8  | 86.3      | MS  | 24.0       |                                     |      |      |      |
| Ck-2 SL8H              | 108        | 143   | 9.3          | 8.8  | 9.4  | 8.2 | 8.4  | 8.8  | 80.4      | MS  |            |                                     |      |      |      |
| Ck-3 Heera-2           | 113        | 148   | 9.6          | 9.4  | 10.4 | 8.6 | 8.5  | 9.3  | 83.6      | M   |            |                                     |      |      |      |
| Ck-4 Tej Gold          | 115        | 141   | 8.4          | 9.3  | 8.8  | 8.2 | 9.4  | 8.8  | 79.7      | S   |            |                                     |      |      |      |
| Mean                   | 109.7      | 142.3 | 9.5          | 9.8  | 9.9  | 8.5 | 9.0  | 9.3  | 82.6      |     |            |                                     |      |      |      |
| CV (%)                 | 2.5        | 5.3   | 10.9         | 8.7  | 7.3  | 6.5 | 9.7  | 7.7  | 3.5       |     |            |                                     |      |      |      |
| LSD (0.05%)            | 1.6        | 4.5   | 0.6          | 0.5  | 0.4  | 0.3 | 0.5  | 0.4  | 1.7       |     |            |                                     |      |      |      |

DS: 4 Dec 2023; DT: 8 Jan 2024; Unit plot size: 30 m<sup>2</sup>

Legend: PH (cm) = Plant height (cm); DTM= Days to maturity; SF (%) = Spikelet fertility (%); GSS= Grain shape and size; S=Slender; MS= Medium Slender; M=Medium; AC (%) = Amylose (%)

#### Development of maintainer and restorer lines through (B×B) and (R×R) crosses

Under parental line improvement programme (B×B & R×R), 14 B×B (Table 7) and 20 R×R (Table 8) crosses were confirmed based on different cyto-sources and amylose content in T. Aman 23 and 11 B×B (Table 9) and 18 R×R (Table 10) crosses were confirmed based on

different cyto-sources, grain type and amylose content in Boro 2023-24. Under field rapid generation advancement programme 58,618 F<sub>2</sub>, F<sub>3</sub>, F<sub>5</sub> and F<sub>6</sub> progenies of B×B, R×R and A×R were advanced in T. Aman 23 (Table 11) and 42,331 progenies of F<sub>2</sub>, F<sub>3</sub>, F<sub>4</sub> and F<sub>6</sub> generations of B×B, R×R and A×R crosses were advanced in Boro 2023-24 (Table 12).

**Table 7. F<sub>1</sub> Confirmation for (B x B) improvement, T. Aman 2023.**

| Genotype              | Amount of harvested F2 seeds |
|-----------------------|------------------------------|
| IR69802B x IR77811B   | 150g                         |
| IR77811B x IR69802B   | 150g                         |
| BRR123B x BRR1152B    | 150g                         |
| IR102760B x IR102573B | 150g                         |
| IR102573B x IR102760B | 150g                         |
| IR77808B x BRR1105B   | 150g                         |
| BRR126Bx IR73328B     | 150g                         |
| BRR1105B x BRR1150B   | 150g                         |

| Genotype            | Amount of harvested F2 seeds |
|---------------------|------------------------------|
| BRR150B x PMS 8B    | 150g                         |
| BRR150B x BRR105B   | 150g                         |
| IR102757B x BRR105B | 150g                         |
| BRR105B x IR102760B | 150g                         |
| IR102760B x BRR105B | 150g                         |

DS: 12 Jul 2023; DT: 29 Jul 2023

**Table 8. F<sub>1</sub> Confirmation for (R x R) improvement, T. Aman 2023.**

| Genotype                                                  | F <sub>2</sub> seeds harvested |
|-----------------------------------------------------------|--------------------------------|
| BRR134R x BRR142R                                         | 200g                           |
| BRR142R x BRR134R                                         | 200g                           |
| PR506R x PR862R                                           | 200g                           |
| PR862R x PR506R                                           | 200g                           |
| PR867R x 2087R                                            | 200g                           |
| 2087R x PR867R                                            | 200g                           |
| 2017R-2-4R x KBPSR                                        | 200g                           |
| KBPSR x 2017R-2-4                                         | 200g                           |
| ACI1R x LP70R                                             | 200g                           |
| LP70R x ACI1R                                             | 200g                           |
| LP106R x GETCO24R                                         | 200g                           |
| GETCO24R x LP106R                                         | 200g                           |
| CHH32R x Bogura1R                                         | 200g                           |
| Bogura1R x CHH32R                                         | 200g                           |
| Tangail2R x SynR-N-1                                      | 200g                           |
| SynR-N-1x Tangail2R                                       | 200g                           |
| IR 86417-26-1-1-1-1-1R x IR86555-16-1-1-1-1-1-1-1-1-1-1-1 | 200g                           |
| IR90928-15-4-1-1-1-1R x IR69712-154-2-3-1-3R              | 200g                           |
| IR69712-154-2-3-1-3R x IR90928-15-4-1-1-1-1R              | 200g                           |

DS: 12 Jul 2023; DT: 29 Jul 2023

**Table 9. F<sub>1</sub> Confirmation of (B×B) crosses, Boro 2023-24.**

| Cross combination | Code                   | Amount of harvested F <sub>2</sub> seeds |
|-------------------|------------------------|------------------------------------------|
| IR77808B×IR80151B | (9 CMSB) × (16 CMSB)   | 200g                                     |
| IR79155B×BRR140B  | (22 CMSB) × (39 CMSB)  | 200g                                     |
| BRR140B×IR77808B  | (39 CMSB) × (9 CMSB)   | 200g                                     |
| BRR173B×IR102760B | (51 CMSB) × (3 HRDCB)  | 200g                                     |
| BRR1127B×IR78369B | (76 CMSB) × (13 HRDCB) | 200g                                     |
| IR102760B×BRR173B | (3 HRDCB) × (51 CMSB)  | 200g                                     |
| IR102571B×BRR181B | (7HRDCB) × (54CMSB)    | 200g                                     |
| BRR120B×IR102760B | (29 CMSB) × (3HRDCB)   | 200g                                     |
| IR68890B×IR78355B | (1CMSB) × (7CMSB)      | 200g                                     |
| BRR1128B×BRR117B  | (77CMSB) × (26CMSB)    | 200g                                     |
| BRR1129B×BRR1126B | (78CMSB) × (75CMSB)    | 200g                                     |

DS: 8 Dec 2023; DT: 10 Jan 2024

**Table 10. F<sub>1</sub> Confirmation of (R×R) crosses Boro 2023-24.**

| Cross combination                          | Code                   | Amount of harvested F <sub>2</sub> seeds |
|--------------------------------------------|------------------------|------------------------------------------|
| BRR112R×IR05N162R                          | (10 SNR) × (63 HRDCR)  | 200g                                     |
| BRR117R×IR 90928-4-1-1-1R                  | (15 SNR) × (69 HRDCR)  | 200g                                     |
| BRR156R×IR 85503-3-3-A-1-1-1-1R            | (54 SNR) × (84 HRDCR)  | 200g                                     |
| PR595R×IR85503-8-1-1-1-1-1R                | (73 SNR) × (85 HRDCR)  | 200g                                     |
| PR812R×IR86417-26-1-1-1-1-1R               | (74 SNR) × (53 HRDCR)  | 200g                                     |
| PR828R×IR69712-154-2-3-1-3R                | (75 SNR) × (87 HRDCR)  | 200g                                     |
| EL144×BRR156R                              | (243 SNR) × (54 SNR)   | 200g                                     |
| EL220R×GETCO23R                            | (168 SNR) × (145 SNR)  | 200g                                     |
| IR85503-8-11-1-1-1-2-1-1R×GETCO13R         | (67HRDC) × (135 SNR)   | 200g                                     |
| EL160R×IR96532-29-1-1-1-1-2-1-1R           | (227 SNR) × (125HRDCR) | 200g                                     |
| IR86526-11-6-2-1-1-1- 1R×Supreme New R (S) | (11 HRDCR) × (283 SNR) | 200g                                     |
| BRR128R×NR Hafizar                         | (26SNR) × (151SNR)     | 200g                                     |
| PR344R×GETCO22R                            | (62SNR) × (144SNR)     | 200g                                     |
| PR326R×RFSR                                | (60SNR) ×(55SNR)       | 200g                                     |
| BRR138R×BRR133R                            | (36SNR) ×(31SNR)       | 200g                                     |
| EL220R×GETCO22R                            | (168SNR) ×(144SNR)     | 200g                                     |
| BR7011-37-1-2R×Muktagacha4R                | (7SNR) ×(176SNR)       | 200g                                     |
| Basmati line India× BR6839-41-5-1R         | (190SNR) ×(5SNR)       | 200g                                     |

DS: 8 Dec 2023; DT: 10 Jan 2024

**Table 11. Progenies selected through Field RGA during T. Aman 2023.**

| Cross type            | No. of crosses |                |                |                | Transplanted | Harvested |
|-----------------------|----------------|----------------|----------------|----------------|--------------|-----------|
|                       | F <sub>2</sub> | F <sub>3</sub> | F <sub>5</sub> | F <sub>6</sub> |              |           |
| B × B                 | 5              | 7              | 13             | 15             | 68900        | 58618     |
| R × R                 | 10             | 11             | 7              | 6              |              |           |
| A × R                 |                |                | 14             |                |              |           |
| Test cross forwarding |                |                | 8              |                |              |           |
| Total                 | 96             |                |                |                |              |           |

DS: 12 Jul 2023; DT: 17 Aug 2023

**Table 12. Progenies selected through field RGA, during Boro 2023-24.**

| Cross type           | No. of crosses |                |                |                | Transplanted | Harvested |
|----------------------|----------------|----------------|----------------|----------------|--------------|-----------|
|                      | F <sub>2</sub> | F <sub>3</sub> | F <sub>4</sub> | F <sub>6</sub> |              |           |
| B×B                  | 13             | 5              | 7              | 13             | 48600        | 42331     |
| R×R                  | 20             | 10             | 11             | 7              |              |           |
| A×R                  |                |                |                | 14             |              |           |
| Testcross forwarding |                |                |                | 8              |              |           |
| Total                | 108            |                |                |                |              |           |

DS: 11 Dec 2023; DT: 17 Jan 2024

### Assessment of specific and general adaptability for selection of suitable rice hybrids under saline prone areas for Boro season

Adaptability under saline condition of BRRI developed and popular company hybrids along with popular saline tolerant inbred checks BRRI dhan67, local rice variety IT, BINA dhan-10 were cultivated at three coastal locations of Satkhira and Khulna. We observed that the salinity levels of Debhata varies from 1.3 ds/m to 1.8 ds/m, which is very low level whereas the salinity levels of Dumuria varies from 4.1 ds/m to 6.1 ds/m, which remains at medium level. On the other hand, salinity levels of Kaliganj varies from 7.3 ds/m to 21.9 ds/m which is very high levels. We found that the highest yielding genotypes of pooled (Debhata and Dumuria) were BRRI

hybrid dhan8 (7.52 t ha<sup>-1</sup>), BRRI hybrid dhan3 (6.14 t ha<sup>-1</sup>), Heera-2 (6.02 t ha<sup>-1</sup>) followed by check variety BRRI hybrid dhan6 (5.64 t ha<sup>-1</sup>), IT (5.47 t ha<sup>-1</sup>) and Bina dhan-10 (5.42 t ha<sup>-1</sup>) respectively. Here the experimental result of Kaliganj was not satisfactory due to high salinity levels and high temperature. That is why this result was not considered as average. In spite of medium salinity levels of Dumuria, the yield is not also satisfactory due to the water stress, high temperature during flowering stage and lodging due to heavy storm just before harvesting period. Therefore, we can conclude that BRRI hybrid dhan8, BRRI hybrid dhan3 and Heera-2 can be cultivated profitably in those locations where the water salinity level of the paddy field remains from 1.3 ds/m to 6.1 ds/m in Debhata and Dumuria (Table 13 and Fig. 1).

**Table 13. Yield and agronomic performance of fifteen genotypes from adaptive trial in Boro 2023-24.**

| Genotype            | GD<br>(day) | PH<br>(cm) | ET | Debhata | Yield (t/ha)                                                                          |                                                      | Pooled<br>(Deb+Dum) |
|---------------------|-------------|------------|----|---------|---------------------------------------------------------------------------------------|------------------------------------------------------|---------------------|
|                     |             |            |    |         | Dumuria<br>(Water stress+high temp<br>stress+salinity+ lodging due<br>to heavy storm) | Kaliganj<br>(High temp<br>stress+salinity<br>stress) |                     |
| BRRI hybrid dhan8   | 137         | 100        | 9  | 10.4    | 4.64                                                                                  | 1.09                                                 | 7.52                |
| BRRI hybrid dhan3   | 134         | 100        | 9  | 8.35    | 3.92                                                                                  | 0.96                                                 | 6.14                |
| BRRI hybrid dhan6   | 139         | 111        | 9  | 7.74    | 3.54                                                                                  | 0.77                                                 | 5.64                |
| Tej Gold            | 135         | 106        | 9  | 7.23    | 3.50                                                                                  | 0.82                                                 | 5.36                |
| BRRI hybrid dhan4   | 140         | 106        | 10 | 6.76    | 3.26                                                                                  | 0.79                                                 | 5.01                |
| BRRI74A/B<br>RRI56R | 133         | 101        | 9  | 7.10    | 3.15                                                                                  | 1.36                                                 | 5.12                |
| SL8H                | 131         | 97         | 9  | 7.48    | 3.28                                                                                  | 0.75                                                 | 5.38                |
| BRRI74A/B<br>RRI42R | 133         | 93         | 9  | 6.48    | 2.99                                                                                  | 1.22                                                 | 4.74                |
| BRRI hybrid dhan5   | 137         | 101        | 9  | 5.90    | 3.03                                                                                  | 1.07                                                 | 4.46                |
| Heera-2             | 135         | 102        | 9  | 8.31    | 3.73                                                                                  | 1.26                                                 | 6.02                |
| BRRI hybrid dhan7   | 142         | 112        | 9  | 6.20    | 2.89                                                                                  | 0.89                                                 | 4.55                |
| BRRI hybrid dhan2   | 137         | 104        | 9  | 7.10    | 3.28                                                                                  | 1.27                                                 | 5.19                |
| Bina dhan-10 (cv)   | 135         | 108        | 9  | 7.35    | 3.49                                                                                  | 2.24                                                 | 5.42                |
| BRRI dhan67 (cv)    | 129         | 106        | 9  | 6.24    | 2.95                                                                                  | 0.65                                                 | 4.60                |

| Genotype     | GD<br>(day) | PH<br>(cm) | ET   | Debhata | Yield (t/ha)                                                                          |                                                      | Pooled<br>(Deb+Dum) |
|--------------|-------------|------------|------|---------|---------------------------------------------------------------------------------------|------------------------------------------------------|---------------------|
|              |             |            |      |         | Dumuria<br>(Water stress+high temp<br>stress+salinity+ lodging due<br>to heavy storm) | Kaliganj<br>(High temp<br>stress+salinity<br>stress) |                     |
| IT (cv)      | 129         | 92         | 9    | 2.5067* | 3.51                                                                                  | 1.39                                                 | 5.47                |
| LSD          | 5.05        | 7.29       | 0.97 | 0.34    | 0.26                                                                                  | 0.59                                                 |                     |
| CV           | 0.56        | 0.61       | 6.22 | 2.78    | 4.50                                                                                  | 32.28                                                |                     |
| Heritability | 0.80        | 0.82       | 0.00 | 0.99    | 0.96                                                                                  | 0.73                                                 |                     |

DS: 12 Dec 2023; DT: 21 Jan 2024

Legend: GD= Growth duration (day); PH=Plant height (cm); ET= Effective tiller; \*= 60-70% rat Dama

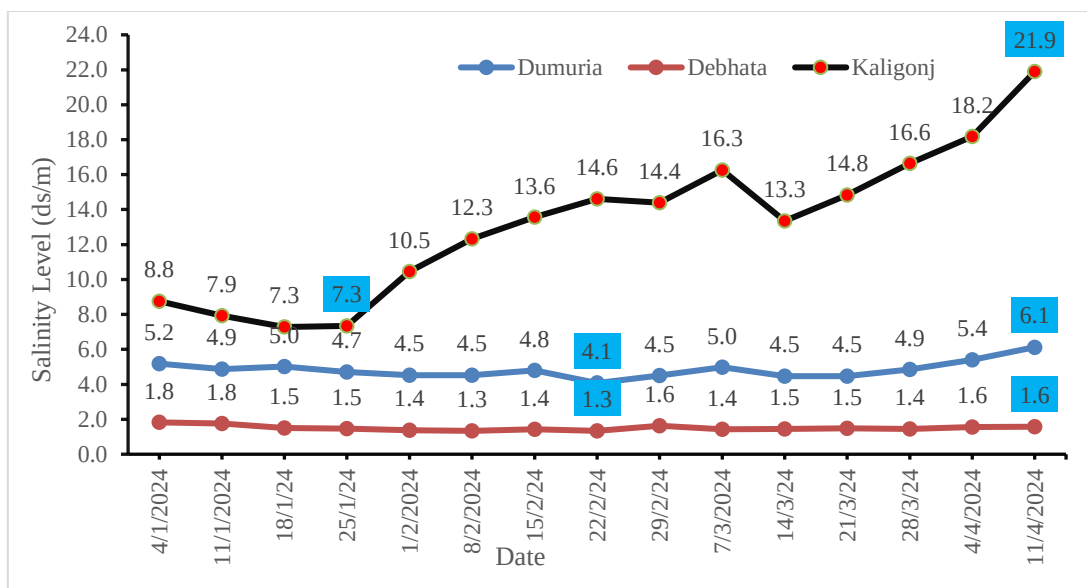


Fig.1. Water salinity levels of different experimental plots in Boro 2023-24 at Debhata (Satkhira), Dumuria (Khulna) and Kaliganj upazila in Satkhira.

#### SEED PRODUCTION OF PARENTAL LINES AND HYBRIDS

##### CMS line multiplication of released hybrids.

Seed yield of 324 kg/plot (0.65 t/ha) and 1100 kg/plot (1.1 t/ha) was obtained from BRRI11A and IR79156A respectively in T. Aman season 2023 (Table 14). Seed yield was poor due to

continuous rain at flowering time. In Boro 2023-24, CMS seed yield of 276 kg (1.73 t/ha), 1193 kg (1.70 t/ha), 178 kg (1.78 t/ha), 344 (1.0 t/ha), 1897 kg (2.8 t/ha) and 1546 (2.21 t/ha) were obtained from BRRI10A, BRRI11A, IR58025A, BRRI7A, IR79156A and BRRI99A, respectively (Table 15). Seed yield some CMS lines of was poor due to high temperature at flowering time.



**Table 14. CMS lines multiplication of BRRI11A and IR79156A in T. Aman 2023.**

| Combination | Plant height (cm) |        | 50% flowering date |        | PER (%) | OCR (%) | Yield    |        | Remark                                                           |
|-------------|-------------------|--------|--------------------|--------|---------|---------|----------|--------|------------------------------------------------------------------|
|             | A line            | B line | A line             | B line |         |         | Kg /plot | (t/ha) |                                                                  |
| BRRI11A/B   | 89                | 93     | 79                 | 81     | 77      | 29      | 324      | 0.65   | Poor seed yield due to rainfall during supplementary pollination |
| IR79156A/B  | 96                | 98     | 85                 | 87     | 77      | 34      | 1100     | 1.1    |                                                                  |

DS: B<sub>1</sub>= 1 Jul 2023, A/B<sub>2</sub>= 4 Jul 2023, B<sub>3</sub>=7Jul 2023; DT: A/B=24 Jul 2023

DS: B<sub>1</sub>= 2 Jul 2023, A/B<sub>2</sub>=5 Jul 2023, B<sub>3</sub>=8 Jul 2023; DT: A/B=28 Jul 2023

PER=Panicle exertion rate, OCR= Out crossing rate.

**Table 15. CMS multiplication of BRRI hybrid dhan2, BRRI hybrid dhan3, BRRI hybrid dhan4, BRRI hybrid dhan5, BRRI hybrid dhan6 and BRRI hybrid dhan8 during Boro 2023-24.**

| Designation | Plant height (cm) |        | 50% flowering (days) |        | PER (%) | OCR (%) | Plot area (m <sup>2</sup> ) | Yield (kg/plot) | Seed yield (t/ha) |
|-------------|-------------------|--------|----------------------|--------|---------|---------|-----------------------------|-----------------|-------------------|
|             | A line            | B line | A line               | B line | A line  | A line  |                             |                 |                   |
| BRRI10A/B   | 87                | 89     | 124                  | 121    | 77.0    | 38.0    | 1600                        | 276             | 1.73              |
| BRRI11A/B   | 97                | 99     | 121                  | 118    | 76.5    | 37.0    | 7000                        | 1193            | 1.70              |
| IR58025A/B  | 92                | 95     | 123                  | 120    | 78.0    | 38.4    | 1000                        | 178             | 1.78              |
| BRRI7A/B    | 94                | 97     | 120                  | 117    | 78.0    | 31.1    | 3200                        | 344             | 1.00              |
| IR79156A/B  | 100               | 103    | 123                  | 121    | 83.0    | 53.5    | 6800                        | 1897            | 2.80              |
| BRRI99A/B   | 87                | 90     | 124                  | 121    | 84.3    | 45.4    | 7000                        | 1546            | 2.21              |
| Mean        | 92.8              | 95.5   | 122.5                | 119.7  | 79.5    | 40.6    | 4433.3                      | 905.7           | 1.9               |
| SD          | 5.3               | 5.4    | 1.6                  | 1.8    | 3.3     | 7.8     | 2832.4                      | 737.1           | 0.6               |
| CV (%)      | 5.7               | 5.6    | 1.3                  | 1.5    | 4.2     | 19.2    | 63.9                        | 81.4            | 32.0              |
| Lsd 0.05%   | 5.6               | 5.6    | 1.7                  | 1.8    | 3.5     | 8.2     | 2983.3                      | 776.4           | 0.6               |

DS: B<sub>1</sub>=2 Dec 2023; A/B<sub>2</sub>= 5 Dec 2023; B<sub>3</sub>= 8 Dec 2023; DT: A/B = 13 Jan 2024; DS: B<sub>1</sub>=7 Dec 2023; A/B<sub>2</sub>=10 Dec 2023; B<sub>3</sub>=13 Dec 2023; DT: A/B =11 Jan 2024; DS: B<sub>1</sub>=5 Dec 2023; A/B<sub>2</sub>=8 Dec 2023;

B<sub>3</sub>=11 Dec 2023; DT: A/B=08 Jan 2024; DS: B<sub>1</sub>=30 Nov 2023; A/B<sub>2</sub>=3 Dec 2023; B<sub>3</sub>=6 Dec 2023; DT: A/B=5 Jan 2024; DS: B<sub>1</sub>=10 Dec 2023; B<sub>2</sub>/A =13 Dec 2023; B<sub>3</sub>=16 Dec 2023; DT: A/B= 17 Jan 2024; PER=Panicle exertion rate, OCR= Out crossing rate.

#### **CMS seed multiplication of selected promising CMS lines during Boro season 2023-24**

Seed amount got from selected promising CMS lines ranging from 1.19 to 2.8 t/ha during Boro 2023-24 (Table 16). Out of six, four CMS entries

were for breeder seed production. Seed amount varied CMS line to CMS line due to high temperature at supplementary pollination time and it was happened in particular entries due to sowing time difference for making time isolation in flowering.

**Table 16. Seed amount got from selected promising CMS lines during Boro 2023-24.**

| Designation | Plant height (cm) |        | D50% flowering |        | PER (%) | OCR (%) | Plot area (m <sup>2</sup> ) | Yield (kg/plot) | Seed yield (t/ha) |
|-------------|-------------------|--------|----------------|--------|---------|---------|-----------------------------|-----------------|-------------------|
|             | A line            | B line | A Line         | B line |         |         |                             |                 |                   |
| BRR172A/B   | 98.0              | 101    | 121            | 118    | 75.0    | 53.7    | 50                          | 14              | 2.8               |
| BRR1197A/B  | 95.0              | 97.0   | 119            | 116    | 77.3    | 47.2    | 50                          | 9.5             | 1.9               |
| IR102758A/B | 104.0             | 107.0  | 120            | 117    | 68.5    | 34.3    | 2000                        | 237             | 1.19              |
| IR105687A/B | 91.0              | 94.0   | 117            | 114    | 76.0    | 43.5    | 1000                        | 213             | 2.13              |
| IR102571A/B | 105.0             | 108.0  | 127            | 124    | 71.6    | 41.2    | 50                          | 10.5            | 2.10              |
| IR99792A/B  | 93.0              | 96.0   | 125            | 122    | 76.5    | 35.3    | 100                         | 12.5            | 1.25              |
| Average     | 97.7              | 100.5  | 121.5          | 118.5  | 74.2    | 42.5    | 541.7                       | 82.8            | 1.9               |
| SD          | 5.8               | 5.9    | 3.8            | 3.8    | 3.4     | 7.3     | 807.1                       | 110.5           | 0.6               |
| Lsd (0.05)  | 6.1               | 6.2    | 4.0            | 4.0    | 3.6     | 7.7     | 850.1                       | 116.3           | 0.6               |
| CV (%)      | 5.9               | 5.9    | 3.1            | 3.2    | 4.6     | 17.3    | 149.0                       | 133.5           | 31.9              |

DS: B<sub>1</sub>/A=10 Dec 2023; B<sub>2</sub>=13 Dec 2023; B<sub>3</sub>=16 Dec 2023; DT: 14 Jan 2024; DS: B<sub>1</sub>/A=10 Dec 2023; B<sub>2</sub>=13 Dec 2023; B<sub>3</sub>=16 Dec 2023; DT: 19 Jan 2024; DS: B<sub>1</sub>/A=1 Dec 2023; B<sub>2</sub>=4 Dec 2023; B<sub>3</sub>=7 Dec 2023; DT: 11 Jan 2024; DS: B<sub>1</sub>/A=07 Dec 2023; B<sub>2</sub>=10 Dec 2023; B<sub>3</sub>=13 Dec 2023; DT: 22 Jan 2024; DS: B<sub>1</sub>/A=1 Dec 2023; B<sub>2</sub>=4 Dec 2023; B<sub>3</sub>=7 Dec 2023; DT: 3 Jan 2024; DS: B<sub>1</sub>/A=10 Dec 2023; B<sub>2</sub>=13 Dec 2023; B<sub>3</sub>=16 Dec 2023; DT: 12 Jan 2024; PER (%) = panicle exertion rate, OCR (%) = Out crossing rate

**F<sub>1</sub> seed production of BRR1 hybrid dhan5, BRR1 hybrid dhan6, BRR1 hybrid dhan7 and BRR1 hybrid dhan8 in Boro 2023-24**

A total of 442 kg seed (1.47 t/ha) from BRR1 hybrid dhan5, 581 kg (2.32 t/ha) from BRR1

hybrid dhan6, 684 kg (1.73 t/ha) from BRR1 hybrid dhan7 and 354 kg (1.77 t/ha) from BRR1 hybrid dhan8 was obtained (Table 17). Seed set was poor due to high temperature (> 38°C) at flowering time hampered pollination.

**Table 17. F<sub>1</sub> seed production of BRR1 hybrid dhan5, BRR1 hybrid dhan6, BRR1 hybrid dhan7 and BRR1 hybrid dhan8 during Boro 2023-24.**

| Hybrid            | Plant height (cm) |        | 50% flowering date |        | PER (%) | OCR (%) | Yield   |      |
|-------------------|-------------------|--------|--------------------|--------|---------|---------|---------|------|
|                   | A line            | R line | A line             | R line |         |         | kg/plot | t/ha |
| BRR1 hybrid dhan5 | 87                | 98     | 123                | 139    | 74      | 37.5    | 442     | 1.47 |
| BRR1 hybrid dhan6 | 90                | 100    | 124                | 131    | 87      | 48.3    | 581     | 2.32 |
| BRR1 hybrid dhan7 | 92                | 104    | 123                | 129    | 80.3    | 43.5    | 684     | 1.73 |
| BRR1 hybrid dhan8 | 97                | 106    | 125                | 132    | 85.5    | 44.0    | 354     | 1.77 |
| Mean              | 91.5              | 102    | 123.8              | 132.8  | 81.7    | 43.3    | 515.3   | 1.8  |
| SD                | 4.2               | 3.7    | 1.0                | 4.3    | 5.9     | 4.4     | 146.2   | 0.4  |
| CV (%)            | 4.6               | 3.6    | 0.8                | 3.3    | 7.2     | 10.3    | 28.4    | 19.6 |
| Lsd 0.05%         | 5.4               | 4.7    | 1.2                | 5.6    | 7.6     | 5.7     | 188.7   | 0.5  |

DS: R<sub>1</sub> = 26 Nov 2023; R<sub>2</sub> = 3 Dec 2023; A = 22 Dec 2023; DT: R = 2 Jan 2024; A = 21 Jan 2024.

DS: R<sub>1</sub> = 28 Nov 2023; R<sub>2</sub> = 3 Dec 2023; A = 12 Dec 2023; DT: R and A = 11 Jan 2024

DS: R<sub>1</sub> = 27 Nov 2023; R<sub>2</sub> = 30 Nov 2023; A = 6 Dec 2023; DT: R=2 Jan 2024; A = 9 Jan 2024

DS: R<sub>1</sub> = 27 Nov 2023; R<sub>2</sub> = 2 Dec 2023; A = 7 Dec 2023; DT: R and A = 05 Jan 2024

PER (%) = panicle exertion rate, OCR (%) = Out crossing rate

### Experimental F<sub>1</sub> seed production of promising and saltol hybrids during Boro 2023-24.

Seed yields were obtained 130 kg/plot (1.0 t/ha), 100 kg (1.7 t/ha) and 106 kg/plot (1.8 t/ha) from

BRRI74A /BRRI31R, BRRI74A/BRRI42R and BRRI74A/BRRI56R combinations (Table 18). Seed yield was poor due to high temperature at flowering time (>38°C) hampered pollination.

**Table 18. Experimental F<sub>1</sub> seed production of promising and Saltol hybrids during Boro 2023-24.**

| Combinations                          | Plant height (cm) |        | 50% flowering date |        | PER (%) | OCR (%) | Yield    |                             |      |
|---------------------------------------|-------------------|--------|--------------------|--------|---------|---------|----------|-----------------------------|------|
|                                       | A line            | R line | A line             | R line |         |         | Kg /plot | Plot size (m <sup>2</sup> ) | t/ha |
| BRRI74A/BRRI31R<br>(Promising hybrid) | 98                | 108    | 118                | 130    | 77      | 30      | 130      | 1300                        | 1.0  |
| BRRI74A/BRRI42R<br>(Saltol hybrid)    | 97                | 110    | 119                | 124    | 81      | 47      | 100      | 600                         | 1.7  |
| BRRI74A/BRRI56R<br>(Saltol hybrid)    | 97                | 109    | 120                | 133    | 81.5    | 31      | 106      | 600                         | 1.8  |

DS: R<sub>1</sub> =27 Nov 2023; R<sub>2</sub> = 2 Dec 2023; A = 15 Dec 2023; DT: R = 2 Jan 2024; A=14 Jan 2024

DS: R<sub>1</sub> =3 Dec 2023; R<sub>2</sub> = 8 Dec 2023; A = 13 Dec 2023; DT: R/A=17 Jan 2024

DS: R<sub>1</sub> =3 Dec 2023; R<sub>2</sub> = 7 Dec 2023; A = 20 Dec 2023; DT: R/A=17 Jan 2024

### F<sub>1</sub> seed production through contract growers

During Boro 2023-24, we got 490 kg (1.23 t/ha) of BRRI hybrid dhan2, 4750 kg (1.69 t/ha) of BRRI hybrid dhan3, 2,750 kg (1.72 t/ha) of BRRI hybrid dhan4, 6680 kg (1.13 t/ha) of BRRI hybrid dhan5, 6800 kg (2.43 t/ha) of BRRI hybrid dhan6,

6,650 kg (2.37 t/ha) of BRRI hybrid dhan7 and 8,020 kg (1.4 t/ha) seeds of BRRI hybrid dhan8 from Ishwardi, Pabna (Table 19). From Barishal 500 kg (1.25 t/ha) of BRRI hybrid dhan5 and 1000 kg (1.0 t/ha) of BRRI hybrid dhan8 seeds were received (Table 20).

**Table 19. F<sub>1</sub> seed production of BRRI developed hybrids through contract grower during Boro 2023-24.**

| Combination       | Contract grower                         | Location | Seed yield (kg) | Area (m <sup>2</sup> ) | Seed yield (t/ha) | Remarks                                                                          |
|-------------------|-----------------------------------------|----------|-----------------|------------------------|-------------------|----------------------------------------------------------------------------------|
| BRRI hybrid dhan2 | AUS<br>Bangla<br>Agro                   | Ishwardi | 490             | 4000                   | 1.23              | Less seed due to high temperature at flowering stage & shattering for hail storm |
| BRRI hybrid dhan3 | AUS<br>Bangla<br>Agro                   | Ishwardi | 4750            | 28000                  | 1.69              | Less seed due to high temperature at flowering stage & shattering for hail storm |
| BRRI hybrid dhan4 | AUS<br>Bangla<br>Agro                   | Ishwardi | 2750            | 16000                  | 1.72              | Good                                                                             |
| BRRI hybrid dhan5 | AUS<br>Bangla<br>Agro<br>+Mazil<br>seed | Ishwardi | 6680            | 60000                  | 1.13              | Less seed due to high temperature at flowering stage & shattering for hail storm |
| BRRI hybrid dhan6 | AUS<br>Bangla<br>Agro                   | Ishwardi | 6800            | 28000                  | 2.43              | Good                                                                             |

| Combination       | Contract grower             | Location           | Seed yield (kg) | Area (m <sup>2</sup> ) | Seed yield (t/ha) | Remarks                                                                            |
|-------------------|-----------------------------|--------------------|-----------------|------------------------|-------------------|------------------------------------------------------------------------------------|
| BRR1 hybrid dhan7 | AUS Bangla Agro             | Ishwardi           | 6650            | 28000                  | 2.37              | Good                                                                               |
| BRR1 hybrid dhan8 | AUS Bangla Agro+ Mazil seed | Ishwardi           | 8020            | 58000                  | 1.00              | Less seed due to high temperature at flowering stage and shattering for hail storm |
| Total             | 36140                       | 222000 (55.5 Acre) |                 |                        |                   |                                                                                    |

**Table 20. F<sub>1</sub> seed production of BRR1 developed hybrids through contract grower during Boro 2023-24 from Barishal.**

| Combinations      | Contract growers | Location           | Seed Yield (kg) | Area (m <sup>2</sup> ) | Seed yield (t/ha) | Remarks                                               |
|-------------------|------------------|--------------------|-----------------|------------------------|-------------------|-------------------------------------------------------|
| BRR1 hybrid dhan5 | Md. Jalal Akand  | Babuganj, Barishal | 500             | 4000                   | 1.25              | Less seeds due to high temperature at flowering stage |
| BRR1 hybrid dhan8 | Md. Jalal Akand  | Babuganj, Barishal | 1000            | 10000                  | 1.00              |                                                       |
| Total             |                  |                    | 1500            | 14000 (3.5 Acre)       |                   |                                                       |

#### DISSEMINATION OF HYBRID RICE TECHNOLOGY

In T. Aman 2023, HRD supplied 7,117 kg F<sub>1</sub> seeds along with 95 kg parental line seeds to 80 farmers, 13 seed companies, scientists, extension people, projects and staffs of BRR1 and during T. Aus 2023, 7,980 kg hybrid seeds of BRR1 hybrid dhan7 distributed among BRR1 RS, department

of agricultural extension and farmers (Table 21). In Boro 2023-24, HRD supplied 27703 kg of parental lines and F<sub>1</sub> seeds to 135 farmers, 24 seed companies, scientists, extension people, projects and staffs of BRR1 (Table 22). Thirty-five stake holders produced more than 508 MT F<sub>1</sub> seeds using BRR1 developed hybrid rice parental lines (Table 23).

**Table 21. Amount of parental line and hybrid seeds supplied to different organization during T. Aman 2023.**

| Recipient                  | No. | F <sub>1</sub> (kg) | A line (kg) | B line (kg) | R line (kg) |
|----------------------------|-----|---------------------|-------------|-------------|-------------|
| Seed companies             | 13  | 807                 | 70          | -           | 25          |
| Farmers                    | 80  | 1470                | -           | -           | -           |
| BRR1 scientists + staffs   | 30  | 1150                | -           | -           | -           |
| BRR1, R/S(5) +DAE          | 25  | 3690                | -           | -           | -           |
| Total                      | 148 | 7117                | 70          | -           | 25          |
| T. Aus (BRR1 hybrid dhan7) |     |                     |             |             |             |
| 01 BRR1, RS(5) +DAE        |     | 7980                |             |             |             |

Investigator: All staff of HRD.

**Table 22. Amount of parental line and hybrid seeds supplied to different organization.**

| Recipient                    | Nos. | F <sub>1</sub><br>(kg) | A line<br>(kg) | B line<br>(kg) | R line<br>(kg) |
|------------------------------|------|------------------------|----------------|----------------|----------------|
| Seed companies               | 24   | 1250.0                 | 5770           | -              | 1842           |
| Farmers                      | 135  | 1800.0                 | 1578           | -              | 55             |
| BRRRI scientists +<br>staffs | 25   | 2028.0                 | -              | -              | -              |
| BRRRI RS (11)<br>+DAE        | 14   | 14800.0                | -              | -              | -              |
| Total                        | 198  | 19878                  | 5928           | 0.00           | 1897           |
| Grand total                  |      |                        | 27703.0        |                |                |

Investigators: All staff of HRD.

**Table 23. Seed production activities of BRRRI developed hybrids during Boro 2023-24 both at private and public sectors.**

| Name of the<br>organization/<br>person                                                                                                 | Location                   | Var  | Supplied Parental<br>lines (kg) |        | Area<br>(acre) | Yield<br>achieved<br>(ton) | Remark      |
|----------------------------------------------------------------------------------------------------------------------------------------|----------------------------|------|---------------------------------|--------|----------------|----------------------------|-------------|
|                                                                                                                                        |                            |      | A line                          | R line |                |                            |             |
| IF Agro Private Ltd.<br>Savar, Dhaka. Md<br>Jamaluddin, Chairman.<br>Mob. 0196877336                                                   | Sherpur,<br>Bogura         | BHD3 | 120                             | 45     | 15             | 12.0                       | Experienced |
|                                                                                                                                        |                            | BHD5 | 100                             | 30     | 10             | 7.0                        |             |
|                                                                                                                                        |                            | BHD6 | 100                             | 30     | 10             | 9.0                        |             |
| Seed Care Crop<br>Science Proprietor: Md<br>Juwel, D-09, Bank<br>Colony, Savar<br>Mob. 01968773337                                     | Sherpur<br>Bogura          | BHD3 | 40                              | 15     | 05             | 4.0                        | Experienced |
|                                                                                                                                        |                            | BHD5 | 50                              | 15     | 05             | 3.5                        |             |
|                                                                                                                                        |                            | BHD6 | 50                              | 15     | 05             | 4.3                        |             |
| Babylon Agro & Dairy<br>Ltd.<br>2B/1, Darussalam<br>Road, Mirpur, Dhaka-<br>1216. Mob.<br>01710327720                                  | Ishwardi,<br>Pabna         | BHD3 | 600                             | 180    | 60             | 45                         | Experienced |
|                                                                                                                                        |                            | BHD8 | 300                             | 100    | 30             | 24                         |             |
| Apreme Seed Company<br>American advanced<br>Agro Ltd. Proprietor<br>Kbd Kamrul Haque<br>Mouchak Tower,<br>Malibagh<br>Mob. 01720053768 | Muktagasha,<br>Mymensingh  | BHD5 | 50                              | 15     | 05             | 3.5                        | Experienced |
| M/S Agriculture crop<br>seeds. Tatalpur,<br>Sherpur<br>Md Moklesur Rahman                                                              | Muktaghacha,<br>Mymensingh | BHD3 | 14                              | 06     | 02             | 1.5                        | Experienced |
|                                                                                                                                        |                            | BHD4 | 14                              | 06     | 02             | 1.4                        |             |
|                                                                                                                                        |                            | BHD5 | 14                              | 06     | 02             | 1.5                        |             |
| M/S Champion Seeds<br>Md Alimul Raji;<br>Sreebordi; Sherpur.<br>Mob. 01710257702                                                       | Madhapur                   | BHD3 | 14                              | 06     | 02             | 1.5                        | Experienced |
|                                                                                                                                        |                            | BHD4 | 14                              | 06     | 02             | 1.4                        |             |
|                                                                                                                                        |                            | BHD5 | 14                              | 06     | 02             | 1.5                        |             |
|                                                                                                                                        |                            | BHD6 | 16                              | 06     | 02             | 1.5                        |             |
|                                                                                                                                        |                            | BHD7 | 16                              | 06     | 02             | 1.5                        |             |
| Bagro Company Ltd.<br>House No# 17, R#09,<br>Uttra                                                                                     | Muktaghacha,<br>Mymensingh | BHD6 | 1200                            | 300    | 120            | 100                        | Experienced |

| Name of the organization/<br>person                                                                                   | Location                | Var                                  | Supplied Parental<br>lines (kg) |                            | Area<br>(acre)             | Yield<br>achieved<br>(ton)       | Remark       |
|-----------------------------------------------------------------------------------------------------------------------|-------------------------|--------------------------------------|---------------------------------|----------------------------|----------------------------|----------------------------------|--------------|
|                                                                                                                       |                         |                                      | A line                          | R line                     |                            |                                  |              |
| Proprietor: M R Ibne Aziz<br>Managing Director<br>Mob. 01711479884                                                    |                         |                                      |                                 |                            |                            |                                  |              |
| Thailand Agro Seeds Vite                                                                                              |                         |                                      |                                 |                            |                            |                                  |              |
| Proprietor: Md. Alamin Hoque. Kandi, Fulpur, Mymensingh Mob. 01719464815                                              | Muktaghacha, Mymensingh | BHD2<br>BHD6                         | 45<br>45                        | 15<br>15                   | 5<br>5                     | 4.5<br>4.5                       | Experienced  |
| Abdur Rahman Agro Company. Muktagasha Proprietor: Md. Abdur Barek Mob. 01978424141/ 01766688323                       | Muktaghacha, Mymensingh | BHD3                                 | 96                              | 36                         | 12                         | 10                               | Experienced  |
| Mirtika Agro Vision Proprietor: Mirthonjoy Roy Executive Director Rangpur. Mob. 01752084181                           | Sherpur, Bogura         | BHD3                                 | 40                              | 15                         | 05                         | 4.2                              | Experienced  |
| Aus Bangla Agro Gohail Road, Mission gate, Bogura. Kbd. Mosharraf Hossain, PM Mob. 01716444502                        | Ishwardi, Pabna         | BHD3                                 | 500                             | 150                        | 60                         | 50                               | Experienced  |
| Bangladesh Agricultural Development Corporation                                                                       | Meherpur Chaudanga      | BHD7<br>BHD5                         | 240<br>50                       | 90<br>21                   | 30<br>07                   | 27.3<br>3.2                      | Experienced  |
| Ahasan seeds and Agrotech Gaffargaon, Mymensingh Mob: 01734414647                                                     | Muktaghacha, Mymensingh | BHD2<br>BHD3<br>BHD4<br>BHD6<br>BHD7 | 18<br>18<br>09<br>150<br>09     | 06<br>06<br>03<br>45<br>03 | 02<br>02<br>01<br>15<br>01 | 1.5<br>2.2<br>0.5<br>13.5<br>0.8 | Experience   |
| Usha Agro Ltd. Proprietor: Md A Khaleque Raja Seed Company Md Aminul Islam Razzak Pirghacha, Rangpur Mob: 01713792560 | Muktaghacha, Mymensingh | BHD3                                 | 40                              | 15                         | 05                         | 3.0                              | Experimental |
| Mr Jalal Akand Babuganj Barishal Mob. 01770674655                                                                     | Rangpur                 | BHD2<br>BHD6                         | 08<br>08                        | 03<br>03                   | 01<br>01                   | 0.7<br>0.8                       | Experimental |
| Monjil Seed Company Ishwardi, Pabna Mob. 01733137743                                                                  | Babuganj Barishal       | BHD3<br>BHD5                         | 32<br>40                        | 12<br>15                   | 04<br>05                   | 3.6<br>2.5                       | Experienced  |
|                                                                                                                       | Ishwardi, Pabna         | BHD5<br>BHD8                         | 80<br>80                        | 30<br>30                   | 10<br>10                   | 3.5<br>5.0                       | Experienced  |

| Name of the organization/<br>person                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Location                       | Var  | Supplied Parental<br>lines (kg) |        | Area<br>(acre) | Yield<br>achieved<br>(ton) | Remark       |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|------|---------------------------------|--------|----------------|----------------------------|--------------|
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                |      | A line                          | R line |                |                            |              |
| Aus Bangla Agro<br>Gohail Road, Mission<br>gate, Bogura. Mob.<br>01716444502<br>Contract growers                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Patirajpur,<br>Ishwardi, Pabna | BHD2 | 10                              | 03     | 1              | 0.5                        | Experienced  |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                | BHD3 | 56                              | 21     | 07             | 4.5                        |              |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                | BHD4 | 20                              | 08     | 2.5            | 2.0                        |              |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                | BHD5 | 56                              | 21     | 07             | 3.7                        |              |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                | BHD6 | 56                              | 21     | 07             | 5.7                        |              |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                | BHD7 | 56                              | 21     | 07             | 6.5                        |              |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                | BHD8 | 56                              | 21     | 07             | 4.5                        |              |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                | BHD5 | 07                              | 03     | 0.6            | 0.2                        |              |
| Hybrid Rice Division,<br>BRRI                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Gazipur                        | BHD6 | 07                              | 03     | 0.3            | 0.3                        | Experienced  |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                | BHD7 | 07                              | 03     | 0.3            | 0.3                        |              |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                | BHD8 | 07                              | 03     | 0.4            | 0.4                        |              |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                |      |                                 |        |                |                            |              |
| Explore Business Ltd.<br>Proprietor: Kbd. Md.<br>Abbas Ali. H#16,<br>R#04, B#B,<br>Kaderabad Housing,<br>Mohammadpur.<br>Mob. 01713041395<br>Metal Seeds Ltd. PBL<br>Tower; Gulshan,<br>Circle-2, Dhaka-1212<br>Uddipon Agro Ltd.<br>H# 09, R#01, B#F,<br>Janata Cooperative<br>Housing Society,<br>Adabar, Dhaka-1207.<br>Dr. M A Matin,<br>Managing Director<br>Mobile: 01711875715<br>Agricas Seeds Private<br>Ltd,<br>Dholpur, Ashulia, Savar<br>Dhaka. Kbd. Mosharoff<br>Hossain, Managing<br>Director, Mob:<br>01711738135<br>Rupom Seeds,<br>Proprietor: Md<br>Shadad Hossain<br>Bhuiyan, Feni, Mob:<br>01716755531<br>Apu Agro Farms,<br>48/B Jail Road (Police<br>line), Mymensingh.<br>Md Abdur Rashid<br>Sarkar, Managing<br>Director, Mob:<br>01615565662<br>Md. Sabuz Hossain,<br>Gupirpara, Songacha<br>bazar, Sirajganj, Mob:<br>01783819700 | Sherpur<br>Bogura              | BHD6 | 80                              | 30     | 10             | 8.0                        | Experienced  |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Sreepur, Gazipu                | BHD8 | 100                             | 30     | 10             | 8.0                        | Experienced  |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                |      |                                 |        |                |                            |              |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Bazitpur<br>Kishoreganj        | BHD3 | 200                             | 60     | 20             | 15.0                       | Experienced  |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                | BHD6 | 50                              | 15     | 05             | 4.5                        |              |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                | BHD8 | 50                              | 15     | 05             | 4.0                        |              |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Muktaghacha                    | BHD3 | 03                              | 01     | 0.33           | 0.2                        | Experimental |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                | BHD5 | 03                              | 02     | 0.33           | 0.2                        |              |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Feni                           | BHD8 | 20                              | 06     | 2.0            | 1.2                        | Experimental |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Muktaghacha                    | BHD6 | 300                             | 100    | 30             | 24.5                       | Experienced  |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Sirajganj                      | BHD6 | 06                              | 1.5    | 0.66           | 0.3                        | Experimental |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                | BHD8 | 06                              | 1.6    | 0.66           | 0.3                        |              |

| Name of the organization/<br>person                                                      | Location   | Var  | Supplied Parental<br>lines (kg) |        | Area<br>(acre) | Yield<br>achieved<br>(ton) | Remark       |
|------------------------------------------------------------------------------------------|------------|------|---------------------------------|--------|----------------|----------------------------|--------------|
|                                                                                          |            |      | A line                          | R line |                |                            |              |
| BRRI R/S Sonagazi                                                                        | Sonagazi   | BHD5 | 30                              | 09     | 03             | 1.5                        | Experienced  |
| BRRI R/S Gopalganj                                                                       | Gopalganj  | BHD8 | 10                              | 03     | 01             | 0.7                        | Experienced  |
| Sugandha Agri<br>Industries, Jamalpur<br>Sadar<br>Proprietor: M R Ibna<br>Aziz           | Jamalpur   | BHD6 | 140                             | 45     | 15             | 11.5                       | Experienced  |
| MS Sayada Biz Vander<br>Gayra Bazar, Kolaroya,<br>Satkhira. Md Azharul<br>Islam          | Satkhira   | BHD2 | 20                              | 06     | 02             | 1.0                        | Experimental |
|                                                                                          |            | BHD3 | 20                              | 06     | 02             | 1.0                        |              |
|                                                                                          |            | BHD8 | 20                              | 06     | 02             | 1.0                        |              |
| Mob: 01740981056<br>Md Saiful Azam<br>Khan, Professor, ATI,<br>Sherpur                   | Sherpur    | BHD3 | 10                              | 03     | 01             | 0.5                        | Experimental |
| Modern Crop Care<br>Ltd.                                                                 | Mymensingh | BHD6 | 08                              | 03     | 01             | 0.5                        | Experimental |
|                                                                                          |            | BHD8 | 08                              | 03     | 01             | 0.5                        |              |
| J R Agro, Choto<br>Koloni, Mahiganj,<br>Rangpur, Mob:<br>01950224466                     | Rangpur    | BHD3 | 16                              | 06     | 02             | 1.0                        | Experimental |
|                                                                                          |            | BHD8 | 16                              | 06     | 02             | 1.0                        |              |
| Rifa Trading,<br>Chankanda, Milon<br>Bazar, Fulbaria,<br>Mymensingh, Mob:<br>01733934426 | Mymensingh | BHD6 | 40                              | 15     | 05             | 3.5                        | Experimental |
| Total                                                                                    |            |      | 5928                            | 1897.1 | 648.08         | 508.9                      |              |

Legend: BHD1= BRRI hybrid dhan1, BHD2 = BRRI hybrid dhan2, BHD3 = BRRI hybrid dhan3, BHD4 = BRRI hybrid dhan4, BHD5 = BRRI hybrid dhan5, BHD6 = BRRI hybrid dhan6, BHD7= BRRI hybrid dhan7, BHD8= BRRI hybrid dhan8



## **Agronomy Division**

|            |                               |
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## SUMMARY

In the T. Aman season, BRRI dhan75 and BRRI dhan87 yielded higher during transplanting on 5 August. The highest yields of medium-duration varieties BRRI dhan52, BRRI dhan79 and BRRI dhna93 were observed during transplanting from 20 July to 5 August. The highest yield of long-duration varieties BRRI dhan89, BRRI dhan92, and BRRI dhan102 were observed during transplanting on 10 January. Ratooning of BRRI dhan88 was affected by cutting height and nitrogen fertilizer doses. In ratoon, crop cutting height of culm above 30 cm was found to be favourable for ratooning ability and grain yield. The highest grain yield ( $1.395 \text{ t ha}^{-1}$ ) was recorded from 30 cm cutting height along with  $60 \text{ kg ha}^{-1}$  nitrogen fertilizer application. Screened three cultivars (BRRI dhan28, BRRI dhan88, Bangabandhu dhan100) showed ratooning potentiality at 30 cm cutting height. To maximize the yield of BRRI hybrid dhan7, it is recommended to transplant 15-day-old seedlings and apply nitrogen ( $90 \text{ kg N ha}^{-1}$ ) in split doses, with 33 % at basal, 33% at 4-5 tillering, and 33% at the panicle initiation stage. The highest grain yield of BRRI dhan70 ( $5.89 \text{ t ha}^{-1}$ ) was obtained from the agronomic-based treatment combination of soil test-based fertilizer application,  $25 \times 25 \text{ cm}$  spacing, 15-day-old seedlings and 15 July seeding. The highest grain yield of BRRI dhan92 ( $8.06 \text{ t ha}^{-1}$ ) was obtained from the treatment combination of soil test-based fertilizer application,  $25 \times 25 \text{ cm}$  spacing and 15-day-old seedling. The highest grain yield was observed in BRRI dhan100×GAPs ( $8.46 \text{ t ha}^{-1}$ ) followed by BRRI hybrid dhan8 with BRPs ( $8.25 \text{ t ha}^{-1}$ ). Most of the tested herbicides performed more than 80% weed control efficiency. The grain yield of BRRI dhan103 was higher in the integrated application of urea and herbicide applied plot compared to those treated with herbicides alone. The salt-tolerance and plant growth-promoting traits

revealed that KB1, KB3, KB5, KB6, KB7, KB9, KB11, KB13 and KB14 are potential salt-tolerant PGPR strains. Among the nine tested PGPR strains, KB1, KB5, KB7, KB9 and KB11 could be considered salt-tolerant PGPR which can significantly contribute to reducing the salinity effect on rice at the seedling stage.

## SCIENTIFIC INFORMATION

### PLANTING PRACTICE

#### **Effect of of planting time on the agronomic output of newly developed BRRI varieties in different agro eco-system**

The experiment was conducted at BRRI HQ farm, Gazipur during T. Aman 2023 and Boro 2023-24 seasons. In T. Aman season, BRRI dhan75, BRRI dhan87, BRRI dhan90, BRRI dhan52, BRRI dhan79 and BRRI dhan93 were used as test materials. The 25-day-old rice seedlings were transplanted in the field at five scheduled times (5 July, 20 July, 5 August, 20 August, and 5 September). In Boro season, the 40-day-old seedlings of BRRI dhan88, BRRI dhan96, BRRI dhan101, BRRI dhan89, BRRI dhan92 and BRRI dhan102 were transplanted in the field on six scheduled times at a 15-day interval, starting on 20 November 2022. It was a factorial experiment conducted in a split-plot design with three replications. Planting time significantly influenced the grain yields in both the seasons. In the T. Aman season, BRRI dhan75 and BRRI dhan87 yielded higher during transplanting on 5 August (Table 1). The highest yields of medium-duration varieties BRRI dhan52, BRRI dhan79 and BRRI dhna93 were observed during transplanting from 20 July to 5 August (Table 2). In the Boro season, BRRI dhan88 and BRRI dhan96 yielded higher during transplanting on 25 January (Table 3). The highest yields of long-duration varieties BRRI dhan89, BRRI dhan92, and BRRI dhna102 were observed during transplanting on 10 January (Table 4).

**Table 1. Effect of planting time on the yield and growth duration of short-duration Aman rice varieties at BRRI HQ, Gazipur during T. Aman 2023.**

| Variety               | Date of transplanting |             |                 |             |                 |             |                 |             |                 |             |
|-----------------------|-----------------------|-------------|-----------------|-------------|-----------------|-------------|-----------------|-------------|-----------------|-------------|
|                       | 5 Jul                 |             | 20 Jul          |             | 5 Aug           |             | 20 Aug          |             | 5 Sep           |             |
|                       | Yield<br>(t/ha)       | GD<br>(day) | Yield<br>(t/ha) | GD<br>(day) | Yield<br>(t/ha) | GD<br>(day) | Yield<br>(t/ha) | GD<br>(day) | Yield<br>(t/ha) | GD<br>(day) |
| BRRI dhan75           | 4.04                  | 117         | 4.60            | 114         | 4.94            | 114         | 4.82            | 111         | 3.51            | 109         |
| BRRI dhan87           | 4.70                  | 128         | 4.87            | 130         | 5.72            | 130         | 5.46            | 126         | 2.78            | 122         |
| BRRI dhan90           | 3.85                  | 124         | 4.50            | 119         | 4.14            | 120         | 5.07            | 116         | 4.02            | 110         |
| LSD <sub>(0.05)</sub> | 1.53                  | 4.0         | 1.05            | 3.5         | 1.30            | 3.7         | 0.94            | 4.5         | 1.46            | 4.4         |
| CV (%)                | 6.2                   | 0.2         | 10.0            | 0.3         | 11.7            | 0.1         | 7.3             | 0.2         | 8.8             | 0.1         |

**Table 2. Effect of planting time on the yield and growth duration of medium-duration Aman rice varieties at BRRI HQ, Gazipur during T. Aman 2023.**

| Variety               | Date of transplanting |             |                 |             |                 |             |                 |             |                 |             |
|-----------------------|-----------------------|-------------|-----------------|-------------|-----------------|-------------|-----------------|-------------|-----------------|-------------|
|                       | 5 Jul                 |             | 20 Jul          |             | 5 Aug           |             | 20 Aug          |             | 5 Sep           |             |
|                       | Yield<br>(t/ha)       | GD<br>(day) | Yield<br>(t/ha) | GD<br>(day) | Yield<br>(t/ha) | GD<br>(day) | Yield<br>(t/ha) | GD<br>(day) | Yield<br>(t/ha) | GD<br>(day) |
| BRRI dhan52           | 6.26                  | 146         | 6.73            | 135         | 6.75            | 130         | 5.36            | 126         | 3.96            | 118         |
| BRRI dhan79           | 5.60                  | 144         | 5.39            | 137         | 5.14            | 130         | 5.01            | 128         | 2.20            | 122         |
| BRRI dhan93           | 5.65                  | 145         | 6.18            | 136         | 6.15            | 131         | 5.55            | 127         | 3.49            | 125         |
| LSD <sub>(0.05)</sub> | 1.39                  | -           | 0.92            | 0.6         | 1.46            | -           | 1.37            | -           | 0.60            | 1.2         |
| CV (%)                | 10.6                  | 0.2         | 6.7             | 0.1         | 10.2            | 0.1         | 11.4            | 0.2         | 8.3             | 0.3         |

**Table 3. Effect of planting time on the yield and growth duration of short duration rice varieties at BRRI HQ, Gazipur during Boro 2023-24.**

| Variety               | Date of transplanting |             |                 |             |                 |             |                 |             |                 |             |                 |             |
|-----------------------|-----------------------|-------------|-----------------|-------------|-----------------|-------------|-----------------|-------------|-----------------|-------------|-----------------|-------------|
|                       | 10 Dec                |             | 25 Dec          |             | 10 Jan          |             | 25 Jan          |             | 10 Feb          |             | 25 Feb          |             |
|                       | Yield<br>(t/ha)       | GD<br>(day) | Yield<br>(t/ha) | GD<br>(day) | Yield<br>(t/ha) | GD<br>(day) | Yield<br>(t/ha) | GD<br>(day) | Yield<br>(t/ha) | GD<br>(day) | Yield<br>(t/ha) | GD<br>(day) |
| BRRI dhan88           | 5.77                  | 167         | 5.43            | 154         | 5.33            | 149         | 6.38            | 143         | 3.00            | 133         | 2.86            | 125         |
| BRRI dhan96           | 5.54                  | 165         | 5.17            | 153         | 5.71            | 143         | 6.37            | 141         | 3.32            | 130         | 2.02            | 120         |
| BRRI dhan101          | 6.20                  | 171         | 6.20            | 158         | 6.44            | 151         | 6.33            | 144         | 7.07            | 139         | 2.89            | 127         |
| LSD <sub>(0.05)</sub> | 1.39                  | 4.6         | 1.22            | 2.0         | 2.0             | 3.0         | 0.29            | 2.5         | 0.44            | 2.4         | 1.09            | 0.75        |
| CV (%)                | 10.5                  | 1.2         | 9.7             | 0.0         | 15.2            | 0.0         | 2.1             | 0.0         | 4.4             | 0.0         | 6.7             | 0.3         |

**Table 4. Effect of planting time on the yield and growth duration of long duration rice varieties at BRRI HQ, Gazipur during Boro 2023-24.**

| Variety     | Date of transplanting |             |                 |             |                 |             |                 |             |                 |             |                 |             |
|-------------|-----------------------|-------------|-----------------|-------------|-----------------|-------------|-----------------|-------------|-----------------|-------------|-----------------|-------------|
|             | 10 Dec                |             | 25 Dec          |             | 10 Jan          |             | 25 Jan          |             | 10 Feb          |             | 25 Feb          |             |
|             | Yield<br>(t/ha)       | GD<br>(day) | Yield<br>(t/ha) | GD<br>(day) | Yield<br>(t/ha) | GD<br>(day) | Yield<br>(t/ha) | GD<br>(day) | Yield<br>(t/ha) | GD<br>(day) | Yield<br>(t/ha) | GD<br>(day) |
| BRRI dhan89 | 6.86                  | 176         | 6.77            | 166         | <b>7.99</b>     | 161         | 7.71            | 150         | 7.62            | 139         | 4.98            | 132         |

| Variety               | Date of transplanting |          |              |          |              |          |              |          |              |          |              |          |
|-----------------------|-----------------------|----------|--------------|----------|--------------|----------|--------------|----------|--------------|----------|--------------|----------|
|                       | 10 Dec                |          | 25 Dec       |          | 10 Jan       |          | 25 Jan       |          | 10 Feb       |          | 25 Feb       |          |
|                       | Yield (t/ha)          | GD (day) | Yield (t/ha) | GD (day) | Yield (t/ha) | GD (day) | Yield (t/ha) | GD (day) | Yield (t/ha) | GD (day) | Yield (t/ha) | GD (day) |
| BRRI dhan92           | 4.40                  | 178      | 5.74         | 166      | <b>8.02</b>  | 163      | 6.91         | 150      | 6.93         | 140      | 2.58         | 134      |
| BRRI dhan102          | 5.81                  | 180      | 5.80         | 167      | <b>7.74</b>  | 164      | 6.92         | 152      | 7.11         | 142      | 3.42         | 134      |
| LSD <sub>(0.05)</sub> | 3.00                  | 0.75     | 2.38         | 1.02     | 0.89         | 3.5      | 1.93         | 2.00     | 2.11         | 3.00     | 1.07         | 2.7      |
| CV (%)                | 13.3                  | 0.1      | 17.2         | 0.2      | 5.0          | 0.3      | 11.9         | 0.3      | 12.9         | 3.00     | 0.2          | 0.2      |

### Increasing productivity of ratoon rice

Optimizing both cutting height and nitrogen fertilizer management practices is essential for maximizing ratoon rice yields. To develop suitable agronomic management practices for productivity enhancement of ratoon rice, an experiment was conducted at BRRI HQ farm, Gazipur during Boro season 2023-24. The treatments of the experiment were included three levels of cutting height (10, 20, and 30 cm) and three levels of nitrogen fertilizer rates (25, 50 and 75% N of main crop). It was a factorial experiment conducted in a spilt-plot design with three replications. The 35-day-old seedlings of BRRI dhan88 were transplanted in the field maintaining

20×20 cm spacing. The BRRI recommended fertilizer doses for N, P, K, S, Zn were applied @ 120, 18, 75, 38 and 3.5 kg ha<sup>-1</sup>, respectively. Results of the experiment showed that, ratooning of BRRI dhan88 affected by cutting height and nitrogen fertilizer doses. In ratoon, crop cutting height of culm at above 30 cm was found to be favourable for ratooning ability and grain yield. (Fig. 1). The highest grain yield (1.395 t ha<sup>-1</sup>) was recorded from 30 cm cutting height along with 60 kg ha<sup>-1</sup> nitrogen fertilizer application. The yield and ratooning ability were lower and field duration was also shorter in ratoon crop due to high temperature during harvesting period in the last week of April.

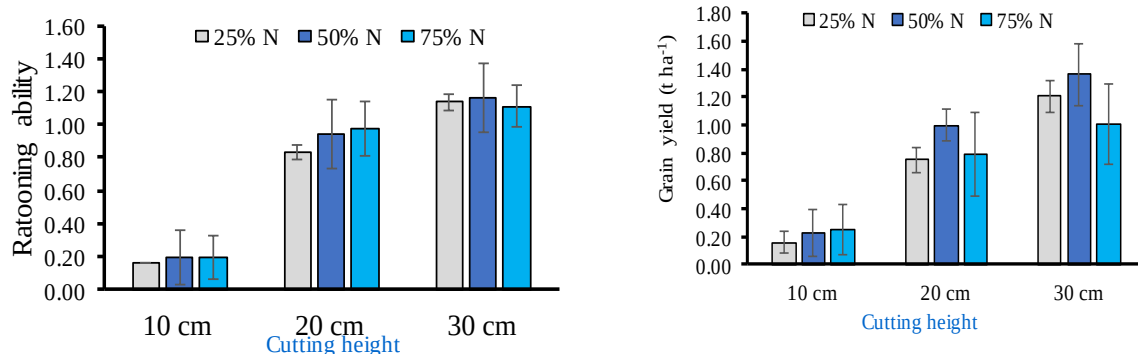


Fig. 1. Effect of cutting height and nitrogen fertilizer doses on the ratooning ability and grain yield of BRRI dhan88.

### Screening inbred and hybrid rice for ratooning ability

To screen and identify rice varieties with strong ratooning ability and other desirable agronomic traits an experiment was conducted at BRRI farm, Gazipur during Boro season 2023-24. Fifteen popular and widely adopted rice cultivars (BRRI dhan28, BRRI dhan29, BRRI dhan50, BRRI

dhan58, BRRI dhan67, BRRI dhan74, BRRI dhan88, BRRI dhan89, BRRI dhan92, Bangabandhu dhan100, BRRI dhan101, BRRI dhan102, BRRI dhan104, BRRI dhan105 and BRRI hybrid dhan5) were tested for ratooning ability under 10, and 30 cm stubble cutting heights. The 35-day-old seedlings of the tested rice cultivars were transplanted in the field maintaining 20×20 cm spacing. The BRRI

recommended fertilizer doses for N, P, K, S, Zn were applied @ 120, 18, 75,38 and 3.5 kg ha<sup>-1</sup> respectively. In ratoon, crop cutting height of culm at above 30 cm was found to be optimum for ratooning ability and grain yield. The ability of each cultivar to produce ratoon varies widely. Screened three cultivars (BRRI dhan28, BRRI

dhan88, Bangabandhu dhan100) showed ratooning potentiality at 30 cm cutting height (Table 5). Of the three cultivars, Bangabandhu dhan100 is only capable of producing a yield of ratoon at least 1.00 t ha<sup>-1</sup>. High temperatures during harvesting in April to May fastened the ratoon growth and reduced the grain yield.

**Table 5. Ratoon performance of the tested cultivars at BRRI HQ, Gazipur.**

| Cultivar          | 10 cm cutting height |          |                             | 30 cm cutting height |          |                             |
|-------------------|----------------------|----------|-----------------------------|----------------------|----------|-----------------------------|
|                   | Ratoon ability       | GD (day) | Yield (t ha <sup>-1</sup> ) | Ratoon ability       | GD (day) | Yield (t ha <sup>-1</sup> ) |
| BRRI dhan28       | 0.416                | 48       | 0.410                       | 0.821                | 39       | 0.978                       |
| BRRI dhan29       | 0.235                | 64       | 0.214                       | 0.419                | 60       | 0.345                       |
| BRRI dhan50       | 0.177                | 56       | 0.173                       | 0.398                | 54       | 0.245                       |
| BRRI dhan58       | 0.268                | 58       | 0.243                       | 0.428                | 52       | 0.321                       |
| BRRI dhan67       | 0.237                | 53       | 0.328                       | 0.504                | 49       | 0.425                       |
| BRRI dhan74       | 0.134                | 51       | 0.406                       | 0.649                | 46       | 0.474                       |
| BRRI dhan88       | 0.153                | 35       | 0.172                       | 0.768                | 35       | 0.924                       |
| BRRI dhan89       | 0.153                | 62       | 0.189                       | 0.436                | 59       | 0.334                       |
| BRRI dhan92       | 0.180                | 61       | 0.192                       | 0.513                | 58       | 0.339                       |
| BRRI dhan100      | 0.596                | 54       | 0.521                       | 1.186                | 43       | 1.179                       |
| BRRI dhan101      | 0.192                | 41       | 0.196                       | 0.544                | 41       | 0.827                       |
| BRRI dhan102      | 0.212                | 61       | 0.242                       | 0.330                | 57       | 0.342                       |
| BRRI dhan104      | 0.155                | 49       | 0.123                       | 0.557                | 46       | 0.245                       |
| BRRI dhan105      | 0.162                | 51       | 0.111                       | 0.491                | 47       | 0.135                       |
| BRRI hybrid dhan5 | 0.198                | 58       | 0.129                       | 0.350                | 55       | 0.435                       |
| CV (%)            | 8.9                  | 2.1      | 6.7                         | 7.93                 | 1.45     | 8.2                         |
| Lsd (0.05)        | 0.136                | -        | 0.102                       | 0.141                | -        | 0.152                       |

## FERTILIZER MANAGEMENT

### Determination of optimum seedling age and N scheduling for yield maximization of BRRI hybrid dhan7 in Aus season

The experiment was conducted during Aus 2023 to find out the optimum seedling age of BRRI hybrid dhan7 for maximum yield and the best N scheduling for BRRI hybrid dhan7. The experiment comprised five seedlings' ages-10, 15 20, 25, and 30-day and three N application (90 kg N ha<sup>-1</sup>) scheduling; i. Basal 1/3, 1/3 after 4-5 tiller (15 DAT) and 1/3 before PI (around 25-30 DAT) (N1), ii. 1/2 at 10-12 DAT and 1/2 before PI (N2) and iii. ½ at basal and ½ before PI (around 25-30 DAT) (N3). The experiment followed the RCB design with three

replications. Results indicate that 15-day-old seedlings of BRRI hybrid dhan7 obtained the highest grain yield in three N splitting in both Gazipur and Kapasia. In Gazipur, N scheduling in 1/3<sup>rd</sup> basal, 1/3<sup>rd</sup> after 4-5 tiller (15 DAT) and 1/3<sup>rd</sup> before PI (around 25-30 DAT showed the highest (5.93 t ha<sup>-1</sup>) grain yield with 15-day-old seedling. On the other hand, at Kapasia, N scheduling in 1/3<sup>rd</sup> basal, 1/3<sup>rd</sup> after 4-5 tiller (15 DAT) and 1/3<sup>rd</sup> before PI (around 25-30 DAT showed the highest (6.39 t ha<sup>-1</sup>) grain yield with 15-day-old seedling (Table 6). For maximizing the yield of BRRI hybrid dhan7, it is recommended to transplant 15-day-old seedlings and apply nitrogen (90 kg N ha<sup>-1</sup>) in split doses, with 33 % at basal, 33% at 4-5 tillering, and 33% at the panicle initiation stage.

**Table 6. Effect of seedling age and N scheduling on grain yield of BRRI hybrid dhan7 at BRRI HQ farm, Gazipur and Kapasia during Aus 2023.**

| N scheduling                                                                      | Seedling age (day) | Gazipur | Kapasia |
|-----------------------------------------------------------------------------------|--------------------|---------|---------|
| Basal 1/3, 1/3 after 4-5 tiller (15 DAT) and 1/3 before PI (around 25-30 DAT (N1) | 10                 | 5.69    | 5.73    |
|                                                                                   | 15                 | 5.93    | 6.39    |
|                                                                                   | 20                 | 5.65    | 6.26    |
|                                                                                   | 25                 | 4.85    | 5.84    |
|                                                                                   | 30                 | 4.10    | 4.39    |
| ½ at 10-12 DAT and 1/2 before PI(N2)                                              | 10                 | 5.42    | 5.49    |
|                                                                                   | 15                 | 5.47    | 6.10    |
|                                                                                   | 20                 | 5.29    | 5.68    |
|                                                                                   | 25                 | 4.32    | 5.01    |
|                                                                                   | 30                 | 3.78    | 4.08    |
| ½ at basal and ½ before PI (around 25-30 DAT) N3                                  | 10                 | 5.45    | 5.72    |
|                                                                                   | 15                 | 5.57    | 6.18    |
|                                                                                   | 20                 | 5.01    | 5.82    |
|                                                                                   | 25                 | 4.35    | 5.24    |
|                                                                                   | 30                 | 3.85    | 3.51    |
| Lsd <sub>(.05)</sub> for seedling age(S)                                          |                    | 0.38    | 0.21    |
| Lsd <sub>(.05)</sub> for N scheduling(N)                                          |                    | 0.30    | 0.16    |
| Lsd <sub>(.05)</sub> for N × S                                                    |                    | Ns      | 0.37    |
| CV(%)                                                                             |                    | 8.1     | 4.1     |

## YIELD MAXIMIZATION

### **Effect of agronomic factors for maximizing yield of long slenderer premium quality fine rice-BRRI dhan70 (*Katarivog* type) through developing sustainable production management protocol in T. Aman season**

The quality of BRRI dhan70 is similar to Katarivog and is now becoming popular in the Dinajpur region. However, the yield of these varieties is very low due to the lack of proper production management protocols. The experiment was conducted to find out the best production management protocol for a sustainable higher yield of BRRI dhan70 in the T. Aman season. The treatments of the experiment were: two times of crop establishment,  $T_1 = 1$  July seeding and  $T_2 = 15$  July seeding; two seedling ages,  $A_1 = 15$  day and  $A_2 = 30$  day; two spacing,  $S_1 = 25 \times 25$  cm (16 hill  $m^{-2}$ ) and  $S_2 = 20 \times 20$  cm (25 hill  $m^{-2}$ ) and two fertilizer management,  $F_1 =$  BRRI recommended fertilizer management,  $F_2 =$  Soil test based high yield goal targeted fertilizer management. There was significant grain yield difference in different agronomic management factor-based treatments. The highest grain yield

(5.89 t  $ha^{-1}$ ) was obtained from the agronomic-based treatment combination of soil test based high yield goal targeted fertilizer management, 25 x 25 cm spacing, 15-day-old seedling and 15 July seeding (Table 7).

### **Effect of agronomic factors for maximizing the yield of medium duration BRRI dhan94 through developing sustainable production management protocol**

The experiment was conducted to determine the effect of some agronomic factors on the yield of a medium duration variety (BRRI dhan94) in T. Aman season. The treatments were: time of crop establishment,  $T_1 = 1$  July seeding and  $T_2 = 15$  July seeding; seedling age,  $A_1 = 15$  day and  $A_2 = 30$ -day; population density,  $S_1 = 25 \times 25$  cm (16 hill  $m^{-2}$ ) and  $S_2 = 20 \times 20$  cm (25 hill  $m^{-2}$ ) and fertilizer management,  $F_1 =$  BRRI recommended fertilizer management,  $F_2 =$  soil test based high yield goal targeted fertilizer management with additional one-ton vermicompost per hector was added during transplanting. The experiment was laid down in a factorial RCBD design with three replications. There was a significant effect of different agronomic

factors on the grain yield. The highest grain yield (7.18 t ha<sup>-1</sup>) was achieved from the treatment combination of soil test based high yield goal

targeted fertilizer management with additional one-ton vermicompost, 15-day-old seedling, 25 × 25 cm spacing and 15 July seeding (Fig. 2).

**Table 7. Effect of agronomic factors for maximizing grain yield of long slenderer premium quality fine rice-BRRI dhan70 (*Katarivog type*) in T. Aman season.**

| Treatment   | Grain yield (t ha <sup>-1</sup> ) | Treatment   | Grain yield (t ha <sup>-1</sup> ) | Treatment             | Grain yield (t ha <sup>-1</sup> ) |
|-------------|-----------------------------------|-------------|-----------------------------------|-----------------------|-----------------------------------|
| F1 S1 A1 T1 | 3.70                              | F1 S2 A2 T1 | 2.08                              | F2 S2 A1 T1           | 1.52                              |
| F1 S1 A1 T2 | 4.01                              | F1 S2 A2 T2 | 2.75                              | F2 S2 A1 T2           | 2.97                              |
| F1 S1 A2 T1 | 4.06                              | F2 S1 A1 T1 | 3.81                              | F2 S2 A2 T1           | 2.30                              |
| F1 S1 A2 T2 | 3.36                              | F2 S1 A1 T2 | 5.89                              | F2 S2 A2 T2           | 2.94                              |
| F1 S2 A1 T1 | 2.42                              | F2 S1 A2 T1 | 5.16                              | CV%                   | 9.23                              |
| F1 S2 A1 T2 | 2.26                              | F2 S1 A2 T2 | 4.16                              | LSD <sub>(0.05)</sub> | 0.4748                            |

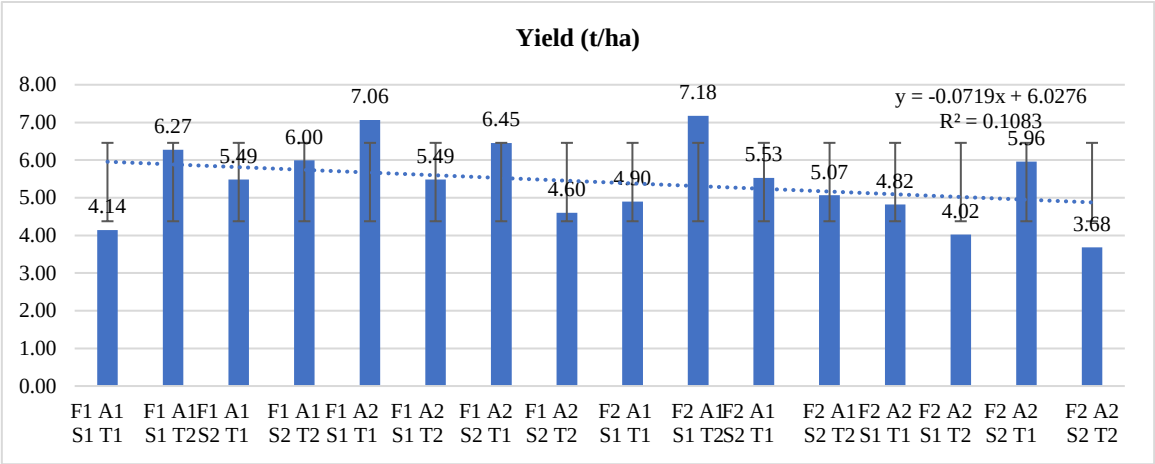


**Fig. 2. Effect of agronomic factors for maximizing yield of medium duration BRRI dhan94 during T. Aman season.**

### Effect of some agronomic factors for maximizing yield of long duration variety BRRI dhan92 through developing sustainable production management protocol in Boro season

The experiment was carried out at BRRI farm, Gazipur to find out the sustainable production management protocol of long duration variety BRRI dhan92. The treatments were: age of seedling, A<sub>1</sub> = 15-day, A<sub>2</sub> = 35 day and A<sub>3</sub> = 55 day; spacing, S<sub>1</sub> = 30 × 30 cm (11.1 hill m<sup>-2</sup>), S<sub>2</sub> = 25 × 25 cm (16 hill m<sup>-2</sup>) and S<sub>3</sub> = 20 × 20 cm (25 hill m<sup>-2</sup>); fertilizer

management, F<sub>1</sub> = AEZ fertility based high yield goal targeted BRRI fertilizer recommendation and F<sub>2</sub> = soil test based high yield goal targeted fertilizer recommendation along with one t ha<sup>-1</sup> vermi compost and 1% MoP solution spray at 30 and 45 DAT. There was significant effect of different treatment on yield and yield contributing factors. The highest grain yield of BRRI dhan92 (8.06 t ha<sup>-1</sup>) was obtained from the treatment combination of soil test-based fertilizer application, 25 × 25 cm spacing and 15-day-old seedling (Fig. 3).

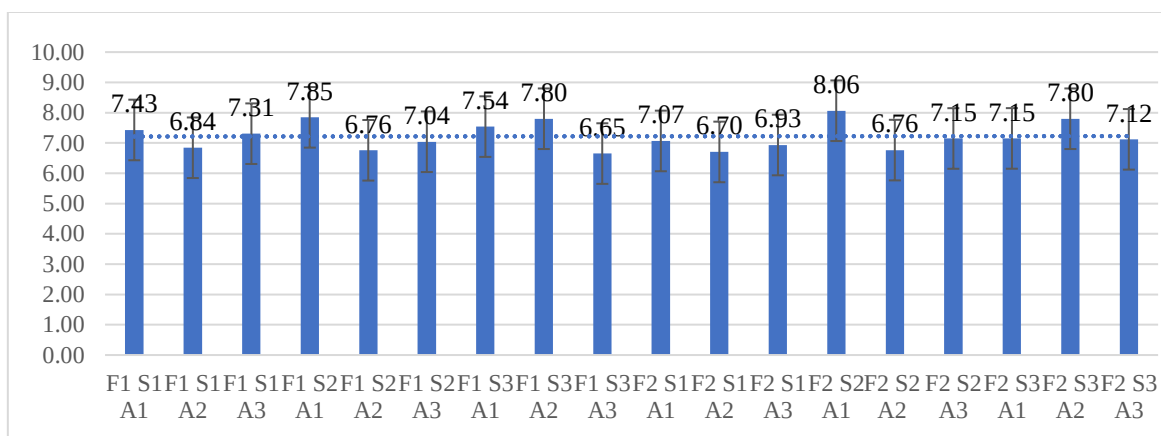


Fig. 3. Effect of some agronomic factors for maximizing grain yield of long duration Boro variety (BRRI dhan92).

### Yield maximization of Boro rice through good agricultural practice (GAP)

The experiment was designed to observe the effect of few GAP components on the growth and yield of three rice varieties during Boro season of 2023-24 at BRRI HQ farm, Gazipur. The varieties were BRRI hybrid dhan8, BRRI dhan92, and BRRI dhan104. Here we considered good agricultural practice (GAP) and BRRI recommended management (BRP). Management of GAPs were: a. Balanced fertilizer application (N, P, K, S, Zn) (soil test based) b. BRRI weeder fb 1 HW at 45 DAT d. Integrated insect and disease management and e. Maintaining planting depth of 2-3 cm. BRRI recommended practices (CRP) were: a. BRRI recommended

fertilizer and cultural practices b. Normal irrigation practice, c. Herbicide fb 1HW d. Insect and disease management by applying pesticides. Presents the results in (Table 8) shows that varieties  $\times$  management differed significantly in grain yield and yield contributing characters. Individual effects of varieties also differed significantly on grain yield and yield character but management have no significant effect on grain yield and other characters. But GAPs management showed better yield in all aspects. The highest grain yield was observed in BRRI dhan100 $\times$ GAPs (8.46 t ha<sup>-1</sup>) followed by BRRI hybrid dhan8 with BRPs (8.25 t ha<sup>-1</sup>). GAPs produced higher grain yield compared to BRRI recommended practices in different varieties, which is safe, environment-friendly, and cost-effective.

**Table 8. Yield and yield characters of BRRI varieties as affected by management practices at BRRI HQ farm, Gazipur during Boro 2023-2024.**

| Variety(V)                  | Management (M) | Panicle m <sup>-2</sup> | Grains panicle <sup>-1</sup> | 1000 GW(g) | GY (t ha <sup>-1</sup> ) |
|-----------------------------|----------------|-------------------------|------------------------------|------------|--------------------------|
| BRRI hybrid dhan8           | GAP            | 324                     | 143                          | 24.16      | 8.46                     |
|                             | CRM            | 318                     | 138                          | 24.14      | 8.25                     |
| BRRI dhan92                 | GAP            | 313                     | 136                          | 23.39      | 7.89                     |
|                             | CRM            | 307                     | 130                          | 23.34      | 7.66                     |
| BRRI dhan104                | GAP            | 297                     | 98                           | 21.49      | 6.88                     |
|                             | CRM            | 294                     | 94                           | 21.47      | 6.61                     |
| LSD (0.05) for V            |                | 10.11                   | 8.21                         | 0.16       | 0.36                     |
| LSD (0.05) for M            |                | ns                      | ns                           | ns         | ns                       |
| LSD (0.05) for V $\times$ M |                | 15.33                   | 12.13                        | 0.25       | 0.53                     |
| CV (%)                      |                | 3.8                     | 5.5                          | 1.0        | 3.9                      |

GAP=Good agricultural practices; CRP= BRRI recommended practice



## WEED MANAGEMENT

### Evaluation of candidate herbicide for weed control efficiency in T. Aman 2023 and Boro 2023-24 season

Field trials were conducted at the Bangladesh Rice Research Institute, Gazipur from T. Aman 2023 and Boro 2023-24 seasons. Most of the herbicides performed more than 80% weed control efficiency in different weed populations observed in the field

(Table 9). Only *cynodon dactylon* cannot be controlled >80% by some herbicides in most cases. Among the herbicides, six herbicides did not control weed effectively and their weed control efficiency was less than 80%. post-emergence herbicides are dominant and most of the herbicides contain more effective combination chemicals. Among the herbicide groups, some new molecule herbicides and their efficacy were given below.

**Table 9. Herbicide chemical name, dose and weed control efficiency of different herbicides evaluated during T. Aman 2023 and Boro 2023-24 at BRRI HQ farm, Gazipur.**

| Chemical                                         | Dose (ha <sup>-1</sup> ) | Season | Weed control efficiency (%) |                        |                      |                   |                   |
|--------------------------------------------------|--------------------------|--------|-----------------------------|------------------------|----------------------|-------------------|-------------------|
|                                                  |                          |        | Cynodon dactylon            | Echinochloa crus-galli | Monochoria vaginalis | Scirpus maritimus | Cyperus difformis |
| Haloxypop-R-methyl 7.5% + Clethodim 15%          | 150 ml                   | Aman   | 58.50                       | 82.50                  | 84.50                | 80.30             | 81.40             |
|                                                  |                          | Boro   | 74.54                       | 86.60                  | 86.32                | 81.40             | 83.50             |
| Pretilachlor 38.5% + Penoxsulam 1.5%             | 1200 ml                  | Aman   | 59.00                       | 85.60                  | 82.65                | 80.90             | 83.00             |
|                                                  |                          | Boro   | 77.80                       | 83.00                  | 80.60                | 82.00             | 80.75             |
| Penoxulam + Butachlor                            | 2000 ml                  | Aman   | 60.50                       | 82.50                  | 81.00                | 83.20             | 81.50             |
|                                                  |                          | Boro   | 77.50                       | 83.00                  | 83.00                | 81.40             | 82.84             |
| Quinclorac 30% + Bispyribac sodium 5%            | 600 g                    | Aman   | 80.00                       | 81.00                  | 83.00                | 80.25             | 80.00             |
|                                                  |                          | Boro   | 81.20                       | 82.00                  | 87.00                | 80.00             | 82.00             |
| Pretilachlor 36% + Bensulfuron methyl 4%         | 1000 g                   | Aman   | 80.80                       | 81.00                  | 82.00                | 80.00             | 80.00             |
|                                                  |                          | Boro   | 77.20                       | 82.00                  | 84.60                | 80.80             | 84.50             |
| Flumioxazim 50 WP                                | 500 g                    | Aman   | 70.00                       | 81.00                  | 83.00                | 83.70             | 87.00             |
|                                                  |                          | Boro   | 76.20                       | 85.00                  | 80.50                | 88.00             | 86.00             |
| Bentazone 400% + MCPA 60% SL                     | 1.8 L                    | Aman   | 70.00                       | 80.00                  | 80.00                | 82.80             | 80.00             |
|                                                  |                          | Boro   | 76.00                       | 81.50                  | 81.00                | 90.80             | 80.00             |
| 2,4-D Amine                                      | 2.0 L                    | Aman   | 70.80                       | 65.00                  | 62.00                | 73.00             | 70.00             |
|                                                  |                          | Boro   | 76.0                        | 63.00                  | 72.00                | 74.00             | 71.00             |
| Bispyribac sodium 20% + Pyrazosulfuron Ethyl 10% | 150 g                    | Aman   | 70.00                       | 81.00                  | 83.00                | 83.70             | 87.00             |
|                                                  |                          | Boro   | 76.20                       | 85.00                  | 80.50                | 88.00             | 86.00             |

### Effect of adding urea with herbicides for controlling weeds and the growth and yield of transplanted rice

The study aims to determine whether integrating urea with herbicides enhances weed suppression, improves rice growth, and ultimately increases grain

yield. The treatments of the experiment were Bensulfuron methyl+acetachlor @ 750g ha<sup>-1</sup> fb 1HW(T1), Penoxsulam@ 93.7 ml ha<sup>-1</sup> fb 1HW(T2), Bispyribac sodiumSC @ 150 ml ha<sup>-1</sup> fb 1HW( T3), Bensulfuron methyl+ acetachlor @ 750g ha<sup>-1</sup> with 1% urea tank mix fb 1HW(T4), Penoxsulam@ 93.7

ml ha<sup>-1</sup> with 1% urea tank mix fb 1HW( T5), Bispyribac sodium SC @ 150 ml ha<sup>-1</sup> with 1% urea tank mix fb 1HW(T6), Bensulfuron methyl+ acetachlor @ 750 g ha<sup>-1</sup> broadcast with urea (5 kg urea /33 decimal) fb 1HW( T7), Penoxsulam@ 93.7 ml ha<sup>-1</sup> broadcast with urea( 5kg urea/33 decimal) fb 1HW(T8), Bispyribac sodium SC @ 150 ml ha<sup>-1</sup> broadcast with urea( 5kg urea/33 decimal) fb 1HW(T9), un-weeded (T10) and weed free by three hand weeding (T11). The experiment followed the RCBD design with three replications. BRRI dhan103 was used as a variety. The combination of urea with herbicides significantly improved weed

control compared to the application of herbicides alone (Table 10). The herbicide-urea combination resulted in a reduced weed density m<sup>-2</sup>(10,12) and dry weight g m<sup>-2</sup> (4.55 5.25, contributing to a cleaner field environment throughout the rice-growing period, resulting in higher grain yield. The treatment Penoxsulam @ 93.7 ml ha<sup>-1</sup> broadcast with urea (5kg urea/33 decimal) produced the highest grain (7.19 t ha<sup>-1</sup>) yield (Table 10). The study indicates that integrating urea with herbicides offers a dual advantage of improved weed management and enhanced rice growth, leading to higher yields.

**Table 10. Weed number, weight weed control efficiency (%) and yield loss (%) of different weed management treatments during T. Aman 2023.**

| Treatment | Weed dry-weight g m <sup>-2</sup> ) | WCE (%) | GY(t ha <sup>-1</sup> ) | Yield loss% |
|-----------|-------------------------------------|---------|-------------------------|-------------|
| T1        | 6.89                                | 79      | 6.13                    | 15          |
| T2        | 6.81                                | 79      | 6.41                    | 11          |
| T3        | 6.74                                | 80      | 6.32                    | 12          |
| T4        | 6.67                                | 80      | 6.43                    | 11          |
| T5        | 6.59                                | 80      | 6.58                    | 8           |
| T6        | 6.62                                | 80      | 6.65                    | 7           |
| T7        | 5.86                                | 82      | 7.12                    | 1           |
| T8        | 4.55                                | 86      | <b>7.19</b>             |             |
| T9        | 5.25                                | 84      | 7.04                    | 2           |
| T10       | 32.91                               |         | 3.51                    | 51          |
| T11       | 5.51                                | 83      | 7.00                    | 3           |
| LSD (.05) | 1.99                                | -       | 0.55                    | -           |
| CV (%)    | 16.1                                | -       | 5.10                    | -           |

## SOIL HEALTH MANAGEMENT

### Isolation and characterization of salt-tolerant PGPR isolated from coastal saline soil in Bangladesh

The experiment was conducted at the soil microbiology laboratory, Agronomy Division during the season of T. Aman 2023. The soil was collected from six locations in the Khulna district viz Basurabad, Batiaghata, Baronpara, Batiaghata, Kholisha, Dacope, Khatail, Dacope, Raipara, Khatail, Dacope, Channirchar, Dacope. Thirty bacteria strains were isolated from the collected soil. The strains were tested at various NaCl concentrations (0, 0.5, 1, 1.5 and 2M). The potential

strains that survived at NaCl concentrations of 1.5 M onwards were further considered for screening of various salt-tolerant and plant growth-promoting traits. Among the 14 bacterial strains the highest amount of floc yield was produced by the strain KB1 (18.36 gL<sup>-1</sup>). The highest exopolysaccharide was produced by the strains KB9 (49.16 gL<sup>-1</sup>) and KB1 (49.11 gL<sup>-1</sup>) followed by KB7 (42.23 gL<sup>-1</sup>) and KB5 (40.33 gL<sup>-1</sup>). The highest amount of Na uptake was measured by the strain KB5 (74 ppm). The highest indole acetic acid (IAA) was produced by the strains KB11(23.98 ppm) followed by KB5 (21.74 ppm). The qualitative screening on the ability to fix atmospheric nitrogen was observed by the strains KB1, KB5, KB9, KB11 and KB13. The qualitative

screening for phosphate solubilization showed by the strains KB1, KB3, KB6, KB7, KB9, KB11, KB13 and KB14 (Table 11). The salt-tolerance and

plant growth-promoting traits revealed that KB1, KB3, KB5, KB6, KB7, KB9, KB11, KB13 and KB14 are potential salt-tolerant PGPR strains.

**Table 11. The salt tolerance and plant growth-promoting traits of the selected PGPR strains.**

| PGPR strain | Floc yield<br>(g L <sup>-1</sup> ) | EPS<br>(g L <sup>-1</sup> ) | Na uptake<br>(ppm) | IAA<br>(ppm) | Nitrogen<br>fixation | Phosphate<br>solubilization |
|-------------|------------------------------------|-----------------------------|--------------------|--------------|----------------------|-----------------------------|
| KB1         | 18.36a                             | 49.11a                      | 66b                | 20.71bc      | +++                  | +++                         |
| KB2         | 9.46fg                             | 29.07bcde                   | 43k                | 13.21g       | -                    | -                           |
| KB3         | 12.41cd                            | 27.19cde                    | 57e                | 20.06bcd     | -                    | +++                         |
| KB4         | 10.34ef                            | 34.22bcd                    | 34l                | 17.80de      |                      | -                           |
| KB5         | 13.66bc                            | 40.33abc                    | 74a                | 21.74ab      | ++                   | -                           |
| KB6         | 11.91d                             | 23.55de                     | 45j                | 16.53ef      | -                    | +++                         |
| KB7         | 14.08b                             | 42.23ab                     | 55f                | 22.79b       | -                    | +++                         |
| KB8         | 7.38hj                             | 17.31ef                     | 52g                | 16.47ef      |                      | -                           |
| KB9         | 13.66bc                            | 49.16a                      | 64c                | 19.29cde     | +                    | +++                         |
| KB10        | 6.40j                              | 3.33g                       | 30n                | 13.82fg      | -                    | -                           |
| KB11        | 14.0b8                             | 34.33bcd                    | 58d                | 23.98a       | ++                   | +++                         |
| KB12        | 10.21ef                            | 3.21g                       | 47i                | 19.08cde     | -                    | -                           |
| KB13        | 11.01de                            | 9.23fg                      | 51h                | 20.70bc      | +++                  | +++                         |
| KB14        | 8.32gh                             | 4.33fg                      | 33m                | 16.53ef      | -                    | +++                         |
| CV%         | 7.44                               | 13.56                       | 8.59               | 9.11         |                      |                             |

Means having the same letter in each bacterium did not differ significantly using Lsd at p>0.05.

#### Effect of salt-tolerant PGPR inoculation on the growth of rice seedlings under salt-stress condition

The experiment was conducted at the laboratory of the Agronomy Division during Boro 2023-24. The treatments comprised of nine bacterial inoculums (No inoculum, KB1, KB3, KB5, KB6, KB7, KB9, KB11, KB13 and KB14. The rice varieties BRRI dhan99 and BRRI dhan88 were considered as a test plant. The two levels of salinity (0 (control), and 7 dSm<sup>-1</sup>) were maintained throughout the growing period. The seeds were seeded in a perforated plastic tray that originally had multiple compartments. The trays were submerged in plastic trays containing the desired level of saline water. The seedlings were allowed to grow up to 45 days. The trays were arranged in RCBD following three replications. Under salt-stress conditions, the highest shoot length of BRRI dhan99 was measured by the inoculation of KB1(46.33 cm) and KB7 (45.57cm) followed by

KB3> KB6>KB11>KB14. Besides, the highest root length was observed by the inoculation of KB1 (13.30cm), KB3 (13cm) and KB13 (13cm) followed by KB7> KB11>KB14. The highest shoot weight was produced by the strains KB1 (0.21 g) followed by KB7 (0.20 g). The highest root weight was produced by the strain KB5 (0.08g) and KB9 (0.08 g) followed by KB1>KB7 (Fig. 4). Likewise, the highest shoot length of BRRI dhan88 was measured by the strains KB7 (44.30 cm) followed by KB1> KB3 (44.23 cm)> KB5>KB9> KB11>KB13>KB14. Besides, the root length did not vary significantly. The highest shoot weight was produced by the inoculation of strain KB1 (0.27g cm) KB5 (0.26g cm), KB7 (0.27) followed by KB14 (0.25). Besides, the highest root weight was produced by strain KB1 (0.11g) (Fig. 5). Among the nine tested PGPR strains, KB1, KB5, KB7, KB9 and KB11 could be considered salt-tolerant PGPR which can significantly contribute to reducing the salinity stress of rice at the seedling stage.

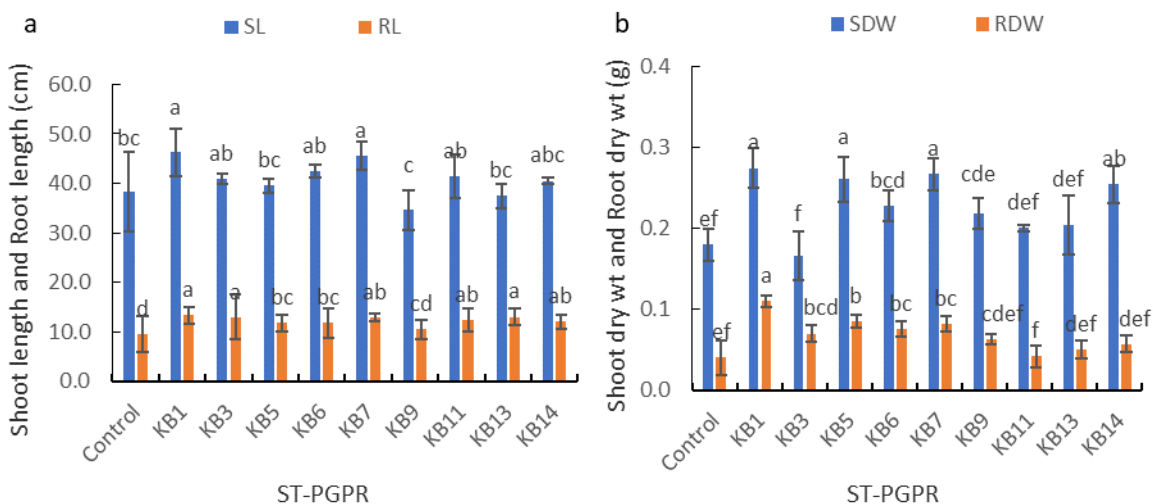


Fig. 4. Effect of ST-PGPR inoculations on (a) shoot length and root length and (b) shoot weight and root weight of BRRI dhan99 under saline conditions. Means having the same letter in each bacterium did not differ significantly using LSD at  $p>0.05$ ; SL: Shoot length; RL: Root length; SDW: Shoot Dry Weight; RDW: Root dry weight.

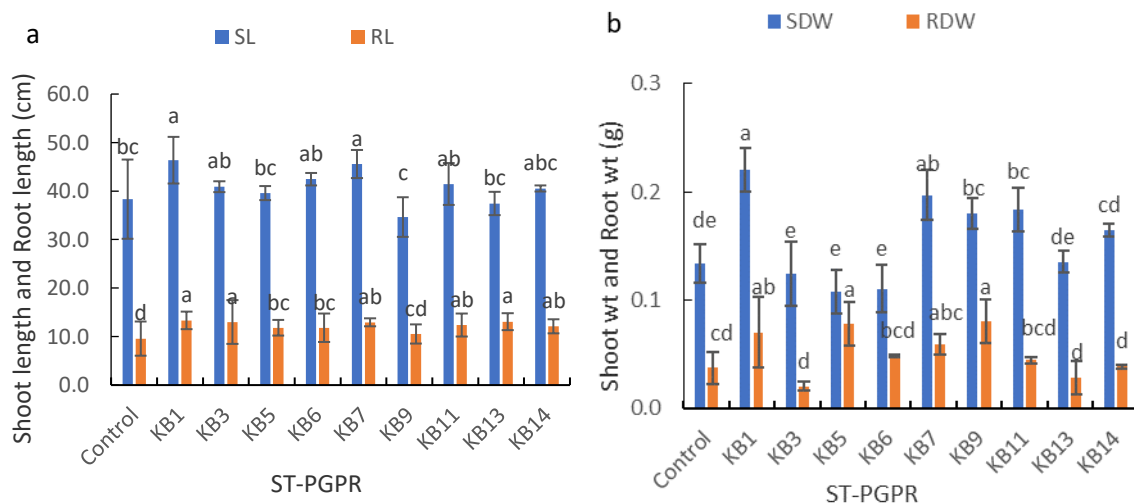


Fig. 5. Effect of ST-PGPR inoculations on (a) shoot length and root length and (b) shoot weight and root weight of BRRI dhan88 under saline conditions. Means having the same letter in each bacterium did not differ significantly using LSD at  $p>0.05$ ; SL: Shoot length; RL: Root length; SDW: Shoot Dry Weight; RDW: Root dry weight.

## **Soil Science Division**

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## SUMMARY

The breeding line BR9158-19-906-50-2-HR1 produced a higher yield compared to the check variety of BRRI dhan44 under tidal submergence condition. High N dose at potassium deficient conditions adversely affects rice yield, while at N deficient conditions, increasing rates of K fertilizer did not influence rice yield in T. Aman. The optimum N and K rates at BRRI HQ farm, Gazipur for achieving the maximum grain yield were 50 and 40 kg/ha, respectively for BRRI hybrid dhan6 in T. Aman. The calculated economically optimum N dose for BRRI dhan95 in T. Aman season was 79 kg ha<sup>-1</sup> under updating N rates for modern varieties experiment. Organic inputs with IPNS-based chemical fertilizer treatment show an increasing trend compared to complete chemical fertilizer treatment. Sulphur and Zinc are not a limiting nutrient yet and have shown similar grain yield compared to complete fertilizer in both T. Aman and Boro seasons in BRRI farm, Gazipur and Rangpur under long-term missing element trial. Intensive rice cropping with NPKSZn resulted in the highest annual yield of rice compared to the other fertilizer treatments. On the other hand, when the fertilizer control plot was reversed with complete fertilization after a long time resulted in yield similar to fertilized treatments, which indicated that complete fertilization could recuperate soil productivity even after a long period of rice cultivation. Application of Zn and Cu fertilizer showed positive effect on rice yield.

Rice yield increased sharply due to P fertilizer application as the soil is very deficient in available P. The response was much lower in T. Aman (wet season) than in Boro (dry season). The economic optimum dose of P for BRRI hybrid dhan6 in T. Aman was 25 kg P ha<sup>-1</sup> and for BRRI hybrid dhan3 in Boro was 27 kg P ha<sup>-1</sup>. The TSP fertilizer alone or the combinations of TSP and DAP fertilizer performed better than DAP fertilizer alone in both the Boro and T. Aman seasons. The STB dose and 50% STB + MM fertilizer produced significantly higher grain yield than farmers' practice and the cumulative yield of triple rice cropping was always

higher than double rice cropping patterns. BRRI hybrid dhan3 significantly increased grain yield compared to the other cultivars in BRRI farms Gazipur and Satkhira. Higher grain yield was recorded in BRRI farm Gazipur than in Satkhira. Regarding CH<sub>4</sub> emissions, BRRI dhan67 and BRRI hybrid dhan3 significantly ( $p < 0.05$ ) reduced cumulative CH<sub>4</sub> emissions compared to BRRI dhan50 and BRRI dhan92 in both the locations of BRRI farm Satkhira and Gazipur. The AWD, 15 cm and AWD, 25 cm treatment reduce about 27-33% and 34-39% of total CH<sub>4</sub> flux than continuous standing water at Gazipur and Kushtia. The highest grain yield (6.33 t/ha) was obtained in the BRRI organic applied treatment (0.5 t/ha), and it was statistically similar with the full dose of chemical fertilizer (6.20 t/ha). The result proved that omission of TSP along with 30% reduction of urea fertilizer did not impact negatively on grain yield. The highest grain yield (7.6 t/ha) was recorded in the 60% bio-coated urea (BCU) with PKS applied treatment and it was statistically similar with 100% prilled urea with PKS (7.17 t/ha) and 100% BCU+PKS (7.03 t/ha) treatment in the Boro season. The higher total bacteria population was found in the Mango orchard of Belchhari union ( $2 \times 10^9$  cfu/g soil). A higher average free living nitrogen fixing bacteria population was found in the mango and malta orchard. INM of BRRI-organic fertilizer (2 ton/ha) and INM with cowdung (2 ton/ha) produced 19.14% and 11.36% grain yield increments over the full dose of synthetic fertilizer respectively in the T. Aman season. INM with cowdung (2 ton/ha) or INM with BRRI-organic fertilizer (2 ton/ha) or Biocoated urea save 30% N and produced higher grain yield over full dose of synthetic fertilizer application. The highest population ( $7.6 \log_{10}$  CFU g soil<sup>-1</sup>) was recorded in the integrated plant nutrient system (IPNS) with cowdung application followed by the full chemical fertilizer. The highest population was recorded in the T<sub>2</sub> ( $7.0 \log_{10}$  CFU g soil<sup>-1</sup>), where 100% N was applied from bio-coated urea followed by 60% N application from bio-coated urea ( $6.9 \log_{10}$  CFU g soil<sup>-1</sup>) (T<sub>3</sub>). The lowest population was found ( $6.4 \log_{10}$  CFU g soil<sup>-1</sup>) in the full chemical urea application treatment (T<sub>1</sub>).

## SOIL FERTILITY AND PLANT NUTRITION

### **Influence of N and K on the performance of modern rice.**

The study was conducted to observe the effect of nitrogen (N) and potassium (K) on the yield of modern rice at BRRI farm, Gazipur during T. Aman 2023 season. The experiment was laid out in a split-plot design with three replications assigning the rates of K in the main plots and that of N in the subplots. Recommended doses of P, S and Zn (10, 4 and 2 kg ha<sup>-1</sup>) were applied to all the plots. The application rate of K was 0, 40, 60, 80 and 100 kg ha<sup>-1</sup>, while N was applied @ 0, 50, 75 and 100 kg ha<sup>-1</sup>. In the Boro 2023-24 season, the experiment was laid out in RCBD with three replications assigning the rates of K (0, 40, 80, 120 and 160 kg ha<sup>-1</sup>) for the yield of modern rice at BRRI farm, Gazipur. Recommended doses of N, P, S and Zn (160, 15, 10 and 2 kg ha<sup>-1</sup>) were applied to all the plots. The test

varieties were BRRI hybrid dhan6 and BRRI hybrid dhan3 in T. Aman and Boro seasons respectively.

**Grain yield.** The interaction effect of rice yield between N and K was significant in T. Aman 2023 (Table 1). Application of 50 and 75 kg N/ha did not show considerable variations in grain yield under K-deficient conditions, but 0 and 100 kg N/ha significantly decreased grain yield of BRRI hybrid dhan6. Application of N @ 50 kg ha<sup>-1</sup> with 40 kg K ha<sup>-1</sup> produced 4.35 t ha<sup>-1</sup> rice grains, which was statistically identical to the highest grain yield of 4.82 t ha<sup>-1</sup> achieved with a combination of 100 kg N and 60 kg K ha<sup>-1</sup> (Table 1). So, the combination of 40 kg K and 50 kg N is suitable for BRRI hybrid dhan6 cultivation to get optimum yield. In Boro 2023-24, K fertilizer increased grain yield relative to the K-control plot, but there was no variation in grain yield due to different rates of K fertilizer. So, 80 kg K ha<sup>-1</sup> is sufficient for optimum rice yield in the Boro season.

**Table 1. Effect of N and K on the grain yield (t ha<sup>-1</sup>) of MV rice in T. Aman 2023 at BRRI farm, Gazipur.**

| K rate (kg ha <sup>-1</sup> ) | N rate (kg ha <sup>-1</sup> ) |        |         |         |
|-------------------------------|-------------------------------|--------|---------|---------|
|                               | 0                             | 50     | 75      | 100     |
| 0                             | 3.79bB                        | 4.20aA | 3.88bAB | 3.54cB  |
| 40                            | 3.89bB                        | 4.35aA | 4.42aA  | 4.11bAB |
| 60                            | 4.04bB                        | 4.48aA | 4.67aA  | 4.82aA  |
| 80                            | 4.60aA                        | 4.50aA | 4.58aA  | 4.56aA  |
| 100                           | 3.85bB                        | 4.46aA | 4.55aA  | 4.63aA  |
| ANOVA (p-values)              |                               |        |         |         |
| Nitrogen (N)                  | <0.001                        |        |         |         |
| Potassium (K)                 | <0.01                         |        |         |         |
| N × K                         | <0.01                         |        |         |         |

Values followed by the same letter are not significantly different at the 5% level of probability.

### **Updating of nitrogen doses for modern rice**

**varieties.** The experiment was conducted at the experimental field of Bangladesh Rice Research Institute, Gazipur in T. Aman 2023 season to determine the optimum N requirement of BRRI dhan95. The experiment was laid out in RCB design with three replications. The applied N doses (kg ha<sup>-1</sup>) for T. Aman were 0, 30, 60, 90, 120 and 150, along

with flat doses of P, K and S fertilizer. The grain yield of BRRI dhan95 was significantly influenced by N rates. The highest yield (4.43 t ha<sup>-1</sup>) was observed with the application of 90 kg ha<sup>-1</sup> N. However, from the response curve, the calculated economically optimum N dose for BRRI dhan95 in T. Aman season was 79 kg ha<sup>-1</sup> (Fig. 1).

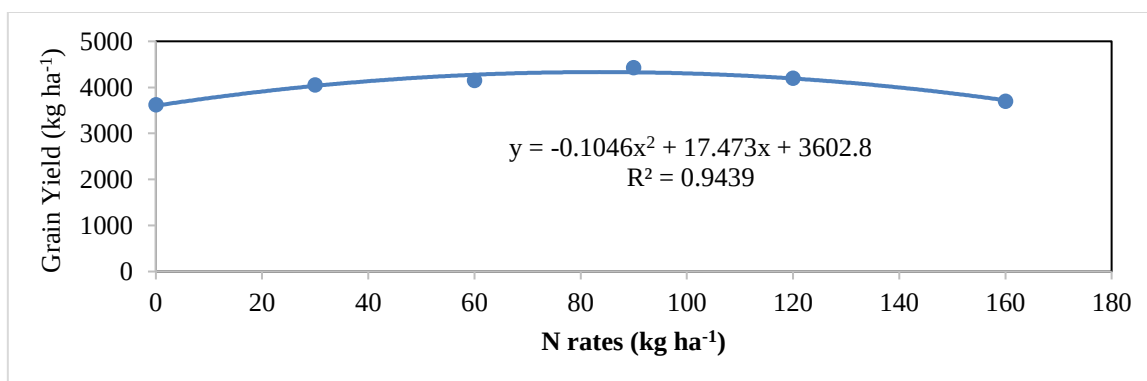


Fig. 1. Grain yield response of BRRi dhan95 to added N during T. Aman, 2023, BRRi, Gazipur.

## IDENTIFICATION AND MANAGEMENT OF NUTRITIONAL DISORDER

**Long-term use of organic and inorganic nutrients in Boro-Fallow-T. Aman rice:** A long-term experiment was initiated on a permanent layout at BRRi HQ farm, Gazipur in 1985 Boro season having 12 treatments assigned in RCB design with four replications. The objective of the study was to find the impact of long-term nutrient management on grain yield and soil health. The treatments were revised according to needs (see BRRi, 2016 and BRRi, 2019). The recent STB doses of NPKSZn were 150-12-80-5-2 kg ha<sup>-1</sup> and 100-10-80-5-2 kg ha<sup>-1</sup> for Boro and T. Aman rice, respectively. In T.

Aman 2023, the variety was BRRi dhan87 and in Boro 2023-24, it was BRRi dhan89.

**Grain yield.** Omission of N, P and K nutrient showed significantly reduction in grain yield than complete fertilizer in both the seasons (Table 2). Among the applied organic materials, PM+IPNS, CD+ IPNS and VC+ IPNS produced statically higher grain yield, but the result was statistically similar compared to complete fertilizer (in both the seasons). Increased K rates (kg ha<sup>-1</sup>) from 40 to 80 have significant impact on grain yield. Sulphur and Zinc are not a limiting nutrient yet and shown similar grain yield compared to complete fertilizer in both T. Aman and Boro seasons.

**Table 2. Effect of organic and inorganic amendments on rice grain yield (t ha<sup>-1</sup>) of BRRi dhan87 and BRRi dhan89 at BRRi HQ, Gazipur, in 2023-24.**

| Treatment                                                         | Grain yield (t ha <sup>-1</sup> ) |              |
|-------------------------------------------------------------------|-----------------------------------|--------------|
|                                                                   | T. Aman 2023                      | Boro 2023-24 |
| T <sub>1</sub> = NPKSZn@150/100-12/10-80-5-2 kg ha <sup>-1</sup>  | 5.90 ab                           | 6.57a        |
| T <sub>2</sub> = NPSZn (-K)                                       | 4.52e                             | 2.82e        |
| T <sub>3</sub> = NKSZn (-P)                                       | 5.04d                             | 2.63ef       |
| T <sub>4</sub> = PKSZn (-N)                                       | 4.60e                             | 2.29f        |
| T <sub>5</sub> = CD (3 t ha <sup>-1</sup> ) + IPNS                | 6.04a                             | 6.09abc      |
| T <sub>6</sub> = NPKS (-Zn)                                       | 5.71ab                            | 6.25ab       |
| T <sub>7</sub> = NPKZn (-S)                                       | 5.87ab                            | 6.32ab       |
| T <sub>8</sub> = PM (2 t ha <sup>-1</sup> ) + IPNS                | 6.10a                             | 6.50ab       |
| T <sub>9</sub> = NPKSZn @150/100-12/10-60-5-2 kg ha <sup>-1</sup> | 5.55bc                            | 5.67cd       |
| T <sub>10</sub> = VC (2 t ha <sup>-1</sup> ) + IPNS               | 6.00a                             | 6.06bc       |
| T <sub>11</sub> = NPKSZn@150/100-12/10-40-5-2 kg ha <sup>-1</sup> | 5.24cd                            | 5.44d        |



| Treatment                                    | Grain yield (t ha <sup>-1</sup> ) |              |
|----------------------------------------------|-----------------------------------|--------------|
|                                              | T. Aman 2023                      | Boro 2023-24 |
| T <sub>12</sub> = Control (native nutrients) | 3.88f                             | 1.30g        |
| <i>LSD</i> <sub>0.05</sub>                   | 3.16                              | 4.21         |
| <i>CV</i> (%)                                | 0.42                              | 0.50         |

### Long-term missing element trial at BRRI RS, Rangpur:

The experiment was initiated in a permanent layout at BRRI farm Rangpur during Boro, 2014-15 combining seven treatments: T<sub>1</sub>= Control, T<sub>2</sub>= NPKSZn, T<sub>3</sub>= PKSzn (-N), T<sub>4</sub>= NKSzn (-P), T<sub>5</sub>= NPSzn (-K), T<sub>6</sub>= NPKZn (-S), T<sub>7</sub>=NPKS (-Zn) in RCB design with three replicates. Fertilizer nutrients i.e., N-P-K-S-Zn rate was 95-8-

40-12-1 kg ha<sup>-1</sup> and 145-10-60-15-2 kg ha<sup>-1</sup> in T. Aman and Boro season, respectively. Urea-N was applied into three equal splits at final land preparation, active tillering and 5-7 days before panicle initiation (PI) stage. Rests of the fertilizers were applied at final land preparation. BRRI dhan87 in T. Aman and BRRI dhan89 in Boro season were cultivated as test rice varieties.

**Grain yield of T. Aman and Boro.** The omission of N in T. Aman and omission of N and P in Boro season from complete fertilizer significantly reduced the grain yield of rice at BRRI RS Rangpur farm (Table 3). Among the major nutrient elements,

the omission of N appeared as the most yield-limiting nutrient followed by P and K omission for rice in both the seasons. Yet the S and Zn omission have less effect on yield reduction at BRRI RS farm, Rangpur in both T. Aman and Boro seasons.

**Table 3. Effect of long-term missing element on grain yield of BRRI dhan87 and BRRI dhan89 at BRRI RS farm, Rangpur in T. Aman and Boro, 2023-24.**

| Treatment      | T. Aman 2023<br>GY (t/ha) | (%) Grain yield<br>decreased due to<br>nutrient omission | Boro2024<br>GY (t/ha) | (%) Grain yield<br>decreased due to<br>nutrient omission |
|----------------|---------------------------|----------------------------------------------------------|-----------------------|----------------------------------------------------------|
| T <sub>1</sub> | 3.37 c                    | -                                                        | 3.04 c                | -                                                        |
| T <sub>2</sub> | 5.82 a                    | -                                                        | 6.71 a                | -                                                        |
| T <sub>3</sub> | 3.95 b                    | 32                                                       | 3.54 c                | 47                                                       |
| T <sub>4</sub> | 5.59 a                    | 4                                                        | 5.10 b                | 24                                                       |
| T <sub>5</sub> | 5.70 a                    | 2                                                        | 6.32 a                | 6                                                        |
| T <sub>6</sub> | 5.65 a                    | 3                                                        | 6.51 a                | 3                                                        |
| T <sub>7</sub> | 5.74 a                    | 1.5                                                      | 6.53 a                | 2.5                                                      |
| <i>CV</i> (%)  | 2.72                      |                                                          | 5.3                   |                                                          |

N.B. T<sub>1</sub>= Control, T<sub>2</sub>= NPKSZn, T<sub>3</sub>= PKSzn (-N), T<sub>4</sub>= NKSzn (-P), T<sub>5</sub>= NPSzn (-K), T<sub>6</sub>= NPKZn (-S), T<sub>7</sub>=NPKS (-Zn)

**Effect of intensive rice cropping on rice yield under continuous wetland condition.** The experiment was designed to harvest three rice crops per year to evaluate the consequences of intensive rice cropping under continuous wetland conditions on rice yield and to monitor soil fertility changes over time. The experiment was initiated in 1971 in a permanent layout with NPK fertilizer application. Since Boro 2000, the experiment was modified to accommodate six treatments viz control (native nutrient), reverse control (NPKSZnCu), NPK,

NPKS, NPKSZn, and NPKSZnCu after several revisions in the years of 1982, 1984 and 1991. In Boro 2020-21, the N and K fertilizer doses were revised from 140 to 160 and 80 to 100 kg ha<sup>-1</sup> respectively. The varieties tested in T. Aus, T. Aman and Boro seasons were BRRI dhan48, BRRI dhan87, and BRRI dhan84 respectively. The NPK doses used were 160-25-100, 60-15-80 and 60-10-60 kg ha<sup>-1</sup> for Boro, T. Aman and T. Aus respectively. Sulfur, Zn and Cu were applied at 10, 4 and 1 kg ha<sup>-1</sup> in Boro season only.

**Grain yield and yield trend.** The annual rice production from 1981 to 2023 showed a decreasing trend because of continuous rice cultivation with no fertilizer application. However, from 2001, the reverse control treatment produced grain yield almost similar to complete fertilized treatment (Fig. 2). In 2022, annual rice production in the control plot was 5.56 t ha<sup>-1</sup>, while its reversed management (addition of NPKSZnCu fertilizer) resulted in 13.35

t ha<sup>-1</sup>yr<sup>-1</sup> grain production, which was close to complete fertilizer treatment (14.56 t ha<sup>-1</sup>yr<sup>-1</sup>). It indicates that complete fertilization can recuperate soil productivity even after a long period of rice cultivation. Results indicate that additional use of Zn and Cu once a year with NPKS increased annual grain yield by more than 1.5 t ha<sup>-1</sup> than the application of NPKS alone.

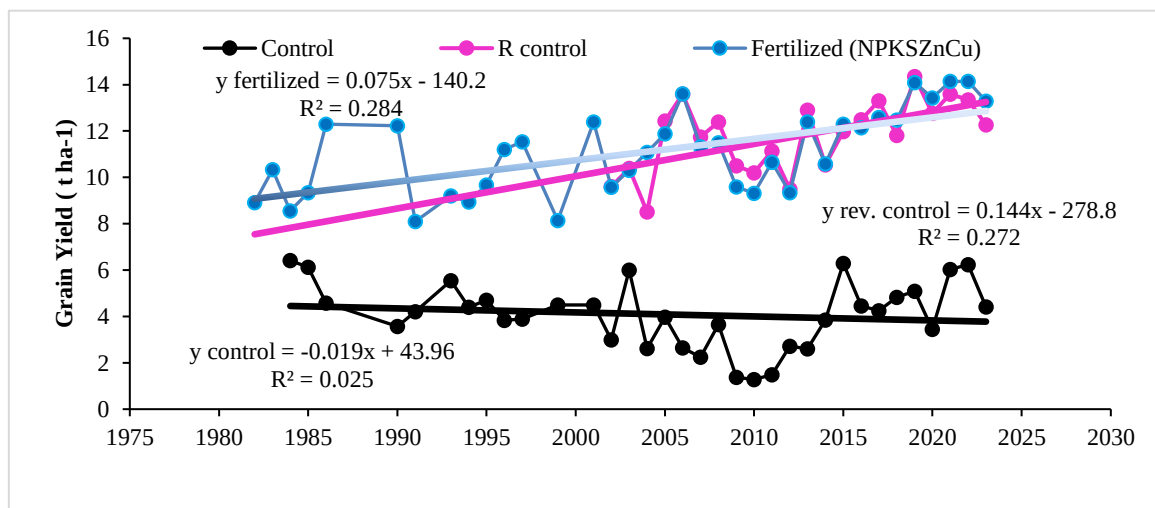


Fig. 2. Annual rice production trend under intensive wetland conditions in BRRI, Gazipur during 1981-2023.

**Performance of rice variety under P deficit conditions.** Acute P deficiency reduces rice yield depending on internal and/or external mechanisms that allow greater soil P extraction. The experiments were conducted at BRRI farm, Gazipur during T. Aman 2023 and Boro 2023-24 seasons having deficit soil available P condition. In both the seasons, six P doses 0, 50%, 75%, 100% 125% and 150% of STB P were evaluated with BRRI hybrid dhan4 in T. Aman while BRRI hybrid dhan3 in Boro season. Each plot received a flat dose of N-K-S-Zn (kg ha<sup>-1</sup>) @ 90-42-10-1 in T. Aman and 60-20-10-2 in Boro season.

**Grain yield of T. Aman and Boro.** Soil P deficit conditions largely influence the grain yield of rice in

both seasons. Soil available P levels can decrease tremendously if P fertilizer is not applied for a long period. Rice yield increased sharply due to P fertilizer application. BRRI hybrid dhan6 in T. Aman and BRRI hybrid dhan3 in Boro season showed better results at 100% of STB P condition (Table 4). The response was much lower in T. Aman (wet season) than in Boro (dry season). The economic optimum dose of P for BRRI hybrid dhan6 in T. Aman was 25 kg Pha<sup>-1</sup> and for BRRI hybrid dhan3 in Boro was 27 kg P ha<sup>-1</sup>. Despite the variations in applied P doses, the application of the optimum dose of P fertilizer might be useful to obtain higher rice yield in both the seasons.

**Table 4. Response of phosphorus on grain yield of BRRI hybrid dhan6 in T. Aman 2023 and BRRI hybrid dhan3 in Boro 2023-24 BRRI farm, Gazipur.**

| Treatment                   | GY(t/ha)     |              |
|-----------------------------|--------------|--------------|
|                             | T. Aman 2023 | Boro 2023-24 |
| T <sub>1</sub> = P control  | 4.19c        | 1.81c        |
| T <sub>2</sub> = 50% STB P  | 5.66b        | 5.95b        |
| T <sub>3</sub> = 75% STB P  | 6.05ab       | 6.42b        |
| T <sub>4</sub> = 100% STB P | 6.45ab       | 7.15a        |
| T <sub>5</sub> = 125% STB P | 6.52a        | 7.23a        |
| T <sub>6</sub> = 150% STB P | 6.32ab       | 7.19a        |
| LSD (0.05)                  | 0.83         | 0.55         |
| CV (%)                      | 4.96         | 3.26         |

N.B. T<sub>1</sub> = 0, T<sub>2</sub> = 11, T<sub>3</sub> = 16.5, T<sub>4</sub> = 22, T<sub>5</sub> = 27.5, T<sub>6</sub> = 33 kg Pha<sup>-1</sup> respectively.

Effect of phosphatic fertilizers on growth and yield of wetland rice. A field experiment was conducted in P-deficient soil in both Boro 2023-24 and T. Aman 2023 seasons at BRRI HQ, Gazipur to observe the effect of P from different sources on rice growth and yield. Six treatment combinations of two P sources viz T<sub>1</sub>: P control, T<sub>2</sub>: TSP-P with basal N, T<sub>3</sub>: TSP-P without basal N, T<sub>4</sub>: DAP-P without basal N, T<sub>5</sub>: 50% TSP-P + 50% DAP-P + with 50% basal N, T<sub>6</sub>: 50% TSP-P + 50% DAP-P + without basal N were evaluated. The test rice varieties were BRRI hybrid

dhan3 in Boro and BRRI hybrid dhan6 in T. Aman season.

**Grain yield of Boro and T. Aman.** Phosphorous availability in soil may varied with sources of P, which is reflected on rice yield (Table 5). The TSP fertilizer alone or the combinations of TSP and DAP fertilizer performed better than DAP fertilizer alone in both the Boro and T. Aman seasons. Regardless of this, the basal application of N fertilizer has some yield advantage in all the cases.

**Table 5. Efficacy of TSP and DAP fertilizer on growth and yield of BRRI hybrid dhan3 and BRRI hybrid dhan6 in Boro and T. Aman at BRRI HQ farm, Gazipur.**

| Treatment                                           | GY (t ha <sup>-1</sup> ) |              |
|-----------------------------------------------------|--------------------------|--------------|
|                                                     | Boro 2023-24             | T. Aman 2023 |
| T <sub>1</sub> : P control                          | 2.78 c                   | 4.20c        |
| T <sub>2</sub> : TSP-P with basal N                 | 7.42 a                   | 6.37a        |
| T <sub>3</sub> : TSP-P without basal N              | 7.01 ab                  | 6.28ab       |
| T <sub>4</sub> : DAP-P without basal N              | 6.58 b                   | 5.73b        |
| T <sub>5</sub> : 50% TSP+ 50% DAP+ with 50% basal N | 6.74 b                   | 6.32a        |
| T <sub>6</sub> : 50% TSP+ 50% DAP+ without basal N  | 6.67 b                   | 6.30a        |
| LSD (0.05)                                          | 0.58                     | 0.56         |
| CV (%)                                              | 3.33                     | 3.37         |

N.B. 100% STB- P = 22 kg Pha<sup>-1</sup> irrespective of P sources in P deficient soil

## INTEGRATED NUTRIENT MANAGEMENT

**Integrated nutrient management for double and triple rice cropping.** The experiment was initiated in Boro 2008-09 at BRRI farm Gazipur in clay loam soil to find suitable fertilizer management for double and triple rice cropping systems and to find out the impact of triple rice cropping on soil health. In Boro-

Fallow-T. Aman pattern, BRRI dhan89 and BRRI dhan87 were used. In Boro-T. Aus-T. Aman pattern, BRRI dhan96, BRRI dhan98 and BRRI dhan87 were included as test varieties. Fertilizer treatments used were: control, STB dose (NPKS @ 160-25-60-20 kg ha<sup>-1</sup> for Boro, 70-12-48-10 kg ha<sup>-1</sup> for T. Aus and 84-

21-32-06 kg ha<sup>-1</sup> for T. Aman), STB (50%) + Mixed manure (MM) (CD @ 2 t ha<sup>-1</sup> + ash @ 1 t ha<sup>-1</sup> oven dried), farmers' practice (FP) (NPKS @ 80-10-20-10 kg ha<sup>-1</sup> for Boro, 70-10-15-0 kg ha<sup>-1</sup> for T. Aus and 70-10-15-0 kg ha<sup>-1</sup> for T. Aman). The experiment was laid out in RCB design with three replications. (Fig. 3) are presents the annual grain

yield of the double rice cropping pattern from 2008 to 2023. A similar increasing trend of grain yield of 100% STB fertilization and 50% STB with mixed manure was observed from the beginning to the date. But control and farmers' practices (FP) showed a decreasing trend with the increment of time.

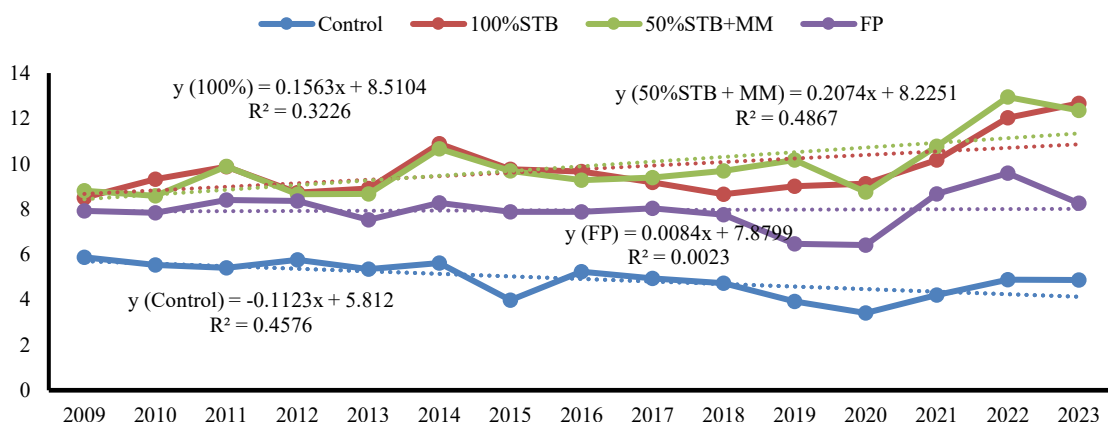


Fig. 3. Annual rice production trend under integrated nutrient management for double rice cropping for maximizing productivity during 2009-2023 in BRRI, Gazipur.

Almost similar pattern was observed in triple rice cropping pattern except FP as the figure 4 shows it. Cumulative yield of triple cropping was always

higher than the double rice cropping pattern irrespective of treatments.

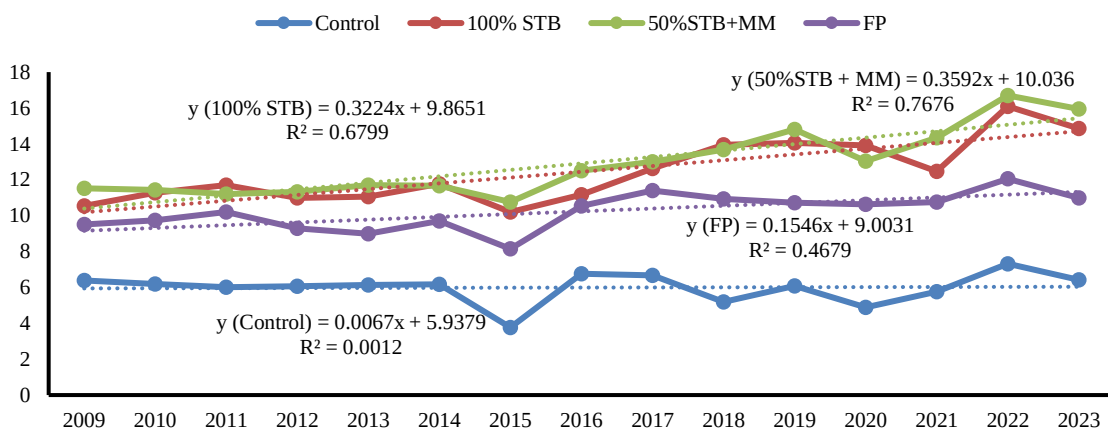


Fig. 4. Annual rice production trend under integrated nutrient management for triple rice cropping for maximizing productivity during 2009-2023 in BRRI, Gazipur.

**Best soil management practices to increase rice productivity.** A semi-long-term field experiment was conducted at BRRI HQ Gazipur in T. Aman and Boro 2023-24 seasons to achieve the best rice productivity while maintaining good soil health. Eight different treatment combinations with organic and inorganic nutrient sources were used viz T<sub>1</sub>: Fertilizer control, T<sub>2</sub>: 100% soil test based (STB) dose (fully inorganic), T<sub>3</sub>: 125% STB dose (fully inorganic), T<sub>4</sub>: 75% STB + cowdung (CD) @ 2 tha<sup>-1</sup>, T<sub>5</sub>: 75% STB + poultry manure (PM) @ 1 tha<sup>-1</sup>, T<sub>6</sub>: 50% STB + CD @ 3 tha<sup>-1</sup>, T<sub>7</sub>: 50% STB + PM @ 2 tha<sup>-1</sup> and T<sub>8</sub>: CD @ 3 tha<sup>-1</sup> + mustard oil cake @ 2 tha<sup>-1</sup> (fully organic) following RCB design with three replications in both seasons. The tested rice variety

for T. Aman was BRRI dhan90 and in Boro season it was BRRI dhan50.

**Grain yield of T. Aman and Boro.** The combinations of organic and inorganic treatments produced similar and satisfactory grain yield compared to chemical fertilizer alone (Table 6). The fully organic treatment i.e. T<sub>8</sub> also produced statistically similar grain yield compared to other INM treatments. But organic combinations using PM and CD with 25-50% reduced doses of chemical fertilizers can save chemical fertilizers cost and as well as minimize environmental pollution in both soil, water and air.

**Table 6. Effect of organic and inorganic fertilizer on rice yield of T. Aman rice (BRRI dhan90) and Boro rice (BRRI dhan50) at BRRI, Gazipur 2023-24.**

| Treatment                                                                                    | GY (t ha <sup>-1</sup> ) |              |
|----------------------------------------------------------------------------------------------|--------------------------|--------------|
|                                                                                              | T. Aman 2023             | Boro 2023-24 |
| T <sub>1</sub> : Fertilizer control                                                          | 3.88c                    | 2.20b        |
| T <sub>2</sub> : 100% STB dose (inorganic)                                                   | 5.37a                    | 5.81a        |
| T <sub>3</sub> : 125% STB dose (inorganic)                                                   | 4.71b                    | 5.43a        |
| T <sub>4</sub> : 75% STB + CD @ 2 tha <sup>-1</sup>                                          | 5.34a                    | 5.61a        |
| T <sub>5</sub> : 75% STB + PM @ 1 tha <sup>-1</sup>                                          | 5.35a                    | 5.74a        |
| T <sub>6</sub> : 50% STB + CD @ 3 tha <sup>-1</sup>                                          | 5.41a                    | 5.30a        |
| T <sub>7</sub> : 50% STB + PM @ 2 tha <sup>-1</sup>                                          | 5.36a                    | 5.76a        |
| T <sub>8</sub> : CD @ 3 tha <sup>-1</sup> + Mustard oil cake @ 2 tha <sup>-1</sup> (organic) | 5.14ab                   | 5.31a        |
| CV (%)                                                                                       | 3.94                     | 3.57         |
| LSD (0.05)                                                                                   | 0.58                     | 0.53         |

#### SOIL AND ENVIRONMENTAL PROBLEMS

**Effects of rice cultivars and fertilizer management on rice yield and greenhouse gas emissions.** The field experiments were conducted in BRRI farm, Satkhira and Gazipur. Four rice varieties were used including BRRI dhan50, BRRI dhan67, BRRI dhan92, and BRRI hybrid dhan3 in both the locations. Two fertilizer treatments were tested: (i) recommended N rate @ 150 kg/ha and (ii) (PU) at 128 kg N ha<sup>-1</sup>. The experiment was laid out in factorial RCB with three replications. Nutrients viz P K S and Zn were used as basal at the recommended rate to all plots and the rates were 15 kg P/ha, 70 kg

K/ha, 15 kg S/ha, and 1 kg Zn/ha respectively. PU was applied in three equal splits. The crop was harvested at full maturity of the crops. After harvest, the plot-wise crop was bundled separately and brought to the threshing floor; threshing was done manually. The rice grains were cleaned and weighed. Then, sundry grain weight was recorded for every plot and the weight in g plot<sup>-1</sup> was adjusted at 14% moisture and finally expressed in t ha<sup>-1</sup>. The sundry weight of straw was also recorded plot-wise and expressed as t ha<sup>-1</sup>.

CH<sub>4</sub> emissions were measured using a closed gas chamber technique and their emission rates were determined from the slope of the linear regression curves of CH<sub>4</sub> concentration against chamber closer time. Cumulative CH<sub>4</sub> and N<sub>2</sub>O emissions were estimated by summing up the daily emissions. Emission rates between two sampling days were estimated by linear interpolation of two consecutive measurements.

**Rice yield and total nitrogen uptake.** Rice cultivars and locations had a significant interaction with grain yield and total nitrogen uptake (TNU) in the Boro seasons. BRRI hybrid dhan3 significantly increased grain yield compared to other cultivars in both locations. At the BRRI HQ farm, Satkhira, BRRI dhan67 showed a similar grain yield with BRRI hybrid dhan3. The lower rice yield under BRRI dhan92 and BRRI dhan50 at Satkhira might be correlated to soil salinity. Higher TNU was found in BRRI hybrid dhan3 in both the locations. In contrast, BRRI dhan50 significantly reduced TNU compared to other varieties in both the locations due to lower grain and straw yield. Across the varieties,

higher N rates produced higher grain yield and TNU. Across the rice cultivars and N rates, higher rice yield and TNU was observed in BRRI farm, Gazipur compared to BRRI farm, Satkhira.

**Greenhouse gas emissions.** Across the N rates, BRRI dhan67 and BRRI hybrid dhan3 significantly ( $p < 0.05$ ) reduced cumulative CH<sub>4</sub> emissions compared to BRRI dhan50 and BRRI dhan92 in both the locations of BRRI farm Satkhira and Gazipur (Fig. 5). The higher CH<sub>4</sub> emissions under BRRI dhan50 and BRRI dhan92 are probably linked to the longer growth duration of rice varieties. However, the higher N rates (N150) significantly ( $p < 0.05$ ) increased cumulative CH<sub>4</sub> emissions compared to lower N rates (N128). The presence of high NH<sub>4</sub><sup>+</sup> concentration from urea hydrolysis can inhibit CH<sub>4</sub> oxidation and enhance CH<sub>4</sub> emissions (Singh et al., 1999). Lower CH<sub>4</sub> emissions were observed in BRRI RS farm Satkhira compared to BRRI HQ farm, Gazipur due to soil salinity. High salt concentrations in soil adversely affect microbial activities leading to the inhibition of methanogenesis (Fagodiya et al., 2022).

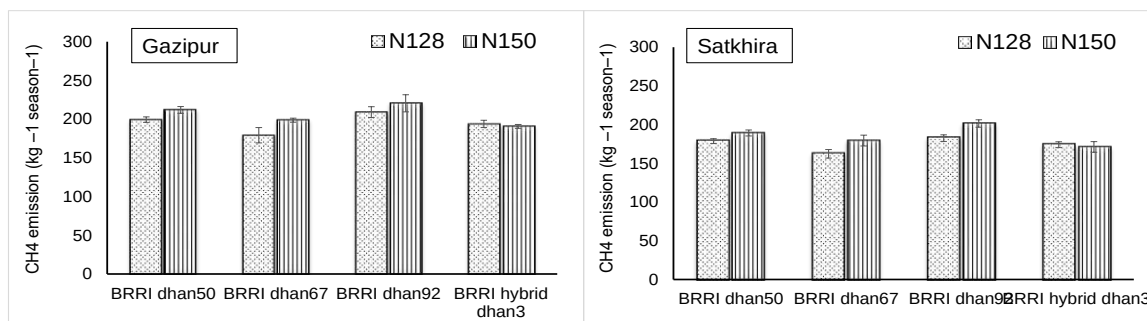


Fig. 5. Effects of rice cultivars and N rates on CH<sub>4</sub> emissions during Boro 2023-24 at BRRI farm, Satkhira, and Gazipur.

### Effect of water management on mitigating of greenhouse gas emission at Gazipur and Kushtia.

The study was undertaken to find out the suitable water management options based on GHG emissions and sustainable rice production. The study was conducted in BRRI HQ farm, Gazipur and farmer's field at Kushtia during Boro 2023-24. The experiment involved randomized complete block

design (RCBD) with four replications. In Boro season, the experiment was carried out with three irrigations management treatments as T<sub>1</sub> = Continuous standing water (CSW), T<sub>2</sub> = AWD (Supplemental irrigation when water level goes 15 cm below ground surface), T<sub>3</sub> = AWD (Supplemental irrigation when water level goes 25 cm below ground surface). The amount of applied irrigation

was measured with a flow meter and was documented. We have followed standard gas sampling techniques for recording N<sub>2</sub>O and CH<sub>4</sub> emission patterns. The grain yield and yield contributing parameters of each treatment were recorded for statistical analysis.

**Yield in Boro season.** Yield of Boro rice varied insignificantly in different water management options at Gazipur and Kushtia (Table 7). Statistically insignificant grain yield (ranged from

6.31 to 6.61 t ha<sup>-1</sup> and 6.95 to 7.15 t ha<sup>-1</sup>) were found among the treatments and location.

**GHG and GWP during Boro season.** The total CH<sub>4</sub> flux was not significant different because of two AWD condition at different location. However, the AWD, 15 cm and AWD, 25 cm treatment reduced about 27-33% and 34-39% of total CH<sub>4</sub> flux than CSW at Gazipur and Kushtia. The GWP reduced about 25-31% and 31-36% by AWD than CSW (Table 7).

**Table 7. Total GHG and GWP under varying irrigation management during Boro 2024**

| Treatment           | Location                            |      |      |                                   |                                     |      |      |                                   |
|---------------------|-------------------------------------|------|------|-----------------------------------|-------------------------------------|------|------|-----------------------------------|
|                     | Gazipur                             |      |      |                                   | Kushtia                             |      |      |                                   |
|                     | GHG emission (kg ha <sup>-1</sup> ) |      |      | Grain Yield (t ha <sup>-1</sup> ) | GHG emission (kg ha <sup>-1</sup> ) |      |      | Grain Yield (t ha <sup>-1</sup> ) |
|                     | CH <sub>4</sub>                     | GWP  | GHGI |                                   | CH <sub>4</sub>                     | GWP  | GHGI |                                   |
| CSW                 | 174                                 | 5075 | 0.77 | 6.61                              | 169                                 | 4919 | 0.69 | 7.15                              |
| AWD,15 cm           | 127                                 | 3805 | 0.60 | 6.39                              | 112                                 | 3383 | 0.48 | 7.10                              |
| AWD, 25 cm          | 113                                 | 3507 | 0.56 | 6.31                              | 104                                 | 3138 | 0.45 | 6.95                              |
| LSD <sub>0.05</sub> | 30                                  | 311  | 0.10 | 0.35                              | 22                                  | 248  | 0.11 | 0.21                              |

**Field evaluation of BRRI organic fertilizer.** BRRI organic fertilizer was developed with the objective to reduce synthetic N and P fertilizer use in rice cultivation and improve soil health. To evaluate its field performance, field experiments were conducted at BRRI, HQ in both the season of T. Aman 2023, and Boro 2023-24. The treatment combinations were NPKS (100%), N (70%) + P (0) + KS (100%), BoF (0.5t/ha) + N (70%) + KS (100%), BoF (0.75 t/ha) +N (70%) + KS (100%), BoF (1.0 t/ha) + N (70%) + KS (100%), BoF (2.0t/ha) and fertilizer control. Recommendation rates of chemical fertilizers for T. Aman and Boro were (kg ha<sup>-1</sup>) N-P-K-S @ 50-12-50-10 and 140-20-50-10, respectively. BRRI dhan34 at T. Aman and BRRI dhan50 was grown in the Boro season.

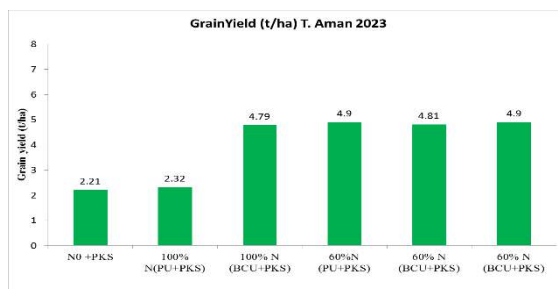
**Grain yield.** Study results proved BRRI organic fertilizer (BoF<sub>1</sub>@ 0.5 t ha<sup>-1</sup>) has the potential to supplement 30% N and 100% P requirement for HYV rice without sacrificing yield. In the T. Aman season, the highest grain yield (4.5 t/ha) was recorded in the treatment where BRRI organic

fertilizer was applied @ 0.5 t/ha along with 30% less urea and 0% TSP fertilizer. However, it was statistically significant with full dose of chemical fertilizer and 1.0 t/ha BRRI organic fertilizer applied treatment. The significantly lowest grain yield was recorded in the control plot. In the Boro season, different dosages of BRRI-organic and chemical fertilizer also affected grain and straw yield of BRRI dhan50. The highest grain yield (6.33 t/ha) was obtained in the BRRI organic applied treatment (0.5t/ha), and it was statistically similar with full dose application of chemical fertilizer (6.20 t/ha). The result proved that omission of TSP along with 30% reduction of urea fertilizer did not impact negatively on grain yield.

From the economic analysis it was found that the highest BCR (1.89) was obtained in BRRI dhan50 that cultivated without TSP, 30% less urea and 0.5 t/ha BRRI organic fertilizer. In case of net income about 922/-tk more benefit was obtained in this treatment over full dose of chemical fertilizer application. In the BRRI dhan34, the highest BCR

(1.72) obtained in the same treatment and Provided 3716 /-tk more benefit over full chemical fertilizer (N-P-K-S) application. In conclusion we found application of 0.5 t/ha BRRI organic fertilizer saved 100% TSP/DAP and 30% urea in rice cultivation with financial benefit.

**Bio-coated urea to improve N fertilizer use efficiency (NUE) and crop yield.** Bio-inoculant coated with commercial prilled urea (PU) might trigger more N fertilizer use efficiency (NUE) and reduce amount of urea in rice cultivation. Present study was conducted to evaluate the efficacy of formulated bio-coated urea (BCU) in rice production. A field study was conducted in BRRI HQ farm, Gaipur to evaluate the efficacy of formulated BCU over PU. Treatment combinations were as; T<sub>1</sub> (fertilizer control), T<sub>2</sub> (N<sub>0</sub>+ PKS), T<sub>3</sub> (N<sub>100%</sub> PU + PKS), T<sub>4</sub> (N<sub>100%</sub> BCU + PKS), T<sub>5</sub> (N<sub>60%</sub> BCU + PKS) and T<sub>6</sub> (N<sub>60%</sub> PU + PKS). Experiment was designed in RCB with three replications.



Standard fertilizer doses for NPKS (kg ha<sup>-1</sup>) were 60-10-30-6 in T. Aman and 170-18-80-10 in Boro season, respectively. Prilled urea and BCU were applied in three equal splits.

**Grain yield.** BRRI dhan87 was cultivated in the T. Aman season. Study result showed that there was no significant difference in grain yield obtained due to the reduction of 40% N from Bio-coated urea with 100% (recommended) applied prilled urea. Significant the lowest grain yield was recorded in the both N<sub>0</sub>+ PKS (2.31 t/ha) and full fertilizer control (2.21 t/ha) treatment (Fig. 6). In the Boro season BRRI dhan89 was grown. The highest grain yield (7.6 t/ha) was recorded in the 60% BCU+PKS applied treatment and it was statistically similar with 100% PU+PKS (7.17 t/ha) and 100% BCU+PKS (7.03 t/ha) treatment. The 40% reduction of prilled urea produced 6.78 t/ha grain yield. The lowest 2.68 t/ha grain yield obtained in the fertilizer control treatment (Fig. 6).

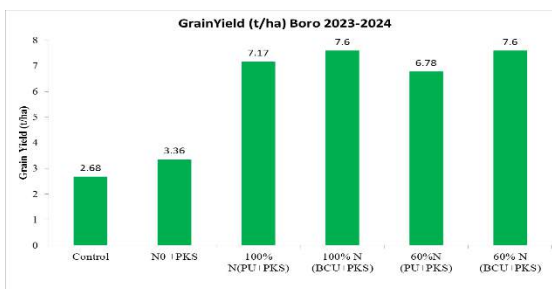


Fig. 6. Effect of Bio-coated urea and prilled urea on rice grain yield in T. Aman 2023 and Boro 2024 at BRRI HQ, Gazipur.

**Study of hill soil health.** Hills are characterized by a rugged, heterogeneous landscape with rapidly changing environmental conditions and providing myriad ecological niches over relatively small spatial spaces. The present study was conducted with the aim to evaluate the agricultural soil health (physical, chemical and biological properties of hill soil ecosystem) of Matiranga upazila. Soil of rice /non rice based cropping pattern was collected (0-15 cm depth) from about 500 locations of each union (Matiranga Sadar, Baranala, Belchhari, Amtoli, Gumti, Tubalchhari, Taindang) and was tested for biological properties following standard protocol.

**Soil biology.** Matiranga is situated under AEZ29. Among the tested (3 unions) soil, higher total bacteria population was found in the Mango orchard of Belchhari union (2 ×10<sup>9</sup> cfu/g soil). Higher average free living nitrogen fixing bacteria population was found in the mango and malta orchard. Average population of phosphate solubilizing bacteria was ranged from 2×10<sup>5</sup> to 9×10<sup>5</sup> cfu/g soil. Actinomycetes populations were very low. Fungal population varied from 2×10<sup>3</sup> to 9×10<sup>3</sup> cfu/g soil. Soil sample analysis of the other unions and study of biodiversity is in progress.



**Low-cost organic wastes recycling and biochemical methods for reduction of synthetic N use in rice cultivation.** Recycling of locally available organic matter at village level and biochemical approaches to supplement urea fertilizer may reduce synthetic N fertilizer demand and improve soil health and rice production in Bangladesh. The study was conducted with the aim to reduce 30% synthetic N use in the rice production by recycled biodegradable kitchen waste (BRRI-organic fertilizer), bio-enriched urea (Bio-coated urea), and cow-urine enriched cowdung compost. A number of four experiments were conducted in both T. Aman and Boro season at the farmer's field of Tengra village of Sripur upazila. Treatment combinations were cowdung compost with 70% N + 100% P, K, S (T<sub>1</sub>), BRRI organic fertilizer without P + 70% N + 100% K, S (T<sub>2</sub>), Bio-coated urea 70% N + 100% P K S (T<sub>3</sub>) and recommended fertilizer i.e. 100% doses of N, P, K, S (T<sub>4</sub>). The recommended fertilizer doses of N P K S nutrient in the T. Aman and Boro season were (kg ha<sup>-1</sup>) 80-20-50-10 and 140-20-50-10, respectively except T<sub>2</sub>, where, P dose was omitted.

**Grain yield.** Integrated nutrient management (INM) either with cow-urine enriched cowdung, BRRI organic fertilizer or application of Bio-coated urea

produced higher grain yield compared to full dose of synthetic fertilizer application (Fig. 7). Grain yield of four farmers' field were averaged and presented in the (Fig. 7). BRRI dhan51 was cultivated in the T. Aman season. Among the treatments, INM with BRRI organic fertilizer treated plot produced higher grain yield (6.35 ton/ha) followed by cowdung treatment. Comparable grain yield was obtained in the both Bio-coated urea (30% less N) and full dose of synthetic fertilizer treatment. In this season, INM of BRRI-organic fertilizer (2 ton/ha) and INM with cowdung (2 ton/ha) produced 19.14% and 11.36% grain yield increment over full dose of synthetic fertilizer respectively. In the Boro season BRRI dhan100 was grown. The average grain yield of the four farmer's field proved that INM with cowdung (2 ton/ha) application produced higher grain yield (8.0 ton/ha) followed by INM with BRRI organic (7.57 ton/ha) and Bio-coated urea (7.32 t/ha) treatment. The lowest grain yield (7.14 ton/ha) obtained in the full synthetic fertilizer treatment. Application of INM with cowdung produced 12.44% grain yield increment over synthetic fertilizer. Overall result showed INM with cowdung (2 ton/ha) or INM with BRRI-organic fertilizer (2 ton/ha) or Bio-coated urea saved 30% N and produced higher grain yield over full dose of synthetic fertilizer application.

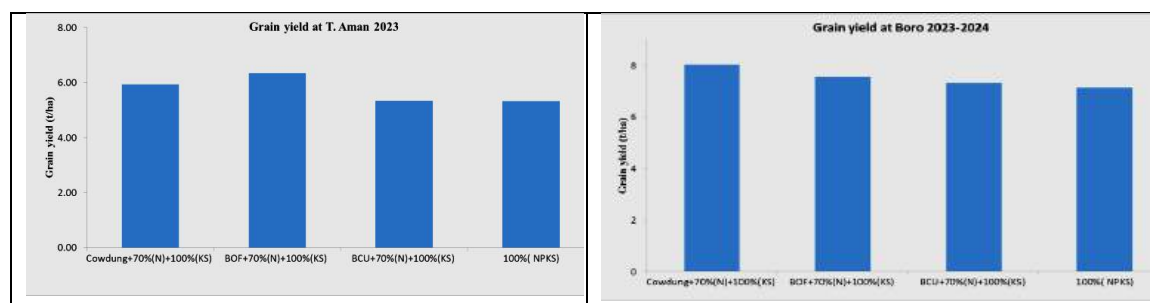


Fig. 7. Effect of cowdung (2 ton/ha), BRRI-organic (2 ton/ha), Bio-coated urea and full dose of synthetic fertilizer application on the grain yield in T. Aman 2023 and Boro 2024 season (average grain yield of four farmers field) at Tengra village of Sripur.

**Effect of water and nutrient management practices on methanotrophs population.** Methanotrophs population may reduce 10 to 20% methane emission from rice field. A study was conducted at BRRI, Gazipur to find the effect of nutrient and water management on methanotrophs

population. Soil samples were collected at crop flowering stage from different long-term experiments. Population of methanotrophs was determined using “Whitley A20 Anaerobic Work Station” in minimal salt (MS) medium. Study result proved that integrated nutrient management, bio-

coated urea and continuous standing water significantly increased methanotrophs population.

**Population of methanotrophs bacteria due to long-term amendments of organic and inorganic nutrients in lowland rice.** Among the tested samples methanotrophs bacteria population were

ranged from  $10^6$  to  $10^7$   $\log_{10}\text{CFU g soil}^{-1}$ . In the study, the highest population ( $7.6 \log_{10}\text{CFU g soil}^{-1}$ ) was recorded in the integrated plant nutrient system (IPNS) with cowdung application followed by the full chemical fertilizer (Fig. 8) treatment. The lowest population was found in the fertilizer control treatment.

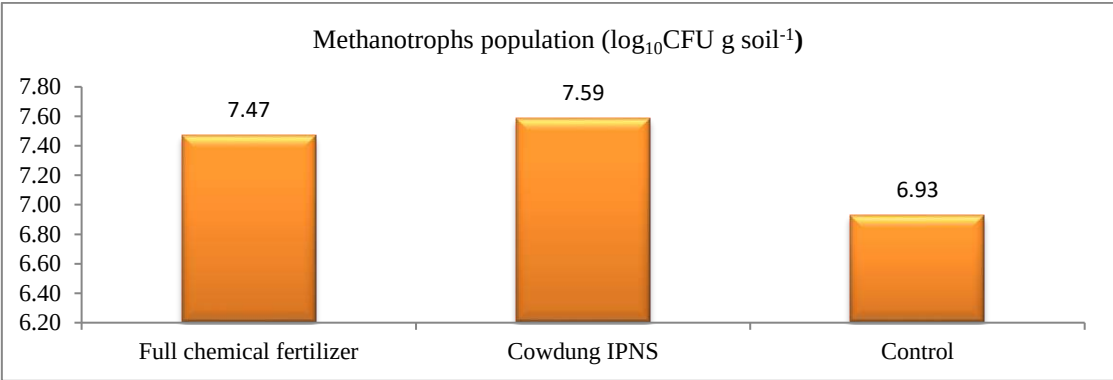


Fig. 8. Effect of long-term nutrient management practice on methanotrophs population in the Boro season.

**Population of methanotrophs bacteria in Bio-coated urea applied field.** A significant difference of methanotrophs population occurred due to bio-coated urea application (Fig. 9). The highest population was recorded in the  $T_2$  ( $7.0 \log_{10}\text{CFU g}$

$\text{soil}^{-1}$ ), where 100% N was applied from bio-coated urea followed by 60% N application from bio-coated urea ( $6.9 \log_{10}\text{CFU g soil}^{-1}$ ) ( $T_3$ ). The lowest population was found ( $6.4 \log_{10}\text{CFU g soil}^{-1}$ ) in the full chemical urea application treatment ( $T_1$ ).

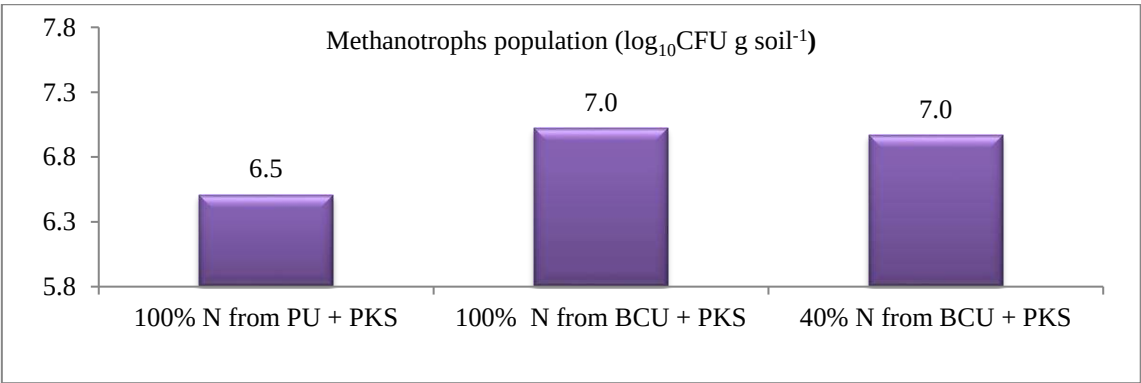


Fig. 9. Effect of bio-coated urea application on methanotrophs population in Boro rice season.

**Population of methanotrophs bacteria in different water management Parties.** Water management significantly influenced methanotrophic bacterial population (Fig. 10). The lowest bacteria ( $6.7 \log_{10}\text{CFU g soil}^{-1}$ ) was found in the AWD treatment ( $T_3$ ), where irrigation water was applied once when water level went down to 25 cm

below soil surface. The second lowest methanotrophic bacterial population was observed in  $T_2$  ( $6.9 \log_{10}\text{CFU g soil}^{-1}$ ), where irrigation water was applied once water level went down 15 cm below soil surface. The highest methanotrophs population was recorded in the continuous flooded treatment ( $7.2 \log_{10}\text{CFU g soil}^{-1}$ ).

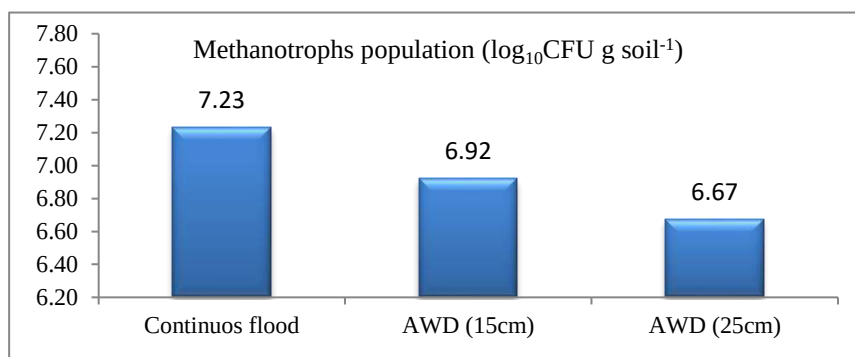


Fig. 10. Effect of water management on methanotrophs population in Boro season.



# **Irrigation and Water Management**

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## SUMMARY

Soil textural classes were predominantly clay and silty clay for IWM research field, BRRI HQ, Gazipur farm. The distribution of bulk density showed that there was no specific plough plan in the field identified. The saturated hydraulic conductivity varied between 3.78 – 6.50 cm/day along the soil profile of 0-70 cm. The average available water contents (AWC) were found in between 21-25% and, the average drainable porosity (DP) range was from 8 to 10% in the same depth of soil profile. During Boro 2023-24 season, four ultrasonic sensor based Automated AWD unit prototype was set up in the field. The average yields were 6.60 t/ha for maintaining continuous standing water, 6.80 t/ha for irrigation application manually using AWD method, and 6.70 t/ha for irrigation application by automated AWD system. The yield performance of treatment of manual and automated AWD systems were nearly same, indicating that automated AWD irrigation system did not hamper the yield. Good yield could be achieved from BR13113-4R-63, BR13106-4R-184, BR13113-4R-116, BR13122-4R-36, BR13111-4R-63 and BRRI dhan104 under AWD irrigation practice as well as from BR13113-4R-63, BR13106-4R-184, BR13113-4R-116, BR13122-4R-36 and BR13111-4R-63 under thin irrigation practice. The subirrigation system found 35.4% more efficient compared to conventional flooding irrigation system in rice field. BRRI dhan89, the tested variety produced about 20% higher yield (7.864 t/ha) in subirrigation managed field compared to conventional irrigation managed field (6.562 t/ha). The number of tillers and panicles per square meter were higher in subirrigation system than that of the conventional system. Transplanting on 15 and 31 January may need extra water but produced the highest yield. Whereas, transplanting on 14 February and 31 January required less irrigation water due to reduced growth duration and increased rainfall but had a lower yield. Increasing irrigation water salinity adversely affected Boro rice growth and yield. Salt

tolerant rice varieties with irrigation water salinity below 4 dS/m can produced good yield. Therefore, to increase Boro rice cultivation in the coastal area, the maximum volume of less saline irrigation water should be stored in the internal canal after the rainy season. Irrigation water salinity at 2-4 dS/m had less adverse effect on soil salinity and rice yield than water salinity at 6-8 dS/m. Using rice straw with gypsum amendment (25% higher than recommended) produced the highest yield and reduced the soil salinity.

## WATER USE EFFICIENCY IMPROVEMENT IN IRRIGATED AGRICULTURE

### **Determination of physical and hydraulic properties in different soil types**

Soil textural classes, parameters of soil water release curves for respective soil depths, available water content in the soil profile, drainable porosity as well as saturated hydraulic conductivity (near saturated constant infiltration rates) information have been determined through different testing and analysis methods in this study for IWM division research field at BRRI HQ, Gazipur farm during 2023-24. Soil samples were collected from different soil profiles at 0-15, 15-30, 30-45, 45-60, and 60-70 cm using standard protocols. Fifteen samples were collected from IWM research field, BRRI Gazipur farm. Soil textural classes were predominantly clay and silty clay for IWM research field, BRRI Gazipur farm. The average soil bulk density of IWM field, BRRI Gazipur farm was 1.29 gm/cc, 1.30 gm/cc, 1.30 gm/cc, 1.32 gm/cc, and 1.30 gm/cc at 0-15, 15-30, 30-45, 45-60 and 60-70 cm depths respectively (Table 1). The distribution of bulk density showed that there was no specific plough plan in the field identified. The saturated hydraulic conductivity varied between 3.78 – 6.5 cm/day along the soil profile of 0-70 cm. At BRRI Gazipur farm, the average saturated water contents varied between 47-51%, average water contents at field capacity varied between 37-43%, and average water contents at wilting point were 22-29% within the soil profile of

0-70 cm depth (Table 2). The average available water contents (AWC) were found in between 21-25% and, the average drainable porosity (DP) range was from 8 to 10% in the same depth of soil profile. Those data and relevant information are documented in a database which can serve as observed/field data source in future.

### **Development of Automated Alternate Wetting and Drying Irrigation System for Rice Production**

The ongoing study, in collaboration with the Department of Computer Science and Engineering at Gazipur University of Engineering and Technology (DUET), Bangladesh, focuses on enhancing the efficiency of water management in agriculture through the adoption of a sensor-based technique in the Alternate Wetting and Drying (AWD) irrigation system. The Boro season 2023-24 witnessed the development and performance evaluation of an ultrasonic sensor-based automated AWD irrigation system, powered by rechargeable batteries charged through solar panels. This innovative system, connected to an online server, allowed real-time monitoring of water table data, coupled with easy access to historical records through a desktop application. The AWD unit seamlessly transmitted water level data via a cellular SIM connection. Installation of the IoT based automated AWD irrigation system in the BRRI HQ, Gazipur farm, we successfully demonstrated its functionality by automatically measuring water levels in the pipe at four intervals throughout the day. The data collected were transmitted to the central server for analysis. Furthermore, to validate the accuracy of our automated system, we installed another AWD pipe nearby, where manual water level measurements were conducted daily at 9:30 am. During Boro 2023-24 season, an experiment was set up with four ultrasonic sensor based Automated AWD unit prototype in the field (Fig. 1). The treatments were: T1 = Maintaining continuous standing water, T2 = Irrigation application manually using AWD method;

and T3 = Irrigation application by automated AWD system with four replications. The experimental design was RCBD. BRRI dhan58 was used as the test variety for this experiment. Table 3 presented yield and other agronomic parameter of the IoT based automated AWD irrigation system. The average yields were 6.60 t/ha for T1 (maintaining continuous standing water), 6.80 t/ha for T2 (irrigation application manually using AWD method), and 6.70 t/ha for T3 (irrigation application by automated AWD system). The yield performance of treatment T2 and T3 were nearly same, indicating that automated AWD irrigation system did not hamper the yield. There was no such difference between manual AWD irrigation system and automated AWD system in terms of tiller number. Due to higher tiller numbers, both T2 and T3 treatments performed higher yield than that of T1.

### **Optimization of Water Use Efficiency Through Subirrigation System in Different Soils of Bangladesh**

A subirrigation system was designed and installed in BRRI research field to evaluate the performance of system in transplanted rice field during 2022-23 irrigated seasons. The length of the installed system area was 10 m, and the width was 6 m. The total area of the installed subirrigation system was 60 square meter. For design purposes, the soil physical and hydraulic properties of the selected field were measured. Then, the lateral (drain) spacing and lateral and main (drain) size were determined using available equation and models (Hooghoudt equation, DRAIN CALCULATOR, etc.). The design spacing was found 1.2 m and design depth was found 30 cm from ground surface. For both lateral and main pipe size, 4 in diameter PVC pipe was selected for the subirrigation system. For subsurface irrigation, an overhead tank (1000 L) was installed to supply adequate irrigation water to crop root zone of the field. A flowmeter (4 in diameter) was set up at the inlet of the system to measure the amount of water supplied to the field. The system was observed

carefully so that the system could run successfully. No major constraint was marked during the whole season except some technical faults of the system. The troubleshooting was done immediately when found at the field. The subirrigation system found 35.4% more efficient compared to the conventional flooding irrigation system in rice field (Table 4). A high yielding BRRI developed rice variety, BRRI dhan89 was grown in the research field. As shown in Table 4, BRRI dhan89 produced about 20% higher yield (7.864 t/ha) in subirrigation managed field compared to the conventional irrigation managed field (6.562 t/ha). The number of tillers and panicles per square meter were higher in subirrigation system than that of conventional system.

#### **Irrigation water requirement and rainfall utilization for delayed transplanting of Boro rice in different locations of Bangladesh**

A field experiment was conducted at BRRI farm Gazipur in 2023-24 Boro season aimed at variation in irrigation water requirement in relation to delayed transplanting. The treatments were four transplanting dates (T1 = 15 January, T2 = 31 January, T3 = 14 February, T4 = 1 March) with four replications. Results showed that transplanting on 14 February and 1 March required less water (21-23%) than transplanting in January because of adding rainfall water in the late transplanting (Table 5). However, transplanting on 14 February and 1 March drastically reduced grain yield (22-48% lower yield) relative to transplanting in January. Water productivity was also higher with the early transplanting (6 kg/ha-mm) compared to delayed transplanting (3.5-5.5 kg/ha-mm) (Table 6). Transplanting on 15 and 31 January may need more water but produced the highest yield. Whereas, transplanting on 14 February and 31 January required less irrigation water due to reduced growth duration and increased rainfall but had a lower yield.

#### **Performance evaluation of the proposed rice varieties under different water regimes**

The experiment was conducted during Boro season 2023-24 at BRRI farm, Gazipur. Five long duration high yielding advanced lines of rice as- BR13113-4R-63, BR13106-4R-184, BR13113-4R-112, BR13122-4R-36 and BR13111-4R-63 were tested under four water management treatments along with BRRI dhan104 (check variety). The cultivars were grown in plots under different water regimes. The treatments were: T1 = Maintaining continuous standing water from +1 to +5 cm; T2 = AWD irrigation practice (+5 to -15 cm); T3 = Thin irrigation condition (AWD: +2 to -15 cm) up to booting stage; and T4 = Thin irrigation condition (AWD: +2 to -20 cm) up to the booting stage. The experimental results show that good yield could be achieved from BR13113-4R-63, BR13106-4R-184, BR13113-4R-116, BR13122-4R-36, BR13111-4R-63 and BRRI dhan104 under both CSW and AWD irrigation practice (Table 7). The experimental results also show that good yield could be achieved from BR13113-4R-63, BR13106-4R-184, BR13113-4R-116, BR13122-4R-36 and BR13111-4R-63 under thin irrigation practice (Table 7).

#### **LAND PRODUCTIVITY IMPROVEMENT IN THE COASTAL ENVIRONMENT**

##### **Saline water irrigation strategies for Boro rice cultivation in the coastal saline area**

Boro rice cultivation in the coastal saline area is challenging due to the scarcity of fresh water. Using less saline irrigation water can be a strategy to increase rice production. A field experiment was conducted at the farmer's field at Dacope upazila in Khulna district in 2022-23 to find out suitable irrigation management options for Boro rice cultivation and the effect of saline water irrigation in response to the growth and yield of rice. The treatments were four saline water irrigation treatments (water salinity < 1 dS m<sup>-1</sup>, 4 dS m<sup>-1</sup>, 6 dS m<sup>-1</sup>, 8 dS m<sup>-1</sup> and 10 dS m<sup>-1</sup>) and two salt tolerant varieties (BRRI dhan67 and BRRI dhan97). The field was arranged with strip plot design and three replications. Both water and soil salinity were



influenced by seasonal rainfall. During harvesting, soil salinity was almost double with irrigation water salinity at 8 and 10 dS/m compared to irrigation water salinity at 1 and 4 dS/m (Fig. 2). Soil salinity was at the permissible level when irrigation water was applied at 1 and 4 dS/m. There was a significant difference in rice yield with saline water irrigation treatments but no difference in the varieties. Irrigation with 1 dS/m and 4 dS/m had of yield 5.3 and 5.1 t/ha. Whereas rice yield was significantly reduced with increasing salinity levels of irrigation water. The grain yield reductions were 19, 45, and 62% for irrigation treatments 6 dS m<sup>-1</sup>, 8 dS m<sup>-1</sup> and 10 dS m<sup>-1</sup> compared to irrigation with 1 dS/m. BRRI dhan97 had a lower yield reduction than BRRI dhan67, indicating that BRRI dhan97 was more salt tolerant than BRRI dhan67. Increasing salinity level of irrigation water also increased unfilled grain and reduced plant height. In conclusion, increasing irrigation water salinity adversely affected boro rice growth and yield. Salt tolerant rice varieties with irrigation water salinity below 4 dS/m can give potential yield. Therefore, to increase boro rice cultivation in the coastal area, the maximum volume of less saline irrigation water should be stored in the internal canal after the rainy season.

#### **Impact of saline water irrigation with rice straw and gypsum amendment on soil physicochemical properties and rice yield in the coastal saline area**

Salinity is one of the major abiotic stresses, which inhibit plant growth and yield in many parts of the world. To ameliorate the harmful effect of salinity and improve soil properties, rice residue incorporation and gypsum application were tested on the change of soil physicochemical properties and yield. The field experiment was conducted at the farmer's field at Batiaghata upazila in Khulna district in 2023-24. The treatments were four levels of saline water irrigation and six gypsum and straw amendments. The saline water irrigation was 1-2 (I1), 4 (I2), 6 (I3) and 8 (I4) dS/m, and amendments were- (i) no-amendments (T1), (ii) rice residue

incorporate during soil puddling (T2), (iii) 25% higher gypsum than recommended (T3), (iv) rice residue and 25% higher gypsum than recommended (T4), (v) 50% higher gypsum than recommendation (T5), (vi) rice residue and 50% higher gypsum (T6). BRRI dhan67 was used as a tested variety. The result showed that the treatments had impact on soil properties and rice growth and yield. The highest plot water salinity was in irrigation with 8 dS/m (I4) which varied from 12-14 dS/m in the middle of March. The no-amendments (T1) showed the highest plot water salinity whereas rice straw incorporate with 25% higher gypsum (T4) maintain the lowest plot water salinity. The soil EC1:5 was the highest at flowering stage, which varied from 0.9-1.4 dS/m. Among the amendments, the treatments T1 (no-amendment) had the higher soil salinity and the treatment T4 (rice straw incorporate with 25% higher gypsum) had the lower salinity throughout the season. As shown in Table 8, The highest yield was 6.4 t/ha in irrigation treatment I1 (water salinity below 2 dS/m) and the lowest yield was 3.3 t/ha in treatments I4 (water salinity at 8 dS/m). Within the amendments, the treatment T4 (rice straw incorporated with 25% higher gypsum) produced the highest yield (5.6 t/ha) and no-amendment treatment (T1) showed the lowest yield (5.0 t/ha).

#### **SUSTAINABLE MANAGEMENT OF WATER RESOURCES**

##### **Assessment of surface and groundwater quality for irrigation in selected locations of Bangladesh**

The experiment was conducted in six regional stations namely Gazipur, Gopalganj, Rajshahi, Rangpur, Barishal, and Habiganj of Bangladesh Rice Research Institute in 2023-24. The water samples were collected from different sources of groundwater and surface water. Collected samples were preserved refrigerator in the laboratory for chemical analysis. The physiochemical characteristics of samples were determined and compared with standard values recommended by FAO. The quality of water for location was assessed

for its irrigational purposes. In the present study SSP value was found in Barishal 51.55 because of high concentration of Na and Ca. Barishal and Gopalganj water samples had higher KR more than 1.0 but very negligible. So, Kelly's ratio showed full satisfaction in using for irrigation. Soluble sodium percentage values found in satisfactory level. Magnesium absorption ratio found satisfactory (desired range <50) for irrigation. That's why surface and ground water for all locations can be easily used in irrigation purposes.

#### TECHNOLOGY VALIDATION IN THE FARMERS' FIELD

##### **Mitigating risk and scaling-out profitable cropping system intensification practices in the salt-affected coastal zones of the Ganges Delta**

**Mass demonstration of Aus rice for crop intensification and land productivity improvement in coastal areas.** Introducing of high yielding Aus rice (BRRI dhan48) after Rabi crops like watermelon, sunflower and mungbean improved land productivity and farmer's income. Growing Aus rice is more profitable than T. Aman and Boro rice. The Barishal region is more suitable to cultivate Aus rice than in Khulna region due to freshwater availability during establishment time. The yield of BRRI dhan48 was higher in Amtali than Batiaghata upazila. The yield varied from 3.5 to 6 t/ha in Amtali and 3.2 to 5.5 t/ha in Batiaghata.

**Mass demonstrations of high yielding T. Aman rice varieties for increasing productivity and facilitating Rabi/Boro crops intensification.** The adoption of high yielding and stress tolerant T. Aman rice is increasing in the coastal area because cultivation of HYV facilitates the early establishment of Rabi/Boro rice which helps to utilize maximum soil residual moisture and escape salinity risk. In submergence or flash flood condition, BRRI dhan51, BRRI dhan52 and BRRI dhan79 is suitable. BRRI dhan76 is suitable where standing water depth around 60 cm but BRRI

dhan87 and BRRI dhan103 are suitable where no standing water by tidal flood or water depth less than 15 cm. In the Barishal region, farmer's prefer BRRI dhan51, BRRI dhan52 and BRRI dhan76 but in the Khulna region, farmer's prefer BRRI dhan87. The overall yield of BRRI dhan87 is much higher than the other varieties. Delaying of the transplanting date of T. Aman rice reduces growth duration and yield. Based on the above advantages farmers were highly interested to cultivate those varieties based on the land suitability. T. Aman rice yield was significantly reduced with delaying of the transplanting dates in both the locations in Barishal and Khulna. The maximum yield obtained (5.5-6 t/ha) when the transplanting completed by the end of July or first week of August. The average yield was around 5 t/ha if the transplanting completed by 15 August. The yield was drastically reduced when transplanting was after 31 August.

**Block demonstration of Boro rice using stored less-saline water in coastal areas for cropping intensification.** The proper agronomic management such as selection of rice varieties (salt tolerant or high yielding), timely establishment, less saline water irrigation and optimum fertilizer increased Boro rice in the coastal areas. Delayed transplanting was related with lower yield and growth duration. In current practice, the probability of achieving the higher yield of about 6.0-8.5 t/ha for BRRI dhan67, BRRI dhan74, BRRI dhan89, and BRRI dhan99 was about 50% in Amtali, Taltoli and Kalapara upazila. Whereas the probability of achieving higher yield of about 6-7 t/ha was only 20% in Dacope and Batiaghata upazila for BRRI dhan67 and BRRI dhan99 respectively. In Dacope and Batiaghata upazila, BRRI dhan99 had higher grain yield than BRRI dhan67. However, the area coverage was higher with BRRI dhan67 than BRRI dhan99. The range of BRRI dhan67 was 5.5 to 6.7 t/ha. In Barishal region, yield was higher with BRRI dhan74 and BRRI dhan89 than BRRI dhan67. In Kalapara and Taltoli upazila, BRRI dhan67 and BRRI dhan74 were more popular than other varieties due to its

shorter growth duration and local adaptability. In Amtali upazila, both BRRI dhan74 and BRRI dhan89 were popular because of its higher yield.

### **Intervention in surface water utilization through integrated minor irrigation schemes for escalating water and land productivity in coastal region**

In Patuakhali Sadar upazila of Patuakhali district, around 27 hectares (200 Bighas) of fallow land were brought under Boro cultivation with modern high-yielding BRRI rice varieties, including BRRI dhan67, BRRI dhan74, and BRRI dhan89. Similarly, in Taltoli upazila of Barguna district, approximately 41 hectares (300 Bighas) of fallow land were brought under Boro cultivation with the same BRRI rice varieties. Yields in Patuakhali Sadar for BRRI dhan67, BRRI dhan74, and BRRI dhan89 were 6.3, 7.3, and 8.2 tons per hectare (t/ha), respectively. In

Taltoli Upazila, yields were 6.6, 7.2, and 8.4 t/ha, respectively. Irrigation water savings using surface-laid PVC distribution pipes reduced time, water, and fuel consumption by about 33%. Farmers were directly involved in seed production and marketing throughout the project, fostering entrepreneurship in seed marketing, with one farmer registering as a seed dealer. In both the locations, rice grain yield decreased when transplanting was delayed beyond the recommended date of 15 January. In Patuakhali Sadar, the highest yield of BRRI dhan67 was 6.93 t/ha with timely transplanting, but this dropped to 6.40 t/ha and 5.65 t/ha with 10 and 20-day delays respectively. A 30-day delay resulted in a 1.93 t/ha yield reduction for BRRI dhan67. Similar reductions occurred for BRRI dhan74 and BRRI dhan89, with 30-day delays decreasing yields by 1.40 t/ha and 1.90 t/ha respectively, emphasizing the importance of timely transplanting for optimal yields.

**Table 1. The soil texture and bulk density of IWM Research field, BRRI Farm, Gazipur 2023-24.**

| Longitude  | Latitude   | Depth (cm) | Bulk density (gm/cc) | Sand% | Silt% | Clay% | Textural Class  |
|------------|------------|------------|----------------------|-------|-------|-------|-----------------|
| 23°59'22"N | 90°24'16"E | 0-15       | 1.30                 | 14.00 | 38.00 | 48.00 | Clay            |
|            |            | 15-30      | 1.28                 | 11.64 | 43.64 | 44.72 | Silty Clay      |
|            |            | 30-45      | 1.24                 | 13.28 | 40.72 | 46.00 | Silty Clay      |
|            |            | 45-60      | 1.24                 | 9.28  | 40.72 | 50.00 | Silty Clay      |
|            |            | 60-70      | 1.33                 | 11.28 | 36.72 | 52.00 | Clay            |
| 23°59'23"N | 90°24'15"E | 0-15       | 1.30                 | 17.28 | 52.00 | 30.72 | Silty Clay Loam |
|            |            | 15-30      | 1.35                 | 11.44 | 39.28 | 49.28 | Clay            |
|            |            | 30-45      | 1.37                 | 15.44 | 37.28 | 47.28 | Clay            |
|            |            | 45-60      | 1.37                 | 10.72 | 39.28 | 50.00 | Clay            |
|            |            | 60-70      | 1.26                 | 13.08 | 37.64 | 49.28 | Clay            |
| 23°59'23"N | 90°24'15"E | 0-15       | 1.25                 | 14.72 | 51.28 | 34.00 | Silty Clay Loam |
|            |            | 15-30      | 1.27                 | 11.08 | 42.92 | 46.00 | Silty Clay      |
|            |            | 30-45      | 1.30                 | 11.08 | 38.92 | 50.00 | Clay            |
|            |            | 45-60      | 1.36                 | 13.08 | 38.92 | 48.00 | Clay            |
|            |            | 60-70      | 1.30                 | 14.72 | 37.64 | 47.64 | Clay            |

**Table 2. The SWC and hydraulic properties estimated by SPAW tool.**

| Location | Depth (cm) | Textural Class     | Saturation % | Field capacity % | Permanent wilting point % | Saturated hydraulic conductivity cm/day |
|----------|------------|--------------------|--------------|------------------|---------------------------|-----------------------------------------|
| 1        | 0-15       | Clay               | 50.6         | 41.9             | 28.4                      | 3.864                                   |
|          | 15-30      | Silty Clay         | 50.1         | 40.9             | 26.7                      | 4.752                                   |
|          | 30-45      | Silty Clay         | 50.2         | 41.2             | 27.3                      | 4.392                                   |
|          | 45-60      | Silty Clay         | 52.0         | 42.8             | 29.4                      | 4.512                                   |
|          | 60-70      | Clay               | 52.1         | 43.5             | 30.5                      | 3.792                                   |
| 2        | 0-15       | Silty Clay<br>Loam | 46.0         | 35.2             | 19.0                      | 8.400                                   |
|          | 15-30      | Clay               | 51.2         | 42.4             | 28.9                      | 4.056                                   |
|          | 30-45      | Clay               | 50.1         | 41.5             | 27.8                      | 3.888                                   |
|          | 45-60      | Clay               | 51.6         | 42.7             | 29.4                      | 4.080                                   |
|          | 60-70      | Clay               | 51.0         | 42.3             | 28.9                      | 3.864                                   |
| 3        | 0-15       | Silty Clay<br>Loam | 47.0         | 36.6             | 20.7                      | 7.224                                   |
|          | 15-30      | Silty Clay         | 50.6         | 41.3             | 27.2                      | 4.728                                   |
|          | 30-45      | Clay               | 51.6         | 42.7             | 29.4                      | 4.080                                   |
|          | 45-60      | Clay               | 50.7         | 41.9             | 28.4                      | 4.032                                   |
|          | 60-70      | Clay               | 50.4         | 41.9             | 28.4                      | 3.696                                   |

**Table 3. Yield and other agronomic parameters of Automated AWD experiment, Boro 2023-24. season.**

| Treatment | Plant Hight (cm) | Tiller/m <sup>2</sup> | Panicle/m <sup>2</sup> | Yield (t/ha) |
|-----------|------------------|-----------------------|------------------------|--------------|
| T1R1      | 97.1             | 260                   | 245                    | 6.52         |
| T1R2      | 98.6             | 260                   | 255                    | 6.30         |
| T1R3      | 91.8             | 274                   | 270                    | 6.86         |
| T1R4      | 97.4             | 265                   | 261                    | 6.72         |
| T2R1      | 102.2            | 280                   | 280                    | 6.26         |
| T2R2      | 92.1             | 263                   | 257                    | 6.85         |
| T2R3      | 94.3             | 274                   | 271                    | 6.34         |
| T2R4      | 97.6             | 281                   | 273                    | 7.75         |
| T3R1      | 101.8            | 277                   | 272                    | 6.52         |
| T3R2      | 94.8             | 259                   | 251                    | 6.51         |
| T3R3      | 92.1             | 262                   | 260                    | 6.75         |
| T3R4      | 96.4             | 242                   | 238                    | 6.93         |

**Table 4. Subirrigation system performance evaluation in Boro 2022-23 at BRRI farm Gazipur.**

| Treatment     | Plant height (cm) | Tiller/m <sup>2</sup> | Panicle/m <sup>2</sup> | Yield (t/ha) | Irrigation water (mm) | Water Use efficiency increased |
|---------------|-------------------|-----------------------|------------------------|--------------|-----------------------|--------------------------------|
| Subirrigation | 98.6              | 264                   | 256                    | 7.864        | 1285                  | 35.4%                          |
| Conventional  | 95.8              | 260                   | 245                    | 6.562        | 1740                  |                                |

**Table 5. Water requirement and water applied for Boro rice in Gazipur in 2023-24.**

| Treatment      | Water requirement (mm)   |                               |                           | Water applied (mm)   |                                   |                    |          |                                 |
|----------------|--------------------------|-------------------------------|---------------------------|----------------------|-----------------------------------|--------------------|----------|---------------------------------|
|                | Evapo-transpiration (ET) | Seepage and Percolation (S&P) | Total water required (mm) | Number of irrigation | Water applied in land preparation | Applied irrigation | Rainfall | Total amount of water used (mm) |
| T <sub>1</sub> | 425                      | 395                           | 820                       | 12                   | 180                               | 800                | 160      | 1140                            |
| T <sub>2</sub> | 418                      | 390                           | 808                       | 11                   | 180                               | 770                | 185      | 1135                            |
| T <sub>3</sub> | 385                      | 348                           | 733                       | 9                    | 180                               | 630                | 185      | 995                             |
| T <sub>4</sub> | 350                      | 315                           | 665                       | 8                    | 180                               | 610                | 257      | 1047                            |

**Table 6. Yield and water productivity of different transplanting dates of Boro rice in Gazipur in 2023-24.**

| Treatments     | Growth duration (days) | Total water use including rainfall (mm) | Yield (t/ha) | Water productivity (kg/ha-mm) |
|----------------|------------------------|-----------------------------------------|--------------|-------------------------------|
| T1             | 141                    | 1140                                    | 6.9          | 6.0                           |
| T2             | 135                    | 1135                                    | 6.6          | 5.8                           |
| T3             | 125                    | 995                                     | 5.4          | 5.4                           |
| T4             | 122                    | 1047                                    | 3.6          | 3.5                           |
| <i>P</i> value |                        |                                         | 0.001        |                               |
| LSD            |                        |                                         | 0.82         |                               |

**Table 7: Irrigation, rainfall and grain yield of the selected genotypes under different water management treatments during Boro season 2023-24 at BRRI farm, Gazipur.**

| Treat | Variety        | Growth duration (days) | No of irrigation | Average Yield (kg/ha) | Change in yield (%) | Irrigation depth (mm) | Rainfall (mm) | Total water applied (mm) | Irrigation water saving (%) |
|-------|----------------|------------------------|------------------|-----------------------|---------------------|-----------------------|---------------|--------------------------|-----------------------------|
| T1    | BR13113-4R-63  | 143                    | 20               | 7435.0                |                     | 1070                  | 10.4          | 1080.4                   |                             |
| T2    |                | 148                    | 16               | 7343.8                | -1.23               | 850                   | 10.4          | 860.4                    | 20.56                       |
| T3    |                | 146                    | 24               | 7014.0                | -5.66               | 780                   | 10.4          | 790.4                    | 27.10                       |
| T4    |                | 150                    | 22               | 6557.3                | -11.80              | 725                   | 10.4          | 735.4                    | 32.24                       |
| T1    | BR13106-4R-184 | 145                    | 20               | 7623.8                |                     | 1070                  | 15.6          | 1085.6                   |                             |
| T2    |                | 146                    | 16               | 7655.5                | 0.42                | 850                   | 15.6          | 865.6                    | 20.56                       |
| T3    |                | 143                    | 24               | 7206.8                | -5.47               | 780                   | 15.6          | 795.6                    | 27.10                       |
| T4    |                | 148                    | 22               | 7051.9                | -7.50               | 725                   | 15.6          | 740.6                    | 32.24                       |
| T1    | BR13113-4R-116 | 146                    | 20               | 7629.1                |                     | 1070                  | 10.4          | 1080.4                   |                             |
| T2    |                | 150                    | 16               | 7909.4                | 3.67                | 850                   | 10.4          | 860.4                    | 20.56                       |
| T3    |                | 145                    | 24               | 7297.2                | -4.35               | 780                   | 10.4          | 790.4                    | 27.10                       |
| T4    |                | 146                    | 22               | 7059.2                | -7.47               | 725                   | 10.4          | 735.4                    | 32.24                       |
| T1    | BR13122-4R-36  | 143                    | 20               | 8262.9                |                     | 1070                  | 16.6          | 1086.6                   |                             |
| T2    |                | 148                    | 16               | 8317.4                | 0.66                | 850                   | 16.6          | 866.6                    | 20.56                       |
| T3    |                | 146                    | 24               | 7596.5                | -8.07               | 780                   | 16.6          | 796.6                    | 27.10                       |
| T4    |                | 150                    | 22               | 7290.0                | -11.77              | 725                   | 16.6          | 741.6                    | 32.24                       |
| T1    | BR13111-4R-63  | 145                    | 20               | 7240.2                |                     | 1070                  | 10.4          | 1080.4                   |                             |

| Treat | Variety           | Growth duration (days) | No of irrigation | Average Yield (kg/ha) | Change in yield (%) | Irrigation depth (mm) | Rainfall (mm) | Total water applied (mm) | Irrigation water saving (%) |
|-------|-------------------|------------------------|------------------|-----------------------|---------------------|-----------------------|---------------|--------------------------|-----------------------------|
| T2    | BRRI dhan104 (ck) | 146                    | 16               | 7396.0                | 2.15                | 850                   | 10.4          | 860.4                    | 20.56                       |
| T3    |                   | 143                    | 24               | 7048.8                | -2.64               | 780                   | 10.4          | 790.4                    | 27.10                       |
| T4    |                   | 148                    | 22               | 6677.7                | -9.71               | 725                   | 10.4          | 735.4                    | 32.24                       |
| T1    |                   | 146                    | 20               | 6734.5                |                     | 1070                  | 10.4          | 1080.4                   |                             |
| T2    |                   | 150                    | 16               | 6805.2                | 1.05                | 850                   | 10.4          | 860.4                    | 20.56                       |
| T3    |                   | 145                    | 24               | 6477.8                | -3.81               | 780                   | 10.4          | 790.4                    | 27.10                       |
| T4    |                   | 146                    | 22               | 6169.1                | -8.40               | 725                   | 10.4          | 735.4                    | 32.24                       |

Date of seeding: 11-Dec-2023; and Date of transplanting: 16-Jan-2024

**Table 8. Effect of water salinity and amendments on rice yield at Batiaghata, Khulna in 2024.**

| Amendments | Irrigation        |                  |                   |                   | Mean |
|------------|-------------------|------------------|-------------------|-------------------|------|
|            | I1                | I2               | I3                | I4                |      |
| T1         | 6.1 <sup>d</sup>  | 5.8 <sup>c</sup> | 4.8 <sup>c</sup>  | 3.1 <sup>b</sup>  | 5.0  |
| T2         | 6.6 <sup>ab</sup> | 6.4 <sup>a</sup> | 5.3 <sup>ab</sup> | 3.4 <sup>a</sup>  | 5.4  |
| T3         | 6.3 <sup>cd</sup> | 5.9 <sup>c</sup> | 5b <sup>c</sup>   | 3.2 <sup>ab</sup> | 5.1  |
| T4         | 6.8 <sup>a</sup>  | 6.6 <sup>a</sup> | 5.4 <sup>a</sup>  | 3.5 <sup>a</sup>  | 5.6  |
| T5         | 6.4 <sup>bc</sup> | 6.1 <sup>b</sup> | 4.9b <sup>c</sup> | 3.3 <sup>ab</sup> | 5.2  |
| T6         | 6.7 <sup>ab</sup> | 6.5 <sup>a</sup> | 5.4 <sup>a</sup>  | 3.6 <sup>a</sup>  | 5.5  |
| Mean       | 6.4               | 6.2              | 5.1               | 3.3               |      |
| CV (%)     | 6.5               |                  |                   |                   |      |

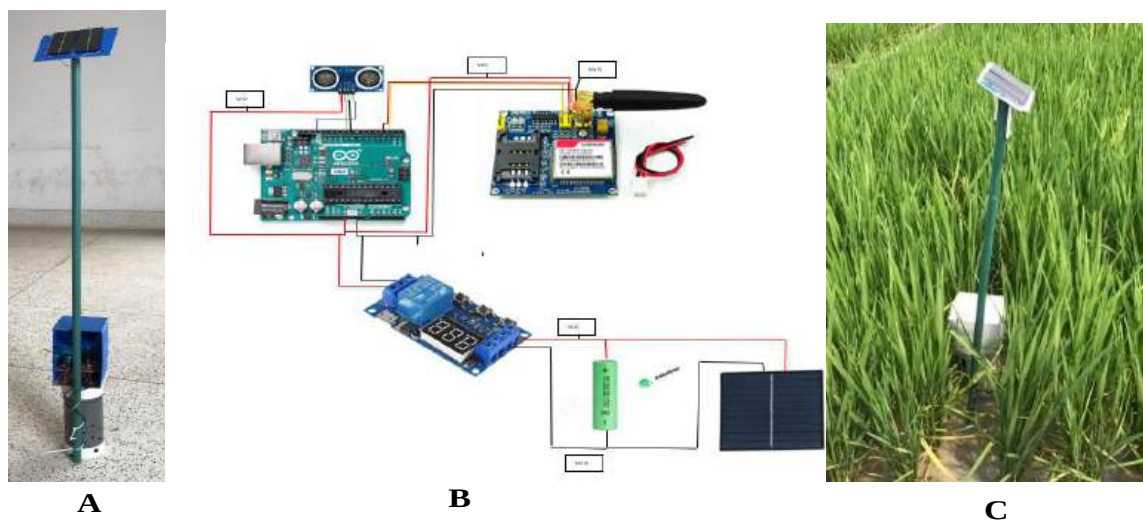


Fig. 1. (A) Automated AWD unit prototype; (B) System instrumentation; (C) Field set up.

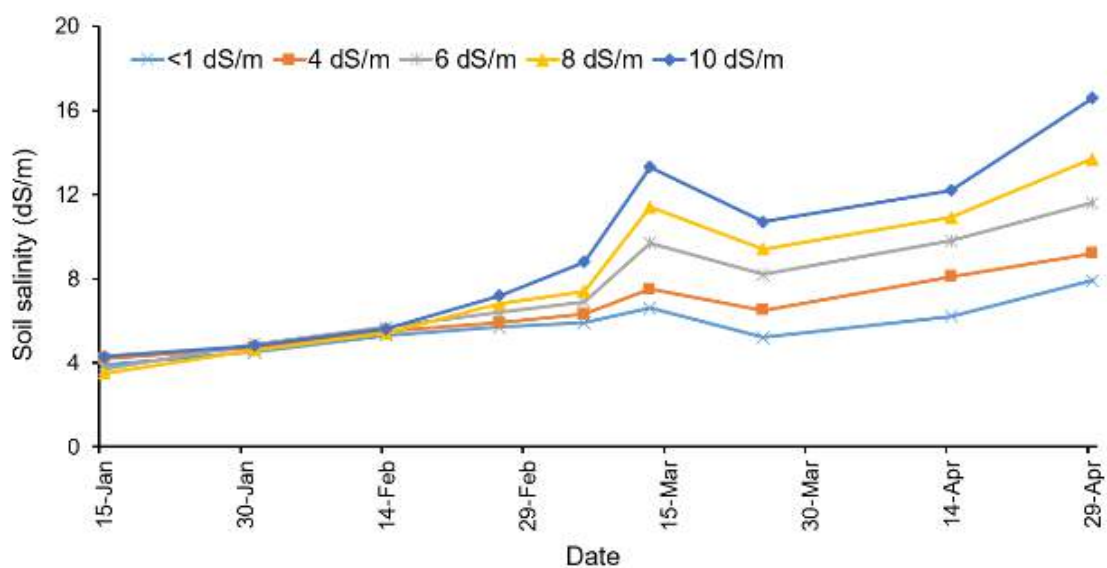


Fig. 2. Soil salinity dynamics at 0-10 cm soil depth with saline water irrigation during the growing season of Boro rice in Dacope, Khulna in 2023-24.

## **Plant Physiology Division**

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## SUMMARY

A total of 22 experiment under eight different projects have been carried out during 2023-24 in Plant Physiology Division of BRRI. In salinity stress about 300 rice germplasm and 120 advanced breeding lines were tested at seedling stage. Out of 300 germplasm four germplasm namely Mohislama (Acc. no. 4233) and Pooshpai (Acc. no. 4242) and an advanced breeding line BR12274-4R-113 were found tolerant to SES score 3. For re-evaluation of the 25 previously screened rice germplasm at seedling stage Acc no. 2779 and Acc. no. 3155 were found tolerant to SES score 3 and Acc no. 2780, 3005, 3142 and 3157 were found moderately tolerant with SES score 5. On the basis of survivability, the BRRI Genebank Acc. no. 2282, 2287 and 2290 performed better having SES score 5 under two weeks flash flood stress. Under water stagnant condition 20 germplasm out of 168 germplasm had higher tiller/hill (>6) compared to the check varieties BR10 and BRRI dhan30 of which two germplasm Acc. No.2134 and 2143) produced  $\geq 10$  tillers/hill. Out of 300 germplasm, 50 genotypes showed better performance in relation to yield under rainfed condition at reproductive phase. BRRI Genebank Acc. no. 2706 and 2728 were confirmed as drought tolerant under controlled drought condition in the rain-out shelter with less than 50% sterility. Out of seven RYT genotypes, IR17L1360 performed better showing the yield reduction below 50% followed by BR12023-6R-111. Ten lines with moderate heat tolerance and spikelet fertility (40.70 to 58.44%) were selected for further evaluation from 41 spikelet fertility QTL introgression lines in the background of BRRI dhan28. Out of 21 high temperature-induced spikelet fertility QTL introgression lines of PYT, four and seven lines in the background of BRRI dhan28 and BRRI dhan29 respectively, having 5-24% yield advantage were selected for further evaluation. Some 126 and 46 BC<sub>1</sub>F<sub>3</sub> fixed progenies having high temperature-induced spikelet fertility QTL (*qHTSF4.1*) in the background of BRRI dhan48 and BRRI dhan62 were selected

through marker genotyping. Hybridized BRRI dhan28 (T)-*qEMF3* line to the BRRI dhan28-*qHTSF4.1* and BRRI dhan29-*qHTSF4.1* for pyramiding of heat tolerance (*qHTSF4.1*) and heat escape (*qEMF3*) mechanism together in the background of BRRI varieties. Out of the 17 progenies genotyped by two linked SSR for *qEMF3*, 15 progenies were confirmed as true F<sub>1</sub>. The selected 15 lines were selfed and proceed for further selection. Some 959 rice germplasms were screened for seedling stage cold tolerance, BRRI Genebank Acc. no. 1534, 1538, 2048 and 2124 had SES score 3 with survival 50%, 50%, 32% and 31% respectively. In first set of sowing on 18 October, grain yield of BR13027-BC1-3R-10 (5.43 t/ha), IR19A1473 (5.27 t/ha) and BR11894-R-R-R-R-169 (5.41 t/ha) was significantly higher than the check variety BRRI dhan28 (3.05 t/ha). In case second set on 3 November sowing, the advanced line BR11894-R-R-R-R-148 produced the highest yield (9.20 t/ha) followed by BR11894-R-R-R-R-169 (7.97 t/ha) which were statistically the similar to the check variety BRRI dhan67 (8.57 t/ha) and BRRI dhan89 (7.18 t/ha). However, other genotypes had statistically similar yield to check variety BRRI dhan28 (6.61 t/ha). Percent sterility was increased significantly on 18 October sowing over 15 November. Eight Boro varieties namely- BR18, BRRI dhan28, BRRI dhan36, BRRI dhan45, BRRI dhan55, BRRI dhan67, BRRI dhan69 and BRRI dhan89 were characterized and evaluated for reproductive stage cold tolerance in natural field condition. Irrespective of rice variety, grain yield was significantly higher on 3 and 15 November sowing than 18 October sowing. On 18 October sowing, BRRI dhan45 gave the highest yield (5.04 t/ha) followed by BRRI dhan89 and BRRI dhan36 which was significantly higher than BRRI dhan28 (3.71 t/ha). While, on 3 November sowing, BRRI dhan89 produced the highest yield (6.88 t/ha) followed by BRRI dhan28 (6.28 t/ha) which were statistically similar to the other tested variety. Similar observations were also observed at 15

November sowing. T. Aman varieties BRRI dhan95 and BRRI dhan90 was identified as lodging tolerant due to well wrapped stem and lower bending moment. But, BRRI dhan87, BRRI dhan93, BRRI dhan94 and BRRI dhan103 were lodged in the field. Breeding lines BR12836-4R-312 and BR9158-19-9-6-50-2-HR1 did not lodge completely from lower internode at field condition but IR16F1148 bend slightly ( $\leq 5\%$ ) due to higher plant height. These three lines showed lodging resistance capacity due to high wrapping score and culm diameter. BRRI dhan101 and BRRI hybrid dhan3 were identified as moderately lodging susceptible, while, BRRI dhan102, BRRI dhan104 and BRRI dhan105 identified as lodging tolerant due to their short plant height, higher wrapping score and low bending moment. BRRI hybrid dhan5 and BRRI hybrid dhan8 identified as lodging tolerant variety due to their higher culm diameter and highest wrapping score than the susceptible check variety BRRI dhan28. Out of 48 advanced breeding lines from favourable Boro rice and cold tolerance rice programme 11 advanced line was identified as lodging tolerant due to their short plant height, higher wrapping score and short lower internode length. But SVIN109, IR17A173, IR17A11694, IR172875 lodged partially ( $\leq 5\%$ ) at field condition. Breeding line BR (Path) 12452-BC3-42-22-11-4 and BR (Path) 12452-BC6-21-11 identified as moderately lodging tolerant with less than 10% lodging rate. Out of twenty-seven RYT materials from premium quality and zinc enriched rice, four lines (BR11359-4R-211, BR11359-4R-288, BR10570-29-7-3-2, BR10571-15-6-8-5) were identified as lodging tolerant. All the advanced lines from PQR#ALART were identified as lodging susceptible. However, Katari, Shibganj (5%) was less susceptible than Zira, Nachol (15%). BRRI dhan100, BRRI dhan92, BRRI dhan28, BRRI dhan89, BRRI dhan98 was lodged but BRRI dhan58, BRRI dhan63, BRRI dhan74, BRRI dhan81 BRRI dhan102, BRRI dhan104 and BRRI dhan107 did not lodge in the field. BINA dhan25 was identified as

lodging susceptible (15%) variety. In photoperiod sensitivity test, four genotypes (Taiboro, Rataboro, BRRI dhan71, BRRI dhan75) were found photoperiod insensitive, 37 lines were strongly photoperiod sensitive and 23 were weakly photoperiod sensitive. Duration of maximum grain filling rate was 9.65 and 10.60 days for BRRI dhan87 and BRRI dhan103. Maximum grain filling rate and weight of grain were 0.1216 g/100 grains/day and 1.2675 g/100 grains which cover almost 51.26% of the total grain weight for BRRI dhan87. In case of BRRI dhan103 maximum grain filling rate and weight of grain were 0.1167 g/100 grains/day and 1.2552 g/100 grains, which cover almost 51.49% of total grain weight. Grain filling rate was higher 9-10 days after fertilization and the initial growth rate determine the active grain filling period or physiological maturity of seed. Under the phonological development of modern rice about 31 to 40% sterility was observed for shifting sowing time. The degree days ( $^{\circ}\text{Cd}$ ) requirements for panicle initiation were  $1559.585 \pm 19.75$ ,  $1602.545 \pm 18.283$ ,  $1429.052 \pm 13.163$ , while for flowering  $582.53 \pm 12.51$ ,  $577.22 \pm 8.11$ ,  $578.10 \pm 0.818$  for BRRI dhan87, BRRI dhan103 and IR64 respectively. Among the rice varieties, BRRI dhan87 produced the highest grain yield (3.96 t/ha). The lowest grain yield (2.53 t/ha) was observed in IR64. Improving salinity tolerance of rice through CRISPR/cas9 system, guide sequence of *OsRR22* gene was properly cloned into the binary vector pC1300-Cas9. Plants were regenerated through *Agrobacterium*-mediated transformation. Hygromycinphosphor transferase positive plants were identified using HPT primer pair designed from Hygromycin phosphotransferase resistant zone of the Cas9 vector. PCRs amplifications have been performed using primer pairs, which generated an amplicon harboring the target site. The resulting amplicons have been sequenced using the Sanger method and mutant plant have been identified where deletion of two nucleotides occurred at the target site. Salinity screening was done using T1 plants and

found tolerant at 12 dS/m compared to its background variety BRRI dhan81. Investigation of anatomical differences in the leaves in comparison of rice and Uridhan has greater number of veins and a denser vascular bundle. The mesophyll cells and vascular bundle in the Uridhan were both well-organized and highly composed compared to rice. Anatomical information was obtained from leaf transverse (TS) section using free hand dissection (~10 µm thick). For ensuring uniformity, the center (widest) part of the leaves was dissected.

#### **PROJECT 1: SALINITY TOLERANCE**

##### **Screening of rice germplasm and advanced breeding lines for salinity tolerance at seedling stage**

Some 420 rice genotypes (300 rice germplasm and 120 advanced breeding lines) were tested under salinity stress at seedling stage to identify salt tolerant rice germplasm. Screening were carried out by the method described Gregorio et al., (1997) at seedling stage in the Plant Physiology Net House, BRRI. The screening was conducted in hydroponic culture of Yoshida solution. Salinity stress (12dS/m) was applied at 9-12 days of seedling growth. The experiment was laid out in RCB design with two replications. Out of 420 genotypes four germplasm namely Mohislama, Pooshpai, Acc. no. 4233 and Acc. no. 4242 and an advanced breeding line BR12274-4R-113 were found tolerant to SES score 3. The SES score of T. check IR58443 and S. check IR154 was 3 and 9 respectively.

##### **Re-evaluation of previously screened saline-tolerant germplasm for salinity tolerance at the seedling stage**

About 25 previously screened rice germplasm were re-evaluated for salinity tolerance at seedling stage to confirm salt tolerance. Screening were carried out by the method described Gregorio et al, (1997) at seedling stage in the Plant Physiology Net House, BRRI. The screening was conducted in hydroponic culture of Yoshida solution. Salinity stress (12dS/m)

was applied at 9-12 days of seedling growth. The experiment was laid out in RCB design with two replications. Among the germplasm Acc no. 2779 and 3155 were found tolerant to SES score 3 while Acc no. 2780, 3005, 3142 and 3157 were found moderately tolerant to SES score 5. The SES of tolerant check Pokkali, Horkuch and IR58443 had 5 but susceptible check IR154 had 9.

#### **PROJECT 2: SUBMERGENCE TOLERANCE**

##### **Identification of local rice germplasm for two weeks flash flood submergence tolerance**

Some 219 local germplasm were tested along with tolerant (FR13A and BRRI dhan79) and sensitive (BR5) checks to identify submergence tolerant germplasm at vegetative phase. Fourteen day old seedlings were transplanted using 20 cm x 20 cm in a concrete submergence tank. Two weeks after transplanting plants were submerged completely for 14 days at one meter water level. During submergence period the water of the tank was made turbid twice daily and the water pH, temperature, dissolve O<sub>2</sub> and turbidity were measured. After 21 days of drain out of water, recovery or survivability score was taken. Survival scoring was done by following standard evaluation system (SES) (IRRI, 2014). The average water pH, temperature and dissolve O<sub>2</sub> of the submergence tank were 8.15, 30.35 °C and 4.64 mg/L respectively. The average turbidity of the water tank was 143.32 and 398.45 FNU (Formazin Nephelometric Units) before and after made turbid respectively during submergence. The results showed that most of the germplasm were non-elongating type and percent elongation was ranged from 0.53 to 94.04%. Out of 219 germplasm 58 germplasm were survived after de-submergence. Survivability of the tolerant check varieties FR13A and BRRI dhan79 was 97% and 37% respectively but susceptible check variety BR5 did not survive. On the basis of survivability, the BRRI Genebank Acc. no. 2282, 2287 and 2290 performed better having SES score 5.

### **Screening of local germplasm for anaerobic tillering ability under water stagnant condition at T. Aman season**

Some 168 local germplasm along with two BRRI varieties BR10 and BRRI dhan30 were tested to observe the anaerobic tillering ability of the local germplasm under water stagnant conditions. Twenty-day-old seedlings were transplanted using 20 cm x 20 cm in a concrete tank. The water pressure of 30 cm was applied just after transplanting. Water pressure @ 5 cm/week was started from seven days after transplanting and continued up to 60 cm. The stagnant water was maintained up to maturity. Data on plant height, tiller number, grain yield (at 14 % moisture) and survivability were taken from average of five hills. The plant height, tiller/hill, yield/hill and survivability ranged from 94.60 - 179.20 cm, 2.40 - 10.80 tillers/hill, 0.33 - 13.10 gm/hill and 100% respectively. Under water stagnant condition, 20 germplasm produced higher tiller/hill (>6) compared to the check varieties BR10 and BRRI dhan30 of which two germplasm (BRRI gene bank Acc. no. 2134 and 2143) produced  $\geq 10$  tillers/hill.

### **PROJECT 3: DROUGHT TOLERANCE**

#### **Screening of rice germplasm for drought tolerance at reproductive phase, T. Aman 2023**

Three hundred BRRI Genebank germplasm along with the check varieties BRRI dhan71 and IR64 were tested at farmers' field in Alimganj, Paba, Rajshahi during T. Aman season 2023 following Field-managed screening protocol (IRRI, 2008). Thirty-day-old seedlings were transplanted at a spacing of 20 cm x 20 cm. The experiment was laid out in Alpha lattice design with two replications. Standard agronomic management practices were followed. Irrigation was withheld for four weeks after transplanting and the field was drained out properly for not allowing any standing water until maturity. Out of 300 germplasm, 50 genotypes showed better performance in relation to yield under rainfed condition at reproductive phase, which were

selected for further confirmation under controlled condition in rainout shelter.

#### **Evaluation of previously selected germplasm under drought stress at reproductive phase in the rain-out shelter**

Previously selected 40 germplasm along with check varieties BRRI dhan71 and IR64 were evaluated in the rain-out shelter, Plant Physiology Division at BRRI HQ, Gazipur during T. Aman 2023. Thirty-day-old seedlings were transplanted in puddled soil at a spacing of 20 cm x 20 cm. Standard agronomic management practices were followed. Four weeks after transplanting, the plots were drained out for inducing drought stress at reproductive phase. The water table depth was below 1 m and soil moisture was around 20%. BRRI Genebank Acc. no. 2706 and 2728 with less than 50% sterility were confirmed as drought tolerant under controlled drought condition in the rain-out shelter.

#### **Confirmation of performance for RYT materials under drought stress at reproductive stage**

Seven advanced breeding lines of RYT along with check varieties BRRI dhan71 and IR64 were evaluated under controlled drought condition in the rain-out shelter in Plant Physiology Net House at BRRI HQ, Gazipur during T. Aman season 2023. Twenty-five-day-old seedlings were transplanted in drum (56 cm x 43 cm) containing 110 kg puddled soil in two sets where the 1<sup>st</sup> set was grown in well-watered conditions and the 2<sup>nd</sup> set under stress condition. At panicle initiation stage water was drained out from 2<sup>nd</sup> set so that the plants experienced drought stress from the reduction division stage. The water table depth and soil moisture content were recorded. At severe drought stress some lifesaving water was applied and calculated as follows:  $= \pi r^2 h$ , Where,  $r = 56/2 = 28$  cm (The radius of the circumference of pot at the base of the hill.)  $h = 0.5$  cm/day (the approximate evapotranspiration at the period of November to December. Advanced line IR17L1360 performance better showing the yield reduction below 50% followed by BR12023-6R-111 (Table 1).

**Table 1. Grain yield, filled grain no. and %sterility of seven tested genotypes as affected by water stress at reproductive phase (T. Aman 2023).**

| Designation              | Grain yield (g/plant) |        |             | Filled grain no./plant |        | % Sterility Under stress condition |
|--------------------------|-----------------------|--------|-------------|------------------------|--------|------------------------------------|
|                          | Control               | Stress | % Reduction | Control                | Stress |                                    |
| BR12023-6R-111           | 22.85                 | 10.56  | 53.8        | 1203                   | 615    | 41.4                               |
| BR12021-6R-117           | 21.04                 | 7.75   | 63.2        | 1159                   | 575    | 41.1                               |
| IR15L1720                | 21.01                 | 9.05   | 56.9        | 1129                   | 475    | 36.5                               |
| IR127009-B-8-2-1-2       | 24.68                 | 11.09  | 55.1        | 1194                   | 627    | 49.1                               |
| IR17L1314                | 23.38                 | 5.69   | 75.7        | 1201                   | 290    | 46.9                               |
| IR100097-B-B-RGA-B-RGA-8 | 28.07                 | 9.00   | 67.9        | 1411                   | 488    | 55.2                               |
| IR17L1360                | 22.13                 | 14.28  | 35.5        | 1080                   | 696    | 34.2                               |
| BRR1 dhan71              | 25.49                 | 18.20  | 28.6        | 1151                   | 923    | 17.9                               |
| IR64                     | 21.23                 | 4.73   | 77.7        | 1030                   | 243    | 61.0                               |

#### PROJECT 4: HEAT TOLERANCE

##### High-temperature tolerance of spikelet fertility QTL introgression lines under controlled high-temperature conditions

The development of a new high-temperature tolerant variety with high yield potential requires the selection of tolerant breeding lines from existing breeding material. In order to facilitate breeding for heat tolerance, 41 spikelet fertility QTL

introgression lines in the background of BRR1 dhan28 were evaluated under controlled high temperature ( $35\pm 3^\circ\text{C}$ ) and high humidity ( $75\pm 5\%$ ) conditions during flowering. Ten introgression lines with moderate heat tolerance and spikelet fertility ranged between 40.70 and 58.44% were selected for further evaluation. However, Kasalath and N22, two donors, scored 1 and 3 (tolerant) under controlled high temperature and humidity conditions (Table 2)

**Table 2. Spikelet fertility (%) under controlled high temperature ( $35\pm 3^\circ\text{C}$ ) and high humidity ( $75\pm 5\%$ ) conditions during flowering of 10 *qHTSF4.1* introgression lines along with parents and checks. Values are the mean  $\pm$  SE (n=9).**

| Designation of Lines/Parents | Spikelet fertility under control condition | Spikelet fertility under stress condition | HT* | SES# based on spikelet fertility under HT stress |
|------------------------------|--------------------------------------------|-------------------------------------------|-----|--------------------------------------------------|
| 23-1-2                       | 84.00 $\pm$ 3.89                           | 50.46 $\pm$ 3.13                          |     | 5                                                |
| 23-1-2                       | 88.27 $\pm$ 5.17                           | 49.47 $\pm$ 1.17                          |     | 5                                                |
| 23-1-2                       | 88.66 $\pm$ 2.64                           | 54.41 $\pm$ 2.06                          |     | 5                                                |
| 23-8-2                       | 91.31 $\pm$ 1.05                           | 58.44 $\pm$ 5.36                          |     | 5                                                |
| 23-8-2                       | 76.96 $\pm$ 9.05                           | 57.15 $\pm$ 4.20                          |     | 5                                                |
| 23-8-2                       | 87.23 $\pm$ 2.12                           | 45.12 $\pm$ 4.39                          |     | 5                                                |
| 23-1-3                       | 79.90 $\pm$ 6.53                           | 48.04 $\pm$ 4.44                          |     | 5                                                |
| 23-1-4                       | 87.19 $\pm$ 1.59                           | 43.42 $\pm$ 5.50                          |     | 5                                                |
| 23-1-6                       | 74.58 $\pm$ 11.14                          | 40.70 $\pm$ 2.83                          |     | 5                                                |
| 23-8-2                       | 91.57 $\pm$ 2.08                           | 42.60 $\pm$ 6.20                          |     | 5                                                |
| BRR1 dhan28 (ck)             | 81.37 $\pm$ 3.91                           | 18.70 $\pm$ 6.80                          |     | 7                                                |
| Kasalath (ck)                | 89.11 $\pm$ 1.44                           | 92.13 $\pm$ 0.93                          |     | 1                                                |
| N22 (ck)                     | 70.52 $\pm$ 15.59                          | 77.70 $\pm$ 0.82                          |     | 3                                                |

\*HT = High temperature, #SES = Standard Evaluation System.

### **Preliminary yield trial of high temperature-induced spikelet fertility introgression lines in the background BRRI dhan28 and BRRI dhan29.**

The preliminary yield trial of high temperature-induced spikelet fertility QTL introgression advanced lines in the background of BRRI dhan28 and BRRI dhan29 were investigated during Boro 2023-24. Along with the parents, the yield potential of 21 introgression lines (9 from BRRI dhan28 and 12 from BRRI dhan29) was tested in the field. Some four introgression lines in the background of BRRI dhan28 and seven lines from BRRI dhan29 having yield advantage 5-24% were selected for further evaluation.

### **Marker-assisted introgression of high temperature-induced spikelet fertility QTL (*qHTSF4.1*) in the background of BRRI dhan48 and BRRI dhan62**

High temperature stress has become a serious threat to rice production in Bangladesh. Previously, it was thought that high-temperature stress was only a problem for Aus season rice; later, it was considered to be a problem for long-duration Boro and late Boro (Boro rice grown after potato harvest) during April to May, and sometimes extended to June/July when rainfall becomes very low or non-existent. However, with the introduction of short-season T. Aman varieties, the problem has extended to T. Aman rice. Short-duration T. Aman cultivars are vulnerable to high temperature-induced spikelet sterility if rainfall is minimal throughout September and October. Considering this, BRRI dhan48 and BRRI dhan62, were subjected to marker-assisted introgression of high temperature-induced spikelet fertility QTL

(*qHTSF4.1*) during the T. Aus and T. Aman seasons. A total of 126 and 46 BC<sub>1</sub>F<sub>3</sub> fixed progenies of BRRI dhna48 and BRRI dhan62 were selected through marker genotyping.

### **Pyramiding of heat tolerance (*qHTSF4.1*) and heat escape (*qEMF3*) mechanism together in the background of BRRI varieties**

The fixed *qHTSF4.1* introgression lines in the background of BRRI dhan28 and BRRI dhan29 had a modest impact on maintaining spikelet fertility, which ranged from 27% to 58% under controlled high temperature ( $>35\pm3$  °C) and high relative humidity ( $75\pm5\%$ ) from the beginning of flowering till to completion of flowering in the Greenhouse condition. Despite the modest effects of this QTL, the introgression of *qHTSF4.1* continues to be mainstreamed into other breeding populations to cover all season's rice. However, the pattern of rising temperatures is shifting more rapidly than in the past. Recent temperature records for the month of April indicate that the critical limits for spikelet sterility are exceeded by 11 am or earlier. Therefore, efforts are being made to pyramid *qEMF3* to the *qHTSF4.1* introgression lines in order to shift flowering earlier than the current flowering pattern (10:00 am to 11:30 am). To combine heat tolerance and escape mechanism together the present study hybridized BRRI dhan28 (T)-*qEMF3* line to the BRRI dhan28-*qHTSF4.1* and BRRI dhan29-*qHTSF4.1*. Out of the 17 progenies genotyped by two linked SSR for *qEMF3* (Fig. 1), 15 progenies were confirmed as true F<sub>1</sub>. The selected 15 lines were selfed and proceed for further selection.

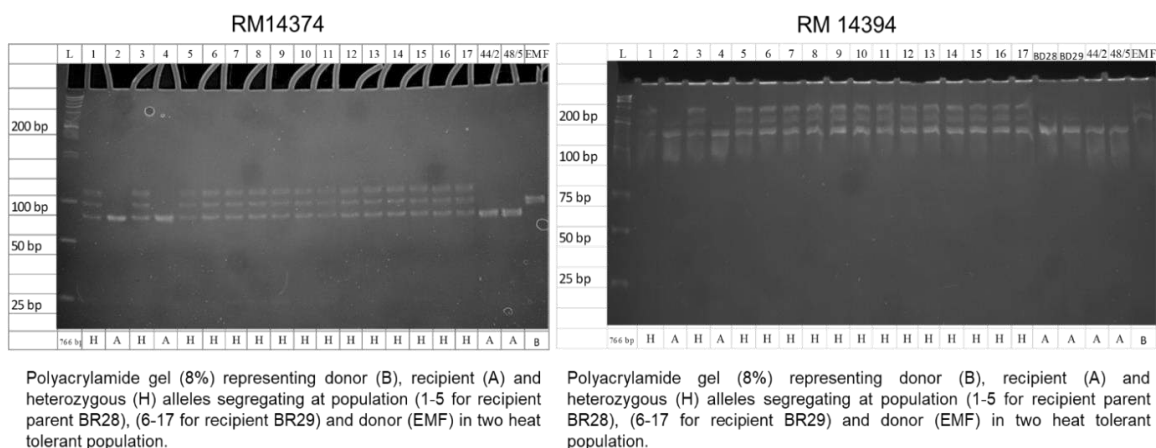


Fig. 1. Amplified PCR product of two *qEMF3* linked SSR marker RM14374 and RM14394 separated in the PAGE (8%).

## PROJECT 5: COLD TOLERANCE

### Screening of rice genotypes for cold tolerance at seedling stage

A total of 959 BRRI Genebank germplasm along with four check varieties namely BRRI dhan28, BRRI dhan36, Bhutan and HbjB-VI were tested for seedling stage cold tolerance in cold water tanks under artificial condition. Among the tested germplasms, BRRI Genebank Acc. no.1534, 1538, 2048 and 2124 had SES score 3 with their recovery survival 50%, 50%, 32% and 31%, respectively. However, Acc. no. 1831 and 8556 also had SES score 3 but their recovery survival percentage were below 20%. BRRI Genebank Acc. no. 1524, 1525, 1532, 1545, 1553, 1559, 1568, 1581, 1584, 1623, 1625, 1649, 1693, 1745, 1747, 1833, 1860, 1865, 2046, 2047, 2048, 2072, 2081, 2090, 2093, 2095, 2096, 2099, 2101, 2102, 2104, 2107, 3430, 3432, 3441 and 4309 had SES score 5 and recovery survival 0-44%. Other genotypes showed visual score 6 to 9 that is susceptible to highly susceptible

### Evaluation of breeding lines for reproductive stage cold tolerance

Some 19 advanced breeding lines along with BRRI dhan28, BRRI dhan67 and BRRI dhan89 as check

varieties were evaluated for reproductive stage cold tolerance in natural field condition. There were three seeding times 18 October, 3 November and 15 November. Thirty-day-old seedlings were transplanted in main field. Early planting was done with a view to falling rice reproductive phase at cold stress. Changes in different parameters of rice in early planted set due to natural cold temperature were compared with normal planting set. Irrespective of rice varieties grain yield was significantly higher in 3 and 15 November sowing than 18 October sowing. In 1<sup>st</sup> seeding date of early sowing/planting, grain yield of BR13027-BC1-3R-10 (5.43 t/ha), IR19A1473 (5.27 t/ha) and BR11894-R-R-R-R-169 (5.41 t/ha) was significantly higher than BRRI dhan28 (3.05 t/ha). In 3 November sowing, the advanced line BR11894-R-R-R-R-148 produced the highest yield (9.20 t/ha) followed by BR11894-R-R-R-R-169 (7.97 t/ha) which were statistically similar to the check variety BRRI dhan67 (8.57 t/ha) and BRRI dhan89 (7.18 t/ha). However, other genotypes had statistically similar yield to check variety BRRI dhan28 (6.61 t/ha) (Table 3). Sterility percentage differed significantly among different varieties sown in different sowing times. Percent sterility was increased significantly in 18 October sowing over 15 November except IR19A1473 which produced statistically similar grain yield on three sowing dates.

**Table 3: Grain yield and spikelet sterility of tested 22 genotypes**

| Genotype            | Yield (t/ha) |       |        | Sterility (%) |       |        |
|---------------------|--------------|-------|--------|---------------|-------|--------|
|                     | 18 Oct       | 3 Nov | 15 Nov | 18 Oct        | 3 Nov | 15 Nov |
| BR13027-BC1-3R-77   | 3.27         | 7.28  | 6.79   | 61.0          | 31.3  | 31.3   |
| IR17A2875           | 1.55         | 5.26  | 4.73   | 80.3          | 47.8  | 29.9   |
| BR11894-R-R-R-R-72  | 4.26         | 5.42  | -      | 57.9          | 28.8  | -      |
| BR13027-BC1-3R-14   | 1.92         | 5.55  | -      | 69.3          | 42.9  | -      |
| BR13027-BC1-3R-10   | 5.43         | 6.43  | 5.94   | 53.6          | 66.5  | 21.3   |
| BR11894-R-R-R-R-158 | 1.78         | 7.35  | 6.25   | 76.2          | 30.3  | 21.7   |
| BR11894-R-R-R-R-148 | 3.40         | 9.20  | 7.22   | 71.5          | 42.4  | 36.6   |
| BR11894-R-R-R-R-152 | 4.39         | 5.54  | 6.09   | 67.4          | 36.0  | 34.9   |
| BR11894-R-R-R-R-59  | 1.85         | 6.52  | 5.88   | 81.4          | 23.6  | 26.5   |
| BR11894-R-R-R-R-115 | 4.16         | 5.89  | 5.81   | 46.8          | 45.9  | 30.7   |
| IR19A1473           | 5.27         | 5.53  | 4.51   | 27.5          | 43.3  | 51.5   |
| IR19A5712           | 2.28         | 6.35  | 5.20   | 64.4          | 57.2  | 44.7   |
| IR19A4821           | 3.24         | 7.20  | 7.09   | 63.3          | 32.9  | 30.3   |
| IR18A2427           | 2.69         | 7.11  | 7.11   | 66.9          | 63.4  | 23.4   |
| IR19A7068           | 2.30         | 6.94  | 8.46   | 77.0          | 35.1  | 18.0   |
| BR11894-R-R-R-R-169 | 5.41         | 7.97  | 7.08   | 58.5          | 32.3  | 31.6   |
| BR11894-R-R-R-R-329 | 2.84         | 5.71  | 7.15   | 64.6          | 19.2  | 18.6   |
| BR11894-R-R-R-R-105 | 2.75         | 7.57  | 5.77   | 47.6          | 25.4  | 34.5   |
| IR18A1859           | 2.22         | 5.26  | 5.66   | 71.0          | 35.4  | 25.4   |
| BRR1 dhan28 (ck)    | 3.05         | 6.61  | 6.81   | 80.7          | 22.3  | 21.8   |
| BRR1 dhan67 (ck)    | 3.57         | 8.57  | 7.54   | 63.1          | 13.9  | 15.3   |
| BRR1 dhan89 (ck)    | 5.95         | 7.18  | 5.45   | 45.5          | 28.4  | 28.2   |
| LSD (5%)            | 1.9          |       |        | 21.7          |       |        |
| CV (%)              | 45.6         |       |        | 50.7          |       |        |

### Evaluation of BRR1 varieties under natural field condition for reproductive stage cold tolerance

Eight BRR1 developed Boro varieties namely: BR18, BRR1 dhan28, BRR1 dhan36, BRR1 dhan45, BRR1 dhan55, BRR1 dhan67, BRR1 dhan69 and BRR1 dhan89 were characterized and evaluated for reproductive stage cold tolerance in natural field condition. There were three seeding times 18 October, 3 November and 15 November (control). Thirty-five-day-old seedlings were transplanted in the main field. Early planting (18 October and 3 November) was done with a view to falling rice reproductive phase at cold stress. Changes in

different parameters of rice after natural cold treatment were compared with control treatment. In early planting, all rice genotypes experienced cold stress at the reproductive phase. Cold stress caused longer growth duration, shorter last internode length as well as plant height, poor panicle exertion and higher percentage of sterility over control treatment in all rice genotypes. Irrespective of rice variety, grain yield was significantly higher in 3 and 15 November sowing than 18 October sowing. In 1<sup>st</sup> seeding date of early sowing/planting, BRR1 dhan45 produced the highest yield (5.04 t/ha) followed by BRR1 dhan89 and BRR1 dhan36, which was significantly higher than BRR1 dhan28 (3.71 t/ha).



In 3 November sowing, BRRI dhan89 produced the highest yield (6.88 t/ha) followed by BRRI dhan28 (6.28 t/ha), which were statistically similar to the other tested variety. Similar observations were also made at 15 November sowing.

## PROJECT 6: GROWTH STUDIES AND YIELD POTENTIAL

### Evaluation for lodging tolerance capacity at T. Aman season

Lodging prior to harvest results in appreciable losses in both quality and quantity of rice resulting in lesser farm income. Six T. Aman varieties (BRRI dhan90, BRRI dhan93, BRRI dhan94, BRRI dhan95, BRRI dhan87, BRRI dhan103) and three breeding materials (IR16F1148, BR12836-4R-312, BR9158-19-9-6-50-2-HR1) along with BR11 (tolerant ck)

and BRRI dhan32 (susceptible ck)), were tested to determine the lodging characters of the rice genotypes. Thirty-day-old seedling was transplanted with 20 cm\*20 cm. The experiment was laid out in RCBD design with three replications. Among the tested varieties BRRI dhan95 and BRRI dhan90 were identified as lodging tolerant due to well wrapped stem and low bending moment. But BRRI dhan87, BRRI dhan93, BRRI dhan94 and BRRI dhan103 were lodged in the field. BRRI dhan93, BRRI dhan94 identified as moderately lodging susceptible. The breeding materials IR16F1148, BR9158-19-9-6-50-2-HR1 did not lodge completely from lower internode at field condition but IR16F1148 bend slightly ( $\leq 5\%$ ) due to higher plant height. These lines have lodging resistance capacity due to high wrapping score and culm diameter (Table 4).

**Table 4. Morphological parameters contributing to lodging as tested.**

| Designation            | Plant Height (cm) | Culm length (cm) | Wrapping Score | Bending moment (gm.cm) | Culm diameter (mm) | Lodging rate (%) |
|------------------------|-------------------|------------------|----------------|------------------------|--------------------|------------------|
| BRRI dhan87            | 133.67            | 111.67           | 27.33          | 2234.90                | 6.44               | 60.00            |
| BRRI dhan90            | 108.33            | 87.33            | 34.67          | 886.83                 | 5.17               | 0.00             |
| BRRI dhan93            | 120.33            | 101.67           | 31.33          | 1477.92                | 4.63               | 18.33            |
| BRRI dhan94            | 113.67            | 88.33            | 31.00          | 1516.67                | 5.07               | 20.00            |
| BRRI dhan95            | 117.33            | 88.33            | 34.67          | 1310.50                | 5.67               | 1.67             |
| BRRI dhan103           | 135.00            | 108.67           | 30.33          | 2079.84                | 5.74               | 56.67            |
| IR16F1148              | 126.67            | 98.67            | 32.00          | 1693.85                | 6.15               | 5.00             |
| BR9158-19-9-6-50-2-HR1 | 149.33            | 119.33           | 33.67          | 2863.72                | 6.92               | 0.00             |
| BR12836-4R-312         | 109.67            | 82.26            | 34.67          | 1179.67                | 6.67               | 0.00             |
| BRRI dhan32 (Sus.ck)   | 126.00            | 103.00           | 29.00          | 1973.83                | 5.39               | 46.67            |
| BR11 (Tol. ck)         | 118.00            | 96.67            | 35.00          | 1547.50                | 6.02               | 0.00             |
| 5%LSD                  | 5.75              | 3.06             | 2.81           | 325.008                | 0.63               | 12.19            |

### Characterization for lodging tolerance of BRRI released varieties at different transplanting times during Boro season

Lodging is the **bending of the stems near ground level**, which makes them very difficult to harvest, and can dramatically reduce yield. An experiment

was conducted to determine the lodging tolerant capacity of newly BRRI released Boro varieties. To achieve the objectives 40-day-old seedling of BRRI dhan101, BRRI dhan102, BRRI dhan104, BRRI dhan105, BRRI hybrid dhan3, BRRI hybrid dhan5 and BRRI hybrid dhan8 with BRRI dhan28 (Sus.) and BRRI dhan29 (Tol.) were transplanted at 15

days interval in four sets. The experiment was laid out in RCBD with three replications and spacing was 20 cm\* 20 cm. Results indicate that transplanting on 4 January 2024 and 18 January 2024 were more suitable for lodging than transplanting before 4 January 2024. BRRI dhan101 and BRRI hybrid dhan3 were identified as moderately susceptible to lodging. On the other hand, BRRI dhan102, BRRI dhan104 and BRRI dhan105 were identified as lodging tolerant due to their short plant height, higher wrapping score and low bending moment. Among the three hybrid varieties, BRRI hybrid dhan5 and BRRI hybrid dhan8 identified as lodging tolerant variety due to their higher culm diameter, highest wrapping score than susceptible check variety BRRI dhan28.

### Screening for lodging tolerance capacity of advanced breeding lines during Boro season

Varietal characteristic have greater impact on lodging. An experiment was conducted to determine the lodging tolerant capacity of advanced breeding lines at Jugitola, Bason, Gazipur during Boro season 2023-24. Forty-day-old-seedlings of total 75 advanced breeding lines under favourable Boro rice (FBR), cold tolerance rice (CTR), premium quality rice (PQR), zinc enriched rice (ZER) from Plant Breeding Division and two advanced lines from

Plant Pathology Division were transplanted using 20 cm X 20 cm spacing. Experiment was laid out in RCBD with three replications. Some 11 advanced lines of FBR and CTR was identified as lodging tolerant due to short plant height, higher wrapping score and short lower internode length. But SVIN109, IR17A173, IR17A11694, IR172875 partially lodged ( $\leq 5\%$ ) at field condition (Table 5). These lines has lodging resistance capacity due to shorter plant height as well as lower internode length. Whereas, BR (Path) 12452-BC3-42-22-11-4 and BR (Path) 12452-BC6-21-11 was identified as medium lodging tolerant line with  $<10\%$  lodging rate. Under PQR and ZER for RYT materials, out of 27 in total four advanced lines (BR11359-4R-211, BR11359-4R-288, BR10570-29-7-3-2, BR10571-15-6-8-5) identified as lodging tolerant. All of the ALART#PQR materials identified as lodging susceptible. Katari, Shibganj (5%) was less susceptible than Zira, Nachol (15%). Out of twelve BRRI varieties, BRRI dhan100, BRRI dhan92, BRRI dhan28, BRRI dhan89, BRRI dhan98 lodged ( $\leq 10\%$ ). BRRI dhan58, BRRI dhan63, BRRI dhan74, BRRI dhan81 BRRI dhan102, BRRI dhan104 and BRRI dhan107 did not lodge in the field. BINA dhan25 identified as lodging susceptible (15%).

**Table 5. Screening of lodging tolerant score under favourable Boro rice (FBR) and cold tolerance rice (CTR) for RYT.**

| Designation            | Plant height (cm) | Wrapping score | 3 <sup>rd</sup> Internode length (cm) | 4 <sup>th</sup> Internode Length (cm) | Lodging rate (%) |
|------------------------|-------------------|----------------|---------------------------------------|---------------------------------------|------------------|
| BR11903-5R-56          | 96.00             | 29.00          | 13.33                                 | 6.67                                  | 0.00             |
| IR18A2119              | 106.00            | 31.67          | 14.00                                 | 7.67                                  | 0.00             |
| BR11845-4R-62          | 97.33             | 31.33          | 11.00                                 | 5.00                                  | 0.00             |
| BR12266-BC3-23-1       | 93.33             | 28.33          | 13.67                                 | 5.67                                  | 0.00             |
| BR12423-6R-38          | 105.33            | 29.67          | 10.00                                 | 6.00                                  | 0.00             |
| IR18A1398              | 108.67            | 29.33          | 11.33                                 | 5.00                                  | 0.00             |
| BR11318-5R-148         | 104.00            | 30.00          | 10.00                                 | 4.67                                  | 0.00             |
| BR7528-2R-19-16-RIL-52 | 105.67            | 29.33          | 14.33                                 | 5.00                                  | 0.00             |
| BR7528-2R-19-16-RIL-55 | 110.33            | 33.33          | 15.00                                 | 5.67                                  | 0.00             |
| BR7528-2R-19-16-RIL-59 | 106.67            | 30.33          | 14.33                                 | 5.00                                  | 0.00             |

| Designation      | Plant height (cm) | Wrapping score | 3 <sup>rd</sup> Internode length (cm) | 4 <sup>th</sup> Internode Length (cm) | Lodging rate (%) |
|------------------|-------------------|----------------|---------------------------------------|---------------------------------------|------------------|
| SVIN109          | 95.00             | 28.33          | 12.67                                 | 5.00                                  | 3.33             |
| IR17A173         | 91.67             | 26.00          | 13.67                                 | 4.67                                  | 3.33             |
| IR17A11694       | 89.33             | 27.33          | 12.00                                 | 6.00                                  | 3.33             |
| IR17A2875        | 97.00             | 28.33          | 11.00                                 | 3.00                                  | 5.00             |
| BRR1 dhan28 (ck) | 100.67            | 31.67          | 13.67                                 | 4.33                                  | 83.33            |
| BRR1 dhan63 (cK) | 94.33             | 31.67          | 14.00                                 | 4.33                                  | 0.00             |
| BRR1 dhan92 (cK) | 112.67            | 31.67          | 14.00                                 | 4.33                                  | 10.00            |
| BRR1 dhan98 (cK) | 100.67            | 30.33          | 13.00                                 | 4.67                                  | 8.33             |
| 5%LSD            | 7.76              | 2.98           | 2.74                                  | 1.79                                  | 28.47            |

### Photoperiod sensitivity test of different types of rice genotypes

Rice cultivars exhibit wide range of variation in the degree of sensitivity to photoperiod (strong sensitive to nearly insensitive). An experiment was conducted to know the photoperiod sensitivity level of tested genotypes. Sixty-four advanced breeding lines along with Gainza and Nizersail as check variety were directly sown to well-prepared land of West Byde of Plant Physiology Division, BRR1 on 4 April 2023. After emergence, plants were thinned and maintained five healthy plants for each entry. Ten-hour photoperiodic treatment (7.00 to 5.00) was started from seed sowing by using black cloth cover. Another set of plants were grown at natural day length. Observations were made on heading date to determine the basic vegetative phase (BVP), photoperiod sensitive phase (PSP) and relative photoperiod sensitivity (RPS). BVP and PSP varied greatly among the tested lines. PSP or lag phase is an indicative of the rice plants sensitivity to photoperiod. Out of 64 tested genotypes four genotypes observed insensitive to photoperiod (Tapiboro, Rataboro, BRR1 dhan71, BRR1 dhan75), 37 lines were strongly photoperiod sensitive and 23 were weakly photoperiod sensitive.

### Study of the grain filling characteristics of rice under different environmental conditions

The contribution of the carbohydrate synthesized and stored in the leaves and culms before flowering to grain carbohydrate varies with variety, nitrogen application and climatic conditions. An experiment was conducted to study the grain filling rate of two Aman varieties (BRRU dhan87 and BRR1 dhan103). The initial growth potential of fertilized flower ( $R_0$ ) was 0.1812 and 0.1739 and the average grain filling rate was found 0.0808 and 0.0775 g/100 grains/day for BRR1 dhan87 and BRR1 dhan103. As the initial growth rate and grain filling rate was higher in BRR1 dhan87 the active grain filling time was earlier than BRR1 dhan103. The time of maximum grain filling rate was 9.65 and 10.60 days for BRR1 dhan87 and BRR1 dhan103 where the maximum grain filling rate and weight of grain was 0.1216 g/100 grains/day and 1.2675 g/100 grains which cover almost 51.26% of total grain weight for BRR1 dhan87. In case of BRR1 dhan103 at the time of maximum grain filling rate the rate and weight of grain was 0.1167 g/100 grains/day and 1.2552 g/100 grains which cover almost 51.49% of total grain weight. From the above discussion we can conclude that at 9-10 days after fertilization the grain filling rate was higher and the initial growth rate determine the active grain filling period or physiological maturity of seed (Table 6).

**Table 6. Values of different grain filling related parameter tested two varieties.**

| Treatment    | Average grain filling rate (Gavg) (g/100 grains/day) | Maximum grain filling rate (Gmax) (g/100 grains/day) | Initial growth potential of fertilized flower (Ro) | Active grain filling time (days) | Time of maximum grain filling rate (Tmax.G) (days) | Weight at the time of maximum grain filling rate (Wmax.G) (g/100 grains) | Growth % of the final growth at the time of maximum grain filling rate (I%) |
|--------------|------------------------------------------------------|------------------------------------------------------|----------------------------------------------------|----------------------------------|----------------------------------------------------|--------------------------------------------------------------------------|-----------------------------------------------------------------------------|
| BRR1 dhan87  | 0.0808 a                                             | 0.1216 a                                             | 0.1812 a                                           | 30.778 a                         | 9.6453 a                                           | 1.2675 a                                                                 | 51.258 a                                                                    |
| BRR1 dhan103 | 0.0775 a                                             | 0.1167 a                                             | 0.1739 a                                           | 31.59 a                          | 10.595 a                                           | 1.2552 a                                                                 | 51.498 a                                                                    |
| LSD 0.05     | 0.0124                                               | 0.0184                                               | 0.0367                                             | 4.1498                           | 1.1212                                             | 0.0975                                                                   | 1.6225                                                                      |
| CV (%)       | 9.05                                                 | 8.93                                                 | 11.95                                              | 7.69                             | 6.40                                               | 4.47                                                                     | 1.83                                                                        |

### Phenological development of some modern varieties as affected by sowing time

The study attempted to analyze developmental stages of modern varieties of rice in different planting times to determine the genetic coefficient of rice. In order to achieve the objective a field experiment was conducted with four different sowing dates – 18 June 2023, 28 June 2023, 8 July 2023 and 18 July 2023 at the farm of Bangladesh Rice Research Institute, Gazipur.in Aman season 2023. Three rice cultivars- BRR1 dhan87, BRR1 dhan103 and IR64 were transplanted with 20×20 cm<sup>2</sup> configuration. Results indicated that planting time exerted significant influence on grain yield, yield components. About 31 to 40% sterility was recorded for shifting sowing time. Environmental temperature extremes coinciding with the critical stage of plant development reduced spikelet fertility of all varieties. Results of this experiment suggested that the varieties did not exhibit their yield potential not only due to environmental condition but might be poor soil nutrient status as well. Measuring the heat accumulated over time provides a more accurate physiological estimate than counting calendar days. “Growing degree days” (abbreviated GDD or DD) is a way of assigning a heat value to each day. The values are added together to give an estimate of the amount of seasonal growth our plants have achieved. The degree days (°Cd) requirements for panicle initiation were 1559.585 ±19.75, 1602.545 ±18.283,

1429.052±13.163, while for flowering 582.53 ±12.51, 577.22 ±8.11, 578.10 ±0.818 for BRR1 dhan87, BRR1 dhan103 and IR64 respectively. Among the rice varieties, BRR1 dhan87 produced the highest grain yield (3.96t/ha). The lowest grain yield (2.53 t/ha) was observed in IR64.

### PROJECT 7: GENOME EDITING

#### CRISPR-Cas9 mutagenesis of the *OsRR22* gene for improving salinity tolerance of rice

Salinity is one of the most important abiotic stress affecting the rice production. Numerous salt tolerance quantitative trait loci were identified and few of them had been transferred into popular rice varieties via marker-assisted selection (MAS) but none of them showed greater promise. The *OsRR22* gene encodes a 696–amino acid B-type response regulator transcription factor that is involved in both cytokinin signal transduction and metabolism; its loss of function has been reported to significantly increase salt tolerance. To design a CRISPR/Cas9 targeting the *OsRR22* gene in rice, a 19bp guide sequence (5'-AGAGGGATCAATCCCCGT-3') was a protospacer adjacent motif lying within the *OsRR22* coding sequence (*LOC\_Os06g08440*). The guide sequence was properly cloned into the binary vector pC1300-Cas9. The binary vector pC1300-Cas9 harboring Cas9/*OsRR22* sgRNA was mobilized into *Agrobacterium tumefaciens* LBA4404 by freeze-thaw method and confirmed through PCR-gel

electrophoresis. Plants were regenerated through *Agrobacterium*-mediated transformation. Genomic DNA was extracted from the leaves of transformed plants using the sodium dodecyl sulphate (SDS) method. Hygromycin phosphotransferase positive plants were identified using HPT primer pair designed from Hygromycin phosphotransferase resistant zone of the Cas9 vector. PCRs amplifications have been performed using primer pairs, which generated an

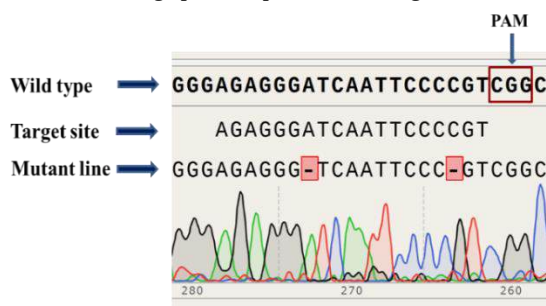


Fig. 2. Nucleotide sequences at the target site of the T1 mutant rice plants.

## PROJECT 8: C4 RICE DEVELOPMENT

### Investigation of anatomical differences in the leaves of rice and Uri dhan

The chloroplast-containing leaf and other green tissues significantly regulate photosynthesis and are essential to each phase, from the absorption of light through the biochemical fixation of carbondioxide. The characterization of anatomical variations between C3 (rice) and C3-C4 lineage plants, such as Uri dhan, has gained increasing attention. Thus, improving yields through enhanced photosynthetic efficiency could directly benefit current research projects that aim to engineer the leaves and other green photosynthetic structures of cultivated rice. On

amplicon harboring the target site. The resulting amplicons have been sequenced using the Sanger method and mutant plant have been identified where deletion of two nucleotides occurred at the target site (Fig. 2). Salinity screening was done using T1 plants and found tolerant at 12 dS/m compared to its background variety BRRI dhan81 (Fig. 3). The selected plants were transplanted for seed multiplication.



Fig. 3: Phenotype of T1 plants (background BRRI dhan81) after salinity screening at EC of 12 dS/m.

the basis of morphological, cellular ultrastructure, and molecular data, Chowrasia and Mondal (2020) have asserted that Uri dhan (*Oryza coarctata*) should be capable of C4 photosynthesis. Based on this knowledge, the morphological distinctions between rice and Uri dhan leaves were examined. Anatomical information was obtained from leaf transverse section (TS) using free hand dissection (~10  $\mu$ m thick). To ensure uniformity, the center (widest) part of the leaves was dissected. Total area of bundle sheath (BS) with vascular bundle (mm<sup>2</sup>), area of vascular bundle (mm<sup>2</sup>) and area of bundle sheath (BS) (mm<sup>2</sup>) were higher in the Uri dhan compared to rice (Fig. 4).

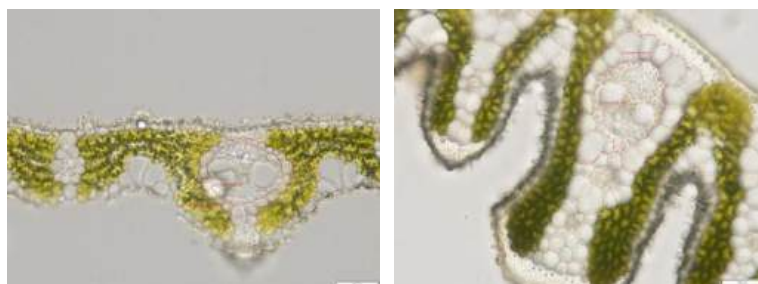


Fig. 4. Leaf section of rice (left) (40 $\times$ ) and Uri dhan leaf (right) (40 $\times$ ).

## **Entomology Division**

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## SUMMARY

Short horned grasshopper (SHG), green leafhopper (GLH) and white leafhopper (WLH) were the most abundant pests and found in all habitats (seedbed, ratoon, grass fallow, grass bund, irrigated rice, rice bund and upland rice) during reporting year. Survey of insect pests of rice in Sylhet, Rangpur, Cumilla, Barishal, Rajshahi and Habiganj region during T. Aman 2023, Khulna, Rangpur, Cumilla, Habiganj and Jashore during Boro 2023-24 season revealed that insect pests infestation was below the ETL in all region. Yellow stem borer (YSB), Leafroller (LR), green leaf Hopper (GLH), short horned grasshopper (SHG) were the major insect pests and found highest in Barishal, Sylhet, Rangpur and Sylhet respectively. Among the natural enemies spider, carabid beetle (CBB), Damsel fly, Green mirid bug (GMB), lady bird beetle (LBB), Dragon fly and parasitic wasp (PW) were found highest in Rajshahi, Rangpur, Rajshahi, Sylhet, Rangpur, Barishal and Sylhet respectively. The range of Fall Armyworm (FAW) moth catches was 0.02 to 0.33/trap/day and YSB catches was 0.04 to 0.74/trap/day in pheromone trap placed in different locations of Bangladesh. Highest FAW moth catches were observed 0.33 moths/trap/day at the farmers field of Kaliganj, Jhenaidha. Highest YSB moths and damages were observed at Batiaghata, Khulna. The growth duration of different developmental stages of rice leafroller (RLR), *Cnaphalocrosis medinalis* from egg to adult has shown differences in changing temperature in the growth chamber. Overall, in lowest temperature (20°C), egg incubation period to adult longevity duration was higher compared to 25°C and 30°C and they completed their life cycle for 34 days which was higher from 25°C and 30°C. Species composition of stem borer species at BRRI HQ farm, Gazipur during T. Aus and T. Aman 2023 showed that in Aus dark headed borer (DHB) was the dominant species followed by striped stem borer (SSB). In Aman yellow stemborer (YSB) was the dominant species followed by SSB and DHB.

Insect pests status remained below the economic threshold level (ETL) both in Eco-engineering plots (T<sub>1</sub>) and insecticide treated plots (T<sub>2</sub>). Highest beneficial insects, predator and parasitoid were observed in rice field with nectar-rich flowering plants on bunds (Eco-engineering). However, least natural enemies and parasitism were found in farmer's practice rice field where 3-4 times insecticides were applied. Moreover, rice equivalent yield (REY) was higher in eco-engineering field compared to farmer's practice field (insecticide application). Attempts have been made to rear green mirid bug on different hosts eg., Corcyra egg and larva, flowers of bottle gourd and other flowering plants but without success.

A total of 188, 45 and 14 commercial formulations of insecticides were evaluated and 96, 13 and 09 were found effective against BPH, YSB and rice weevil respectively.

Silica (SiO<sub>2</sub>) nanoparticles showed 74.0% and 73.0% mortality against BPH nymph at 94 and 72 hours after spray (HAS) respectively in 1000 ppm concentration. Mortality rates increased over time, with higher concentrations exhibiting the highest rates of mortality.

Highest rice weevil insect mortality was found in neem oil (85%), followed by biskatali plants powder (75%), neem leaf powder (61.67%) and mahogany seed kernel powder (60%).

Temperature effect on the growth and survival rates of *Sitophilus oryzae* showed that hundred percent mortality of rice weevil were found in -80°C, -20°C, 4°C and 50°C treatments. There was no mortality observed in 25°C treatments.

To determine the susceptibility of more than eighteen generations greenhouse (GLH) population to six insecticides, a bioassay was conducted with six different concentrations for each insecticide. The lethal dose (LD<sub>50</sub>) values were found 48.44 for Mipcin 75 WP, 360.32 for Dursban 20 EC, 8.19 for Confidor 70 WG, 216.41 for Suntap 50 SP, 24.78 for Award 40 SC, and 0.91 for Nitro 505 EC.

Total number of natural enemy (NE) and other non-pest, comparable with control were found highest in fipronil, cartap, tetraniliprole+ fipronil, Abamectin and *Celastrus angulatus* among eight commercially registered insecticides. So, these insecticides may be considered as safer for NE.

Insecticide residue tests on polished rice grain showed no pesticide presence or were below the detection level when applied with standard dose of chlorantraniliprole and imidacloprid. The detection concentration for double dose application was 0.018 mg kg<sup>-1</sup> for chlorantraniliprole and 0.029mg kg<sup>-1</sup> for imidacloprid, which was below the Maximum Residue Limit (MRL: 0.4 mg kg<sup>-1</sup> for chlorantraniliprole and 0.6 mg kg<sup>-1</sup> for thiamethoxam, EU).

Multiple insecticide residue tests in polished rice found no residues or were below detection level.

A total of 15 insecticides determination methods namely carbofuran, chlorantraniliprole, chlorpyrifos, isoprocarb and thiamethoxam, malathion, diazinon, dinotefuran, imidacloprid, pymetrozine, nitenpyram, carbaryl, carbosulfan, cypermethrin, and fipronil were standardized by Shimadzu LCMSMS 8050.

Analysis of 16 rice samples collected from different regions of the country showed that no pesticide residue was found in any sample other than Chinigura rice samples.

Among the 100 germplasms, three germplasms Munsur, Dighi baual and Kalosaitta showed moderately susceptible reaction (score 5) against BPH in T. Aman 2023 season.

All of the 20 RYT advanced breeding lines of rainfed lowland rice (RLR) showed susceptible reaction (score 7 and 9) against BPH.

In drought tolerant rice (DTR) trial, one breeding lines IR127009-B-8-2-1-2, out of eight showed moderately susceptible (score 5) reaction against BPH.

All of the eight zinc enriched (ZER) lines of RYT during the evaluation at green house showed susceptible reaction (score 7 and 9) against BPH.

Among four ALART Antioxidant enriched rice materials one ALART material BR12836-4R-312 showed moderately susceptible reaction (score 5) against BPH.

Most of the entries of three ALART (SD) favourable Boro rice (FBR), two ALART (LD) FBR, six ALART (LB) FBR, four ALART cold tolerant rice (CTR), three PVT (Fertilizer Management) FBR breeding lines showed susceptible reaction (score 7 and 9).

In FBR cold tolerant rice, one entry IR17A2922 showed moderately resistant reaction (score 3) and four entries BR12676-4R-392, BR13138-5R-141, IR17A2917 and IR12A173 out of 188 entries showed moderately susceptible reaction (score 5) against BPH.

All of 12 ALART Boro lines, 15 disease resistant rice, nine RYT-1 of premium quality rice (PQR), eight RYT-2 PQR, 13 RYT-3 PQR, nine RYT zinc enriched rice (ZER) entries showed susceptible reaction (score 7 and 9) against BPH.

Among 76 FBR (BPH 17 and BPH 32) BPH gene rice, two entries BR13418-5R-81 and BR13418-5R-93 showed moderately resistant reaction (score 3) and 13 entries BR13418-5R-3, BR13418-5R-6, BR13418-5R-8, BR13418-5R-26, BR13418-5R-37, BR13418-5R-40, BR13418-5R-47, BR13418-5R-51, BR13418-5R-53, BR13418-5R-76, BR13418-5R-78, BR13418-5R-82 and BR13418-5R-100 showed moderately susceptible reaction (score 5) against BPH.

Among 62 FBR lodging tolerance trial, one entry IR17A2922 showed moderately resistant reaction (score 3) and three entries BR12676-4R-392, BR7528-2R-19-16-RIL-59 and IR12A173 showed moderately susceptible reaction (score 5) against BPH.

One entry IR17A2922 out of 20 showed moderately resistant reaction (score 3) against BPH. Among 352 OYT insect resistant rice (IRR) lines, one entry BR13482-4R-202 showed moderately resistant reaction (score 3) and ten entries BR13466-4R-10, BR13466-4R-42, BR13467-4R-208,



BR13471-4R-88, BR13472-4R-1, BR13472-4R-6, BR13472-4R-124, BR13480-4R-29, BR13482-4R-54 and BR13482-4R-115 showed moderately susceptible reaction (score 5) against BPH.

Two entries out of 84 PYT insect resistant rice lines, BR12678-4 R-187 and BR12685-4 R-251 showed moderately susceptible reaction (score 5) against BPH.

All of 45 AYT insect resistant rice (IRR) entries showed susceptible reaction (score 7 and 9) against BPH.

Irrespective of locations and rice varieties the insect pests were remain below the economic threshold level (ETL) both in IPM practiced ( $T_1$ ) and farmers practice i.e., insecticide application ( $T_2$ ) during Boro 2023-24. Benefit cost ratio (BCR) analysis was done on full cost basis and were found always higher in  $T_1$  compared to  $T_2$ .

Newly developed burrows became inactive (dead) surrounding the 50 m dia of watching tower set in BRRI, Gazipur field indicating activity of owl at night to control rat in rice.

## SURVEY AND MONITORING OF RICE ARTHROPODS

### Pest and natural enemy incidence at BRRI farm, Gazipur

Populations of rice insect pests, their natural enemies and crop damage intensities in seven habitats (seedbed, ratoon, grass fallow, grass bund, irrigated rice, rice bund and upland rice) were monitored weekly at BRRI HQ farm, Gazipur. Overall insect pest incidence was low in the reporting year. Green leafhopper (GLH), white leafhopper (WLH) and short horned grasshoppers (SHG) were the most abundant pests and found almost in all habitats. Highest number of SHG was found in seedbed followed by grass fallow, transplanted rice, grass bund and broadcast rice (Fig. 1).

Higher numbers of natural enemies were found in the seedbed, grass fallow and ratoon. Green mirid bug (GMB), ladybird beetle, spider, damsel fly (Dam. fly), spider and carabid beetle (CDB) were the dominant predators in almost all the habitats of the reporting year (Fig. 2).

**P.I:** Mir Md Moniruzzaman Kabir **C.I:** Tapon Kumar Roy **PL:** Sheikh Shamiul Haque

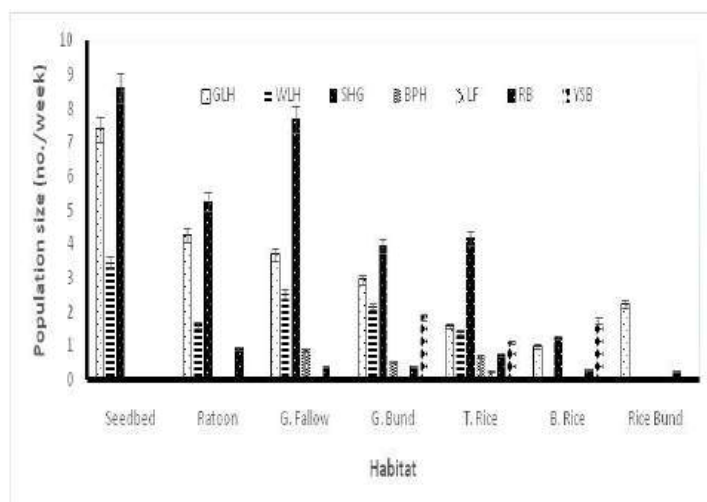


Fig. 1. Incidence of insect pest in different habitats at BRRI farm, Gazipur.

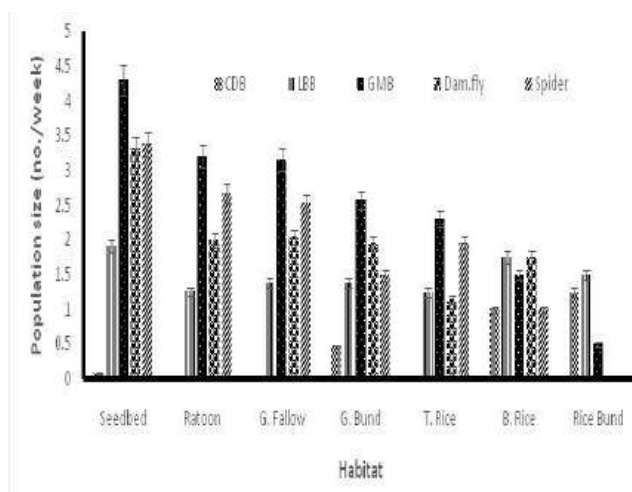


Fig. 2. Incidence of natural enemies in different habitats at BRRI HQ farm, Gazipur.

### Incidence of insect pests and natural enemies in light trap

Rice insect pests and their natural enemies were monitored throughout the year by Pennsylvania light trap from dusk to dawn at BRRI HQ, Gazipur and six BRRI regional stations. The highest number

of insect pests were observed at Habiganj followed by Gazipur, Barishal, Cumilla, Rangpur, Rajshahi and Sonagazi respectively (Fig. 3). In case of natural enemies, the highest catch of natural enemies in light trap was recorded at Gazipur followed by Barishal and Habiganj.

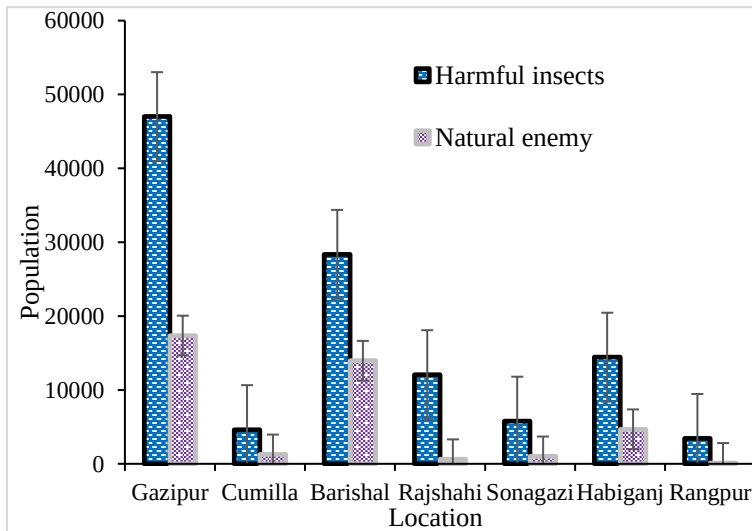


Fig. 3. Insect pests and natural enemies at BRRI HQ, Gazipur and regional stations (RS).

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### Survey of rice insect pests in selected Agro-ecological zones (AEZ's) of Bangladesh

The insect pest population, their damage intensities and abundance of the natural enemies were surveyed in Sylhet, Rangpur, Cumilla, Barishal, Rajshahi and Habiganj region during T. Aman 2023 and Khulna,

Rangpur, Cumilla, Habiganj and Jashore during Boro 2023-24. Twenty complete sweeps were taken randomly in 27 locations of each AEZ. The insect pests were below the ETL in both of T. Aman and Boro season.

Highest population of yellow stem borer (YSB) was found in Barishal (5.03/20 sweep) followed by Rangpur (1.59/20 sweep) and Sylhet (1.44/20 sweep) and Rajshahi (1.41/20 sweep) during T. Aman season. The lowest was observed in Cumilla 0.17/20 sweep (Fig. 1). Leafroller (LR) population was found the highest at Sylhet (4.74/20sweep) followed by Barishal (2.02/20sweep) and Rangpur (1.47/20 sweep). Abundance of GLH was found highest in Rangpur (3.87/20 sweep) followed by Cumilla (3.55/20 sweep) and Sylhet (2.37/20 sweep) during T. Aman season (Fig. 4). Among the all-insect pests short horned grasshopper (SHG) was found the highest in Sylhet (10.85/ 20 sweep) followed by Barishal and Cumilla (each of 5.50 /20sweep) and Rangpur (5.05/20sweep) and the lowest SHG was observed in Rajshahi, 1.69/20 sweep (Fig. 4). Highest number of spider (8.56/20 sweep) was found in Rajshahi followed by Sylhet (7.52/20 sweep), Barishal (2.93/20 sweep) and the lowest was in Cumilla (1.68/20 sweep). Among the natural enemies carabid beetle (CBB) and staphylinid beetle (STPD) were remarkably highest in Rangpur (27.42 and 3.7/ 20 sweep respectively) than other locations (Fig. 5).

Damsel fly (Dam.fly) was found highest in Rajshahi (3.84/20 sweep) followed by Sylhet (2.85/20 sweep) and Rangpur (1.2/20 sweep). Green mirid bug (GMB) and parasitic wasp (PW) were found highest in Sylhet, lady bird beetle (LBB) in Rangpur and Dragon fly (Drag. fly) in Barishal during T. Aman 2023 (Fig. 5). Highest YSB was found in Khulna (3.5/20 sweep) followed by Jashore (0.83/ 20 sweep). The range of other insect pests were (0 to 0.67/20 sweep) during Boro season (Fig. 6). Rice leafroller (RLR) population found highest in Khulna (1.33/ 20sweep) followed by Jashore (1.0 /20sweep). Abundance of GLH was found highest in Cumilla (3.80/20 sweep) followed by Habiganj (2.75/20 sweep). Among the all-insect pests SHG found highest in Cumilla (19.22/ 20 sweep) followed by Habiganj and Rangpur (3.5 and 2.03/20sweep) and lowest was observed in Khulna and Jashore each of 1.50/20 sweep (Fig. 6). BPH and WBPH were found highest in Cumilla and Khulna 4.22 and 1.83/20 sweep respectively (Fig. 6). Highest spider (5.75/20 sweep) was found in Habiganj followed by Cumilla (4.22/20 sweep) and Khulna (3.33/20 sweep) and lowest in Jashore (2.83/ 20 sweep. Other natural enemies i.e., parasitic wasp (PW) and STB were found highest 5.67 and 3.47/ 20 sweep respectively in Rangpur region and Dam. fly in Habiganj (3.27/20 sweep) during Boro 2023-24 season (Fig. 7).

PI: Md. Nazmul Bari, CI: All entomologist, PL: Sheikh Shamiul Haque.

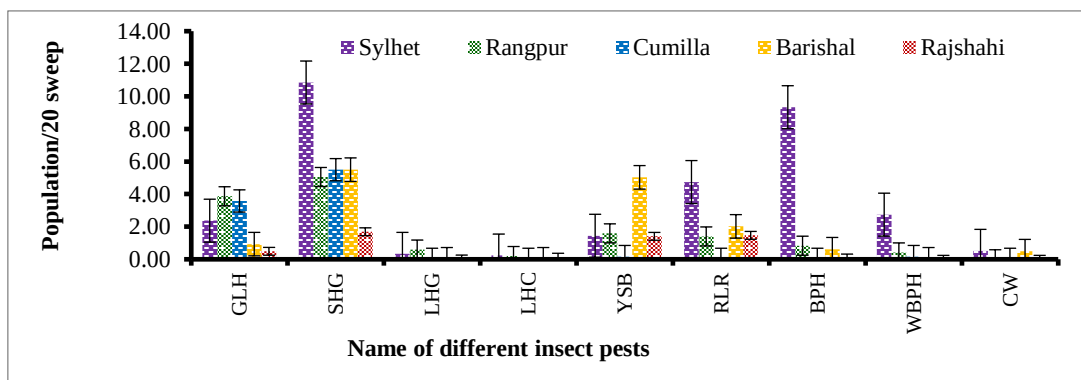


Fig. 4. Rice insect pests status in different AEZ's of Bangladesh during T. Aman 2023.

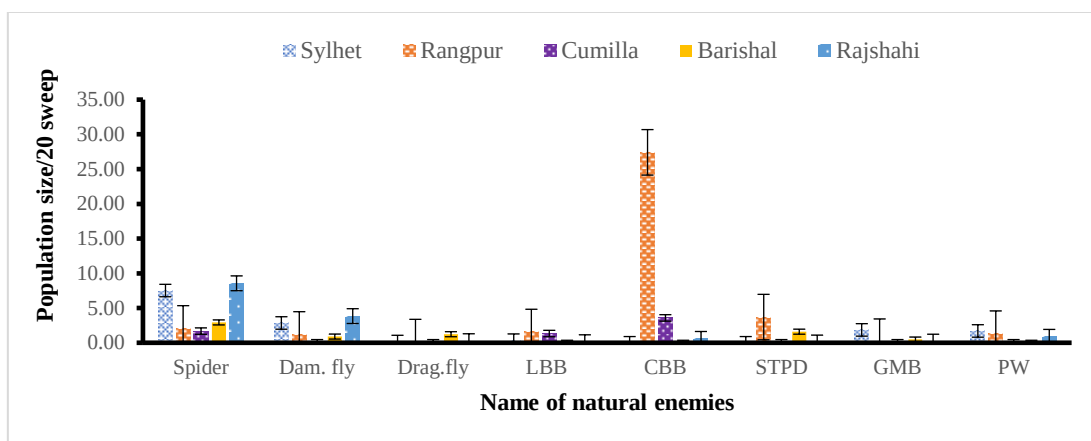


Fig. 5. Natural enemies of rice insect pests in different AEZ's of Bangladesh, T. Aman 2023.

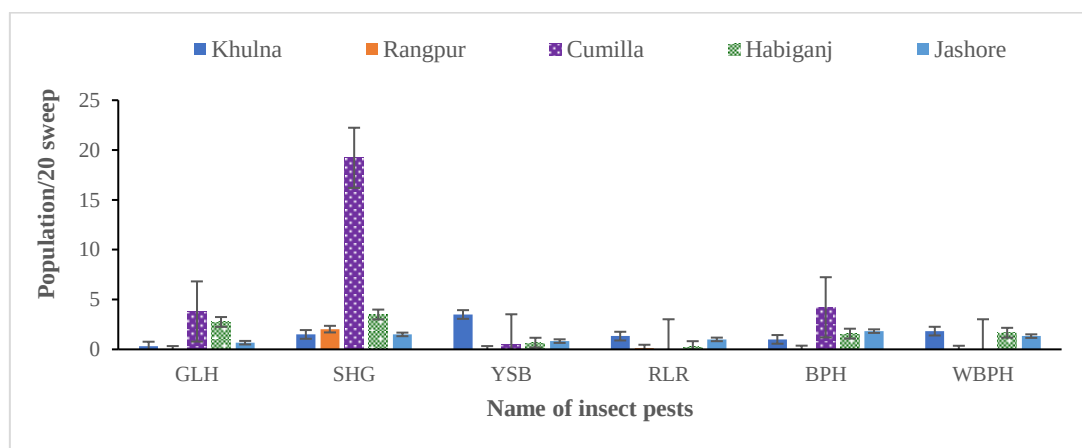


Fig. 6. Rice insect pests status in different AEZ's of Bangladesh during Boro 2023-24.

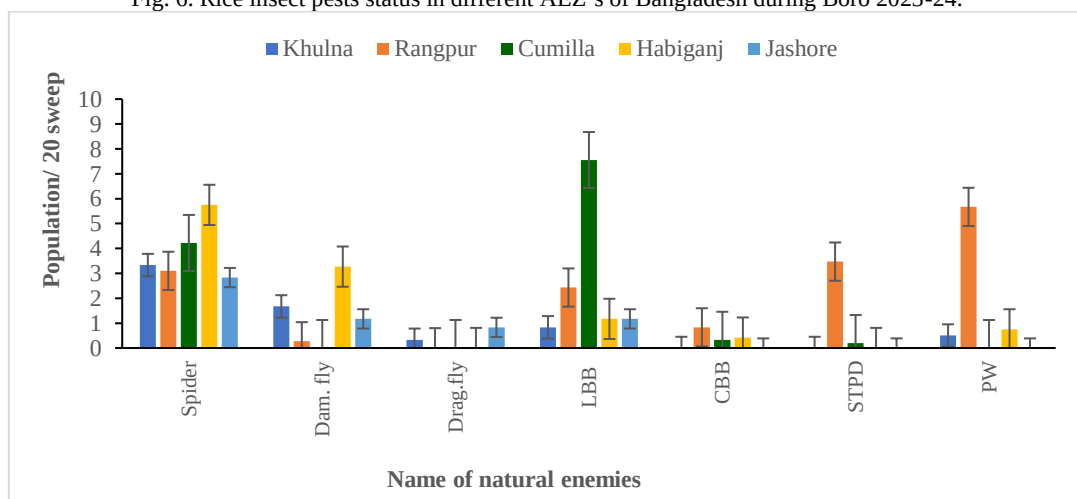


Fig. 7. Natural enemies of rice insect pests in different AEZ's of Bangladesh, Boro 2023-24.

## Fall armyworm (FAW) and Yellow stem borer (YSB) monitoring through pheromone trap

Each of four FAW and YSB pheromone trap were set up in all seven experimental plots for monitoring and control purpose respectively. FAW pheromone traps were set 100 m between traps in each of the seven locations. YSB pheromone traps were set @40/ha. Trapped catch data were taken on an average of eight weeks in all seven locations during Boro 2023-24 season. In each of the field, BRRI Scientists/Scientific Assistance or SAAOs carefully examined 10 rice leaves for signs of new Fall Armyworm damage for Fresh Windowpanes (FW) (Fresh pinholes, window panes, leave damage etc.) or Infested Plants (IW) (infested stem, infested panicle, fresh frass etc.). Every Monday the trap catch and field scouting data were collected and recorded. The average trap catch and field scouting

data were recorded. The ranged of FAW catches was 0.02 to 0.33/trap/day and YSB catches was 0.04 to 0.74/trap/day (Fig. 8). Highest FAW moth catches were observed 0.33/trap /day at the farmers field of Kaliganj, Jhenaidha (Fig. 8). That might be happened as maize field was remained adjacent to the trial field. In case of FAW, no fresh window panes (WP) and infested plants (WP) were found during scouting. Again, no dead hearts and white heads were observed in case of YSB except Batiaghata, Khulna. Highest YSB populations and damages were observed at Batiaghata, Khulna and it is obvious that YSB status remain highest in the coastal belt of Khulna, Bangladesh due to vast fallow areas remain in those areas after T. Aman cultivation. So, diapausing YSB remain highest in that areas

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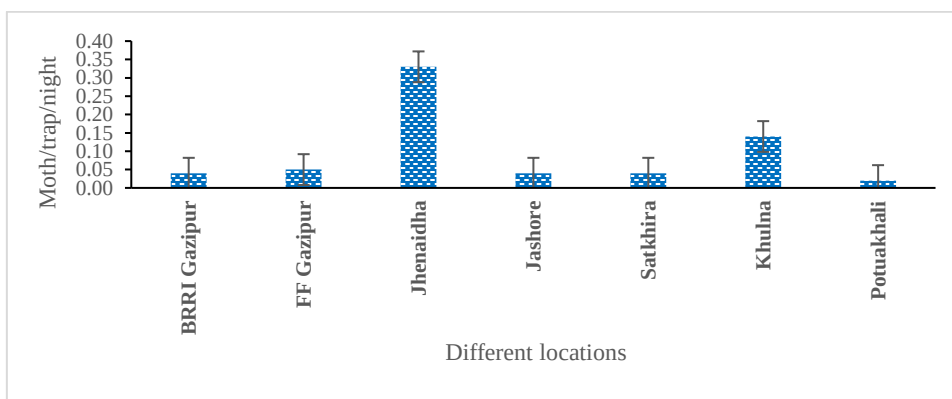


Fig. 8. Catches of FAW and YSB status in pheromone trap at different locations of Bangladesh, Boro 2023-24.

## BIO-ECOLOGY OF RICE INSECT PEST AND NATURAL ENEMY

### Effect of temperature on the biology and life cycle of rice leafroller, *Cnaphalocrosis medinalis*

Rice leafroller colony was maintained on BR3 plants under greenhouse conditions at BRRI HQ, Gazipur to know the impact of elevated temperature on the development of rice leafroller. Egg incubation period was significantly higher in 20°C compared to 25°C and 30°C. Larval period was significantly

different in three different temperatures. In lowest temperature (20°C), the duration was higher compared to 25°C and 30°C. Pupal duration was completed quickly at 30°C than 20°C and 25°C (Fig. 9). Adult longevity was found highest at 25°C followed by 30 and 20°C (Fig. 10). Total growth duration was found highest at 20°C that was decrease with increases temperature 25 to 30°C (Fig. 11).

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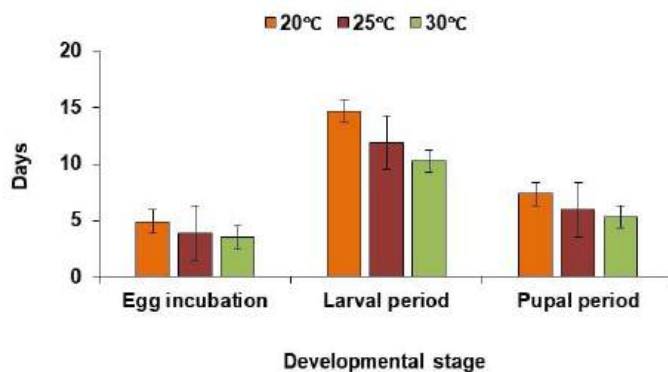


Fig. 9. Effect of temperature on the growth duration of rice leafroller.

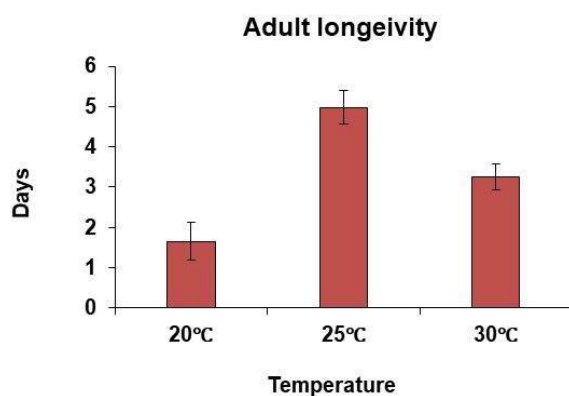


Fig. 10. Adult longevity of rice leafroller in different temperature.

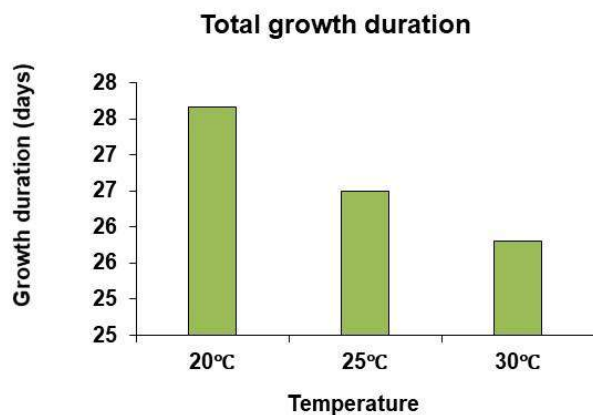


Fig. 11. Total growth duration of rice leafroller in different temperatures.

### Stem borer species abundance and assessing yield losses in rice

In Aus, dark headed borer (DHB) was the dominant species followed by striped stem borer (SSB). In

Aman, YSB was the dominant species followed by SSB and DHB (Fig. 12). In total 37 stem borer larvae

were found from 93 tiller dissection in Aus and 167 stem borer larvae were found from 506 tiller dissection in Aman season. The filled grain number

was reduced in infested hill than uninfested hill. Thus 42% yield loss was occurred in stem borer treated plot (Fig. 13).

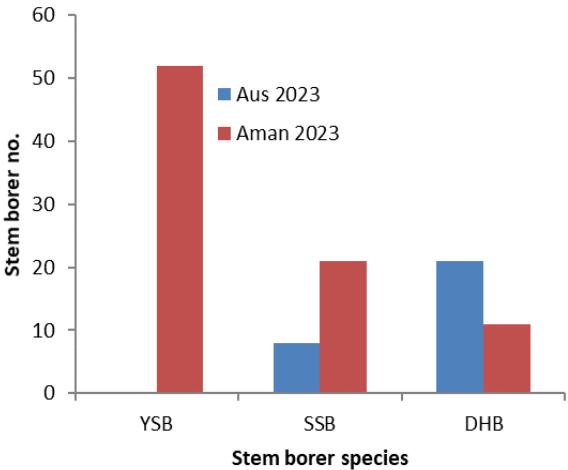


Fig. 12. Stem borer species abundances in Aus 2023 and T. Aman 2023 at BRRI HQ, Gazipur.



Fig. 13. Filled and unfilled grain number in stem borer infested rice hill at BRRI HQ, Gazipur.

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# BIOLOGICAL CONTROL OF RICE INSECT PESTS

## Conservation of natural enemies through eco-engineering

The experiment was conducted with BRRI dhan103 at BRRI HQ farm, Gazipur during T. Aman 2023

season. A large field (one acre) was divided into two blocks for two treatments. The treatments were T<sub>1</sub>=Rice field with flowering plants (sesame and cosmos) on bunds (to provide food and shelter for different parasitoids). T<sub>2</sub>=Farmers practice i.e. prophylactic insecticide use. Insecticide applied three times Vayego Superb 1.0 GR (tetraniliprole + fipronil) @ 10.0 kg/ha for one time and Virtako 40WG (chlorantraniliprole+thiamethoxam) @ 75g/ha for two times in T<sub>2</sub> at 15 days interval after

Vayego superb 1.0 GR used. Vayego superb 1.0G was used with 1st top dressing of urea fertilizer followed by Virtako 40WG at 15 days interval. Twenty complete sweeps were taken from both the blocks three days after insecticide used in T<sub>2</sub>. Insect pests and natural enemies' number of all sweeps from both blocks were counted and recorded separately. Egg parasitism of yellow stem borer (YSB) was determined through retrieval method and natural parasitism of rice leafroller (RLR) larvae was also determined. Insect pests' status remained below the economic threshold level (ETL) in both the treatments. Highest number of SHG was found in T<sub>1</sub> (5.83/20 sweep) followed by green leafhopper (2.0/20 sweep) and whorl maggot (1.17/20 sweep) during T. Aman 2023 (Fig. 14). The range of other insect pests like, YSB, BPH, WBPH, RB and RLR was found (0.33 to 0.67/20 sweep) in T<sub>1</sub> (Fig. 12). Short horned grasshopper was also found highest (4.17/20 sweep) in T<sub>2</sub> followed by GLH (1.33/20 sweep) and WLH and WM both of 1.0/20 sweep in T<sub>2</sub>. The range of other insect pests were (0.5 to

0.83/20 sweep in T<sub>2</sub> at BRRI Gazipur (Fig. 14). Among the natural enemies highest numbers of natural enemies were found in T<sub>1</sub> where insecticide was not used. Number of lady bird beetle (LBB), spider (SPD), damsel fly (Dam. fly) and parasitic wasp (PW) were found highest 2.33, 2.17, 1.67 and 1.00 per 20 complete sweep respectively in T<sub>1</sub> compared to T<sub>2</sub> (0.0 to 1.0 /20 sweep) at BRRI farm, Gazipur (Fig. 15). Rice leafroller larval parasitism and YSB egg parasitism observed highest in T<sub>1</sub> (27.5 and 44.31 % respectively) compared to T<sub>2</sub> (2.26 and 6.87 % respectively). Though grain yield was observed similar both in T<sub>1</sub> and T<sub>2</sub> (5.88 and 5.9 t/ha respectively) but additional sesame was produced in T<sub>1</sub> which increase the rice equivalent yield (REY) to 6.13 t/ha. As a result, 3.75 % additional yield obtained in T<sub>1</sub> compared to T<sub>2</sub> (Fig. 16).

**PI:** Md Nazmul Bari, **CI:** Farzana Nowrin, **PL:** Sheikh Shamiul Haque

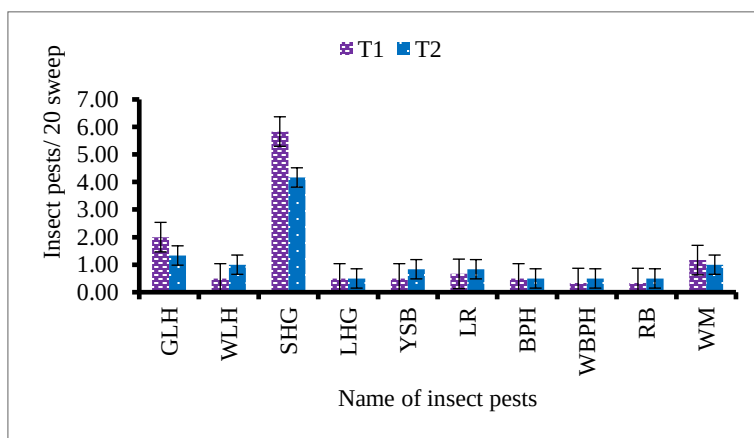


Fig. 14. Insect pests number per 20 sweep in different treatments during T. Aman 2023, BRRI, Gazipur (T<sub>1</sub>=Rice field with flowering plant on bunds, T<sub>2</sub>= Farmers Practice i.e., insecticide application).



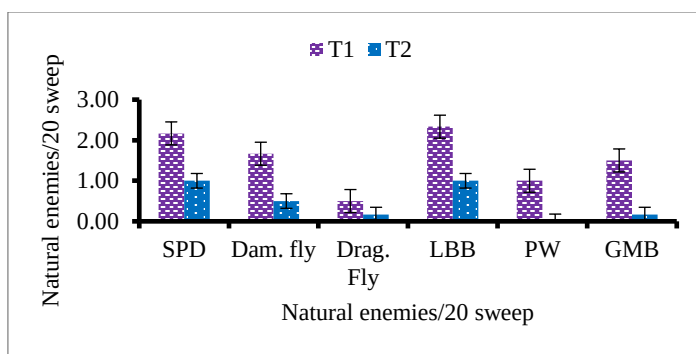


Fig. 15. Natural enemies number per 20 sweep during T. Aman 2023, BRRI, Gazipur (T<sub>1</sub>=Rice field with flowering plants on bunds, T<sub>2</sub>= Farmers practice i.e., insecticide application).

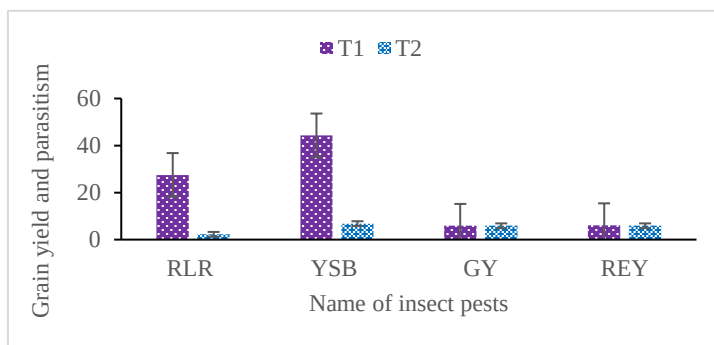


Fig. 16. Grain yield, REY and % parasitism of YSB egg and RLR larvae during T. Aman 2023, BRRI Gazipur. (T<sub>1</sub>=Rice field with flowering plant on bunds, T<sub>2</sub>= Farmers Practice i.e., insecticide application).

### Study on the biology of green mirid bug, an egg predator of BPH

The mirid bug, *Cyrtorhinus lividipennis*, is a plant-feeding and predatory insect, preferring plant and leafhopper eggs and young nymphs. It is now one of the important predators of brown planthopper (BPH) *Nilaparvata lugens* and white backed planthopper (WBPH) *Sogatella furcifera*. Adult green mirid bugs was collected from light trap, vegetable flowers and BPH infested fields. Initially the population was reared in caged rice plants having BPH eggs-and adults. After having a good number of population, attempts was taken to determine the food habit of the insect. The test food materials was different vegetable flowers, nectar honey solutions, sugar solutions and eggs of moths specially the *Corcyra cephalonica*. Attempts were made to rear green mirid bug on different hosts eg., *Corcyra* egg and

larva, flowers of bottle gourd and other flowering plants but no success found. GMB didn't complete life cycle.

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**PL:** Sheikh Shamiul Haque

### EVALUATION OF CHEMICALS AND BOTANICALS AGAINST RICE INSECT PESTS

#### Test of different insecticides against major insect pests of rice

The effectiveness of commercial formulations of different insecticides against major insect pests of rice was evaluated in field and storage condition. A total of 188, 45 and 14 commercial formulations of insecticides were evaluated against brown planthopper (BPH), yellow stem borer (YSB) and rice weevil (RW) respectively. Among them 96, 13 and nine insecticides were found effective against BPH, YSB and RW respectively (Fig. 17).

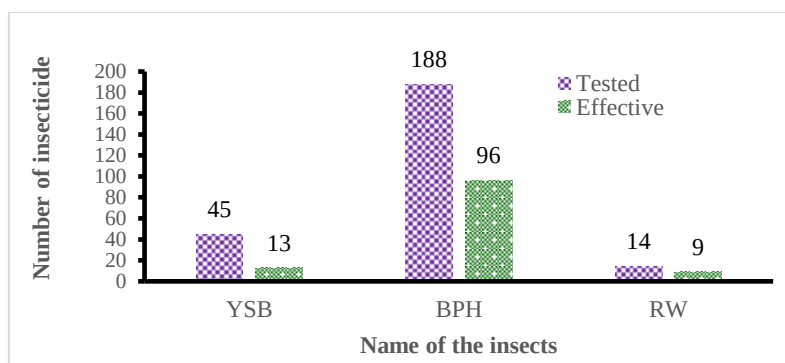


Fig. 17. No. of tested insecticides against major insect pests.

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### Use of nanoparticle to control rice insect pests

The effectiveness of biosynthesized silica (SiO<sub>2</sub>) nanoparticles against BPH was evaluated at four concentrations (1000, 750, 500, and 250 ppm). The nanoparticle solutions at different concentrations were sprayed on 15-day-old rice seedlings. Twenty 2nd to 3rd instar nymphs of BPH were introduced into each treatment and maintained at room temperature within separate Mylar film cages. Insect mortality was recorded at 24, 48, 72 and 96 hours post-spray. The percentage of insect mortality was calculated using the corrected Abbott's formula. Silica (SiO<sub>2</sub>) nanoparticles demonstrated significant efficacy against BPH nymphs, with 74% mortality observed at a concentration of 1000 ppm after 96 hours of application, followed by 73% mortality at

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72 hours post-application (Fig.18). Conversely, the control group showed the lowest mortality at 24 hours post-application. Mortality rates increased over time, with higher concentrations exhibiting the highest rates of mortality. Silica (SiO<sub>2</sub>) nanoparticles demonstrated significant efficacy against rice weevil, with 67% mortality observed at a concentration of 1000 ppm after 120 hours of application, followed by 59% mortality at 96 hours post-application (Fig.19). Conversely, the control group showed the lowest mortality at 24 hours post-application. Mortality rates increased over time, with higher concentrations exhibiting the highest rates of mortality.

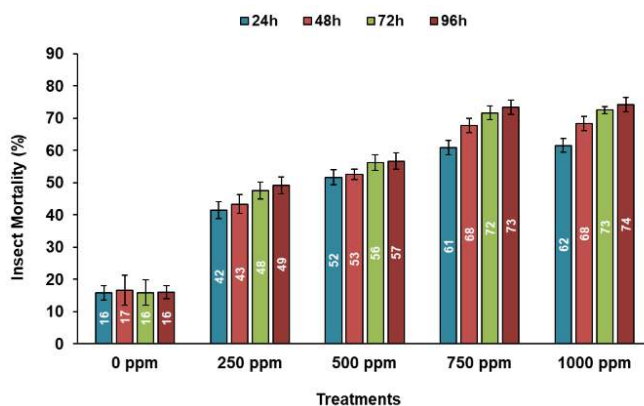


Fig. 18. Effect of SiO<sub>2</sub> nanoparticle on the mortality of brown planthopper (BPH).

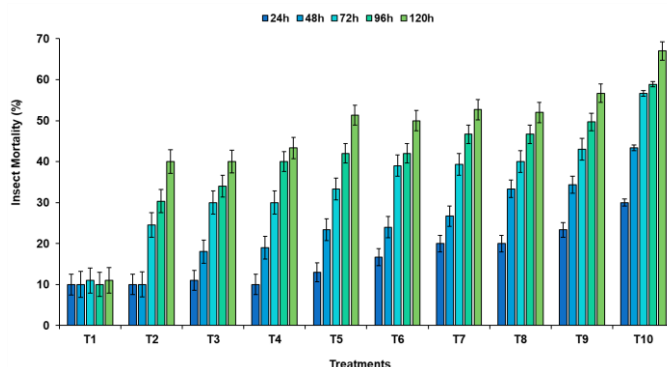


Fig. 19. Effect of SiO<sub>2</sub> nanoparticle on the mortality of rice weevil.

### Pesticidal effect of different botanicals against rice weevil (*Sitophilus oryzae* L)

This experiment was conducted in Entomology Division BRRI following a CRD design with three replications. The treatments were included T<sub>1</sub>=Neem oil, T<sub>2</sub>=Mahogany seed kernel powder, T<sub>3</sub>=Neem leaf powder, T<sub>4</sub>=Biskatali plants powder and T<sub>0</sub>=Control (untreated). Fresh leaves of neem and biskatali, along with mahogany fruits, were collected and prepared by washing, drying, and grinding into powder. Sterilized BRRI dhan87 rice was placed in containers, treated with the extracts, and then infested with 10 pairs of adult weevils per container. The containers were covered with netting to ensure proper aeration, and the conditions were maintained at 65±5% relative humidity and 25±2°C temperature. Insects mortality data were taken at 24, 48, 72 and 96 HAT. Number of F<sub>1</sub> adult emergence, weight loss percentage and germination percentage

data were also recorded. All data were subjected to statistical analysis separately by using the analysis of variance technique by R software (versions 2024.04.1). The results showed that the highest insect mortality was found in T<sub>1</sub> (85%), followed by T<sub>4</sub> (75%), T<sub>3</sub> (61.67%) and T<sub>2</sub> (60%) (Fig. 20). The highest mortality in T<sub>1</sub> resulted in the lowest emergence of F<sub>1</sub> progeny compared to the other treatments, indicating its effectiveness in reducing the reproductive capacity of rice weevils (Fig. 21). Additionally, T<sub>1</sub> exhibited the least weight loss of grain, followed by T<sub>2</sub>, T<sub>4</sub>, T<sub>3</sub>, and T<sub>0</sub> (Table 1). Regarding seed germination, T<sub>4</sub> had the highest germination rate (94%), followed by T<sub>3</sub> (90%), T<sub>2</sub> (89.67%), T<sub>1</sub> (88%), and T<sub>0</sub> (80.67%). The findings indicated that the use of neem oil and biskatali plant powder can effectively control rice weevil in stored rice.

**P.I:** Tapon Kumar Roy, **PL:** Sheikh Shamiul Haque

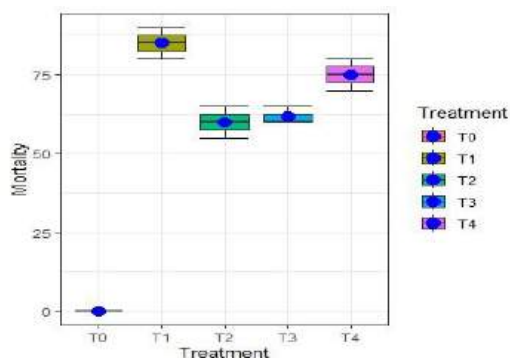


Fig. 20. Effect of SiO<sub>2</sub> nanoparticle on the mortality of rice weevil.

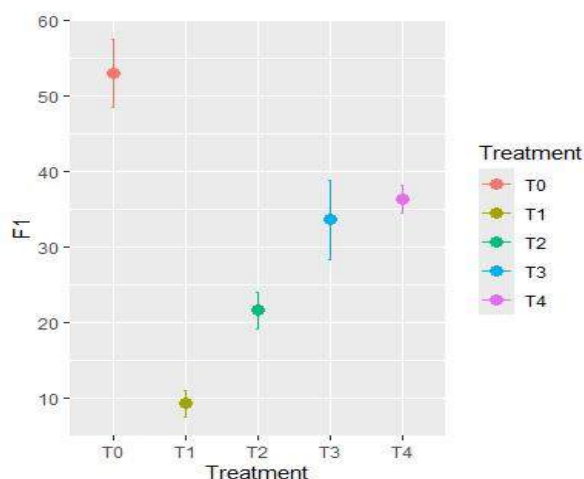


Fig. 21. Effects of botanicals on number of F<sub>1</sub> adult emergence of rice weevil.

**Table 1. Effects of botanicals on weight loss of and germination grain against rice weevil**

| Treat.         | % weight loss of grains | % seeds germination | % germination over control |
|----------------|-------------------------|---------------------|----------------------------|
| T <sub>0</sub> | 32.97 a                 | 80.67 c             | -                          |
| T <sub>1</sub> | 11.03 d                 | 88.00 b             | 9.08                       |
| T <sub>2</sub> | 19.14 c                 | 89.67 b             | 11.16                      |
| T <sub>3</sub> | 21.81 b                 | 90.00 b             | 11.56                      |
| T <sub>4</sub> | 21.41 bc                | 94.00 a             | 16.52                      |
| LS             | ***                     | ***                 | -                          |
| LSD            | 2.54                    | 3.79                | -                          |
| CV%            | 6.56                    | 2.35                | -                          |

### Effect of temperature on growth and development of *Sitophilus oryzae* L. on polished rice

This experiment was conducted in the laboratory of Entomology Division, BIRRI from October to December 2023 by using a complete randomized design (CRD), with three replications. The experiment consisting of eight treatments i.e., T<sub>1</sub>= -80°C, T<sub>2</sub>= -20°C, T<sub>3</sub>=4°C, T<sub>4</sub>=20°C, T<sub>5</sub>=25°C, T<sub>6</sub>=35°C, T<sub>7</sub>=40°C and T<sub>8</sub>=50°C. Twenty grams of fresh rice was taken in Petri dishes. Ten pairs of rice weevils then introduced in each replication of each treatment. Then the petri dishes were kept at room temperature for seven days for mating and egg laying. After seven days, treatments were applied according to design. Weevil mortality was recorded

after 24 hours and the adult weevils were removed and treated as designed treatments for 24 hours. All data were subjected to statistical analysis separately by using the analysis of variance technique by R software (versions 2024.04.1).

Hundred percent mortality of rice weevil were found in T<sub>1</sub>, T<sub>2</sub>, T<sub>3</sub> and T<sub>8</sub> treatments. There was no mortality observed in T<sub>5</sub> treatments (Table 2). Rice weevils could not sustain at very high temperature as well as low temperature. Although there was 100% mortality observed in T<sub>3</sub> and T<sub>8</sub> treatments but F<sub>1</sub> adult's emergence found there. A indicates that, this temperature could be lethal for adult rice weevils but egg could survive. The highest number of F<sub>1</sub> adult were emerged in T<sub>5</sub> treatments which was statistically different from others followed by T<sub>4</sub>.

There were no single F<sub>1</sub> adult emerged in T<sub>1</sub> and T<sub>2</sub>. The highest (%) of weight loss was observed in T<sub>6</sub> and the lowest was in T<sub>1</sub>, T<sub>2</sub> and T<sub>8</sub>.

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**Table 2. Mortality, F<sub>1</sub> adult emergence of rice weevils and weight loss of grain in different treatments**

| Treatment              | Mortality (%) | F <sub>1</sub> adult emergence | Weight loss (%) |
|------------------------|---------------|--------------------------------|-----------------|
| T <sub>1</sub> (-80°C) | 100 a         | 0.00 e                         | 2.71 e          |
| T <sub>2</sub> (-20°C) | 100 a         | 0.00 e                         | 3.79 e          |
| T <sub>3</sub> (4°C)   | 100 a         | 3.33 de                        | 16.81 d         |
| T <sub>4</sub> (20°C)  | 5.00 c        | 24.67 b                        | 29.20 b         |
| T <sub>5</sub> (25°C)  | 0.00 d        | 44.33 a                        | 32.83 a         |
| T <sub>6</sub> (35°C)  | 6.67 c        | 9.00 c                         | 30.79 ab        |
| T <sub>7</sub> (40°C)  | 86.67 b       | 5.00 cd                        | 19.07 c         |
| T <sub>8</sub> (50°C)  | 100 a         | 1.33 de                        | 3.42 e          |
| LS                     | ***           | ***                            | ***             |
| LSD                    | 4.99          | 4.34                           | 2.23            |
| CV                     | 4.63          | 22.89                          | 7.44            |

### Effect of different insecticides on susceptibility of green leafhopper (GLH)

More than 18 generations mass rearing GLH population were used for the experiment in laboratory of Entomology Division, BRRI. International resistance action committee (IRAC) susceptible test method 005 was followed (IRAC, 2022) in lab condition with 25°C temperature and 70% humidity. Treatments: T<sub>1</sub>= Mipcin 75 WP, T<sub>2</sub> = Durshban 20 EC, T<sub>3</sub> = Confidor 70WG, T<sub>4</sub>= Suntap 50 SP, T<sub>5</sub>= Award 40 SC, T<sub>6</sub>= Nitro 505 EC. Design was CRD with three replication.

Six concentrations of each six-group insecticide solution were used in this experiments. Mortality data were recorded to Carbamate and Organophosphate group after 24 and 48 hours of treatment, Neonicotinoids and Neristoxin analogue group after 72 hours of treatment and Orghanophospate and Pyrethroid combinations after 24, 48, and 72 hours after treatment (IRAC, 2022). In Mipcin 75WP, highest mortality (100%) was found at double of the recommended dose @ 3450 ppm, followed by 1725 ppm, 864 ppm, 432 ppm, 216 ppm and control. More than 80% or above mortality

was found with recommended dose 1,725 ppm at 24 hours after spray (HAS). Mortality above 80% was also found @ 864 ppm and 432 ppm and 216 ppm. The percent mortality increases with higher concentration and over time up to 72 HAS (Fig. 22). In Dursban 20 EC, none of the concentrations, including recommended dose 400 ppm even 8-fold of the recommended dose 3200 ppm failed to show mortality 80% or above at 24 hours after spray (HAS). The highest mortality of greenhouse GLH was found 86.66% @ 3200 ppm at 72 HAS (Fig. 23). The recommended dose showed 53, 62, and 64% mortality at 24, 48, and 72 hours after treatment respectively. This indicated that the insecticide Dursban 20EC did not work well in the field to control the GLH. GLH might be resistant to Dursban 20EC. The insecticide Confidor 70 WG showed GLH mortality more than 80% at recommended dose 49 ppm and 98 ppm after 24 HAT ((Fig. 24). Recommended dose of Nereistoxin analogue group insecticide Suntap 50SP showed more than 80% mortality at 48 HAT at the same time (Fig. 25). Award 40SC recommended dose showed more than eighty percent mortality at 72 hours after treatment (Fig. 26). Nitro 505EC is a combination formulation

consists of Organophosphate and Synthetic Pyrethroids group insecticides. Synthetic Pyrethroids group insecticides are not recommended to use in rice field. But it is widely used to control rice insect pests. In these circumstances, we have included in the experiments for bioassay test. The recommended dose of Nitro 505EC is 500 ppm for field crops except rice. It was found that more than 80% mortality occurred @ 8.0 ppm at 24 hours after treatment (Fig. 25). But it is widely used in the rice

field @500 ppm (extreme dose). As a result it kills all living organisms both in the terrestrial and aquatic rice ecosystems. It disrupts the faunal biodiversity in the ecosystem as well as it creates negative impact on environment. It is urgently needed to ban such type of insecticide use in the rice field.

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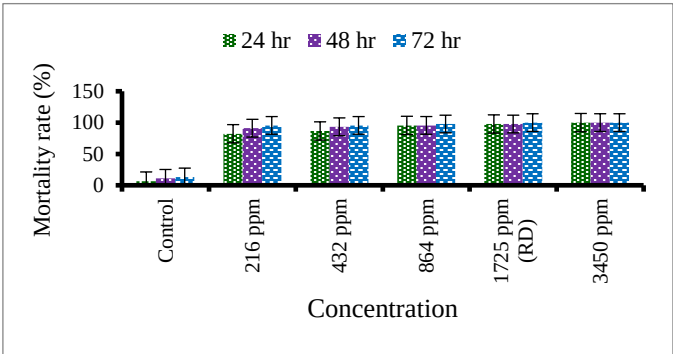


Fig. 22. Mortality of GLH after the application of Mipcin 75WP in different doses.

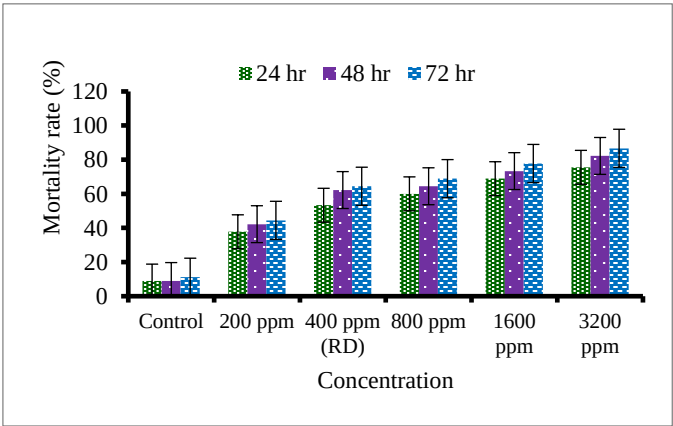


Fig. 23. Mortality of GLH after the application of Dursban 20EC in different doses.

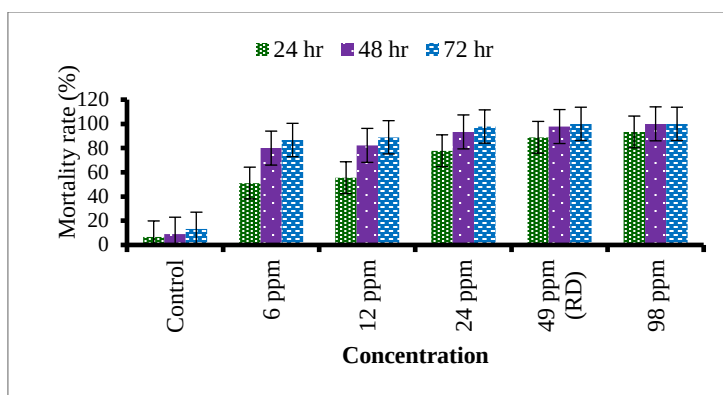


Fig. 24. Mortality of GLH after the application of Confidor 70WG in different doses.

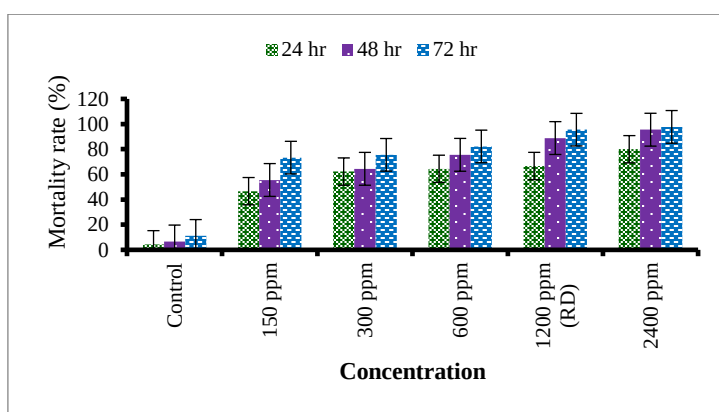


Fig. 25. Mortality of GLH after the application of Suntap 50SP in different doses.

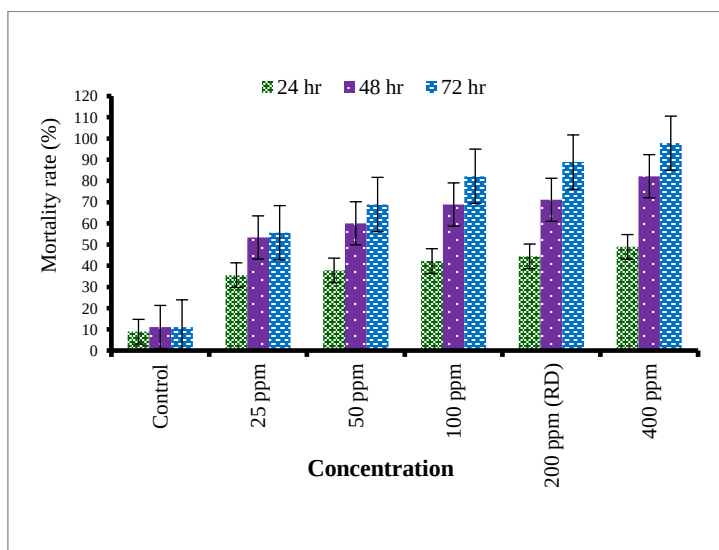


Fig. 26. Mortality of GLH after the application of Award 40SC in different doses.

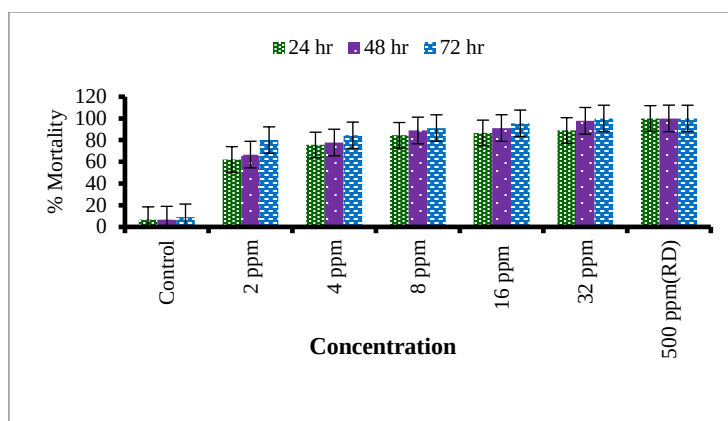


Fig. 27. Mortality of GLH after the application of Nitro 505EC in different doses.

### Effect of different doses of Mipcin 75WP on resurgence development to Green Leafhopper (GLH)

A laboratory experiment was carried out at the Entomology Division, BRRI, to determine the insecticide doses that cause resurgence of the green leafhopper (GLH). Rice seedlings with four tillers were grown in pots. The GLH population was developed in a net house mass rearing box. Subsequently 25 third instar nymphs were released per treatment. After 48 hours, Mipcin 75WP was applied at the following doses: T<sub>1</sub> = low (3450 ppm), T<sub>2</sub> = recommended (1725 ppm), T<sub>3</sub> = low (864 ppm), and T<sub>4</sub> = Control (water). The experiment was laid out on CRD with four replications. The number of dead and alive GLH was recorded 48 hours after treatment (HAT). The first-generation GLH population was also recorded 30 days after the initial data collection. The resurgence ratio was calculated as the population one month after the first generation divided by the control population. Two days after the application of Mipcin 75 WP insecticide, the survival rates of the green leafhopper (GLH) in treatments T<sub>1</sub>, T<sub>2</sub>, T<sub>3</sub>, and T<sub>4</sub> were found to be 0, 1.25, 1.50, and 19.75 respectively. Statistically significant differences were observed among the four treatments 48 hours after insecticide application and one month after the first generation at the 5% level of significance. One month after the insecticide

application, first-generation GLH (1st or 2nd instar) emerged from the surviving population. The number of first-generation nymphs was recorded as 0.00, 2.75, 44.25, and 129.5 in treatments T<sub>1</sub>, T<sub>2</sub>, T<sub>3</sub>, and T<sub>4</sub>, respectively. The highest resurgence ratio of 0.34 was found in the low dose treatment (T<sub>3</sub>), followed by the recommended dose (T<sub>2</sub>) with 0.02, and the high dose (T<sub>1</sub>) with 0.00. The highest mortality (100%) was observed in treatment T<sub>1</sub>, followed by 95% in T<sub>2</sub>, 94% in T<sub>3</sub>, and the lowest mortality (21%) in T<sub>4</sub>, 48 hours after insecticide application.

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### Effect of insecticides on natural enemies of rice insect pests

Eight commercially registered insecticides for rice of different chemical group were evaluated at BRRI, Gazipur in T. Aman 2023 and Boro 2023-24 with popular BRRI variety. The generic name of eight insecticides were *Celastrus angulatus*, tetraniliprole+ fipronil(vayego), abamectin, cyantraniliprole+ lufenuron (Minectoxta 40SC), clothianidin, isocycloserum, cartap and Fipronil. These insecticides were sprayed in rice at vegetative stage with three replicated trial and control plot remain free of insecticides. Recommended dose was used for each insecticide. Insects and natural enemy population were collected after 48 hours after spraying (HAS) by 20 complete sweeps.



The data of natural enemy populations were counted and recorded. Different natural enemies were found lower in all the insecticide treated plots than the control plot at 48 after spraying. Spider, damsel fly, dragon fly, green mirid bug, carabid beetle, chironomids, parasitoids and dipteran flies were the major natural enemies (NE) found in the counted sweep sample. Total number of NE and other non-

pest, comparable with control were found highest in fipronil, cartap, tetraniliprole+ fipronil, Abamectin and *Celastrus angulatus* (Fig. 28). So these insecticides may be considered as comparatively safer for NE.

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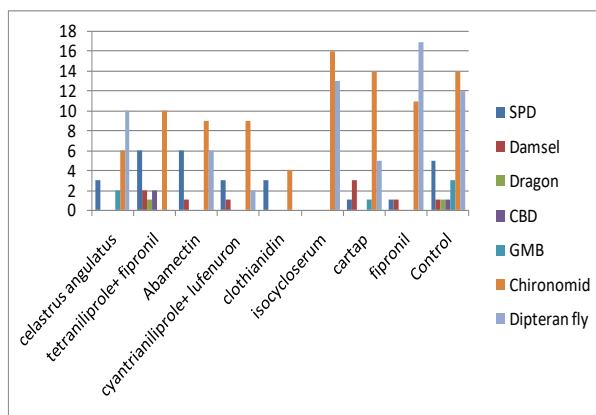


Fig. 28. Total natural enemies and non-pest rice insects per 20 sweeps from different insecticides treated plots.

## INSECTICIDE TOXICOLOGY

### Residue analysis of different insecticide in rice by LCMS

The field study was carried out at BRRI HQ, Gazipur during Boro 2023-24 season in three adjacent field plots with complete randomized block design (CRD), each with an area of  $5 \times 4 = 20 \text{ m}^2$  for a particular insecticide. Most popular selected insecticide was applied at doses. Four treatments were used i.e.,  $T_1$ =chlorantraniliprole (3 times) with standard dose,  $T_2$ = chlorantraniliprole (3 times) double of standard dose,  $T_3$ =imidacloprid (3 times) with standard dose, and  $T_4$ = imidacloprid (3 times) @ double dose and  $T_5$ = Control. After harvest, a homogenous sample 1.0 kg was separated for each treatment. The collected samples were then stored in a freezer at  $-20^\circ\text{C}$  during 30 day period until extraction for pesticide residues analysis. The concentrations of chlorantraniliprole (CTP), and imidacloprid (IMIDA) were analyzed separately by

the developed method of LCMS. The insecticide residues in different treatments were below the detection level so, that was not detected (n.d.) by the LCMS except CTP in  $T_2$  and IMIDA in  $T_4$  where insecticide was used double of the recommended doses. The detection concentration of chlorantraniliprole was found  $0.018 \text{ mg kg}^{-1}$  only in  $T_2$  and imidacloprid was  $0.029 \text{ mg kg}^{-1}$  in  $T_4$ , which were below the Maximum Residue Limit (MRL:  $0.4 \text{ mg kg}^{-1}$  for chlorantraniliprole and  $0.6 \text{ mg kg}^{-1}$  for thiamethoxam, EU).

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### Multiple residue analysis of different insecticide in rice ecosystem

The field study was carried out at BRRI HQ, Gazipur during Boro 2023-24 as describe in experiment 6.1. Most popular selected insecticide was applied at the recommended doses or with different combination in different growth stages of the rice plant. Three

treatments were used in the experiments i.e.,  $T_1$ = chlorantraniliprole (2 times),  $T_2=T_1$  + imidacloprid (1 times) and  $T_3= T_1 + T_2$ +thiamethoxam (1 times). Three plots were remained untreated (not sprayed) as a control ( $T_4$ ). After harvest, a homogenous sample 1.0 kg was separated for each treatment. The collected samples were then stored in a freezer at -20°C during 30 day period until extraction for pesticide residues analysis. Insecticide residues were detected using a LC-MS2020 fitted with electrospray ionization (ESI) probe operated in the positive ion mode. The concentrations of chlorantraniliprole (CTP), imidacloprid (IMIDA) and thiamethoxam (THM) were analyzed separately by the developed method of LCMS. The concentration of the insecticide residues in different treatments were below the detection level. So, that was not detected (n.d.) by the LCMS except  $T_3$ . The concentration of the insecticide residues was below the detection level so, that was not detected (n.d.) by the LCMS. The concentration of thiamethoxam were found 0.022 mg kg<sup>-1</sup> only in  $T_3$ , which were below the Maximum Residue Limit (MRL: 0.6 mg kg<sup>-1</sup> for thiamethoxam, EU).

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#### **Development and validation of analytical methods for multiple pesticide residue determination in rice grain using LC-MS/MS**

Method development for multiple pesticide residue determination in rice grain was carried out by using Liquid Chromatography with Tandem Mass Spectrometry (LCMS/MS8050, SHIMADZU) fitted with electrospray ionization (ESI) probe operated in the positive ion mode. The methods were developed for the determination of carbofuran, chlorantraniliprole, chlorpyrifos, isoprocarb, thiamethoxam, malathion, diazinon, dinotefuran, imidacloprid, pymetrozine, nitenpyram, carbaryl, carbosulfan, cypermethrin and fipronil. The pesticide residue database of the LCMS/MS system was used for the data analysis. QuEChERS Method

for Pesticide Residue Analysis (Method AOAC 2007.01) was applied for sample preparation. A total of 15 insecticides determination methods namely carbofuran (m/z 222.2500>123.1000 and RT 1.81 mins), chlorantraniliprole (m/z 482.0000>283.9500 and RT 1.41 mins), chlorpyrifos (m/z 350.0000>97.1000 and RT 2.73 mins), isoprocarb (m/z 194.1000>95.0000 and RT 1.51 mins) and thiamethoxam (m/z 292.0000>211.1000 and RT 1.96 mins), malathion (m/z 331.0000>97.0000 and RT 5.44 mins), diazinon (m/z 305.1000>169.1000 and RT 2.08 mins), dinotefuran (m/z 203.1000>114.2000, RT 9.62 mins), imidacloprid (m/z 256.15000>175.2000 and RT 1.36 mins), pymetrozine (m/z 218.1000>105.000 and RT 1.16 mins), nitenpyram (m/z 270.8000>225.0000), carbaryl (m/z 202.2000>127.1000 RT 3.50 mins), carbosulfan (m/z 381.2000>118.1000), cypermethrin (m/z 433.1000>191.1000), and fipronil (m/z 435.0000>330.000 and RT 4.21 mins) were standardized by Shimadzu LCMSMS 8050. The ranged of LoD were 0.04 to 7.45 ppb and LoQ were 0.13 to 22.58 ppb. In the method file, ESI interface, Desolvation temperature, DL temperature, nebulizing gas flow, heating gas flow, and drying gas flow were set at 300°C, 526°C, 250°C, 2.00 L/min, 10.00 L/min and 10.00 L/min respectively. Detection was carried out in multiple reactions monitoring (MRM).

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#### **Determination of insecticide residues in rice grain samples collected from different locations of Bangladesh**

Forty rice sample were collected randomly from Dinajpur, Rangpur, Chattogram, Khulna and Cox's bazar. A homogenous sample 0.5 kg amount of 8 to 12 different rice varieties from each of the locations were collected. The collected samples were then stored in a freezer at -20°C during 30-day period until extraction for pesticide residues analysis. Different popular rice samples i.e., Shampa Katari,

Siddho Katari, Dhekichata Shampa Katari, Nizershail, Chinigura, Summon Swarna, Ranjit Swarna, Anowarapajam, Radhunijira, Rajbhog, Amin Minikit, Jirashail, JahuraMinikit, Kumragore, Ranisalute and Gobindobhog were collected from local popular market of Dinajpur, Rangpur and Khulna region. Among the collected 40 samples, 16 were analyzed to determine 10 different insecticides i.e., chlorantraniliprole (ctp), imidacloprid (imida), thiamethoxam (thm), carbofuran (carbo), diazinon (diazi), dinotefuran (dinote), fipronil (fipro), iso procarb (isop), malathion (mala) and carbaryl (cabryl). The concentrations of different insecticides were determined by the developed multi-residue analysis methods. Insecticides residues were not found in all the samples (not detected) except Chinigura. Among the tested 10 different insecticides three insecticide residues were determined in Chinigura rice. The concentrations of chlorantraniliprole (ctp), imidacloprid (imida) and isoprocarb (isop) were found in the chinigura rice samples 0.012, 0.021 and 0.19 mgkg<sup>-1</sup> respectively. The maximum residue limit of the insecticides is 0.4, 0.5 and 0.3 mgkg<sup>-1</sup> respectively. The retention time of the tested insecticides were 1.67 to 33.22 minutes. The highest (33.22 minutes) and lowest (1.67 minutes) retention time were observed in diazinon and dinotefuran respectively.

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## HOST PLANT RESISTANCE

### Screening of rice germplasms against major rice insect pests

Seeds of one hundred germplasms was collected from GRS Division, BRRI and tested against BPH. Each test line was seeded in 20-cm-long rows in a seed box (60 × 45 × 10 cm). Rows were 5 cm apart. A row of the susceptible check variety (BR3) and a resistant check variety (T27A) was planted randomly in the seed boxes. Among the one hundred

germplasm, three germplasm showed moderately susceptible reaction (score 5) against BPH in T. Aman 2023 season. The three germplasm are Munsur, Dighi baual and Kalosaitta.

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### Screening of rice advanced lines against major rice insect pests

Twenty RYT advanced breeding lines of rainfed lowland rice (RLR) were screened in T. Aman 2023. Most of the entries showed susceptible reaction (score 7 and 9). Eight advanced breeding lines of drought tolerant rice (DTR) were screened in T. Aman 2023. One drought tolerant rice (DTR) IR127009-B-8-2-1-2 showed moderately susceptible reaction (score 5) against BPH. Eight advanced breeding lines of zinc enriched rice (ZER) were screened in T. Aman 2023. Most of the entries showed susceptible reaction (score 7 and 9). Four ALART Antioxidant enriched rice materials were screened in T. Aman 2023. One ALART antioxidant enriched rice BR12836-4R-312 showed moderately susceptible reaction (score 5) against BPH in T. Aman 2023 season. Three ALART (SD) favourable Boro rice (FBR), two ALART (LD) FBR, six ALART (LB) FBR, four ALART cold tolerant rice (CTR), three PVT (Fertilizer Management) FBR breeding lines were screened in Boro 2023-24 season. Most of the entries showed susceptible reaction (score 7 and 9). One hundred eighty-eight FBR cold tolerant rice (CTR) were screened against BPH in Boro 2023-24 season. Among the FBR cold tolerant rice, one entry IR17A2922 showed moderately resistant reaction (score 3) and four entries BR12676-4R-392, BR13138-5R-141, IR17A2917 and IR12A173 showed moderately susceptible reaction (score 5) against BPH. Twelve ALART Boro, 15 disease resistant rice, nine RYT-1 of premium quality rice (PQR), eight RYT-2 PQR, 13 RYT-3 PQR, nine RYT zinc enriched rice (ZER) were screened in Boro 2023-24 season. Most of the entries showed susceptible reaction (score 7 and 9)

against BPH. Seventy-six FBR (BPH 17 and BPH 32) materials were screened against BPH in Boro 2023-24 season. Among FBR (BPH 17 and BPH 32) BPH gene rice, two entries BR13418-5R-81 and BR13418-5R-93 showed moderately resistant reaction (score 3) and 13 entries BR13418-5R-3, BR13418-5R-6, BR13418-5R-8, BR13418-5R-26, BR13418-5R-37, BR13418-5R-40, BR13418-5R-47, BR13418-5R-51, BR13418-5R-53, BR13418-5R-76, BR13418-5R-78, BR13418-5R-82 and BR13418-5R-100 showed moderately susceptible reaction (score 5) against BPH. Sixty-two FBR lodging tolerance rice were screened against BPH in Boro 2023-24 season. Among FBR lodging tolerance trial, one entry IR17A2922 showed moderately resistant reaction (score 3) and three entries BR12676-4R-392, BR7528-2R-19-16-RIL-59 and IR12A173 showed moderately susceptible reaction (score 5) against BPH. Twenty RYT\_CS1 on cold tolerant rice were screened against BPH in Boro 2023-24 season. Among RYT\_CS1 cold tolerant rice one entry IR17A2922 showed moderately resistant reaction (score 3). Twenty-one RYT\_CS2 on cold tolerant rice were screened against BPH in Boro 2023-24 season. Among RYT\_CS2 cold tolerant rice, one entry IR17A2922 showed moderately resistant reaction (score 3). Three hundred fifty-two OYT insect resistant rice (IRR) were screened against BPH in Boro 2023-24 season. Among OYT insect resistant rice, one entry BR13482-4R-202 showed moderately resistant reaction (score 3) and ten entries BR13466-4R-10, BR13466-4R-42, BR13467-4R-208, BR13471-4R-88, BR13472-4R-1, BR13472-4R-6, BR13472-4R-124, BR13480-4R-29, BR13482-4R-54 and BR13482-4R-115 showed moderately susceptible reaction (score 5) against BPH. Eighty-four PYT insect resistant rice (IRR) were screened against BPH in Boro 2023-24 season. Among PYT insect resistant rice, two entries BR12678-4 R-187 and BR12685-4 R-251 showed moderately susceptible reaction (score 5) against BPH. Forty-five AYT insect resistant rice (IRR) were evaluated against

brown plant hopper (BPH) in Boro 2023-24 season. Most of the entries showed susceptible reaction (score 7 and 9) against BPH.

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## INTEGRATED PEST MANAGEMENT

### **Scale up trials on develop IPM package for rice during Boro 2023-24 season in different locations of Bangladesh**

Seven experiments were conducted in seven different locations i.e., i) BRRI HQ farm, Gazipur ii) Farmers field at Kaliganj, Gazipur iii. Farmers field at Kaliganj, Jhenaidha iv). Farmers field at Jhikargacha, Jashore v) Farmers field at Tala, Satkhira vi) Farmers field at Batiaghata, Khulna and vii) Farmers field at Patuakhali Sadar during Boro 2023-24 season to validate IPM packages for pest management in farmers field with conserving natural enemies in rice eco system. Each of the fields was divided in to two blocks for two treatments. The treatments were  $T_1$ = Integrated pest management (IPM) practice and  $T_2$  = Farmers' practice i.e. prophylactic insecticide use. In  $T_1$ , flowering plants (Marigold, cosmos and sunflower) were grown on bunds surroundings of the rice crop (to serve as nectar and pollen sources and shelter for different parasitoids and predators). Irrespective of location and rice variety the insect pests were remained below the economic threshold level (ETL) both in IPM practiced ( $T_1$ ) and farmers practiced field ( $T_2$ ) during Boro 2023-24 season. Among the insect pests short horned grasshopper (SHG) and green leafhopper (GLH) were found in all the locations except GLH in  $T_1$  at Khulna. No significant differences were observed in case of SHG, YSB and BPH between IPM practiced plot ( $T_1$ ) and farmers practiced plots ( $T_2$ ) i.e., insecticide application plots. Another two major pests, white backed planthopper (WBPH) and rice leafroller (RLR) were found significantly higher in  $T_2$ , where insecticide was applied three times. Four common natural enemies i.e., spider (SPD), damselfly (Dam. fly), lady bird beetle (LBB) and

parasitic wasp (PW) were found in all locations. Among the natural enemies spider (SPD) population was found highest in all the locations. The range of grain yield were 6.19 to 12.72 t/ha in T<sub>1</sub> and 5.97 to 12.77 t/ha in T<sub>2</sub> (Table 5). Neither insecticide nor herbicide or fungicide was used in T<sub>1</sub> in all locations. But herbicide one time, insecticide thrice and fungicides were used twice in T<sub>2</sub> (Farmers' practice) which indicate that pesticides were applied six times in farmer' practiced field (T<sub>2</sub>) in a season. But no significant difference of yield was observed in T<sub>1</sub> and T<sub>2</sub> in three locations. In the other three locations highest yield was obtained in T<sub>1</sub> and significantly the highest yield was obtained only one location in T<sub>2</sub> at Tala, Satkhira. Moreover, on average 0.16 t/ha i.e., 1.99% yield reduction was found in T<sub>2</sub>. Irrespective of location and variety on average 8.04 t/ha yield was obtained in IPM practiced field (T<sub>1</sub>) and 7.88 t/ha in farmers practiced field (T<sub>2</sub>) and the average BCR 1.39 and 1.32 were observed in T<sub>1</sub> and T<sub>2</sub> respectively.

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## VERTEBRATE PEST MANAGEMENT

### Use of owl Watch Tower to manage rice rats

The study on rat damage around the watch tower was conducted at BRRI HQ, Gazipur experimental field. Ten owl Watch Tower were installed in the field. Watch Towers having 3.5m long pole prepared by bamboo or iron with cross (X) shaped top for seating owl on it and perching and searching rat in crop field. Rat damaged by rat was assessed around the watch tower areas. Rat damage assessment around the owl Watch Tower was done by two ways. One- number of active burrow count methods and another- crop damage assessment method. Active burrow count and crop damage was done three 0-25, 26-50 and 51-75 meters apart around the owl Watch Tower. Newly developed burrows became inactive (dead) surrounding the 50 m dia of Watch Tower. The collected and observed pellets of owl from Watch Tower confirmed the rat predation.

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# **Plant Pathology Division**

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## SUMMARY

Disease incidence and severity was higher in T. Aman season, 2023 compared to Boro 2023-24. Irrespective of season number of diseases was found higher in Cumilla and Shirajgonj compared to other regions. The prevalence of BB, BS, NB and ShB diseases were noticeable whereas the severity of BS, ShB and BB were higher compared to other diseases. All of the conidia in each blast isolate from different hosts were pyriform in shape, two-septate three celled. The conidium in each isolate was observed hyaline to pale olive colors. There is no significant difference in disease severity and incidence at 15 and 18°C temperatures for development of blast symptom. Eighteen seed borne pathogens were detected from T. Aus and Boro seeds and T. Aus seed was observed with higher infection followed by Boro.

Blast resistant long duration (LD) lines, BR(Path)15855-BC3-2HR-5 and BR(Path)15855-BC2-3HR-23 produced similar yield to the check BRRI dhan29. All of the tested medium duration lines were found resistant to blast across the locations. Both short duration (SD) lines, BR(Path)15641-3HR-15 and BR(Path)15641-3HR-45 were found better both for yield and blast disease resistance. In MLT no disease infection was observed in the long duration and short duration lines. The yield of the tested lines in each group was equal or better than the checks. In another MLT, the yield of the lines PL-547(1, 2), PL-548, PL-582 and PL-615 were found better compared to the checks in yield performance. In BC<sub>3</sub>F<sub>6</sub> generation, 10 plants were selected (having *Pi9* in the background of BRRI dhan58) which would be further advance based on morphological homogeneity, and yield potentiality. Vector constructs were prepared for both the *Bsrk1* and *Sweet14* gene(s) aimed to achieve both blast and BLB resistance, and were also ready for plant transformation. Vector constructs were prepared with susceptible genes *OsSWEET11* for rice ShB disease. Construct were commercially

sent for sequencing. Among the 101 tested materials 25 entries showed moderate resistant (MR) reaction against leaf blast. Screening performance of hybrid rice variety against blast showed comparatively better resistance reaction than inbred lines or varieties. The *Pi9* haplotype mostly exhibited resistance to both leaf and neck blast diseases. Out of sixty-one advanced breeding lines only eleven materials showed moderately susceptible to ShB. Phenotypic screening was done of 175 transformants and out of them 19 was found blast resistance. Now genotyping is on-going. Different zinc label did not make any effect on Disease incidence or severity of any variety. *Pi9* gene was upregulated in all 3 lines, but best expression was found in line 13800-Bc3-8-9. Both partial resistance genes (*Pb1* and *Pi21*) and the broad spectrum gene (*Pi9*) significantly contributed to reducing disease incidence and maximizing yield in the genetic backgrounds of BRRI dhan63 and BRRI dhan64.

Egg mass found dried and no dead heart was observed after application of biopesticides and yield increased upto 30% compared to control. Yield and 1000 grain weight was similar in T1 (8.36t/ha and 23g) where only Trichocompost @1.5t/ha was applied and in T4 (8.37t/ha and 23g) where recommended dose of fertilizers were applied. In pot experiment, all treatments exhibited 30.68% to 63.78% disease reduction after 14 days and 28.12% to 58.09% after 21 days from Disease Control, suggesting their effectiveness. H<sub>2</sub>O<sub>2</sub> @ 1.0-0.1M completely inhibited mycelial growth of *Pyricularia oryzae* and *Rhizoctonia solani* whereas *Xanthomonas oryzae* pv. *oryzae* was completely inhibited by 1.0-0.01M H<sub>2</sub>O<sub>2</sub> solutions. Concentration @ 1.0 M reduced Sheath blight disease compared to commercial fungicide, Amister Top in pot experiment. Similarly, BB was reduced by 1.0 M H<sub>2</sub>O<sub>2</sub> in nursery bed when compared with streptomycin and other treatments of H<sub>2</sub>O<sub>2</sub>. Reduction of blast disease in nursery seed bed at 1.0-

0.1M concentration was comparable with commercial fungicide, Trooper. Copper chitosan nanoparticles alone or in combination with Bismethiozol (Bis) at three different dosages—0.15%, 0.125%, and 0.1% at different ratios exhibited 30.68% to 63.78% disease reduction after 14 days and 28.12% to 58.09% after 21 days compared to control. No residual effect was found from the collected rice samples sprayed with trooper at field condition. The toxic effects of the fungicides were more pronounced immediately after the application of fungicides. After 28 days it became stagnant and there is no significant difference with before Amister top spray. The UV-visible spectrum of the synthesized SiO<sub>2</sub> nanoparticles (SiO<sub>2</sub>NPs) from rice husk showed a maximum absorption band edge at 215 nm with an absorbance of 1.95 confirming the presence of silica nanoparticles. Particle size analysis indicated a polydisperse distribution, with particle sizes ranging from 80.3 nm to 160.5 nm and an average diameter of 116.4 nm. Among the new 30 chemicals none of the fungicides showed efficacy level 80% or above. Similarly, tested 35 chemicals were ineffective against sheath blight disease.

Twelve batches of a ‘day-long’ training program on integrated rice disease management were conducted. In 16 trials of upscaling of blast disease management, among the locations, the highest neck blast disease incidence (DI) was observed in the farmer’s practice plot (DI-90%) with severity 9. In the trials, the yield losses saved ranged from 78.98% to 8.06% using BRRI technology.

### **TECHNOLOGY DEVELOPED WITH SALIENT FEATURES**

One bacterial blight resistant line, BR(Path)13784-BC3-63-6-4-HR6 and two blast resistant lines, BR(Path)12454-BC2-69-97-39-5-44 and BR(Path)12452-BC6-53-21-11 have been recommended as BRRI dhan112, BRRI dhan115 and BRRI dhan117, respectively by the National Technical Committee (NTC).

### **Useful Scientific Information**

#### **SURVEY AND MONITORING OF RICE DISEASE.**

Incidence pattern and severity of rice diseases over the locations and varieties were assessed. Three upazilas in each district, except Sunamganj (10 upazilas), were selected for disease survey. Disease incidence (%) and disease severity data of major rice diseases were recorded following SES IRRI, 2013.

In Satkhira district, during T. Aman 2023 sheath blight was most prevalent (28%-36%), while BLB was also common (8%-30%). However, in Boro 2023-24, Shamnagor had the highest rice bacterial blight incidence, while rice sheath blight was most dominant in Satkhira Sadar. Despite some rice blast in BRRI dhan28, significant yield loss is not expected as crops were at the maturity stage. In Khagrachori and Rangamati district, in Aman’23, Narrow brown leaf spot was comparatively higher followed by brown spot, sheath blight and BLB disease whereas the prevalence of blast disease was very low (<2%). In Boro 2024, BLB was comparatively higher (≤50%), followed by BS and ShB whereas the prevalence of blast disease was very low (<3%). But the severity of blast disease was high (≤7) followed by sheath blight disease. In Cumilla, during T. Aman 2023, neck blast disease was found predominant in the aromatic rice varieties (%DI 3-62, DS 5-9). The diseases observed were sheath blight, bacterial blight, false smut, sheath rot and brown spot. During Boro 2023-24 season, major rice diseases including leaf blast, neck blast, bacterial blight, sheath blight, sheath rot and brown spot were recorded. In Rangpur district, in T.aman sheath blight (ShB), bacterial leaf blight (BLB), brown spot (BS) and false smut disease was observed. Disease incidence was higher than severity in ShB, BLB and BS but lower in false smut disease. In Boro 2023-24, average BB (incidence: 35.21% and severity: 3.89), brown spot (incidence: 29.21% and severity: 1.73) and blast (incidence: 6.67% and severity: 1.56) were observed. In Rajshahi district, during T. Aman 2023 brown spot



was observed as the highest infested disease followed by BLB, BLS and sheath blight. Incidence of blast disease was not considerable in this season. Ten Upazilas in Sunamganj district were surveyed during Boro 2023-24. Higher disease incidence (%DI) was observed in Jagannathgpur lower in Chattak upazila. Farmers preferred hybrid rice than BRRI dhan29 in this district but Hybrid varieties were highly infected by bacterial leaf streak (BLS) disease. In Boro'2024, among the diseases the incidence of BLB was comparatively high but not exceeded more than 50%, followed by brown spot, sheath blight and bacterial leaf streak disease whereas the prevalence of blast disease was very low, less than 0.5% in Gazipur district. In Sirajganj district, T. Aman: BS (DI 99%, DS 1.72), ShB(60%,7), BB(72%, 3). Boro: BS (96%, 3), ShB (75%, 8), BB(62%, 3). In Habigonj and Brahmanbaria districts, Blast and bacterial blight (BB) diseases were observed predominant in haor ecosystem of both the districts. Bacterial leaf streak (BLS) disease was also observed increasing trend in both the districts. Sheath blight (ShB) and Brown spot (BS) disease were also recorded around 5% incidence with low severity in both the districts.

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#### PATHOGEN POPULATION STRUCTURE and BIOLOGY OF MAJOR PATHOGEN

**Pathotyping, virulence analysis and genome sequencing of *X. oryzae* pv. *oryzae*.** The experiment was conducted to develop effective source for using resistant breeding programme. Xoo infected samples were collected, isolated and maintained. Ten virulent isolates were identified and DNA extracted from 5 bacterial isolates for sequencing. Experiment is

going on for more identification of isolates from different location of Bangladesh

■ A Ara and TH Ansari

**Identification of critical climate status for rice blast disease outbreak.** To identify the real time for disease development and overcome the risk experiments were conducted at BRRI HQ Gazipur. In the first trial identical disease symptom were developed on neck with higher severity at 20°C temperature and 70 % relative humidity. We found that in pot -1, percent disease incidence was 44 in one hill. At 18°C and 15°C temperature at day and night, simultaneously 70 % and 75 % relative humidity at day and night condition develop significant leaf blast disease, respectively.

■ MA Monsur, MR Hera, MAI Khan, M. Kamruzzaman, S Rahman, TH Ansari

**Cultural and morphological characteristics of blast isolates (*Magnaporthe* spp.) from different hosts.** The blast isolates were grown on PA media (Fig. 1). The excellent source for sporulation was oat meal agar, whereas prune agar medium was a good source. Other two media were found to be poor for sporulation activity. All the isolates collected from rice, wheat, foxtail millet and torpedo grass showed differences in their colony characters. Based on colony colour the isolates were classified into four groups. Rice isolates produced black colour colonies, wheat isolates produced white colour colonies and millet isolates produced light gray to milky. Whitish colonies were produced by torpedo grass isolates. Isolates also exhibited variation concerning colony texture. Based on colony texture, isolates were placed into four groups, rice and wheat isolates were whitish and raised fluffy. On the other hand, smooth fluffy, and flat smooth colonies were produced by millet and torpedo grass respectively. All isolates have circular margins.

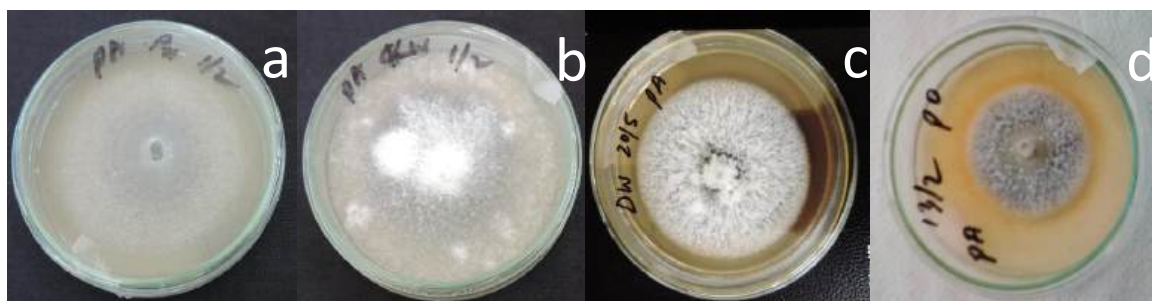


Fig 1. Blast isolates from different sources a) Torpado grass, b) kaun c) wheat and rice

■ M S Mian, M A Monsur, Q S A Jahan, T H Ansari & M A Latif

## DISEASE RESISTANCE AND MOLECULAR STUDIES

### **RYT#2. Regional yield trial of medium/long duration blast resistant lines having *Pita2* gene.**

Regional yield trial consisting of five genotypes including one check (BRRI dhan29) was conducted in eight locations during Boro, 2023-24 (Table 1).

Fungicides recommended for blast were not given during the experimental period. No blast incidence was found irrespective of location. The growth duration of the tested materials varied from 153-161 days. BR(Path)15855-BC3-2HR-5 produced the similar yield to the check BRRI dhan29 with Seven days earlier. Further, BR(Path)15855-BC2-3HR-23 and BR(Path)15855-BC3-2HR-11 produced similar yield growth duration.

**Table 1. Yield scenario of blast resistant long duration (LD) lines at different locations.**

| Line                       | Yield (t/ha) |           |          |          |          |         |         | Average |
|----------------------------|--------------|-----------|----------|----------|----------|---------|---------|---------|
|                            | Bhanga       | Gopalganj | Satkhira | Rajshahi | Habiganj | Rangpur | Cumilla |         |
| BR (path)15855-BC3-2HR-5   | 7.89         | 7.56      | 8.42     | 7.00     | 6.85     | 7.89    | 7.58    | 7.60    |
| BR (path)15855-BC3-2HR-11  | 7.27         | 7.38      | 6.29     | 7.65     | 6.97     | 7.27    | 8.11    | 7.28    |
| BR (path)15855-BC2-3HR-8   | 6.82         | 7.08      | 7.29     | 7.39     | 5.67     | 6.82    | 7.93    | 7.00    |
| BR (path) 15855-BC2-3HR-23 | 7.89         | 7.73      | 7.54     | 7.91     | 7.36     | 7.89    | 5.93    | 7.46    |
| BR (path)15855-BC2-3HR-47  | 7.07         | 7.52      | 6.69     | 7.73     | 6.48     | 7.07    | 7.74    | 7.18    |
| BRRI dhan29(S. ck)         | 8.65         | 7.26      | 7.51     | 7.71     | 6.49     | 8.65    | 6.84    | 7.59    |
| BRRI dhan89 (S. ck)        | 7.77         | 7.90      | 6.02     | 7.6      | 6.82     | 8.32    | 9.63    | 7.72    |
| LSD (0.05)                 |              |           |          |          |          |         |         | 0.47    |

■ T H Ansari, M Khatun, H R Hera, A. Monsur and scientists of regional stations

**RYT#3. Regional yield trial of medium/short duration blast resistant lines (*Pi9* gene).** Four genotypes including two checks (BRRI dhan59 and BRRI dhan89) was evaluated in eight locations during Boro' 23-24 (Table 2). Fungicides for blast control were not given during the experimental period. No blast incidence was found irrespective of location. The growth duration of the tested materials

varied from 147-153 days. BR(Path)15854-BC1-3HR-3 and BR(Path)15641-4HR-31 produced 6.9-7.1 t/ha in 147 and 151 days respectively. Rod miniet-1, a pure line moderately blast resistant premium quality rice, produced 0.81 t/ha more yield compared to the check BRRI dhan58 (6.85 t/ha) in 153 days while it produced similar yield to the check BRRI dhan89 with 6-day earlier maturity.

**Table 2. Yield scenario of blast resistant medium duration (MD) lines at different locations.**

| Line                     | Yield (t/ha) |           |          |          |          |         |         | Average |
|--------------------------|--------------|-----------|----------|----------|----------|---------|---------|---------|
|                          | Bhanga       | Gopalganj | Satkhira | Rajshahi | Habiganj | Rangpur | Cumilla |         |
| BR(Path)15854-BC1-3HR-21 | 7.18         | 6.83      | 6.92     | 6.6      | 6.46     | 6.75    | 6.43    | 6.73    |
| BR(Path)15641-4HR-31     | 7.30         | -         | 6.90     | 6.7      | 6.72     | 6.26    | 8.81    | 7.11    |

| Line                    | Yield (t/ha) |           |          |          |          |         |         | Average |
|-------------------------|--------------|-----------|----------|----------|----------|---------|---------|---------|
|                         | Bhanga       | Gopalganj | Satkhira | Rajshahi | Habiganj | Rangpur | Cumilla |         |
| BR(Path)15853-BC1-3HR-3 | 7.38         | 7.23      | 6.06     | 6.3      | 6.19     | 7.51    | 7.88    | 6.93    |
| Rod miniket-1           | 8.05         | -         | 7.08     | 7.4      | 6.83     | 8.42    | 8.11    | 7.66    |
| BRRI dhan58 (S. ck)     | 6.52         | 6.89      | 6.39     | 6.2      | 6.31     | 7.59    | 8.09    | 6.85    |
| BRRI dhan89 (S. ck)     | 7.77         | 7.52      | 6.02     | 7.6      | 6.82     | 8.32    | 9.63    | 7.67    |
| LSD (0.05)              |              |           |          |          |          |         |         | 0.562   |

■ T H Ansari, M Khatun, H R Hera, A. Monsur and scientists of regional stations

**RYT#4. Regional yield trial of short duration blast resistant lines with Pi9 gene:** Four genotypes including two checks (BRRI dhan28 and BRRI dhan88) were evaluated in eight locations during Boro 2023-24 (Table 3). BR(Path)15857-BC3-4HR-6 was severely infected with leaf (DI 70%, Severity-7) and neck blast (DI 70% severity- 9) disease. The

growth duration of the tested resistant materials varied from 143-148 days. BR(Path)15641-3HR-15 and BR(Path)15641-3HR-45 produced 6.8-6.9 t/ha in 145 and 1453 days respectively. The results indicate 0.4-0.5 t/ha higher with similar growth duration than both the check BRRI dhan28 and BRRI dhan88 (6.5 t/ha).

**Table 3. Yield scenario of blast resistant short duration (SD) lines at different locations.**

| Line                     | Yield (t/ha) |           |          |          |          |         |         | Average |
|--------------------------|--------------|-----------|----------|----------|----------|---------|---------|---------|
|                          | Bhanga       | Gopalganj | Satkhira | Rajshahi | Habiganj | Rangpur | Cumilla |         |
| BR(Path )15641-3HR-15    | 6.83         | 6.84      | 6.27     | 6.9      | 6.52     | 7.73    | 7.3     | 6.92    |
| BR(Path )15641-3HR-45    | 6.67         | -         | 5.86     | 7.1      | 6.66     | 6.92    | 7.4     | 6.78    |
| BR(Path )15857-BC3-4HR-6 | 6.82         | 6.79      | 6.37     | 6.4      | 5.75     | 6.87    | 6.0     | 6.44    |
| BR(Path )15641-3HR-12    | 5.93         | 7.75      | 5.65     | 5.9      | 5.21     | 6.75    | 6.3     | 6.21    |
| BRRI dhan28              | 7.10         | 5.93      | 6.19     | 6.7      | 6.20     | 7.14    | 6.3     | 6.51    |
| BRRI dhan88              | 7.31         | 6.69      | 5.39     | 6.9      | 6.25     | 6.70    | 6.0     | 6.46    |
| LSD (0.5)                |              |           |          |          |          |         |         | 0.321   |

■ T H Ansari, M Khatun, H R Hera, A. Monsur and scientists of regional stations

**RYT#5. Regional yield trial of disease resistant premium quality short duration lines.** Three genotypes including two checks (BRRI dhan50 and BRRI dhan63) were evaluated in eight locations during Boro 2023-24 (Table 4). Fungicides recommended for blast were not sprayed. All the lines were infected with both leaf (30-50% DI, DS-

5) and neck blast (20-40%DI, DS-9) except BR(Path)15857-BC3-4HR-2. Those resistant lines produced 6.5 t/ha yield in 152 days which is similar to BRRI dhan50. BR(Path)15857-4HR-19, a Banglamoti type line produced 6.8 t/ha which was higher than the check BRRI dhan50 (6.2 t/ha).

**Table 4. Yield scenario of blast resistant short duration (SD) premium quality lines at different locations.**

| Line                     | Yield (t/ha) |          |          |          |         |         | Average |
|--------------------------|--------------|----------|----------|----------|---------|---------|---------|
|                          | Bhanga       | Satkhira | Rajshahi | Habiganj | Rangpur | Cumilla |         |
| BR (Path)15857-BC3-4HR-2 | 6.39         | 5.69     | 6.30     | 6.00     | 7.08    | 7.3     | 6.46    |
| BR (Path)15857-4HR-19    | 6.87         | 5.63     | 7.32     | 6.28     | 6.55    | 8.0     | 6.78    |
| BR (Path)15857-4HR-33    | 6.73         | 5.79     | 6.20     | 5.25     | 6.03    | 6.2     | 6.04    |
| BRRI dhan50              | 6.19         | 5.62     | 6.15     | 5.47     | 7.61    | 5.9     | 6.15    |
| BRRI dhan63              | 6.82         | 6.13     | 6.77     | 5.67     | 6.87    | 7.3     | 6.58    |
| LSD (0.5)                |              |          |          |          |         |         | ns      |

■ T H Ansari, M Khatun, H R Hera, A. Monsur and scientists of regional stations

**Development of blast resistant lines with *Pita2* gene.** Twenty-three blast resistant fixed lines containing *Pita2* gene were developed. Eight lines were developed from the cross between BR28 × IRBL-ta2-Pi which are BR(Path)17121-BC2-5HR-3, BR(Path)17121-BC2-5HR-3, BR(Path)17121-BC2-5HR-3, BR(Path)17121-BC2-5HR-3, BR(Path)17121-BC2-5HR-5, BR(Path)17121-BC2-5HR-11, BR(Path)17121-BC2-5HR-31, BR(Path)17121-BC2-5HR-39, BR(Path)17121-BC2-5HR-51, BR(Path)17121-BC2-5HR-63 and BR(Path)17121-BC2-5HR-70. The yield and growth duration are equal to BRRI dhan28.

Five lines were developed from the cross between BRRI dhan63 and IRBL ta2Pi. These lines were designated as BR(Path)17118-BC3-3HR-311, BR(Path)17118-BC3-3HR-325, BR(Path)17118-BC3-3HR-349, BR(Path)17118-BC3-3HR-467 and BR(Path)17118-BC3-3HR-480. The growth durations are equal to BRRI dhan63. The yield range of those lines were 5.0-5.5 t/ha

Ten lines were developed using IRBL-ta2-Pi crossed with BRRI dhan29. These are- BR(Path)15855-BC2-3HR-8, BR(Path)15855-BC2-3HR-23, BR(Path)15855-BC2-3HR-47, BR(Path)15855-BC2-3HR-5, BR(Path)15855-BC2-3HR-21, BR(Path)15855-BC2-3HR-18, BR(Path)15855-BC2-3HR-42, BR(Path)15855-BC2-3HR-37, BR(Path)15855-BC2-3HR-39 and BR(Path)15855-BC2-3HR-48. All the above lines were found resistant against rice blast disease under artificial and hotspot condition. The yield range of those lines were 7.5-8.0 t/ha and growth durations ranged from 155-160 days.

■ T H Ansari

**Pyramiding *Pi9* and *Pita2* genes.** A total of 42 fixed lines containing both *Pi9* and *Pita2* genes were developed. First *Pita2* gene from IRBL-ta2Pi was introgressed into BRRI dhan29 (F4 generation). Then *Pi9* gene from IRBL-9W was introgressed into BRRI dhan29 (F1 generation). Then the cross

between the *pita2* gene containing line (F4) and *Pi9* containing line (F1). The F1 containing both the genes *Pi9* and *Pita2* were then identified through MAS. The advanced fixed lines were developed and designated as BR(Path)15860-BC2-3HR-8, BR(Path)15860-BC2-3HR-21, BR(Path)15860-BC2-3HR-28, BR(Path)15860-BC2-3HR-39, BR(Path)15860-BC2-3HR-23, BR(Path)15860-BC2-3HR-88, BR(Path)15860-BC2-3HR-78, BR(Path)15860-BC2-3HR-43, BR(Path)15860-BC2-3HR-29, BR(Path)15860-BC2-3HR-11, BR(Path)15860-BC2-3HR-72, BR(Path)15860-BC2-3HR-63, BR(Path)15860-BC2-3HR-59, BR(Path)15860-BC2-3HR-88, BR(Path)15860-BC2-3HR-49, BR(Path)15860-BC2-3HR-55, BR(Path)15860-BC2-3HR-35, BR(Path)15860-BC2-3HR-28, BR(Path)15860-BC2-3HR-1, BR(Path)15860-BC2-3HR-27, BR(Path)15860-BC2-3HR-87, BR(Path)15860-BC2-3HR-77, BR(Path)15860-BC2-3HR-69, BR(Path)15860-BC2-3HR-99, BR(Path)15860-BC2-3HR-67, BR(Path)15860-BC2-3HR-71, BR(Path)15860-BC2-3HR-94, BR(Path)15860-BC2-3HR-90, BR(Path)15860-BC2-3HR-81, BR(Path)15860-BC2-3HR-105, BR(Path)15860-BC2-3HR-302, BR(Path)15860-BC2-3HR-155, BR(Path)15860-BC2-3HR-191, BR(Path)15860-BC2-3HR-300, BR(Path)15860-BC2-3HR-285, BR(Path)15860-BC2-3HR-172, BR(Path)15860-BC2-3HR-263, 290, BR(Path)15860-BC2-3HR-149, BR(Path)15860-BC2-3HR-127 and BR(Path)15860-BC2-3HR-144. These lines are strong, lodging tolerance and highly blast resistant. The flag leaves are deep green, erect and large in width. The lines can produces 6.0-8.5 t/ha grain yield with 155-160 days growth duration.

■ T H Ansari

**Blast resistance lines from segregating population of IRBL-9W.** A blast resistant fixed line identified from the segregating progenies of IRBL-9W, a monogenic blast resistance line containing *Pi9* gene. IRBL-9W seeds were received from JIRCAS

through JIRCAS-BRRI collaboration. The lines were selected after four generations of head-row selection. The line was designated as IRBL-9W-BD-4HR. The number of tillers ranged from 9-10 and the average plant height ranged from 110-115 cm. The grain colour is whitish black.

■ T H Ansari

**Sheath blight disease resistance in rice through Crispr-Cas9 genome editing:** The rice sugar transporter gene *OsSWEET11* (Fig. 2) was selected for completely and permanently silencing the gene at the DNA level through Crispr-Cas9 knockout system. Targeted sites of *OsSWEET11* were identified by using the web-based tool such as ‘Rice Genome Annotation Project’ (<http://rice.uga.edu/index.shtml>) and rap-db (<https://rapdb.dna.affrc.go.jp>). Vector-specific and gene-specific forward and reverse primers were designed with ‘Primer Primer’ software. Twenty-one nucleotide bases of gRNA of *SWEET11* gene were synthesized from the company. Plasmid extracted from binary vector pRGEB31 and digested with *BsaI* restriction enzyme. Guide RNA was

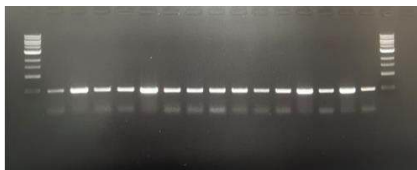


Fig. 2. Constructs with *OsSWEET11* gene

ligated with digested plasmid through T4 DNA ligase enzyme. Ligation was confirmed through PCR band. Vector construct was prepared with *OsSWEET11* genes. Construct were commercially sent for sequencing.

■ H A Diljahan, H R Barman, M Hossain, M R Bhuiyan and T H Ansari

**Introgression of blast resistance *Pi9* and *Pb1* gene(s) into BRRI dhan58:** To observe the phenotypic reaction of newly developed BRRI breeding lines against rice sheath blight disease this experiment was conducted in an artificial inoculated

condition. BRRI dhan58 was used as recurrent parent, while IRBL9-W possessing *Pi9* for leaf blast resistance were used as the donor parents. Primer/marker NMSM-*Pi9* was used to detect *Pi9*, while RM206 was used for *Pb1* confirmation. In BC<sub>3</sub>F<sub>6</sub> generation, we selected 10 plants which would be further advanced based on morphological homogeneity, and yield potentiality.

■ M R Bhuiyan, M A I Khan, T H Ansari, and M A Latif

**Expression level of *Pi9* and *Pb1* gene(s) in the introgressed advanced lines.** *Pi9* gene introgressed lines were grown in a greenhouse under controlled growth conditions for 14 days. The plants were inoculated and collected leaf samples at different time intervals (0 h, 24 h, 48 h and 72 h). Total RNA was isolated from a leaf, using a TRIzol reagent. cDNA was then generated using the Superscript TM III for RT-PCR. qRT-PCR reaction was performed in 20 mL reaction volume. In the resistance response, *Pi9* gene was upregulated at 24 h, 48 h and 72 h post inoculation in three lines 13800-Bc3-8-1, 13800-Bc3-8-9 and 13800-Bc3-134-8. The *Pi9* gene expression increased significantly in advanced line 13800-Bc3-8-9 at 48 h and 72 h and produced higher level of mRNA 85.13% and 86.97% respectively. In advanced line 13800-Bc3-134-8 gene expression was higher in 24 h and 72, but expression was reduced at 48 hours. *Pi9* gene was upregulated in all three lines, but the best expression was found in line 13800-Bc3-8-9.

■ M A Monsur, M R Hera, M A I Khan, S A Islam, H B Shojib, T H Ansari

**Development of Blast and BB resistance in rice through CRISPR/Cas9.** An investigation was carried out to enhance blast and bacterial leaf blight (BLB) resistance in rice by mutating the *Bsrk1* and *Sweet14* genes using CRISPR/Cas9. In case of blast resistance, plants with the *OsERF922* gene were regenerated through the Agrobacterium-mediated. In Planta method, out of 175 transformants, 10

exhibited blast resistance, with genotyping currently in progress. For the *Bsrk1* gene, vector constructs are prepared for plant transformation. Similarly, vector constructs for the *Sweet14* gene, aimed at BLB resistance, are also ready for plant transformation.

■ M R Bhuiyan, H R Barman, S A Islam, M A I Khan, T H Ansari, and M A Latif

#### **Investigation of disease resistance performance in Zn content rice variety:**

Three zinc content rice variety BRRI dhan33, BRRI dhan62, BRRI dhan72 and as a control check BRRI dhan87 were transplanted in T. Aman season. Three doses of zinc fertilizer were used i) Zn present in soil 0.93 ppm (control) ii) soil test based recommended dose iii) soil test base double of recommended dose. Different zinc label did not make any effect on Disease incidence or severity of any variety. Effect of zinc fertilizer showed good performance to control brown spot disease in BRRI dhan72 at hard dough stage.

■ MA Monsur, MR Hera, MAI Khan, TH Ansari

#### **Evaluation of advanced breeding lines against sheath blight disease in Boro 2023-24.**

Sixty-one advanced breeding lines were grown and inoculated with *Rhizoctonia solani* in Boro 2023-24 season at BRRI HQ East bayed Plant Pathology field to investigate their disease reaction against rice sheath blight disease. Out of them 11 lines exhibited a moderately susceptible reaction, with a relative lesion height (RLH) ranging from 31 to 45% (SES score 5). The remaining lines were classified as susceptible (SES score 7) to highly susceptible (SES score 9).

■ M R Bhuiyan, H R Dilzahan, M Hossain, T H Ansari

#### **Evaluation of IRR154-Pi9 haplotypes and BR lines at blast hotspot:**

A total of 42 lines, including IRR154-Pi9 (6), BR line-Pi9 (30), and IR64-Pi9 (1) were evaluated during the Boro 2022-23 and 2023-24 at the blast hotspot in Hankata, Gazipur,

alongwith susceptible checks. The Pi9 haplotype mostly exhibited resistance to both leaf and neck blast diseases. IRR154 also showed a resistant reaction, despite not carrying the Pi9 allele. BR lines harboring the Pi9 allele similarly demonstrated predominantly resistant reactions. Interestingly, in some cases, no Pi9 materials showed resistance, indicating the presence of other genes or gene combinations.

■ M A I Khan, M R Bhuiyan, H R Hera, M A Monsur and T H Ansari

#### **Performance of blast-resistant genes (*Pi9*, *Pb1*, and *pi21*) in reducing the spray frequency for blast disease management under field conditions (JIRCAS).**

Six advanced lines, including the checks BRRI dhan63 and BRRI dhan64, were evaluated at blast hotspots in Gazipur, Cumilla, and Rangpur. Trooper 75WP was applied at a rate of 8.0 g/10L. Four spray schedules were implemented: Sp#1 = 1 spray, Sp#2 = 2 sprays, Sp#3 = 3 sprays, and Zero Sp = no spray. Both partial resistance genes (*Pb1* and *pi21*) and the complete resistance gene (*Pi9*) significantly contributed to reducing disease incidence.

■ M A I khan, M R Bhuiyan, H R Hera, M A Monsur and T H Ansari

#### **Dissecting novel source of BB resistance in rice germplasm.**

Collection of germplasm, Isolation of BB pathogen for Inoculation, pathogen inoculation and screening of germplasm, statistical analysis were done. Mapping population development/diverse panel and screening were done for detection of new resistant QTL(s)/ R gene(s) through GWAS. Out of hundred materials only two germplasms were found as moderately resistant against BB after phenotypic screening in Boro2023-24 season.

■ A Ara and T H Ansari

#### **Screening of breeding materials and commercial hybrid rice against blast and BB diseases.**

For leaf blast, out of 78 materials, 11 entries showed

resistant, where 16 showed moderate reaction against leaf blast disease. Out of 24 hybrid varieties 22 varieties showed resistant reaction, but only two varieties observed susceptible to blast disease. In another screening experiment against leaf blast, out of 101 breeding lines 25 entries showed moderately resistant reaction against leaf blast and rest of the entries showed moderately to highly susceptible reaction. Out of 381 breeding materials, 95 showed resistant reaction (Disease severity score 0 to 1), 48 materials showed moderately resistant (2 to 3), the other materials were highly susceptible (4 to 5) to blast disease. In another trial, out of 220 native germplasms collected from BRRI gene bank, 23 showed resistant reaction and 40 materials were moderately resistant and others were highly susceptible. For BLB, Out of 61 materials only two were found as moderately resistant phenotypically in Boro 2023-24.

■ M A Monsur, M R Hera, M A I Khan, T H Ansari

#### EPIDEMIOLOGY, YIELD LOSS AND GRAIN QUALITY STUDIES

**Identification of the source of infection of major rice diseases.** Two seed sources - healthy (uninfected) and diseased (infected) from BRRI dhan34 and BRRI dhan49 were used. Three years results revealed that blast disease was significantly higher in disease seed source in 2022 ( $P \leq 0.05$ ), whereas in the year 2023, the incidence of blast disease was very low but shows the reverse result. In the previous year (2021), there was a tendency of higher blast incidence in diseased seed source; however, the difference was not significant with healthy seed source. In the following year (2022), false smut disease did not appear and in year 2023, there were also negligible amount of false smut disease appeared in the field.

■ Bodrun Nessa

#### Present health status of rice seed in Bangladesh.

A total of 20 and 80 rice seed samples were collected during T. Aus 2023 and Boro 2023-24 respectively.

Four seed sources viz. farmers' own seed, DAE seed, BADC seed and BRRI seed were maintained. One rice variety BRRI dhan48 for T. Aus and four varieties viz BRRI dhan67, BRRI dhan75, BRRI dhan87 and BRRI dhan95 were evaluated. Irrespective of variety and seed source, 18 different seed borne pathogens were detected from T. Aus and Boro seeds. The lower incidence of seed borne pathogens was recorded in BRRI seed precedingly followed by BADC dealer and DAE seed where as higher incidence was observed in farmers' own seed. During Boro season, the higher incidence of seed borne pathogens was recorded in BRRI dhan28 followed by BRRI dhan81, BRRI dhan29 and BRRI dhan92. T. Aus seed was observed with higher infection of seed borne pathogens followed by Boro.

■ M Hossain, M R Bhuiyan, H A Diljahan, M R M S Mian and T H Ansari

**Identification of critical climate status for rice blast disease outbreak.** A series of trials were done by maintaining different weather points, like as 23°C +70% RH, 20°C +70% RH and 18°C +65% RH. A 12/12 hrs day/night condition was maintained. In the first trial identical disease symptom were developed on neck with higher severity (44%) at 20°C+70 % RH. Other weather conditions had no significant effect on leaf blast disease severity and incidence. To find out critical temperature and moisture more trial would be done.

■ M A Monsur, M R Hera, M A I Khan, M. Kamruzzaman, S Rahman, T H Ansari

**Genotype and environmental interaction on neck blast incidence.** The experiment was conducted with variety and planting time against blast disease under natural conditions at BRRI HQ, Gazipur during Boro 2023-24. Four varieties were transplanted (V1= BRRI dhan29, V2= BRRI dhan89, V3= BRRI dhan28 and V4= BRRI dhan28) at first planting time (Set A, T1= 15 December, 2023). V4 was transplanted at 20 days later after first transplanting to synchronize the flowering time with

BRRI dhan29 and BRRI dhan89. The same varieties were transplanted at the second planting time (Set B, T2= 5 January 2023). In 2<sup>nd</sup> year trial, it was observed that overall neck blast disease incidence was low. It might be due to high temperatures and low humidity during the flowering time.

■ M S Mian, M A Monsur & T H Ansari

## DISEASE MANAGEMENT

**Evaluation of biopesticides for management of stem borer in field condition.** Four treatments (T1= *Bacillus thuringiensis* @25 mL/L, T2= *Serattia* sp.@25 ml/L, T3=Insecticide (Suntup plus, Bayer) @0.5 ml/L, and T4=control) were used in T. Aman. Twenty stem borer moth per/plot were inoculated for 1 m<sup>2</sup> area. Higher moth (35%) was observed in control (T4) treatment followed by T2 (20%) and T1 (15%) whereas, egg mass was almost similar in all treatments except T3 after three days of treatment application. None of the moth and egg mass was observed in T3 (0%) where insecticide was sprayed after three days of treatment application. No moth was observed in any treatment but higher egg mass was counted in T1 and no egg mass was observed in T3 after nine days of spray with biopesticide. Dead heart and white head was observed in control (T4) treatment only. Higher yield was increased in T2 (31%) followed by T3 (28%) and T1 (15%) over control (T4).

■ Q S A Jahan

**Integrated management of bakanae disease of rice.** Four treatments (T1= Seed treatment with Autistin @ 3g/L H<sub>2</sub>O, T2= Bacterial biopesticide @ 25ml/L H<sub>2</sub>O sprayed on bakanae infected plot after one week of transplantation, T3= Trichocompost @ 1.5t/ha applied in plot during final land preparation and T4=control) were used. In seed bed bakanae infection was 15-20%. At harvest there was no bakanae symptom observed in any treatment. Plant height and total tiller were observed almost similar in T1, T2 and T3 whereas, lower height and decreased tiller number were observed in control

(T4) treatment. Total tiller was also found similar in T1, T2 and T3 treatment but some decreased in T4. Total tiller increased (8-9%) in T1, T2 and T3 compared to control might be due to high gibberellic acid increased in T4 (control). Higher yield increase was found in T2 (1.49 t/ha) followed by T1 (0.83t/ha) and T3 (0.34 t/ha) compared to control. Hence, biopesticide (T2) could be a good option.

■ Q S A Jahan

**Effect of trichocompost on nutrient and disease management in rice.** Four treatments (T1= Trichocompost @ 1.5 t/ha (NPSZn full dose), T2= Trichocompost @ 1.5 t/ha + 50 kg/ha MOP (NPSZn full dose), T3= Trichocompost @ 1.5 t/ha + 100 kg/ha MOP (NPSZn full dose) and T4=control (Fertilizers @ recommended dose) were used. Plant height was almost similar in all treatments. Tiller/m<sup>2</sup> and panicle/m<sup>2</sup> was found higher in T1 (373) and T4 (370) compared to T2 (344) and T3 (358). It was also observed that tiller/m<sup>2</sup> and panicle/m<sup>2</sup> were similar in T1 and in T4 where only Trichocompost (1.5t/ha) was applied in T1 and recommended dose of fertilizers were applied in T4. Yield (8.36t/ha) and 1000 grain weight (23g) were similar in T1 and where only Trichocompost @1.5t/ha was applied and in T4 (8.37t/ha and 23g) where recommended dose of fertilizers were applied.

■ Q S A Jahan

**Efficacy of copper chitosan NPs incorporated bactericide against BLB.** Three dosages eg., 0.15%, 0.125%, and 0.1% at different ratios [CuChNPs:dH<sub>2</sub>O(6:4) and CuChNPs:dH<sub>2</sub>O (4:6)] were used maintaining healthy, disease and standard control with Bismethizol (0.2%) and CuChNPs (10:0). In pot experiment, all treatments exhibited 30.68% to 63.78% disease reduction after 14 days and 28.12% to 58.09% after 21 days from disease control, suggesting their effectiveness. The lesion length of BB was significantly shorter in the T5: Bis(0.15%)+CuChNsP:dH<sub>2</sub>O(6:4) and disease reduction 63.78% and 58.09% respectively. T3:



CuChNPs showed 47.58% and 35.59% after 14 days and 21 days of inoculation. In field experiment, T5:Bis(0.15%)+CuChNPs:dH<sub>2</sub>O(6:4) showed disease reduction by 62.54% and 57.88% at 14 and 21 days, respectively and T3: CuChNPs showed 47.49% and 39.83% after 14 days and 21 days of inoculation.

■ R Akter, S Akter, L Rahman, A K M Shafiqul Islam, M A Latif and T H Ansari

**Efficacy of Zn-chitosan NPs incorporated bactericide against BB.** Three different dosages—0.15%, 0.125%, and 0.1% at the ratio [ZnChNP s:dH<sub>2</sub>O(8:2)] was used keeping healthy, disease and standard control with Bismethiazol (0.2%) and ZnChNPs (10:0). In pot experiment, all treatments exhibited a 36 to 73.54% reduction in lesion length after 14 days and 34.98 to 63.66% after 21 days compared to disease control, suggesting their effectiveness. At 14 days, the T5 treatment achieved the highest reduction (67.83%) in lesion length of BB, whereas the T6 treatment achieved a 63.24% reduction in lesion length. ZnChNPs alone also demonstrated a good reduction in lesion length, with 38.89% at 14 days and 29.82% at 21 days

In field experiment, ZnChNPs alone demonstrated limited effectiveness, with 34.93% and 26.66% reduction in lesion lengths reduction at 14 and 21 days, respectively after inoculation. Interestingly, T5:Bis(0.15%)+ZnChNP:dH<sub>2</sub>O(8:2) displayed the expected result, with 66.14% and 61.27% reduction in lesion lengths at 14 and 21 days, respectively. Furthermore, T6:Bis(0.125%)+ZnChNP:dH<sub>2</sub>O(8:2) treatment also showed significant efficacy, with

58.48% and 54.70% reduction in lesion lengths at 14 and 21 days, respectively.

■ R Akter, L Rahman, S Akter, A K M Shafiqul Islam, M A Latif and T H Ansari

**Residual effect analysis of trooper fungicide (tricyclazol group) using LCMS/MS.** Fungicide trooper was sprayed twice on BRRI dhan 34. To determine tricyclazole group of fungicidal residues in rice grain liquid chromatography tandem mass spectrometry (LC-MS/MS) was used (Model: LCMS/MS 8050, Shimadzu). In the study none of the sample showed any residual effect. The standard was 50 ppb, retention time 2.047 and R value was 0.999 (model: LCMS/MS 8050, Shimadzu).

■ R Akter, H B Shozib, M Islam and T H Ansari

**Effect of fungicide on microbial community in rhizosphere of rice.** Four treatments-Amister top (Azoxystrobin + Difenconazole), Amister top + Sheath blight, Disease control and healthy control were used. For the enumeration of bacterial population in the soil samples serial soil dilution was done. Maximum number of colonies found three days before fungicide spray in all the treatments. And the number of colonies significantly reduced after spraying Amister top. The toxic effects of the fungicides were more pronounced immediately after the application of fungicides. On the other hand, with an increasing incubation period, the bacterial population tended to increase. After 28 days it became stagnant and there is no significant difference with before Amister top spray.

■ A Dilzahan, M R Bhuiyan, M Hossain, M A Latif and T H Ansari

**Synthesis of silica (SiO<sub>2</sub>) nanoparticles from rice husk ash.** Silica nanoparticles were synthesized by dissolving rice husk ash. The optical properties of the SiO<sub>2</sub> nanoparticles were analyzed using a UV–vis spectrophotometer. Crystal structure was determined and functional groups were identified. Particle size and zeta potential were measured with a Litesizer 500, and morphology was examined via

SEM, FESEM and TEM. The UV-visible spectrum of the synthesized SiO<sub>2</sub> NPs (SiO<sub>2</sub>NPs) showed a maximum absorption band edge at 215 nm with an absorbance of 1.95 confirming the presence of silica nanoparticles. FESEM and TEM images demonstrate that the silica nanoparticles were spherical and uniformly distributed, though in an agglomerated state (Fig. 3).

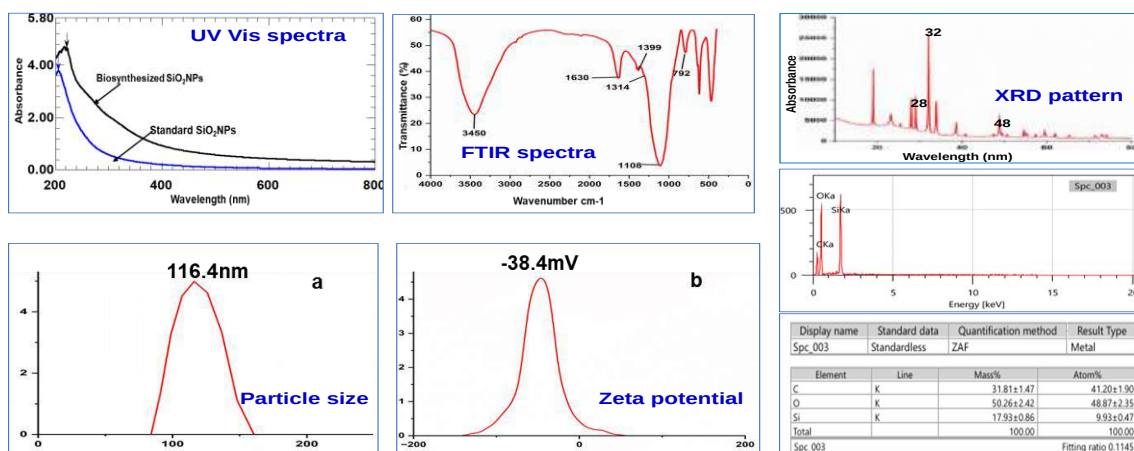


Fig. 3.

■ M A I Khan, A K M Shafiqul Islam, H R Hera, T H Ansari and M A Latif

**Suppression of microbial development by hydrogen peroxide.** Commercial H<sub>2</sub>O<sub>2</sub> (6%) was and converted to different molar solutions for using in this experiment. Hydrogen peroxide of different concentrations was mixed with PDA and PSA media for fungal and bacterial growth, respectively. Treatments for H<sub>2</sub>O<sub>2</sub> were T<sub>1</sub> (1.0 M H<sub>2</sub>O<sub>2</sub> solution), T<sub>2</sub> (10<sup>-1</sup> M H<sub>2</sub>O<sub>2</sub> solution), T<sub>3</sub> (10<sup>-2</sup> M H<sub>2</sub>O<sub>2</sub> solution), T<sub>4</sub> (10<sup>-3</sup> M H<sub>2</sub>O<sub>2</sub> solution) and T<sub>5</sub> (10<sup>-4</sup> M H<sub>2</sub>O<sub>2</sub> solution). A standard control fungicide/bactericide (T<sub>6</sub>) and a diseased control having no chemical (T<sub>7</sub>) were maintained. Amistar top, Trooper, Streptomycin were used in the media as standard control for sheath blight, blast and BLB pathogens respectively. H<sub>2</sub>O<sub>2</sub> @ 1.0-0.1M completely inhibited mycelial growth of *Pyricularia oryzae* and *Rhizoctonia solani* whereas *Xanthomonas oryzae* pv. *oryzae* was completely inhibited by 1.0-0.01M H<sub>2</sub>O<sub>2</sub>

solutions. Concentration @ 1.0 M reduced sheath blight disease compared to commercial fungicide, Amistar Top in pot experiment. Similarly, BB was reduced by 1.0 M H<sub>2</sub>O<sub>2</sub> in nursery bed when compared with streptomycin and other treatments of H<sub>2</sub>O<sub>2</sub>. Reduction of blast disease in nursery seed bed at 1.0-0.1M concentration was comparable with commercial fungicide, Trooper.

■ M Hossain, M R Bhuiyan, H A Diljahan, A Ara and T H ansari

**Evaluation of new chemicals against blast and sheath blight diseases of rice.** For leaf blast: Among 30 chemicals, only three (mostly Tricyclazole group fungicide) controlled leaf blast (artificial inoculation) by more than 80%. In another experiment, among the 21 tested chemicals, only 10, including the check (Trooper 75WP), reduced leaf damage by more than 80% compared to the untreated control.

For sheath blight: A total of 35 fungicides including one standard check Folicur were tested against ShB. None of the tested chemicals reduced sheath blight disease by 80%.

■ Sheath blight PI: M R Bhuiyan and Blast PI: M A Monsur; CI: M Hossain, H A Dilzahan, M H R Hera, M A I Khan and T H Ansari

**Characterization of biosynthesized AgNPs and ZnONPs.** Experiment was conducted to determine the physical and chemical properties of nanoparticles. Ag and ZnO were confirmed as NPs through characterization by using different techniques (UV- spectroscopy, Zeta potential, XRD, SEM, FESEM, TEM and FTIR).

■ S Akter, R Akter, A Khatun, A K M Shafiqul Islam and M A Latif

**Effect of fungicide mediated AgNPs and ZnONPs for controlling sheath blight.** To reduce the cost and to minimize the residual effect of fungicides on environment this experiment was conducted in the field condition at BRRI. 76% disease reduction was obtained by the application of AgNPs along with Folicur at 2:1 ratio. 58% reduction by application of ZnONPs along with Folicur at the same ratio.

## TECHNOLOGY TRANSFER

**Farmers training on integrated rice disease management.** Ten batches of a ‘day-long’ training programme on integrated rice disease management were conducted. Each training programme consisted of 30 farmers having both male and female

participants. Therefore, altogether 210 farmers were trained on different rice diseases and its management technique under changing climatic condition of Bangladesh.

■ T H Ansari, Q S A Jahan, M Hossain, M S Mian, M A I Khan, S Akter, M Ahmad, M R Bhuiwan, B Nesa, M M Rashid, A Ara, S A I Nihad, H R Hira, R Akter, H A Dilzahan and M A Latif

**Upscaling of blast disease management at farmer’s field during Boro 2023-24.** Sixteen trials of upscaling of blast disease management were conducted in three bigha of land for each trial at different locations during Boro 2023-24. Among the locations, the highest neck blast disease incidence (DI) was observed in the farmer’s practice plot (DI-90%) with severity 9 at BRRI dhan81 field, Burichang, Cumilla where the same variety showed 0.1% DI with severity 5 and 78.98% yield loss was saved by using BRRI developed technology. In the farmer’s practice, the lowest disease incidence (3%) was observed in the plot of BRRI dhan100 at Gopalganj Sadar, On the other hand, in the BRRI practice plot, DI was found only 0.3% with severity 5. The yield loss was saved by 6.75% by applying BRRI technology in the field of BRRI dhan100. In the rest of the trials, the yield losses saved ranged from 33.33% to 8.45% at different varieties by using BRRI technology.

■ T H Ansari, Q S A Jahan, M Hossain, M S Mian, M A I Khan, S Akter, M Ahmad, M R Bhuiwan, B Nesa, M M Rashid, A Ara, S A I Nihad, H R Hira, R Akter, H A Dilzahan and M A Latif

## **Rice Farming Systems Division**

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## SUMMARY

### Experiments on Cropping Patterns

- Two experiments were carried out at BRRI HQ, Gazipur, to identify profitable cropping patterns for irrigated medium-high land ecosystems. The four-crop pattern, Potato-Relay Pumpkin-T. Aman and the three-crop pattern, Onion-Jute-T. Aman were found to be the most profitable.
- Another experiment focused on identifying suitable rice varieties for different planting windows in Mustard-Boro-T. Aman cropping system. BARI Sarisha-14 performed well when sown between 01-15 November. In Boro season, BRRI dhan89 produced higher grain yield when transplanted from 10 January to 09 February and BRRI dhan98 was found suitable from 19 February to 29 February when transplanted after mustard. In T. Aman season, BRRI dhan71 and BRRI dhan87 performed well at all planting dates.
- Newly released Boro and T. Aman rice were also evaluated at BRRI, Gazipur under Boro-Fallow-T. Aman cropping pattern. BRRI dhan92 and BRRI dhan102 in Boro season and BRRI dhan103 in T. Aman season was found promising.

**Enhancing productivity in waterlogged wetland ecosystems.** Two activities were conducted at BRRI, Gazipur to increase the productivity of waterlogged wetland ecosystem. Cultivating rice, fish, and vegetables across various niches yielded a gross margin of Tk 8,460 per decimal. In another experiment, Coriander leaf-Stem amaranth on dyke and Bottle gourd-Ash gourd on trellis resulted a gross margin of Tk 4,761 from one decimal area under different fruit trees.

**Validation of improved cropping patterns.** Under the validation programme, various improved cropping patterns were tested across different ecosystems in the country. In saline ecosystem (Batiaghata and Dacope, Khulna), BRRI dhan67-

Fallow-BRRI dhan87 cropping pattern in two rice ecosystem and inclusion of Aus rice in Watermelon-Fallow-T. Aman cropping pattern increased the productivity of the existing cropping patterns. In the Jhum ecosystem, BRRI dhan83 performed well in several upazilas of CHT, while BRRI dhan92 and BRRI dhan74 were well-suited for fringe lands in Rangamati. In Nabiganj, Habiganj, inclusion of Aus rice (BRRI dhan98) increased the cropping intensity of single T. Aman cropping system. Incorporation of BARI Sarisha-14 in Boro-Fallow-T. Aman cropping pattern at different locations of Bangladesh increased the REY about 28-58%.

**Farming systems research.** In the farming systems research and development site, Muktarpur, Kaliganj, Gazipur, inclusion of mustard/sunflower increased the productivity of Boro-Fallow-T. Aman cropping pattern. BRRI dhan100 in Boro and BRRI dhan103 in T. Aman season significantly increased the productivity of the Boro-Fallow-T. Aman cropping pattern. Whereas BRRI dhan92 exhibited excellent performance in a single rice ecosystem. Farmers' participatory evaluation of recently released BRRI varieties revealed that BRRI dhan71 in T. Aman and BRRI dhan92, BRRI dhan100 and BRRI dhan102 in Boro season were suitable in that area. Farmers' participatory quality seed production activities ensured the use of quality seed in Boro and T. Aman season. Moreover, the productivity of the mixed orchard was increased with the introduction of vegetables and spices. Homestead vegetables, livestock, fisheries and agroforestry interventions resulted in an annual profit of Tk 73,481 per farmer.

### CROPPING PATTERN DEVELOPMENT FOR FAVORABLE ECOSYSTEM

#### Performance of four-cropped cropping patterns for irrigated medium high land ecosystem

An experiment was conducted at the BRRI HQ research farm, Gazipur to compare the yield and profitability of six four-cropped cropping patterns

viz CP<sub>1</sub>: Tomato (BARI Tomato-21)-Mungbean (BARI Mung-6)-T. Aus (BRRI dhan98)-T. Aman (BRRI dhan75), CP<sub>2</sub>: Mustard (BARI Sarisha-14)-Boro (BRRI dhan88)-T. Jute (BJRI Tossa Pat-8)-T. Aman (BRRI dhan71), CP<sub>3</sub>: Mustard (BARI Sarisha-14)-Mungbean (BARI Mung-6)-T. Aus (BRRI dhan98)-T. Aman (BRRI dhan71), CP<sub>4</sub>: Potato (Asterix)\Pumpkin (BARI Hybrid Mistikumra-2)-T. Aus (BRRI dhan98)-T. Aman (BRRI dhan90), CP<sub>5</sub>: Potato (Asterix)+Maize (BARI Hybrid Maize-16)-T. Aus (BRRI dhan98)-T. Aman (BRRI dhan75), CP<sub>6</sub>: Mustard (BARI

Sarisha-14)-Vegetable (BARI Puishak-2)-T. Aus (BRRI dhan98)-T. Aman (BRRI dhan71) against the CP<sub>7</sub>: Mustard (BARI Sarisha-14)-Boro (BRRI dhan88)-T. Aman (BRRI dhan75) cropping pattern. Table presents individual crop yield, REY and economics of representing cropping patterns. Among the tested cropping patterns, the highest rice equivalent yield (REY) of 35.92 t/ha and gross margin (GM) of 5,36,000 Tk/ha resulted from Potato\Pumpkin-T. Aus-T. Aman cropping pattern (CP<sub>4</sub>) with a marginal benefit cost ratio (MBCR) of 3.72

**Table 1. Yield and profitability of different crop combinations under four cropped cropping patterns, BRRI HQ, Gazipur, 2023-24.**

| CP                    | Yield (t/ha) |         |        |       |          |         |           |      |      |        |         | REY (t/ha) | TVC ('000 Tk/ha) | GM ('000 Tk/ha) | MBCR |
|-----------------------|--------------|---------|--------|-------|----------|---------|-----------|------|------|--------|---------|------------|------------------|-----------------|------|
|                       | Tomato       | Mustard | Potato | Maize | Mungbean | Pumpkin | Vegetable | Jute | Boro | T. Aus | T. Aman |            |                  |                 |      |
| CP <sub>1</sub>       | *9.58        | -       | -      | -     | *0.30    | -       | -         | -    | -    | 4.01   | 4.00    | 20.58 b    | 452              | 94              | 0.68 |
| CP <sub>2</sub>       | -            | 1.23    | -      | -     | -        | -       | -         | 1.22 | 4.87 | -      | 5.14    | 16.38 cd   | 313              | 97              | 0.81 |
| CP <sub>3</sub>       | -            | 1.72    | -      | -     | *0.39    | -       | -         | -    | -    | 4.59   | 5.65    | 17.15 cd   | 260              | 169             | 1.98 |
| CP <sub>4</sub>       | -            | -       | 20.01  | -     | -        | 7.6     | -         | -    | -    | 4.37   | 4.27    | 35.92 a    | 362              | 536             | 3.72 |
| CP <sub>5</sub>       | -            | -       | *14.30 | 7.21  | -        | -       | -         | -    | -    | 4.54   | 4.09    | 34.44 a    | 418              | 443             | 2.49 |
| CP <sub>6</sub>       | -            | 1.47    | -      | -     | -        | -       | 8.04      | -    | -    | 4.44   | 5.25    | 19.22 bc   | 292              | 188             | 1.74 |
| CP <sub>7</sub> (ck.) | -            | 1.77    | -      | -     | -        | -       | -         | -    | 5.42 | -      | 4.05    | 15.15 d    | 219              | 160             | -    |
| CV (%)                | 8.19         |         |        |       |          |         |           |      |      |        |         |            |                  |                 |      |

\*Yield affected by different biotic and abiotic stresses. Means with the same letter(s) are not significantly different.

Price (Tk/kg): Tomato=30, Mustard=80, Potato=30, Maize=30, Mungbean=90, Pumpkin=20, Vegetable (Indian spinach)=15, Jute=50, Rice=25, Jute stick=10; Stover=6

### Performance of three-cropped cropping patterns for irrigated medium high land ecosystem

The experiment was conducted at BRRI research farm, Gazipur to evaluate the agronomic and economic performance of eight three-cropped cropping patterns viz CP<sub>1</sub>: Boro (BRRI dhan88)-T. Aus (BRRI dhan48)-T. Aman (BRRI dhan75), CP<sub>2</sub>: Mustard (BARI Sarisha-18)-Boro (BRRI dhan88)-T. Aman (BRRI dhan75), CP<sub>3</sub>: Potato (Asterix)-Boro (BRRI dhan88)-T. Aman (BRRI dhan95), CP<sub>4</sub>:

Wheat (BARI Gom-30)-Mungbean (BARI Mung-6)-T. Aman (BRRI dhan75), CP<sub>5</sub>: Sunflower (BARI Surjamukhi-3)-T. Aus (BRRI dhan48)-T. Aman (BRRI dhan75), CP<sub>6</sub>: Onion (BARI Piaj-4)-Jute (BJRI Tossa Pat-8)-T. Aman (BRRI dhan87), CP<sub>7</sub>: Lentil (BARI Mashur-8)-T. Aus (BRRI dhan48)-T. Aman (BRRI hybrid dhan6) and CP<sub>8</sub>: Boro (BRRI dhan92)-Fallow-T. Aman (BRRI dhan49) (ck) were tested. Onion-Jute-T. Aman (CP<sub>6</sub>) resulted in the highest REY (50.52 t/ha), GM (10,09,000 Tk/ha) and MBCR (8.05) (Table 2).

**Table 2. Yield and profitability of different crops combination under three-cropped cropping pattern, BRRI, Gazipur 2023-24.**

| CP                    | Yield (t/ha) |        |       |           |       |            |      |          |      |        |         | REY<br>(t/ha) | TVC<br>(‘000<br>Tk/ha) | GM (‘000<br>Tk/ha) | MBC<br>R |
|-----------------------|--------------|--------|-------|-----------|-------|------------|------|----------|------|--------|---------|---------------|------------------------|--------------------|----------|
|                       | Mustard      | Potato | Wheat | Sunflower | Onion | Lentil     | Boro | Mungbean | Jute | T. Aus | T. Aman |               |                        |                    |          |
| CP <sub>1</sub>       | -            | -      | -     | -         | -     | -          | 6.62 | -        | -    | 4.22   | 4.16    | 14.99 c       | 239                    | 177                | 2.36     |
| CP <sub>2</sub>       | 1.77         | -      | -     | -         | -     | -          | 5.42 | -        | -    | -      | 4.05    | 15.15 c       | 220                    | 205                | 3.45     |
| CP <sub>3</sub>       | -            | *11.8  | -     | -         | -     | -          | 4.33 | -        | -    | -      | 5.07    | 23.63 b       | 300                    | 312                | 2.76     |
| CP <sub>4</sub>       | -            | -      | 3.74  | -         | -     | -          | -    | *0.16    | -    | -      | 4.09    | 10.65 cd      | 220                    | 59                 | 0.61     |
| CP <sub>5</sub>       | -            | -      | -     | 1.54      | -     | -          | -    | -        | -    | 4.04   | *2.81   | 9.93 cd       | 227                    | 42                 | 0.38     |
| CP <sub>6</sub>       | -            | -      | -     | -         | 20.55 | -          | -    | -        | 1.82 | -      | 5.05    | 50.52a        | 299                    | 1009               | 8.05     |
| CP <sub>7</sub>       | -            | -      | -     | -         | -     | damg<br>ed | -    | -        | -    | 5.06   | 2.5     | 7.56 d        | 223                    | -8                 | -0.57    |
| CP <sub>8</sub> (ck.) | -            | -      | -     | -         | -     | -          | 5.32 | -        | -    | -      | 3.80    | 9.11 d        | 167                    | 79                 | -        |
| CV (%)                |              |        |       |           |       |            |      |          |      |        |         | 18.25         |                        |                    |          |

\*Yield affected by different biotic and abiotic stresses.

Price (Tk/kg): Mustard=80, Potato=30, Wheat=40, Sunflower=50, Onion=50, Lentil=85, Mungbean=90, Jute=60, Rice=25, Jute stick=10, Stover=6

### Evaluation of newly released BRRI varieties under Boro-Fallow-T. Aman cropping pattern

A study conducted at BRRI HQ, Gazipur to identify the profitable crop sequence using newly released BRRI rice varieties in Boro-Fallow-T. Aman cropping pattern. During the Boro season, the varieties-BRRI dhan92, Bangabandhu dhan100, BRRI dhan102, BRRI dhan104, BRRI dhan105 and BRRI dhan107 were tested alongside the control variety BRRI dhan29, while BRRI dhan87 and BRRI dhan103 were evaluated against BRRI dhan49. Out of the 13 cropping combinations, BRRI dhan92-Fallow-BRRI dhan103 turned out the highest total grain yield of 12.32 t ha<sup>-1</sup>. Cost and return analysis indicates that this combination generated the maximum gross margin of 249,109 Tk/ha, with a marginal benefit-cost ratio of 18.80.

### Determination of optimum planting window of newly released rice varieties in Mustard-Boro-T. Aman cropping system

An experiment was conducted at BRRI research farm in Gazipur to determine the optimal

sowing/planting window for the crops in the Mustard-Boro-T. Aman cropping pattern. Mustard variety, BARI Sarisha-14 was sown on 01, 08, 15, 22 and 29 November. During the Boro season, BRRI dhan88, BRRI dhan89, BRRI dhan48 and BRRI dhan98 were transplanted across six planting dates viz. 10, 20, 30 January and 09, 19, 29 February. For T. Aman season, BRRI dhan71, BRRI dhan75, BRRI dhan87 and BRRI dhan49 were transplanted on 10, 20, 30 July and 09, 19, 29 August. BARI Sarisha-14 performed better when sown between 01-15 November. During the Boro season, BRRI dhan89 provided higher grain yield among the tested varieties when transplanted from 10 January to 09 February, while BRRI dhan98 produced the highest grain yield when transplanted between 19 February and 29 February. In T. Aman season, BRRI dhan71 and BRRI dhan87 yielded higher grain than the other varieties across all transplanting dates, with optimal performance when transplanted between 20 July and 09 August (Fig. 1).

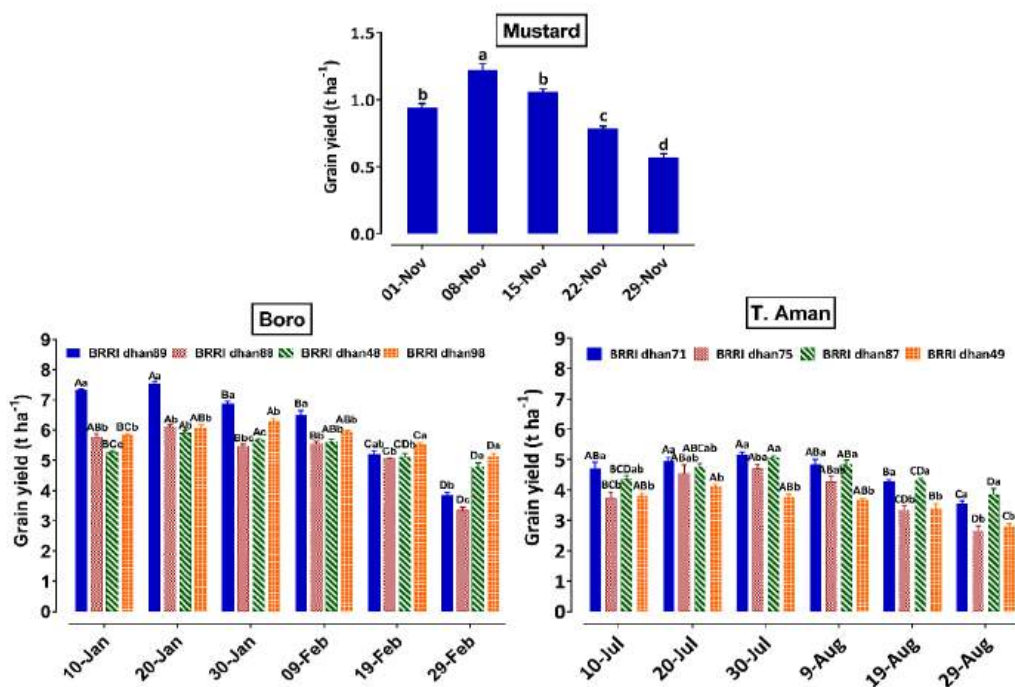


Fig. 1. Effects of planting/sowing date and variety on grain yield of Mustard, Boro and T. Aman. Capital letters indicate the comparison among different planting dates of a given variety. Lower case letters indicate the comparison among different varieties within a given planting date. Different letters indicate significant differences at  $P < 0.05$ .

### Transformation of waterlogged wetland into three-tier production system for integrated rice-fish, vegetables and fruit cultivation

A waterlogged marshy fallow land (12.02 decimal) was converted to a three-tier production system, i.e., dyke (3.64 decimal), rice land (4.83 decimal) and canal around the pond (3.57 decimal) for integrated rice+fish, vegetables and fruit cultivation. In the rice land area, BRRI dhan89 was cultivated in Boro and BR22 and BRRI dhan30 in T. Aman season. Different Kharif vegetables and year-round papaya

were cultivated in the dykes. Monosex tilapia, sorputi and common carp were reared in the canal. In the rice land, the CP<sub>2</sub> (BR22-Fallow-BRRI dhan89) performed better (Total grain yield: 11.09 t/ha; gross margin: 2,03,524 Tk/ha and BCR: 1.22) than CP<sub>1</sub> (Table 3). On average, 116 kg of vegetables and 4.23 kg of fish were harvested per decimal area of the dyke (The entire field overflowed with a heavy shower on 6th October 2023) and rice land with a gross margin of 3,193 Tk and 920 Tk decimal<sup>-1</sup>, respectively (Table 4).

**Table 3. Yield and profitability of Boro-Fallow-T. Aman cropping patterns in waterlogged wetland ecosystem, BRRI HQ, Gazipur 2023-24.**

| Treatment                                        | T. Aman | Boro | Total grain yield (t ha <sup>-1</sup> ) | TVC ('000 Tk ha <sup>-1</sup> ) | GM ('000 Tk ha <sup>-1</sup> ) | BCR  |
|--------------------------------------------------|---------|------|-----------------------------------------|---------------------------------|--------------------------------|------|
| CP <sub>1</sub> : BRRI dhan30-Fallow-BRRI dhan89 | 3.77 b  | 6.91 | 10.68                                   | 167                             | 198                            | 1.19 |
| CP <sub>2</sub> : BR22-Fallow-BRRI dhan89        | 4.26 a  | 6.83 | 11.09                                   | 166                             | 204                            | 1.22 |
| CV (%)                                           | 2.44    | 3.05 | 2.56                                    | -                               | -                              | -    |

Means with the same letter(s) are not significantly different. Price (Tk./kg): Rice; Boro=30, Aman=30-32.5, Straw; Boro=2.5, Aman=6.5



**Table 4. Average yield and profitability of vegetables and fish in dyke and canal of a three-tier production system, BRRI HQ, Gazipur 2023-24.**

| Niche             | Yield<br>(Kg decimal <sup>-1</sup> ) | TVC<br>(Tk decimal <sup>-1</sup> ) | GM<br>(Tk decimal <sup>-1</sup> ) | BCR  |
|-------------------|--------------------------------------|------------------------------------|-----------------------------------|------|
| Dyke (Vegetables) | 116                                  | 1606.86                            | 3193                              | 3.19 |
| Canal (Fish)      | 4.23                                 | 93.17                              | 920                               | 9.87 |

Price (Tk./kg): Papaya (Green)=30, Red amaranth=40, Jute (leaf)=60, Kangkong=40, Brinjal=80, Okra=70, fish=190-400

### **Modification of waterlogged fallow land into integrated agroforestry and fishery production system**

A study was conducted at BRRI HQ, Gazipur to bring waterlogged fallow land under year-round integrated production system with six different combinations of crops and vegetables, fruit trees and fishes. Among the six crop combinations tested on dyke, the Coriander leaf-Stem amaranth, Tomato-Kangkong, and Spinach-Jute leaf combinations performed notably well under various fruit trees, achieving gross margins of Tk 3,284, 2,939, and 2,713 respectively, from 141, 166, and 182 kg of vegetables per decimal area. Among the six combinations on trellis, the Pumpkin-Pumpkin, Bottle gourd-Ash gourd, and Watermelon-Snake gourd sequences showed promising results, generating gross margins of Tk 1,117, 1,477, and 1,012 from 62, 58, and 34 kg of vegetables per decimal area. The fruit trees, being only two years old, have not yet reached significant bearing levels. However, the Guava, Jujube, and Mango trees produced 4.03, 2.14, and 3.48 kg of fruit per tree respectively.

### **Utilization of fallow land to intensify the single T. Aman area and boost up the productivity in the Sylhet region**

A field trial was conducted in farmers' fields of Nabiganj, Habiganj district in collaboration with DAE to intensify the single T. Aman cropping pattern in Sylhet region. The inclusion of BRRI dhan98 in T. Aus season and the replacement of the traditional T. Aman variety significantly increased

the productivity of the existing cropping pattern. Among the combinations, BRRI dhan98 in T. Aus and BRRI dhan87 in T. Aman season (CP<sub>3</sub>) resulted in the highest productivity (11.09 t/ha); which was 137.5% higher than the existing cropping pattern. These approaches generated a gross margin of 1,87,165 Tk/ha with a MBCR of 2.01.

### **DEVELOPMENT OF CROPPING PATTERN FOR STRESS PRONE ENVIRONMENT**

#### **Improvement of Boro-Fallow-T. Aman cropping pattern with BRRI newly released rice varieties in saline coastal area**

The study was conducted in the farmers' fields of Batiaghata upazila in Khulna district to enhance the productivity of the existing Boro-Fallow-T. Aman cropping system using newly released BRRI rice varieties. In Boro season, the salt-tolerant varieties BRRI dhan99 and BRRI dhan67 were cultivated against BRRI dhan28; while in the T. Aman season, BRRI dhan87 and BR23 were grown alongside the local variety Ranisalute. The results showed that maximum total rice production (10.2 t/ha), gross margin (Tk 83,000/ha) and MBCR (1.57) obtained from the cropping pattern BRRI dhan67-Fallow-BRRI dhan87 cropping pattern.

#### **Intensification of Watermelon-Fallow-T. Aman cropping pattern by inclusion of Aus rice**

The study was conducted on farmers' fields in Dacope upazila, Khulna district to increase the productivity of Watermelon-Fallow-T. Aman cropping pattern by incorporating Aus rice and replacing the traditional T. Aman variety. BRRI

dhan98 in the Aus season and BRRI dhan87 in place of the local Morichshail variety significantly boosted the productivity of the existing cropping system,

resulting in a rice equivalent yield (REY) of 43.24 t/ha, Gross margin of 7,93,330 Tk/ha, and marginal benefit-cost ratio (MBCR) of 3.72 (Table 5).

**Table 5. Yields and economic analysis of different crops under Watermelon-T. Aus-T. Aman cropping pattern, Dacope, Khulna 2023-2024.**

| Cropping pattern                                                     | Yield (t/ha) |        |         | REY (t/ha) | TVC ('000 Tk/ha) | GM ('000 Tk/ha) | MBCR |
|----------------------------------------------------------------------|--------------|--------|---------|------------|------------------|-----------------|------|
|                                                                      | Watermelon   | T. Aus | T. Aman |            |                  |                 |      |
| ICP: Watermelon (Hybrid) -T. Aus (BRRI dhan98)-T. Aman (BRRI dhan87) | 44.80        | 5.9    | 4.3     | 43.24      | 330.92           | 793.33          | 3.72 |
| ECP: Watermelon (Hybrid)-Fallow-T. Aman (Morichshail)                | 41.30        | -      | 1.8     | 33.40      | 262.20           | 606.30          | -    |

ICP=Improved Cropping Pattern, ECP=Existing Cropping Pattern, Price (Tk/kg): Rice = 26; Watermelon = 19.2

## DEVELOPMENT OF CROPPING PATTERN FOR HILLY AREA

### Productivity improvement of Jhum cultivation system through the replacement of local Aus rice in hilly areas

A study was conducted in different upazilas of Khagrachhari (Sadar and Panchhari), Rangamati (Baghaichhari and Naniarchor) and Bandarban (Ruma and Thanchi) districts to evaluate the yield performance of high yielding Aus (BRRI dhan43, BRRI dhan48, BRRI dhan65 and BRRI dhan83) varieties against farmers' adopted local rice varieties for jhum system. The average grain yield of BRRI dhan43, BRRI dhan48, BRRI dhan65 and BRRI dhan83 was 3.34 t/ha, 3.74 t/ha, 3.38 t/ha and 3.85 t/ha respectively whereas Mongthongno (3.37 t/ha), Ranqui (3.19 t/ha), and Kanbui (3.14 t/ha) yielded better among the local varieties.

### Feasibility study of Boro rice cultivation in fringe land at Rangamati district

Kaptai Lake in Rangamati district encompasses approximately 6,500 hectares of land suitable for rice cultivation during the dry season. In Boro 2023-24, a total of 50 trials were conducted in the fringe

land across four upazilas- Borkol, Longodu, Baghaichhori, and Naniarchor- to expand the coverage of Boro rice. Modern varieties such as BRRI dhan74, BRRI dhan89, BRRI dhan92 and BRRI dhan100 were assessed in the fringe lands of Kaptai Lake. Among the varieties tested, BRRI dhan92 demonstrated significantly higher yields in Borkol, Longodu, and Naniarchor, while BRRI dhan74 excelled in Baghaichhori upazila.

## VALIDATION AND DELIVERY OF CROPPING SYSTEM TECHNOLOGY

### Intensification of Boro-Fallow-T. Aman cropping pattern through integration of mustard/sunflower

The introduction of short-duration, high-yielding BARI Sarisha-14/BARI Surjomukhi-3 in Boro-Fallow-T. Aman cropping pattern aimed to enhance productivity, profitability, and cropping intensity. In Aman season, BRRI dhan71 was cultivated, while BRRI dhan100 and BRRI dhan102 were used in Boro season under improved cropping practices. These interventions resulted in 28-58% higher REY and 38-87% higher gross margin compared to the existing cropping pattern (Table 6).

**Table 6. Grain yield and profitability of different cropping patterns 2023-24.**

| Location               |     | Grain yield (t/ha) |      |            | REY (t/ha) | TVC<br>(‘000<br>Tk/ha) | GM<br>(‘000<br>Tk/ha) | MBCR |
|------------------------|-----|--------------------|------|------------|------------|------------------------|-----------------------|------|
|                        |     | Mustard/ Sunflower | Boro | T.<br>Aman |            |                        |                       |      |
| Mustard-Boro-T. Aman   |     |                    |      |            |            |                        |                       |      |
| Dhanbari,              | ICP | 1.59               | 7.12 | 6.18       | 18.36      | 276.63                 | 183                   | 0.03 |
| Tangail                | ECP | -                  | 6.14 | 5.47       | 11.61      | 157.2                  | 133                   | -    |
| Kaliganj,              | ICP | 1.33               | 6.11 | 5.48       | 14.63a     | 354                    | 204                   | 2.03 |
| Gazipur                | ECP | -                  | 6.79 | 4.66       | 11.45b     | 282                    | 129                   | -    |
| Sunflower-Boro-T. Aman |     |                    |      |            |            |                        |                       |      |
| Kaliganj               | ICP | 3.19               | 6.04 | 5.44       | 16.04a     | 395                    | 241                   | 198  |
| Gazipur                | ECP | -                  | 6.79 | 4.66       | 11.45b     | 282                    | 129                   | -    |

Price (Tk/Kg): Boro = 30 to 35, T. Aman = 30 to 32.5, Boro straw= 2-4, T. Aman straw= 6-9, Mustard= 80, Sunflower= 60, Stover (mustard and sunflower) = 2

## INTEGRATED FARMING SYSTEMS RESEARCH AND DEVELOPMENT

### Crops and Cropping Pattern

#### Introducing newly released BRRI rice varieties for the improvement of major cropping patterns in FSRD site, Kaliganj, Gazipur

Two trials were conducted in Kaliganj, Gazipur to increase productivity of Boro-Fallow-T. Aman and

Boro-Fallow-Fallow cropping pattern. In the double rice ecosystem, BRRI dhan100 in Boro and BRRI dhan103 in T. Aman season led to a gross margin (GM) of 1,73,000 Tk/ha with a MBCR of 2.81. While, BRRI dhan92 in the single rice ecosystem resulted in a GM of 84,000 Tk/ha and MBCR of 6.99 (ICP) (Table 7).

**Table 7. Grain yield and profitability of double and single rice-based cropping patterns, Kaliganj, Gazipur 2023-24.**

| Cropping pattern |     | Yield (t/ha) |         |                    | TVC ('000 Tk/ha) | GM ('000 Tk/ha) | MBCR |
|------------------|-----|--------------|---------|--------------------|------------------|-----------------|------|
|                  |     | Boro         | T. Aman | Total productivity |                  |                 |      |
| Double rice      | ICP | 7.25         | 5.28    | 12.53a             | 291              | 173             | 2.81 |
|                  | ECP | 6.32         | 4.50    | 10.82b             | 274              | 143             | -    |
| Single rice      | ICP | 7.32a        | -       | 7.32a              | 154              | 84              | 6.99 |
|                  | ECP | 6.90b        | -       | 6.90b              | 152              | 74              | -    |

Double-rice based cropping Pattern: ICP=BRRI dhan100-Fallow-BRRI dhan103, ECP=BRRI dhan28-Fallow-Ranjit (ck.); Single rice-based cropping pattern: ICP= BRRI dhan92-Fallow-Fallow, ECP=BRRI dhan29-Fallow-Fallow (ck.), MBCR=Marginal Benefit Cost Ratio; Price (Tk/Kg): Boro = 32.5 to 35, T. Aman = 30 to 32.5, Boro straw= 2-3, T. Aman straw= 5-9

#### Farmers' participatory evaluation of recently released BRRI varieties for Boro and T. Aman season

A study was conducted to assess suitable T. Aman and Boro rice varieties for the FSRD site. During the Aman season, farmers were satisfied with the higher yield of BRRI dhan71. However, farmers were also interested in cultivating BRRI dhan90 because of its excellent grain quality and high market price. In the Boro season, BRRI dhan92 and BRRI dhan102

performed better. In addition, farmers appreciated BRRI dhan100 for its nice grain quality and palatability.

#### Evaluation of intercropping under mixed orchard in Madhupur tract

The experiment was conducted at the FSRD site of Muktarpur, Kaliganj, Gazipur at six farmer's orchards with six patterns of various vegetables, fruit trees and spices to generate additional income for farmers. On average, each orchard (10 decimals)

yielded a gross margin of Tk 17,591, with vegetables, spices, and fruits contributing 23%, 46%, and 31% respectively. In addition to fruit production, farmers harvested an average of 138 kg of vegetables and 57 kg of spices from 10 decimals of orchard.

### **Homestead production system**

The homestead area of 10 farmers at the FSRD site of Kaliganj, Gazipur was utilized under six production units viz, bed, around bed, fence, roof, trellis and boundary to improve the vegetables production round the year. On average, a total of 135 kg summer and winter vegetables were produced from eight decimals of area; of which each farmer consumed 88 kg and sold 41 kg vegetables. The average gross margin from homestead vegetable production was Tk 4,355 per farmer during the reporting period. Each farmer received 143 kg turmeric and 35 kg ginger per decimal of area; of which each farmer consumed 7 kg and sold 136 kg spices, respectively. The average gross margin from homestead spices production was Tk 23,643 per farmer during the reporting period.

### **Compost production using household waste**

Compost was produced by the intervene farmers at FSRD site of Kaliganj, Gazipur by using household wastes, vegetable waste, cow dung, poultry litter and other living materials. The annual average amount of compost produced by the farmers was 49.43 kg/04 m<sup>2</sup>. The compost was used for vegetables, spices and fish cultivation.

### **Livestock production system**

Twenty Sonali chicks, two pairs of adult pigeons and one Black Bengal doe were distributed to each of the ten selected farmers at the FSRD site, Muktarpur,

Kaliganj, Gazipur to assist in meeting the nutritional requirements as well as increasing income of farm families. Technical supports (feeding and watering management, vaccination etc) as well as necessary treatments were provided as per requirement. Monthly average egg production was 13 per farmer during the reported time. Average body weight gain per chicken after 12 months from distribution was 1.61 kg. On average, each farmer earned a total of Tk 4,800 by selling chicken and eggs. Pigeon rearing was found profitable, and it provides an additional Tk 5,450 per farmer by producing squab. Nine goats gave birth to fifteen kids whereas one goat did not give birth to kids yet.

### **Semi-aquatic production system of vegetables and fish in derelict mini pond**

Aroid (BARI Panikachu-3) was cultivated in the derelict pond along with fish (Mixed carp) at the FSRD site, Muktarpur, Kaliganj, Gazipur to increase the productivity and farm income. Farmer earned Tk 7,605 by selling stolon and Tk 1,31,400 by selling of Aroid from a 30 decimal derelict pond. A total of Tk 38,978 was earned from harvested fish. The gross margin obtained from this production system was Tk 69,538/30 dec.

### **Overall scenario of integrated homestead, fishery and livestock production**

Figure 2 presents the average annual profit obtained from various household components of a farmer from 10 decimals of household area and 10 decimal pond. The figure shows that among the various household components the livestock (chicken, pigeon and goat rearing) production is most profitable, which contributed 43% to the total annual profit of the small and marginal farmers, followed by aquaculture (37%).

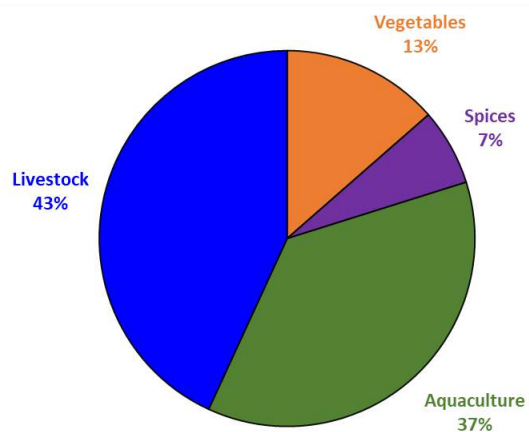


Fig. 2. Contribution of household components to annual profit of integrated farming systems at FSRD site, Kaliganj, Gazipur, 2023-24.

## **Agricultural Economics Division**

|            |                                                                                                                               |
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## SUMMARY

The adoption of modern varieties in 2023-24 was 95.30, 89.64, and 99.71% in the Aus, T. Aman and Boro seasons, of which coverage of BRRI-released varieties was about 74.55, 58.66, and 59.09% respectively. BRRI dhan48 ranked in the top position (46.28%) in the Aus season, followed by BRRI dhan85 (5.36%). The coverage of Indian varieties in the T. Aman season was about 16.24% which was 19.78% in 2022-23. On the other hand, BRRI dhan28 and BRRI dhan29 were still the most dominant varieties in the Boro season covering 16.34% of areas. However, both the varieties accounted for 41.25% of areas in 2021-22. In addition, BRRI dhan89 in Boro season, is gaining popularity in all the regions of Bangladesh and is covered by 13.07% area. BRRI dhan102 produced the highest yield (5.50 ton/ha) in the Aus season whereas, in T. Aman and Boro seasons, it was BRRI dhan53 (5.76 ton/ha) and BRRI dhan92 (6.64 ton/ha) respectively. BRRI hybrid dhan2 and BRRI hybrid dhan3 yielded the highest, which was 7.70 ton/ha whereas the average hybrids' yield was 7.43 ton/ha in the Boro season.

Bangladesh made significant progress in reducing poverty and malnutrition over the past two decades. The nature of malnutrition has significant long-term implications for the country's economic development. It is presumed that Bangladesh will face enormous challenges in achieving nutrition security and ensuring food security for all individuals and groups in the country if the country cannot implement a sustainable development goal (SDG) by 2030. However, this study aims to investigate whether both in the short and long run, the reduction of poverty can increase the nutrition security status of rural farmers in Bangladesh using panel data and to draw some policy recommendations.

Three-period panel data collected from the International Food Policy Research Institute (IFPRI) were used in this study. We used the Household Dietary Diversity Score (HDDS) as an indicator of

nutrition security. The HDDS is constructed based on the number of food groups consumed by the household during a given reference period. Food items were categorized into 12 different food groups as proposed by the Food and Agriculture Organization of the United Nations (FAO, 2011).

Since from the very beginning, BRRI has been performing demonstration programmes all over the country. To find out the effect of the demonstration programme on rice variety adoption and food production, a study was conducted in Habiganj and Feni district. The most popular demonstrated varieties in Aus season are BRRI dhan48, BRRI dhan85, BRRI dhan96, BRRI dhan98 and BRRI hybrid dhan7. But the farmers changed their attitude regarding variety selection when they have alternative options. After certain period of time one popular variety was replaced by the other better variety. Higher yield, fine and slender grain, and less pest attack are the major factors for selecting a variety. In Aman season, it is observed that the area coverage of BRRI dhan80 and BRRI dhan93 has been increased whereas area coverage of BRRI dhan71 and BRRI dhan87 decreased over time. BRRI dhan22 and BRRI23 are still popular in Habiganj district.

During the Aman season, BRRI dhan80 and BRRI dhan93 show the highest rate of change that is about 233% and 166% respectively. BRRI dhan49 and BRRI dhan94 was at increasing trend. But the area of BRRI dhan71 and BRRI dhan87 decreased over the time. It is also observed that, non-demonstrated old varieties like BR22 and BR23 are the most popular in Habiganj district because of good yield and good taste. In addition to this, BR22 has short plant, strong root system that prevent it from lodging, the grain is small and slender, suitable for low land.

In Boro season, farmers have significantly increased the cultivation of BRRI dhan74 and BRRI dhan92 with an increase in the area by 436% and 158%,

respectively in 2023. Also, there is an increase in the area of BRRI dhan89, Bangabandhu dhan100 and BRRI hybrid dhan5. On the other hand, the area coverage under BRRI dhan67, BRRI dhan81, BRRI dhan88 decreased over time. The area of BRRI hybrid dhan8 decreased due to unavailability of seed. The farmers in the study area got demonstration for the first time in 2023 for BRRI dhan102 and BRRI dhan105.

According to DAE report, area under BRRI variety has been increased from 8.02% in 2014 to 50.44% in 2024 in T. Aman season at Tanore upazila of Rajshahi district. In 2014, area coverage of Indian varieties was more than 60% which is declining over the time. The most popular variety was BRRI dhan51 (47.51%) due to higher yield. Indian variety covered more than 49% area in 2024. In Boro season area coverage of BRRI variety was 27.50% in 2014, which reached at 3.31% in 2023. Other MVs like BRAC 576 covered almost 25% area in 2023. Most popular variety BRRI dhan28 lost demand over the time and in 2023 area coverage of this variety was nil. In Boro season, Zirashail become a most popular variety due to higher price higher yield and demand. BRAC 576 and 65 dhan also gained popularity due to higher yield, slender gain, short duration suitable potato cultivation and also high market price and demand. Some BINA varieties were found covering very minimum areas. In our survey report, area coverage of T. Aman variety was closer to DAE report (46.67% and 50.44%, respectively).

Rice farmers in the country often face significant welfare losses due to market price fluctuations as well as declining farm gate prices. Understanding the dynamics behind the welfare losses is essential for developing sustainable agricultural policies and interventions aimed at improving farmers' economic resilience.

Therefore, this research aimed to assess the paddy producers' welfare loss based on actual market price and government declared procurement price in the Boro season.

The findings of this study ensuring paddy price positively influence rice supply in Bangladesh. Other positively influential factors are rice area, yield, pesticide use, and agricultural credit. The government should ensure these factors for maintaining surplus rice production. Moreover, farmers had to sell paddy for less than the declared procurement price, which impacted their surplus. However, from the initiation of the COVID-19 pandemic, farmers are getting better price (more than the declared procurement price) and gaining surplus. Therefore, to be farmer-oriented, ensuring better farm gate price is essential.

Cost and return analysis is essential for researchers and planners to develop technologies and policies that increase farmers' returns by reducing costs. This study has been undertaken to assess the level of inputs used, the cost of rice cultivation at the farm and profitability of MV Aus, MV T. Aman, and MV Boro rice cultivation at the farm level. Farmers used more seed than recommended amount. They are dependent on hired labour due to shortage of family labour. Farmers did not use balanced and recommended fertilizer dose because of improper knowledge. Most farmers used power threshers on a custom-hired basis for threshing paddy. Costs of production of T. Aman, Aus and Boro rice was 135598, 135058 and 151633Tk/ha respectively. Per kg production cost in T. Aman, Aus, and Boro season was 25, 24, and 26Tk/kg respectively. The gross margin per hectare for Boro rice was Tk 63,490, followed by T. Aman (Tk 61,194) and Aus (Tk 56,513). The benefit-cost ratio (BCR) based on full-cost calculation was the highest for Boro (1.26) and T. Aman (1.26), followed by Aus (1.24), reflecting the profitability of rice cultivation in all three seasons.

#### FARM LEVEL ADOPTION AND EVALUATION OF MODERN RICE CULTIVATION IN BANGLADESH

MS Islam, MA Islam, MC Rahman, MS Rahaman, L Deb, and SA Jui



Rice is the staple food in Bangladesh, which provides about 55 and 75% of the total protein and calories of the daily human diet. About 72% of the total cropped area is devoted to rice cultivation in the country. Bangladesh Rice Research Institute has developed 115 high-yielding modern varieties (MVs) along with 8 hybrids for different production environments, which contributed to attaining rice self-sufficiency in Bangladesh. The adoption rate of the cultivated modern varieties (MVs) differs substantially in different regions and seasons in Bangladesh. The study has been designed to;

- Determine the region-wise adoption rate of rice varieties in different seasons; and
- Assess the yield of diverse rice varieties in different regions and seasons.

Variety wise adoption and yield data have been collected from 14 agricultural regions of Bangladesh. Data were collected in three seasons namely Aus, T. Aman, and Boro. Rice varietal adoption data of 64 districts during 2023-24 directly collected from the Additional Director's (AD) office of the Department of Agricultural Extension (DAE). Finally, data were compiled and analyzed using descriptive statistics.

### **Adoption of modern varieties**

The adoption of modern varieties (MVs) in Aus season was about 95.30%, which was recorded as 94.23% in 2022-23. Adoption of BRRI varieties was 74.63%. The highest adoption (93.73%) of BRRI varieties was observed in the Mymensingh region, while the lowest (21.66%) was recorded in the Rangamati region. Among all BRRI varieties, BRRI dhan48 ranked in the top position (46.28%), followed by BRRI dhan85 (5.36%) and BRRI dhan98 (4.66%). Other MVs, Indian, and hybrids coverage in the Aus season was about 8.93, 6.57, and 5.17% respectively. The area coverage of traditional varieties was about 5.17% in Aus season.

The adoption of modern varieties (MVs) in T. Aman season was about 89.64% on which the BRRI

varieties covered 58.85%. The adoption of BRRI varieties Cumilla, Sylhet, and Dhaka regions was 85.44, 83.05, and 81.09% respectively. BRRI dhan49 covered the highest area in T. Aman season having 11.46% of the total area, followed by BRRI dhan87 (7.54%) and BRRI dhan75 (5.81%). On average, Indian varieties covered 16.24% of areas in T. Aman season. Notably, the adoption of Indian varieties in border regions like Jashore, Dinajpur, Bogura, and Rajshahi was relatively high (19.69 to 43.51% of total areas). In comparison, the area coverage of local rice varieties in the Aman season was 10.36%.

The adoption of modern rice varieties (MVs) in 2023-24 was 99.71% of total Boro areas, of which 59.24% of areas was covered by BRRI varieties. The area coverage of BRRI dhan28 and BRRI dhan29 was about 16.34% in 2023-24. The adoption of those two varieties has been decreasing gradually due to disease (Blast) susceptibility. Besides, overall adoption of recently released BRRI dhan89 was about 13.07%. On the other hand, the overall adoption of hybrid and Indian varieties was 29.04 and 7.72% respectively. A significant adoption (28.83%) was recorded for BRRI dhan74 in the Barishal region.

### **Yield of modern rice varieties**

In the Aus season, the average yield of inbred BRRI varieties was about 4.25 ton/ha; among them, BRRI dhan102 produced the highest yield (5.50 ton/ha), followed by BRRI dhan92 (5.45 ton/ha). Prominent BRRI variety like BRRI dhan48 did not perform well in terms of yield potentiality in all regions, which reduced the average yield. The yield performance of the hybrid varieties was 5.49 ton/ha. Yield of Indian varieties was 4.56 ton/ha in this season. The average yield of all MVs in the Aus season was 4.67 ton/ha.

In Aman season, among the HYVs, BRRI dhan53 was the top yielder (5.76 ton/ha), followed by BRRI dhan64 (5.68 ton/ha), BR26 (5.40 ton/ha), and BRRI dhan29 (5.26 ton/ha). On the other hand, the average

yield of BINA varieties, hybrids, and Indian varieties were 4.61, 5.81, and 4.67 ton/ha, respectively. The average yield of BRRI inbred varieties was 4.58 ton/ha. Overall yield of modern varieties (MVs) was 4.95 ton/ha (Table 5).

In the Boro season, the average yield of BRRI inbred varieties was about 6.19 ton/ha. Among BRRI varieties, BRRI dhan92 was the top yielder (6.64 ton/ha), followed by BRRI dhan89 (6.61 ton/ha), BRRI dhan102 (6.56 ton/ha), and BRRI dhan36 (6.54 ton/ha). The average yield of the hybrid was 7.51 ton/ha, whereas Indian varieties yielded 6.26 ton/ha. The overall yield of modern varieties in Boro season was about 6.97 ton/ha.

#### IMPACT OF POVERTY REDUCTION ON NUTRITION SECURITY IN RURAL HOUSEHOLDS OF BANGLADESH

M A Islam, MC Rahman, M S Rahaman, and M S Islam

Bangladesh made significant progress in reducing poverty and malnutrition over the past two decades, yet many indicators of food insecurity and malnutrition remain high (HIES, 2022). The nature of malnutrition has significant long-term implications for the country's economic development. It is presumed that Bangladesh will face enormous challenges in achieving nutrition security and ensuring food security for all individuals and groups in the country if the country cannot implement a sustainable development goal (SDG) by 2030. This study aims to investigate whether both in the short and long run the reduction of poverty can increase the nutrition security status of rural farmers in Bangladesh using panel data and to draw some policy recommendations from the findings.

Three-period panel data of periods (2011-12, 2015 and 2018-19) nationwide surveys covering 6,500 rural households in each the period collected by International Food Policy Research Institute (IFPRI) were used to achieve the goal of the study.

In this study, we used the Household Dietary Diversity Score (HDDS) as an indicator of nutrition security and FAO,2011 guideline is followed. The other related tools were used to analyze the data and finally to interpret the findings.

#### Results and discussion

In the short-term period, if the poverty gap decreases by 1%, then nutrition security (HDDS) increases by 27.40% from the period 2011-12 to the period 2015 (Table 1). Similarly, in another short-term period, if the poverty gap decreases by 1%, then nutrition security (HDDS) increases by 23.70% from the period 2015 to the period 2018-19. Nutrition security in terms of HDDS decreases by 3.70% from the period (2011/12 to 2015) to another period (2015 to 2018-19). On the one hand, it might be due to less consumption of different food groups, on the other hand, a higher inflation rate prevails in the 2015 to 2018-19 period compared to 2011-12 to 2015. In addition, in the long-term period, if the poverty gap decreases by 1%, then nutrition security (HDDS) increases by 26% from the period 2011-12 to the period 2018-19 (Table 1). The analysis shows that the production diversity score, male members and female members in the households, access to information, and asset index significantly increased nutrition security. The analysis further shows that the year effect exists in both short and long-term models. In short, nutrition security was significantly increased due to the reduction of poverty among households over the different short and long-term periods in Bangladesh. At present, one of the top policy priorities in the country is to improve food and nutrition security. To boost income-generating activities and guarantee stable income, decrease the rate of inflation for food and non-food commodities to a manageable limit, lower the cost of obtaining credit, and encourage social and political accountability to enhance social well-being and quality of living are all necessary short- and long-term policy measures that can help reduce poverty and increase food and nutrition security in Bangladesh.

**Table 1. Estimated short and long-term impact of poverty reduction on nutrition security (HDDS) in Bangladesh using the Poisson fixed effect regression.**

| Particulars                                                                  | 2011-12 and 2015<br>(Short term)             |             | 2015 and 2018-19<br>(Short term)             |             | 2011-12 and 2018-19<br>(Long term)        |          | 2011-12, 2015 and<br>2018-19 (Pooled)       |             |
|------------------------------------------------------------------------------|----------------------------------------------|-------------|----------------------------------------------|-------------|-------------------------------------------|----------|---------------------------------------------|-------------|
|                                                                              | APE<br>coeff.                                | Boot.<br>SE | APE<br>coeff.                                | Boot.<br>SE | APE<br>coeff.                             | Boot. SE | APE<br>coeff.                               | Boot.<br>SE |
| Poverty gap index <sup>5</sup>                                               | -0.274***                                    | 0.03262     | -0.237***                                    | 0.03837     | -0.260***                                 | 0.02242  | -0.260***                                   | 0.02411     |
| Household head age (year)                                                    | -0.000                                       | 0.00019     | -0.000                                       | 0.00016     | -0.000                                    | 0.00013  | -0.000                                      | 0.00011     |
| Household head sex (Male=1)                                                  | 0.006                                        | 0.00515     | 0.005                                        | 0.00381     | -0.001                                    | 0.00372  | 0.003                                       | 0.00291     |
| Household head occupation<br>(Farming=1)                                     | 0.003                                        | 0.00249     | 0.002                                        | 0.00259     | -0.001                                    | 0.00236  | 0.001                                       | 0.00176     |
| Male member in the family<br>(Number)                                        | 0.007***                                     | 0.00208     | 0.003*                                       | 0.00146     | 0.005***                                  | 0.00143  | 0.005***                                    | 0.00113     |
| Female member in the family<br>(Number)                                      | 0.009***                                     | 0.00164     | 0.006***                                     | 0.00117     | 0.007***                                  | 0.00120  | 0.007***                                    | 0.00094     |
| Production diversity score                                                   | 0.001***                                     | 0.00026     | 0.001***                                     | 0.00022     | 0.001***                                  | 0.00021  | 0.001***                                    | 0.00016     |
| Access to information (Access=1)                                             | 0.012***                                     | 0.00365     | 0.010**                                      | 0.00445     | 0.008**                                   | 0.00347  | 0.010***                                    | 0.00280     |
| Migration (Migrated=1)                                                       | 0.002                                        | 0.00250     | -0.003                                       | 0.00209     | -0.002                                    | 0.00215  | -0.002                                      | 0.00162     |
| Farm size (decimal)                                                          | -0.000                                       | 0.00001     | 0.000                                        | 0.00001     | 0.000*                                    | 0.00001  | 0.000                                       | 0.00001     |
| Asset index                                                                  | 0.000                                        | 0.00130     | 0.002**                                      | 0.00084     | 0.003***                                  | 0.00077  | 0.002***                                    | 0.00067     |
| Market participation<br>(Participated=1)                                     | -0.000*                                      | 0.00005     | -0.000                                       | 0.00005     | 0.000                                     | 0.00004  | -0.000                                      | 0.00004     |
| Year dummy 2015                                                              | 0.032***                                     | 0.00177     | 0.006***                                     | 0.00140     | -                                         | -        | 0.033***                                    | 0.00148     |
| Year dummy 2018-19                                                           | -                                            | -           | -                                            | -           | 0.037***                                  | 0.00144  | 0.038***                                    | 0.00144     |
| Diagnostic statistic:                                                        |                                              |             |                                              |             |                                           |          |                                             |             |
| Pseudo-log likelihood                                                        | -4226.77                                     |             | -4263.08                                     |             | -4233.99                                  |          | -9022.38                                    |             |
| Wald chi2 (13)                                                               | 942.99                                       |             | 203.52                                       |             | 1473.12                                   |          | Wald chi2 (14)<br>=1615.97                  |             |
| Prob > chi2                                                                  | 0.0000                                       |             | 0.0000                                       |             | 0.0000                                    |          | 0.0000                                      |             |
| Wald Chi2 test:                                                              |                                              |             |                                              |             |                                           |          |                                             |             |
| Ho: Time-varying unobserved<br>heterogeneity does not exist in the<br>model. | Chi2 (13) = 14.76<br>Prob > Chi2 =<br>0.3225 |             | Chi2 (13) = 17.27<br>Prob > Chi2 =<br>0.1874 |             | Chi2 (13) = 13.76<br>Prob > Chi2 = 0.3913 |          | Chi2 (14) = 18.74<br>Prob > Chi2 =<br>0.175 |             |
| H1: Time-varying unobserved<br>heterogeneity exists in the model.            |                                              |             |                                              |             |                                           |          |                                             |             |
| Number of observations                                                       | 8,186                                        |             | 8,186                                        |             | 8,186                                     |          | 12,279                                      |             |

Source: BIHS panel data (2011-12, 2015 and 2018-19), Note: 1) APE means average partial effect, 2) \*\*\*p<0.01, \*\*<0.05, \*<0.10, 3) Bootstrapping standard errors with 1000 iterations, 4) International monetary poverty line used (\$1.90 per capita/per day: original 2011 PPP), 5) Poverty gap index was calculated by using gross consumption expenditure Bangladeshi Taka.

IMPACT OF DEMONSTRATION IN SELECTED  
AREAS OF BANGLADESH (HABIGANJ AND  
FENI)

Limon Deb, Saida Akter Jui, Md. Saiful Islam

The demonstration programme is considered as the major tool for popularizing technology to the end users. From the very beginning, BRRI has been performing demonstration programmes all over the country in order to popularize BRRI released rice varieties. Recently, a programme has been taken to find out the impact of the demonstration programme in the northern and southern parts of the country in adapting newly released rice variety. A study was undertaken in Habiganj and Feni district where several demonstrations were implemented. Primary data were collected from randomly selected farmers having demonstration in the previous period. The

key observations from the primary data collection on demonstration impact of BRRI released variety are presented in this report in detail.

**Aus Season**

The most popular demonstrated varieties in Aus season are BRRI dhan48, BRRI dhan85, BRRI dhan96, BRRI dhan98 and BRRI hybrid dhan7. It is apparent from the Table 2 that farmers did cultivate one variety for longer period. Trend in increase in area of demonstrated variety is changes over time. Area of BRRI dhan48 area was increased for three years but in the last it was deleted. In 2019, the average area of BRRI dhan85 was 100 decimals, which showed highest increase in 2020 by 300%. But in 2022, the area decreased by 45% than in 2019. Farmers always search new variety unless and until they become satisfied.

**Table 2. Status of the demonstrated variety among the farmers who got demonstration (Aus season).**

| Demonstrated variety | Cultivated<br>area in<br>2018 | Cultivated<br>area in 2019 | Cultivated<br>area in 2020 | Cultivated<br>area in<br>2021 | Cultivated<br>area in<br>2022 | Cultivated<br>area in<br>2023 |
|----------------------|-------------------------------|----------------------------|----------------------------|-------------------------------|-------------------------------|-------------------------------|
|                      | Area<br>(decimal)             | Area<br>(decimal)          | (decimal)<br>Base Year     | Area<br>(decimal)             | Area<br>(decimal)             | Area<br>(decimal)             |
| BRRI dhan48          | 30                            | 60 (100%)                  | 60 (100%)                  | 120<br>(300%)                 | 30 (0%)                       | -                             |
| BRRI dhan85          | -                             | 100                        | 400 (300%)                 | 171 (71%)                     | 55 (-45%)                     | 169 (69%)                     |
| BRRI dhan96          | -                             | -                          | -                          | -                             | 15                            | 22 (47%)                      |
| BRRI dhan98          | -                             | -                          | 300                        | 245 (-18%)                    | 200 (-33%)                    | 183 (-39%)                    |
| BRRI hybrid dhan7    | -                             | -                          | -                          | -                             | 200                           | 200 (0%)                      |

Source: Field survey 2024

**Table 3. Yield status of demonstrated and non-demonstrated variety during Aus season in the study area.**

| Demonstrated variety | Yield<br>(t/ha) | Other non-demonstrated<br>variety | Yield<br>(t/ha) |
|----------------------|-----------------|-----------------------------------|-----------------|
| BRRI dhan48          | 5.59            | Binadhan-19                       | 4.19            |
| BRRI dhan85          | 4.87            | Rajashail                         | 4.19            |
| BRRI dhan98          | 7.00            |                                   |                 |
| BRRI hybrid dhan7    | 8.38            |                                   |                 |

Reasons for selecting the rice variety are higher yield, which include slender grain, good taste, higher market price, shorter duration and tolerant to disease and insect (Table 4). As for example BRRI dhan48

has very good acceptance among the farmers as they have mentioned that this variety has very good yield, no shattering problem, seed is available and good taste as well.

**Table 4. Popular variety and reasons for varietal popularization in the study area (Aus season).**

| Variety      | Reasons for varietal popularization                                                                      |
|--------------|----------------------------------------------------------------------------------------------------------|
| BRRRI dhan48 | 1. Good yield, 2. Short duration, 3. Less shattering, 4. Good taste, 5. Long plant, 6. Seed is available |
| BRRRI dhan85 | 1. Low disease infestation, 2. Low insect infestation, 3. Strong root, 4. High yield                     |
| BRRRI dhan98 | 1. Small and slender grain, 2. High yield, 3. Low disease infestation, 4. Good taste                     |
| Binadhan-19  | 1. Low disease infestation, 2. Low insect infestation, 3. Good yield, 4. Strong root                     |

**Aman Season**

In Aman season, BRRRI dhan80 and BRRRI dhan93 showed the highest rate of change that was about 233% and 166%, respectively. BRRRI dhan49 also

showed increasing trend, from 50 decimals in 2020 to 103 decimals in 2023. The area of BRRRI dhan94 was 40 decimals in 2020 that increased to 75 decimals in 2023. But the area of BRRRI dhan71 and BRRRI dhan87 decreased over the time.

**Table 5. Status of the demonstrated variety among the farmers who got demonstration (Aman season).**

| Demonstrated variety | Cultivated area in<br>2020<br>(decimal)<br>Base Year | Cultivated area in<br>2021<br>Area<br>(decimal) | Cultivated area in<br>2022<br>Area<br>(decimal) | Cultivated area in<br>2023<br>Area<br>(decimal) |
|----------------------|------------------------------------------------------|-------------------------------------------------|-------------------------------------------------|-------------------------------------------------|
| BRRRI dhan49         | 50                                                   | 64 (28%)                                        | 113 (126%)                                      | 103 (106%)                                      |
| BRRRI dhan71         | 100                                                  | 100 (0%)                                        | 100 (0%)                                        | 47 (-53%)                                       |
| BRRRI dhan80         | -                                                    | 33                                              | 20 (-39%)                                       | 110 (233%)                                      |
| BRRRI dhan87         | -                                                    | 40                                              | 27 (-33%)                                       | 33 (-18%)                                       |
| BRRRI dhan93         | -                                                    | 32                                              | 78 (144%)                                       | 85 (166%)                                       |
| BRRRI dhan94         | 40                                                   | 50 (25%)                                        | 40 (0%)                                         | 75 (88%)                                        |
| BRRRI dhan95         | -                                                    | 21                                              | -                                               | 30(43%)                                         |

Source: Field survey 2024

Some old varieties like BR22 and BR23 are still popular especially in Habiganj district having an average yield of 3.73 t/ha and 4.94 t/ha respectively. BR22 has short plant, strong root system that prevent from lodging, the grain is small and slender, suitable

for low land and BR23 has less pest and rat infestation and it can be cultivated and harvested late. Table 6 presents the other varieties cultivated in the study areas.

**Table 6. Yield status of demonstrated and non-demonstrated varieties during Aman season in the study area.**

| Demonstrated variety | Yield (t/ha) | Other non-demonstrated variety | Yield (t/ha) |
|----------------------|--------------|--------------------------------|--------------|
| BRRRI dhan49         | 5.96         | Binadhan-17                    | 3.62         |
| BRRRI dhan52         | 5.5          | BR10                           | 5.19         |
| BRRRI dhan80         | 3.95         | BR11                           | 6.33         |
| BRRRI dhan93         | 4.5          | BR22                           | 3.73         |
| BRRRI dhan94         | 7.23         | BR23                           | 4.94         |
| BRRRI dhan95         | 9.00         | BRRRI dhan44                   | 6.89         |
| BRRRI dhan103        | 7.84         | BRRRI dhan46                   | 5.6          |
|                      |              | BRRRI dhan51                   | 4.62         |

| Demonstrated variety | Yield (t/ha) | Other non-demonstrated variety | Yield (t/ha) |
|----------------------|--------------|--------------------------------|--------------|
|                      |              | BRRi dhan71                    | 7.36         |
|                      |              | BRRi dhan72                    | 6.21         |
|                      |              | BRRi dhan76                    | 7.90         |
|                      |              | BRRi dhan80                    | 7.00         |
|                      |              | BRRi dhan87                    | 5.37         |
|                      |              | Shwarnobashuri                 | 6.28         |
|                      |              | Ranjit                         | 2.96         |
|                      |              | Rajashail                      | 3.31         |
|                      |              | Guti swarna                    | 7.41         |

Source: Field survey 2024

Table 7 presents the variety and reasons for acceptance of T. Aman variety. The common reasons are higher yield, slender grain, good taste, tolerant to disease and insect, shorter duration, strong root, no lodging etc.

**Table 7. Popular variety and reasons for varietal popularization in the study area (Aman season)**

| Variety      | Reasons for varietal popularization                                                                                                                                                                     |
|--------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| BR10         | 1. Good yield, 2. Good taste, 3. Strong root, 4. Waterlogging tolerant, 5. Medium slender, 6. Low insect infestation                                                                                    |
| BR11         | 1. Good yield, 2. More weight, 3. Low disease infestation, 4. Short duration, 5. No lodging                                                                                                             |
| BR22         | 1. Good yield, 2. Good taste, 3. Short plant, 4. Strong root, 5. Waterlogging tolerant, 6. Lodging tolerant, 7. Small and slender rice                                                                  |
| BR23         | 1. Good yield, 2. Suitable for low land, 3. Easy to harvest as the land becomes dry for its long and late life cycle, 4. Can cultivate even it is late, 5. Good taste, 6. Less pest and rat infestation |
| BRRi dhan46  | 1. Late transplanting can be done, 2. Good taste, 3. Waterlogging tolerant                                                                                                                              |
| BRRi dhan49  | 1. High yield, 2. Good taste, 3. Medium slender grain, 4. Good price, 5. Less shattering, 6. Good straw quality                                                                                         |
| BRRi dhan51  | 1. Slender rice, 2. Short plant                                                                                                                                                                         |
| BRRi dhan52  | 1. Waterlogging tolerant, 2. Good taste, 3. Small grain size                                                                                                                                            |
| BRRi dhan87  | 1. Good yield, 2. Early variety, 3. Mustard can be grown after harvesting                                                                                                                               |
| BRRi dhan93  | 1. Good yield, 2. Good taste, 3. Strong plant, 4. Slender grain, 5. Waterlogging tolerant                                                                                                               |
| BRRi dhan94  | 1. High yield, 2. Good taste, 3. Strong plant                                                                                                                                                           |
| BRRi dhan95  | 1. Good yield, 2. Good market price, 3. Slender grain                                                                                                                                                   |
| BRRi dhan103 | 1. Good yield, 2. Lodging tolerant                                                                                                                                                                      |

Source: Field survey 2024

## Boro Season

During the Boro season, farmers have significantly increased the cultivation of BRRI dhan74 and BRRI dhan92 with an increased area by 436% and 158%, respectively in 2023. Also, there is an increase in the area of BRRI dhan89, Bangabandhu dhan100 and BRRI hybrid dhan5. On the other hand, the area

coverage under BRRI dhan67, BRRI dhan81, BRRI dhan88 decreased over time. The area of BRRI hybrid dhan8 decreased due to unavailability of seed. The farmers in the study area got demonstration for the first time in 2023 for BRRI dhan102 and BRRI dhan105.

**Table 8. Status of the demonstrated variety among the farmers who got demonstration in Boro season.**

| Demonstrated variety | Cultivated area in 2018 | Cultivated area in 2019 | Cultivated area in 2020 | Cultivated area in 2021 | Cultivated area in 2022 | Cultivated area in 2023 |
|----------------------|-------------------------|-------------------------|-------------------------|-------------------------|-------------------------|-------------------------|
|                      | Area (decimal)          | Area (decimal)          | (decimal) Base Year     | Area (decimal)          | Area (decimal)          | Area (decimal)          |
| BRRI dhan67          | 96                      | 30 (-69%)               | -                       | -                       | 42 (-56%)               | 40 (-58%)               |
| BRRI dhan74          | -                       | 47                      | 62 (32%)                | 149 (217%)              | 142 (202%)              | 252 (436%)              |
| BRRI dhan81          | -                       | 40                      | 40 (0%)                 | 10 (75%)                | 20 (-50%)               | -                       |
| BRRI dhan84          | -                       | -                       | -                       | 30                      | -                       | 30 (0%)                 |
| BRRI dhan88          | -                       | -                       | -                       | 54                      | 49 (-9%)                | 28 (-48%)               |
| BRRI dhan89          | -                       | -                       | -                       | 39                      | 56 (44%)                | 76 (95%)                |
| BRRI dhan92          | -                       | -                       | 40                      | 60 (50%)                | 87 (118%)               | 103(158%)               |
| BRRI dhan96          | -                       | -                       | -                       | -                       | -                       | 22                      |
| BRRI dhan97          | -                       | -                       | -                       | 100                     | -                       | -                       |
| Bangabandhu dhan100  | -                       | -                       | -                       | 65                      | 55 (-15%)               | 96 (48%)                |
| BRRI dhan102         | -                       | -                       | -                       | -                       | -                       | 78                      |
| BRRI dhan105         | -                       | -                       | -                       | -                       | -                       | 100                     |
| BRRI hybrid dhan3    | -                       | -                       | -                       | 60                      | 105 (75%)               | 60 (0%)                 |
| BRRI hybrid dhan5    | -                       | -                       | -                       | 88                      | 165 (88%)               | 120(36%)                |
| BRRI hybrid dhan8    | -                       | -                       | -                       | -                       | 100                     | 65 (-35%)               |

Source: Field survey 2024

Some old varieties like BRRI dhan29 are still most popular in the study areas because of their grain quality, good taste as well as high yield. Bangabandhu dhan100 and BRRI dhan92 have received huge acceptance among the farmers with an average yield of 5.80 t/ha and 6.10 t/ha respectively. The reasons behind the popularity of these varieties are lower disease and insect infestation, high yield, good taste, slender grain and high market price

Among the other varieties which are not being demonstrated, Janakraj yielded the highest 8.05 t/ha which is hybrid (Table 9). Moreover, different hybrid varieties like Aftab, Agrani, Hira, Krishibid, Nafco, National-4 etc have significant area coverage that could be a good opportunity for BRRI to extend its potential hybrid varieties in those study areas.

**Table 9. Yield status of demonstrated and non-demonstrated variety during Boro season in the study area.**

| Demonstrated variety | Yield<br>(t/ha) | Other non-demonstrated<br>variety | Yield<br>(t/ha) |
|----------------------|-----------------|-----------------------------------|-----------------|
| Bangabandhu dhan100  | 5.80            | Aftab                             | 7.46            |
| BRRRI hybrid dhan8   | 9.23            | BRRRI dhan81                      | 5.35            |
| BRRRI hybrid dhan5   | 6.96            | BRRRI dhan29                      | 5.93            |
| BRRRI hybrid dhan3   | 7.00            | BBRI dhan28                       | 7.57            |
| BRRRI dhan96         | 6.71            | Agrani                            | 6.81            |
| BRRRI dhan92         | 6.10            | Binadhan-10                       | 2.00            |
| BRRRI dhan89         | 5.28            | Binadhan-25                       | 4.23            |
| BRRRI dhan88         | 4.14            | BR16                              | 3.29            |
| BRRRI dhan84         | 6.09            | Zira                              | 3.29            |
| BRRRI dhan74         | 6.71            | Surovi                            | 6.18            |
| BRRRI dhan67         | 6.57            | Sugandha                          | 7.82            |
| BRRRI dhan105        | 6.84            | Poshusail                         | 4.28            |
| BRRRI dhan104        | 7.50            | Partex                            | 7.33            |
| BRRRI dhan102        | 6.29            | National4                         | 7.58            |
| BRRRI dhan101        | 9.00            | Nafco                             | 7.32            |
|                      |                 | Krishibid                         | 7.23            |
|                      |                 | Janakraj                          | 8.05            |
|                      |                 | Hira                              | 7.15            |
|                      |                 | Chamak                            | 6.04            |

Source: Field survey 2024

**Table 10. Popular variety and reasons for varietal popularization in the study area (Boro season).**

| Variety             | Reasons for varietal popularization                                                                                                             |
|---------------------|-------------------------------------------------------------------------------------------------------------------------------------------------|
| Bangabandhu dhan100 | 1. High yield, 2. Good taste, 3. Low disease infestation, 4. Low insect attack, 5. Short duration, 6. Slender grain and higher market price     |
| BRRRI dhan92        | 1. High yield, 2. Good taste, 3. Slender grain, 4. Low insect attack, 5. Low disease infestation, 6. High price and alternative to BRRRI dhan29 |
| BRRRI dhan29        | 1. High yield, 2. Good taste, 3. No shattering, 4. Slender grain                                                                                |
| BRRRI dhan74        | 1. Good yield, 2. Low insect infestation, 3. Low disease attack, 4. Good taste, 5. Early and short duration variety, 6. No lodging              |
| BRRRI dhan89        | 1. Good taste, 2. Medium slender, 3. Good yield, 4. Low insect attack                                                                           |
| BRRRI hybrid dhan8  | 1. High yield, 2. Slender grain, 3. Low pest and disease                                                                                        |
| Agrani              | 1. High yield, 2. High market demand, 3. High price, 4. Drought tolerant                                                                        |
| Hira                | 1. High yield, 2. High market demand and price, 3. No shattering, 4. Early variety, 5. Low insect attack, 6. Low disease infestation            |
| Janakraj            | 1. High yield, 2. No shattering, 3. Good weight                                                                                                 |
| Nafco               | 1. High yield, 2. No shattering, 3. Lower disease, 4. Good weight                                                                               |
| National 4          | 1. High yield, 2. Low shattering, 3. More weight                                                                                                |
| Shuravi             | 1. High yield, 2. Slender grain                                                                                                                 |

Source: Field survey 2024



## PROSPECT AND CONSTRAINTS TO ADOPTION OF BRRI RELEASED MODERN RICE VARIETIES IN BANGLADESH: A CASE OF RAJSHAHI DISTRICT

This study is a regular research work to know the in-depth information about rice variety chosen by the farmers of particular district. Tanore upazila of Rajshahi district was selected purposively. Farmers of all unions and blocks were included in focus group discussion (FGD) meeting with

the following objectives to:

- Identify the drivers and constraints of adoption of rice varieties in different seasons;
- Delineate the prospect for BRRI varieties for large scale adoption at the farm level.

According to DAE report, area under BRRI variety has been increased from 8.02% in 2014 to 50.44% in 2024 in T. Aman season at Tanore upazila of Rajshahi district.

In 2014, area coverage of Indian varieties was more than 60% which has been declining over the time. The most popular variety was BRRI dhan51 (47.51%) due to higher yield (Table11 and Table12). Indian variety covered more than 49% area in 2024. In Boro season, area of coverage of BRRI variety was 27.50% in 2014 which reached at 3.31% in 2023 (Table 11). Other MVs like BRAC 576 covered almost 25% area in 2023. Most popular variety BRRI dhan28 lost demand over the time and in 2023 area coverage of this variety was nil (Table 12). In Boro season, ZiraShail (Table 13) become a most popular variety due to higher price and yield as well.

**Table 11. Adoption (%) of different T. Aman rice varieties by different years in Tanore Upazila under Rajshahi district.**

| Variety     | 2014  | 2015  | 2016  | 2017  | 2018  | 2019  | 2020  | 2021  | 2022  | 2023  |
|-------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| BRRI        | 8.02  | 21.02 | 18.41 | 17.84 | 22.79 | 21.79 | 33.15 | 34.21 | 38.99 | 50.44 |
| BR11        | 0.65  |       |       |       |       |       |       |       |       |       |
| BR23        | 0.44  |       |       |       |       |       |       |       |       |       |
| BRRI dhan32 | 0.32  |       |       |       |       |       |       |       |       |       |
| BRRI dhan34 | 0.32  | 1.45  | 0.38  | 1.50  | 0.96  | 0.22  | 0.25  | 0.22  | 0.23  |       |
| BRRI dhan39 | 0.99  | 1.47  | 0.72  | 1.63  | 0.58  | 0.08  | 0.04  | 0.04  | 0.04  |       |
| BRRI dhan49 | 2.21  | 5.76  | 6.81  | 7.29  | 8.57  | 3.75  | 3.33  | 3.42  | 3.50  | 0.66  |
| BRRI dhan51 | 1.99  | 6.77  | 9.61  | 5.46  | 11.82 | 17.08 | 28.39 | 29.44 | 34.11 | 47.31 |
| BRRI dhan52 | 1.10  | 3.38  | 0.18  | 0.69  | 0.25  | 0.13  | 0.77  | 0.63  | 0.65  |       |
| BRRI dhan56 |       | 1.44  | 0.37  | 0.52  | 0.06  |       |       |       |       |       |
| BRRI dhan57 |       |       | 0.05  | 0.08  |       |       |       |       |       |       |
| BRRI dhan62 |       | 0.76  | 0.29  | 0.68  | 0.26  | 0.12  | 0.04  | 0.04  | 0.04  |       |
| BRRI dhan66 |       |       |       |       | 0.31  |       |       |       |       |       |
| BRRI dhan71 |       |       |       |       |       | 0.12  | 0.08  | 0.08  | 0.08  | 0.00  |
| BRRI dhan75 |       |       |       |       |       | 0.08  | 0.04  | 0.04  | 0.04  | 1.29  |
| BRRI dhan80 |       |       |       |       |       | 0.10  | 0.08  | 0.08  | 0.08  | 0.00  |
| BRRI dhan87 |       |       |       |       |       | 0.11  | 0.12  | 0.21  | 0.21  | 0.61  |
| BRRI dhan90 |       |       |       |       |       |       |       |       |       | 0.32  |
| BRRI dhan93 |       |       |       |       |       |       |       |       |       | 0.12  |
| BRRI dhan94 |       |       |       |       |       |       |       |       |       | 0.08  |
| BRRI dhan95 |       |       |       |       |       |       |       |       |       | 0.04  |
| Hybrid      |       |       |       |       |       |       | 0.04  | 0.08  | 0.08  | 0.08  |
| Arize 7006  |       |       |       |       |       |       | 0.04  | 0.08  | 0.08  | 0.04  |
| Tezgold     |       |       |       |       |       |       |       |       |       | 0.04  |
| Indian      | 60.35 | 65.02 | 65.13 | 67.05 | 68.86 | 70.47 | 61.81 | 61.27 | 57.90 | 49.07 |
| Swarna      | 60.35 | 65.02 | 65.13 | 67.05 | 68.86 | 70.47 | 61.81 | 61.27 | 57.90 | 49.07 |

| Variety     | 2014  | 2015  | 2016  | 2017  | 2018  | 2019  | 2020  | 2021  | 2022  | 2023  |
|-------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| BRRI        | 8.02  | 21.02 | 18.41 | 17.84 | 22.79 | 21.79 | 33.15 | 34.21 | 38.99 | 50.44 |
| Local       | 15.88 | 9.22  | 9.58  | 5.93  | 3.55  | 3.31  | 4.23  | 3.58  | 2.14  | 0.20  |
| Chenguin    | 0.65  |       |       |       |       |       |       |       |       |       |
| Chiniatob   | 15.23 | 7.88  | 9.15  | 5.01  | 3.11  | 3.31  | 4.23  | 3.58  | 2.14  | 0.20  |
| Kalozira    |       | 1.33  | 0.44  | 0.92  | 0.44  |       |       |       |       |       |
| OMVs        | 15.75 | 4.74  | 6.88  | 9.18  | 4.81  | 4.43  | 0.77  | 0.87  | 0.89  | 0.20  |
| BINA dhan17 |       |       |       |       | 0.58  | 0.05  | 0.12  | 0.24  | 0.25  | 0.20  |
| BINA dhan7  | 15.63 | 4.74  | 6.88  | 9.18  | 4.23  | 4.38  | 0.65  | 0.63  | 0.65  |       |
| Nerica      | 0.12  |       |       |       |       |       |       |       |       |       |
| Average     | 100   | 100   | 100   | 100   | 100   | 100   | 100   | 100   | 100   | 100   |

Source: DAE, 2024

**Table 12. Adoption (%) of different Boro rice varieties by different years in Tanore upazila under Rajshahi district.**

| Variety      | 2013  | 2014  | 2015  | 2016  | 2017  | 2018  | 2019  | 2020  | 2021  | 2022  | 2023  |
|--------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| BRRI         | 27.50 | 30.50 | 26.07 | 24.72 | 9.71  | 10.61 | 9.43  | 4.79  | 3.80  | 4.11  | 3.31  |
| BRRI dhan28  | 27.50 | 30.50 | 22.14 | 18.48 | 8.04  | 8.28  | 7.07  | 2.91  | 1.86  | 1.85  |       |
| BRRI dhan29  |       |       | 2.88  | 3.49  | 0.38  | 0.68  | 0.52  | 0.42  | 0.38  | 0.38  |       |
| BRRI dhan50  |       |       | 1.05  | 2.41  | 0.47  | 0.45  | 0.34  | 0.13  | 0.12  | 0.12  |       |
| BRRI dhan55  |       |       |       |       | 0.05  | 0.05  | 0.11  | 0.05  |       |       |       |
| BRRI dhan58  |       |       |       | 0.28  | 0.29  | 0.36  | 0.27  |       |       |       |       |
| BRRI dhan63  |       |       |       | 0.06  | 0.47  | 0.74  | 0.53  | 0.27  | 0.25  | 0.25  |       |
| BRRI dhan65  |       |       |       |       |       |       |       |       | 0.24  | 0.52  | 1.24  |
| BRRI dhan74  |       |       |       |       | 0.01  |       |       |       |       |       |       |
| BRRI dhan81  |       |       |       |       |       | 0.05  | 0.59  | 0.69  | 0.63  | 0.63  | 0.09  |
| BRRI dhan84  |       |       |       |       |       |       |       | 0.05  | 0.05  | 0.05  |       |
| BRRI dhan86  |       |       |       |       |       |       |       | 0.10  | 0.09  | 0.10  |       |
| BRRI dhan88  |       |       |       |       |       |       |       | 0.03  | 0.05  | 0.05  | 0.13  |
| BRRI dhan89  |       |       |       |       |       |       |       | 0.09  | 0.09  | 0.09  | 1.31  |
| BRRI dhan92  |       |       |       |       |       |       |       | 0.02  | 0.05  | 0.07  | 0.21  |
| BRRI dhan100 |       |       |       |       |       |       |       |       |       |       | 0.34  |
| Hybrid       |       |       |       |       |       |       |       |       |       |       | 0.55  |
| S 1204       |       |       |       |       |       |       |       |       |       |       | 0.13  |
| S 1208       |       |       |       |       |       |       |       |       |       |       | 0.21  |
| SL8H         |       |       |       |       |       |       |       |       |       |       | 0.21  |
| Indian       | 72.34 | 69.36 | 73.35 | 75.03 | 82.05 | 73.40 | 70.04 | 71.46 | 69.17 | 69.04 | 70.03 |
| Nayanmoni    | 21.70 | 19.88 | 5.72  | 1.10  |       |       |       |       |       |       |       |
| Pariza       | 22.53 | 20.63 | 1.81  | 1.14  | 0.10  |       |       |       |       |       |       |
| Zira Shail   | 28.11 | 28.85 | 65.82 | 72.79 | 81.95 | 73.40 | 70.04 | 71.46 | 69.17 | 69.04 | 70.03 |
| OMVs         | 0.16  | 0.15  | 0.58  | 0.25  | 8.24  | 15.99 | 20.53 | 23.76 | 27.03 | 26.85 | 26.10 |
| BINA dhan10  |       |       |       |       |       | 0.03  |       |       |       |       |       |
| BINA dhan14  |       |       | 0.11  | 0.12  | 0.16  | 0.80  | 0.71  | 2.56  | 2.30  | 2.29  | 1.21  |
| BINA dhan19  |       |       |       |       |       |       | 0.01  | 0.05  |       |       | 0.09  |

| Variety     | 2013  | 2014  | 2015  | 2016  | 2017 | 2018  | 2019  | 2020  | 2021  | 2022  | 2023  |
|-------------|-------|-------|-------|-------|------|-------|-------|-------|-------|-------|-------|
| BRR1        | 27.50 | 30.50 | 26.07 | 24.72 | 9.71 | 10.61 | 9.43  | 4.79  | 3.80  | 4.11  | 3.31  |
| BINA dhan21 |       |       |       |       |      |       |       |       |       |       | 0.04  |
| BINA dhan25 |       |       |       |       |      |       |       |       |       |       | 0.21  |
| BINA dhan7  |       |       | 0.27  |       | 8.08 | 7.49  | 5.02  | 3.63  | 2.00  | 1.82  | 0.04  |
| BRAC 576    |       |       |       |       |      | 7.62  | 14.80 | 17.51 | 22.73 | 22.74 | 24.50 |
| IR 50       | 0.16  | 0.15  |       |       |      |       |       |       |       |       |       |
| Nerica      |       |       | 0.19  | 0.13  |      | 0.05  |       |       |       |       |       |
| Grand Total | 100   | 100   | 100   | 100   | 100  | 100   | 100   | 100   | 100   | 100   | 100   |

Source: DAE, 2024

**Table 13. Paddy yield (t/ha) of different T. Aman rice varieties by different years in Tanore Upazila under Rajshahi district.**

| Variety     | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 |
|-------------|------|------|------|------|------|------|------|------|------|------|
| BRR1        | 4.39 | 4.90 | 4.37 | 4.53 | 4.77 | 4.90 | 4.94 | 4.94 | 4.94 | 5.06 |
| BR11        | 4.50 |      |      |      |      |      |      |      |      |      |
| BR23        | 4.20 |      |      |      |      |      |      |      |      |      |
| BRR1 dhan32 | 4.50 |      |      |      |      |      |      |      |      |      |
| BRR1 dhan34 | 3.60 | 4.20 | 3.30 | 3.31 | 3.31 | 3.54 | 3.54 | 3.53 | 3.54 |      |
| BRR1 dhan39 | 4.65 | 4.59 | 4.63 | 4.62 | 4.61 | 4.64 | 4.65 | 4.67 | 4.69 |      |
| BRR1 dhan49 | 4.60 | 5.25 | 4.93 | 3.55 | 5.25 | 5.37 | 5.39 | 5.38 | 5.37 | 5.20 |
| BRR1 dhan51 | 4.60 | 5.70 | 4.94 | 5.70 | 5.83 | 5.85 | 5.84 | 5.83 | 5.85 | 5.70 |
| BRR1 dhan52 | 4.50 | 5.25 | 4.46 | 4.80 | 5.68 | 5.68 | 5.69 | 5.67 | 5.68 |      |
| BRR1 dhan56 |      | 4.80 | 4.23 | 5.55 | 4.20 |      |      |      |      |      |
| BRR1 dhan57 |      |      | 4.46 | 4.50 |      |      |      |      |      |      |
| BRR1 dhan62 |      | 4.50 | 4.02 | 4.20 | 4.48 | 4.47 | 4.47 | 4.48 | 4.48 |      |
| BRR1 dhan66 |      |      |      |      | 4.80 |      |      |      |      |      |
| BRR1 dhan71 |      |      |      |      |      | 4.77 | 4.77 | 4.77 | 4.78 |      |
| BRR1 dhan75 |      |      |      |      |      | 4.20 | 4.49 | 4.48 | 4.49 | 5.10 |
| BRR1 dhan80 |      |      |      |      |      | 4.79 | 4.78 | 4.79 | 4.78 |      |
| BRR1 dhan87 |      |      |      |      |      | 5.70 | 5.79 | 5.79 | 5.79 | 5.00 |
| BRR1 dhan90 |      |      |      |      |      |      |      |      |      | 4.00 |
| BRR1 dhan93 |      |      |      |      |      |      |      |      |      | 5.20 |
| BRR1 dhan94 |      |      |      |      |      |      |      |      |      | 5.20 |
| BRR1 dhan95 |      |      |      |      |      |      |      |      |      | 5.10 |
| Hybrid      |      |      |      |      |      |      | 7.43 | 7.39 | 7.44 | 6.50 |
| Arize 7006  |      |      |      |      |      |      | 7.43 | 7.39 | 7.44 | 6.50 |
| Tezgold     |      |      |      |      |      |      |      |      |      | 6.50 |
| Indian      | 4.80 | 5.70 | 5.16 | 5.67 | 5.87 | 5.88 | 5.85 | 5.91 | 5.86 | 5.40 |
| Swarna      | 4.80 | 5.70 | 5.16 | 5.67 | 5.87 | 5.88 | 5.85 | 5.91 | 5.86 | 5.40 |
| Local       | 2.40 | 1.95 | 2.27 | 1.95 | 2.18 | 2.49 | 2.48 | 2.49 | 2.48 | 2.85 |
| Chenguin    | 2.70 |      |      |      |      |      |      |      |      |      |
| Chiniatob   | 2.10 | 2.10 | 2.39 | 2.10 | 2.25 | 2.49 | 2.48 | 2.49 | 2.48 | 2.85 |
| Kalozira    |      | 1.80 | 2.16 | 1.80 | 2.10 |      |      |      |      |      |
| OMVs        | 4.05 | 4.50 | 4.25 | 4.50 | 4.75 | 5.01 | 4.96 | 4.97 | 4.99 | 5.10 |
| BINA dhan17 |      |      |      |      | 4.80 | 5.29 | 5.25 | 5.26 | 5.27 | 5.10 |
| BINA dhan7  | 4.50 | 4.50 | 4.25 | 4.50 | 4.71 | 4.73 | 4.67 | 4.68 | 4.70 |      |
| Nerica      | 3.60 |      |      |      |      |      |      |      |      |      |
| Average     | 4.07 | 4.40 | 4.08 | 4.19 | 4.45 | 4.82 | 5.01 | 5.01 | 5.01 | 5.14 |

Source: DAE, 2024

**Table 14. Paddy yield (t/ha) of different Boro rice varieties by different years in Tanore Upazila under Rajshahi district.**

| Variety       | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 |
|---------------|------|------|------|------|------|------|------|------|------|------|------|
| BRRRI         | 4.80 | 4.80 | 5.53 | 5.63 | 5.74 | 5.72 | 5.61 | 5.67 | 5.78 | 5.79 | 5.97 |
| BRRRI dhan28  | 4.80 | 4.80 | 5.25 | 5.40 | 5.40 | 5.68 | 5.68 | 5.40 | 5.75 | 5.75 |      |
| BRRRI dhan29  |      |      | 6.50 | 6.80 | 6.60 | 6.20 | 6.20 | 6.20 | 6.19 | 6.21 |      |
| BRRRI dhan50  |      |      | 5.10 | 5.10 | 5.03 | 5.02 | 5.04 | 5.04 | 5.05 | 5.04 |      |
| BRRRI dhan55  |      |      |      |      | 6.75 | 6.60 | 5.70 | 4.50 |      |      |      |
| BRRRI dhan58  |      |      |      | 5.60 | 5.53 | 5.53 | 5.54 |      |      |      |      |
| BRRRI dhan63  |      |      |      | 5.50 | 5.43 | 5.43 | 5.43 | 5.42 | 5.42 | 5.42 |      |
| BRRRI dhan65  |      |      |      |      |      |      |      |      | 5.08 | 5.07 | 5.20 |
| BRRRI dhan74  |      |      |      |      | 5.80 |      |      |      |      |      |      |
| BRRRI dhan81  |      |      |      |      |      | 5.60 | 5.57 | 5.56 | 5.60 | 5.59 | 5.57 |
| BRRRI dhan84  |      |      |      |      |      |      |      | 5.65 | 5.61 | 5.63 |      |
| BRRRI dhan86  |      |      |      |      |      |      |      | 5.69 | 5.67 | 5.67 |      |
| BRRRI dhan88  |      |      |      |      |      |      |      | 5.56 | 5.58 | 5.59 | 5.51 |
| BRRRI dhan89  |      |      |      |      |      |      |      | 6.63 | 6.62 | 6.68 | 6.67 |
| BRRRI dhan92  |      |      |      |      |      |      |      | 7.00 | 6.99 | 7.01 | 7.00 |
| BRRRI dhan100 |      |      |      |      |      |      |      |      |      |      | 5.88 |
| HYBRID        |      |      |      |      |      |      |      |      |      |      | 7.64 |
| S 1204        |      |      |      |      |      |      |      |      |      |      | 7.50 |
| S 1208        |      |      |      |      |      |      |      |      |      |      | 7.75 |
| SL8H          |      |      |      |      |      |      |      |      |      |      | 7.66 |
| Indian        | 4.37 | 4.37 | 4.47 | 4.73 | 5.30 | 5.76 | 5.76 | 5.77 | 5.85 | 5.85 | 6.10 |
| Nayanmoni     | 4.08 | 4.07 | 4.07 | 4.08 |      |      |      |      |      |      |      |
| Pariza        | 4.24 | 4.24 | 4.28 | 4.04 | 4.50 |      |      |      |      |      |      |
| Zira Shail    | 4.80 | 4.80 | 5.06 | 5.40 | 5.70 | 5.76 | 5.76 | 5.77 | 5.85 | 5.85 | 6.10 |
| OMVs          | 4.00 | 4.00 | 4.29 | 4.02 | 4.65 | 4.78 | 5.02 | 4.96 | 5.08 | 5.13 | 5.49 |
| BINA dhan10   |      |      |      |      |      | 6.60 |      |      |      |      |      |
| BINA dhan14   |      |      | 5.06 | 5.04 | 5.09 | 5.27 | 5.25 | 5.25 | 5.26 | 5.27 | 5.52 |
| BINA dhan19   |      |      |      |      |      |      | 4.20 | 4.50 |      |      | 5.40 |
| BINA dhan21   |      |      |      |      |      |      |      |      |      |      | 5.40 |
| BINA dhan25   |      |      |      |      |      |      |      |      |      |      | 6.50 |
| BINA dhan7    |      |      | 4.20 |      | 4.20 | 4.37 | 4.37 | 4.38 | 4.50 | 4.50 | 4.65 |
| BRAC 576      |      |      |      |      |      | 5.10 | 5.20 | 5.20 | 5.19 | 5.30 | 5.45 |
| IR 50         | 4.00 | 4.00 |      |      |      |      |      |      |      |      |      |
| Nerica        |      |      | 3.60 | 3.00 |      | 3.15 |      |      |      |      |      |
| Grand Total   | 4.45 | 4.45 | 4.84 | 5.06 | 5.45 | 5.41 | 5.44 | 5.47 | 5.59 | 5.61 | 6.04 |

Source: DAE, 2024

Table 15 presents findings of the study revealed that area coverage of BRRRI varieties in T. Aman season is comparatively lower than the other varieties and reasons behind this.

The field survey result indicates that area coverage of BRRRI varieties in Boro season was very minimum compared to Indian and other modern varieties.

**Table 15. Positive and negative traits of different rice varieties (T. Aman).**

| Variety                | Positive trait                                                                               | %<br>opined | Negative trait                                                                                                                | %<br>opined |
|------------------------|----------------------------------------------------------------------------------------------|-------------|-------------------------------------------------------------------------------------------------------------------------------|-------------|
| BRRI dhan51            | Gives impressive yield (5898 kg/ha)                                                          | 100         | Medium bold grain. Price is a bit lower than Swarna 5                                                                         | 100         |
|                        | Market demand is high.                                                                       | 100         | Need more chemical fertilizers and pesticide.                                                                                 | 100         |
|                        | Has drought and submergence tolerant capacity.                                               | 100         | Stem borer infestation is observed.                                                                                           | 100         |
|                        | Medium plant height. Demand of straw is high. Straw is good for cattle feeding               | 100         | Stem borer attacks high.                                                                                                      | 100         |
|                        | Strong stem. No lodging problem.                                                             | 100         | Sheat rot problem is observed.                                                                                                | 100         |
|                        | Effective tillers are upto 21                                                                |             | Lower straw price.                                                                                                            | 90          |
|                        | Sale of paddy is 1000-1200 Tk/40 kgs.                                                        | 100         | Observed melibug problem                                                                                                      | 90          |
|                        | Milling outturn is 26-27 kgs/40 kgs paddy                                                    | 100         | False mart problem is detected.                                                                                               | 90          |
|                        | Medium slander grain and teste is good.                                                      | 100         | Long duration. Need 7 days more compare to Swarna 5.                                                                          | 80          |
|                        | Good for double transplanting                                                                | 100         |                                                                                                                               |             |
| Swarna-5/summon swarna | Yield is 5988 kg/ha.                                                                         | 100         | Sheath rot disease infestation is observed                                                                                    | 100         |
|                        | Market demand is high, so it is easy to sale.                                                | 100         | More BPH infestation is observed.                                                                                             | 100         |
|                        | Medium bold grain.                                                                           | 100         | Melibug problem is detected.                                                                                                  | 100         |
|                        | Market price is 1100-1300 Tk./40 kgs.                                                        | 100         | Less taste than BRRI dhan51                                                                                                   | 100         |
|                        | Swarna-5 – Potato – BRAC-576/65dhan/Zirashal(short plant height)                             | 100         | Nor suitable for low lying and highland areas. It creates lodging problem during panicle initiation due to long plant height. | 100         |
|                        | Need comparatively lower chemical fertilizers, and pesticide and insecticide to BRRI dhan51. | 100         | Need 20-25 days more time for harvesting compared to BINA dhan17.                                                             | 55          |
|                        | Straw demand is high.                                                                        | 100         |                                                                                                                               |             |
|                        | Less disease and paste infestation compared to BRRI dhan51.                                  | 100         |                                                                                                                               |             |
|                        | Harvest 10 days early compared to BRRI dhan51.                                               | 100         |                                                                                                                               |             |
|                        | Have drought tolerant capacity.                                                              | 100         |                                                                                                                               |             |
|                        | Suitable for highland.                                                                       | 90          |                                                                                                                               |             |
|                        | Milling outturn is 25-27 kgs/40 kgs paddy.                                                   | 100         |                                                                                                                               |             |
| Lal Swarna             | Yield is lower (5688 kg/ha) than BRRI dhan51, Swarna-5)                                      | 100         | Sheath rot infestation is observed                                                                                            | 100         |
|                        | Rice is slender and tasty.                                                                   | 100         | Melibug infestation is detected                                                                                               | 100         |
|                        | Impressive market price (1000-1100 Tk./40 kgs).                                              | 100         | Shorter plant height. Weak stem.                                                                                              | 100         |
|                        | Slander grain and good taste.                                                                | 100         | False smat infestation is observed.                                                                                           | 100         |
|                        | Need fewer chemical fertilizers compare to BRRI dhan51.                                      | 80          | Straw price is low.                                                                                                           | 100         |
|                        |                                                                                              |             | No drought tolerant capacity.                                                                                                 | 100         |
|                        |                                                                                              |             | Uneven flowering                                                                                                              | 100         |
|                        |                                                                                              |             | Late variety. Difficult to cultivate Robi crops.                                                                              | 100         |

| Variety     | Positive trait                                  | %<br>opined | Negative trait                                                               | %<br>opined |
|-------------|-------------------------------------------------|-------------|------------------------------------------------------------------------------|-------------|
| BRRI dhan49 | Medium slender grain.                           | 100         | Severe false Smart problem. More unfilled grain.                             | 100         |
|             | Rice plant is short and strong.                 | 100         | Yield is lower than Swarna-5 and BRRI dhan51                                 | 90          |
|             | Market demand is high.                          | 100         | Low panicle size                                                             | 100         |
|             | Market price is high.                           | 100         | Less tiller (12-13/hill)                                                     | 100         |
|             | Straw quality is good for fodder.               | 100         |                                                                              |             |
|             | Milling outturn is 23-24 kgs/40 kgs paddy.      | 90          |                                                                              |             |
| BINA dhan17 | Early variety/Short Duration.                   | 100         | Low amylose (Sticky Rice).                                                   | 100         |
|             | Rice is medium slender.                         | 100         | Lower plant height (Less straw)                                              | 100         |
|             | Rice plant is strong.                           | 100         | Lower market price                                                           | 100         |
|             |                                                 |             | Low yield.                                                                   | 90          |
| Guti Swarna | Drought tolerant.                               | 100         | Mouse attacks more due to early variety.                                     | 90          |
|             |                                                 |             | Market price is a bit lower than BRRI dhan51 and Swarna-5 due to bold grain. | 100         |
|             | All types of land are suitable for cultivation  | 100         | Yield is low than BRRI dhan51                                                | 90          |
|             | Market Demand is high.                          | 100         | Melibug infestation is observed.                                             | 80          |
|             | Milling outturn is 26-27 kg/40kgs paddy.        | 100         | Stem borer infestation is detected.                                          | 80          |
|             | Less pest and disease infestation are observed. | 100         |                                                                              |             |
|             | 7 days earlier than BRRI dhan51.                | 100         |                                                                              |             |
|             | Need fewer chemical fertilizers.                | 100         |                                                                              |             |

**Table 16. Positive and negative traits of different Boro rice varieties.**

| Variety        | Positive trait                                                                                   | %<br>opined | Negative trait                                      | %<br>opined |
|----------------|--------------------------------------------------------------------------------------------------|-------------|-----------------------------------------------------|-------------|
| Zira Sail      | Yield of Zirasail is 6267 Kg/ha. Yield is high than BRAC-576 (6219 kg/ha).                       | 100         | Lodging susceptible (Long plant height).            | 100         |
|                | Good taste and long slender grain.                                                               | 100         | Susceptible to stem borer.                          | 100         |
|                | Market price is 1200-1250 Tk./40 kgs                                                             | 90          | Susceptible to BPH.                                 | 100         |
|                | Lodging tolerant (medium plant height).                                                          | 95          | Need more irrigation.                               | 60          |
|                | Need lower amount of insecticide and pesticide.                                                  | 90          | Long duration (>150 days).                          | 40          |
|                | Non sticky rice.                                                                                 | 100         | Short duration (140-145 days).                      | 80          |
|                | High market demand                                                                               | 100         | Unfilled grain during heavy heat.                   | 80          |
|                | Milling outturn is 24 kg from 40 kgs paddy.                                                      | 80          | Neck blast problem (But less than other varieties). | 90          |
|                | High quality straw. High demand                                                                  | 100         | Bacterial panicle blight problem                    | 70          |
|                | Short Duration (110-120 days)                                                                    | 100         | Susceptible to stem borer.                          | 80          |
| BR-65/ 65 dhan | Yield is 6312. kg/ha. Yield is higher than Zira Sail (6267.11 kg/ha) and BRAC -576 (6219 kg/ha). | 100         | Need more insecticide and pesticide.                | 70          |
|                | Drought tolerant.                                                                                | 100         | BPH infestation                                     | 80          |
|                | Requires less irrigation.                                                                        | 90          |                                                     |             |
|                | Slender grain. Long panicle. Taste is good.                                                      | 100         |                                                     |             |
|                | Market demand is high.                                                                           | 100         |                                                     |             |

| Variety                   | Positive trait                                          | %<br>opined | Negative trait                                           | %<br>opined |
|---------------------------|---------------------------------------------------------|-------------|----------------------------------------------------------|-------------|
| BRAC-576                  | Market price is 1000-1200 Tk/40 kgs                     | 100         |                                                          |             |
|                           | Strong stem. No lodging and shattering problems.        | 100         |                                                          |             |
|                           | Yield is 6219 kg/ha.                                    | 100         | Susceptance to BPH.                                      | 90          |
|                           | Medium slander grain like BRRI dhan28.                  | 100         | Rice is hard.                                            | 80          |
|                           | Less disease infestation.                               | 95          | Uneven flowering.                                        | 90          |
|                           | No lodging problem.                                     | 100         |                                                          |             |
|                           | Short duration (110-115 days)                           | 100         |                                                          |             |
| Bina-14<br>(Siattar dhan) | High market demand. Market price is 1100-1200 Tk/40 kgs | 100         |                                                          |             |
|                           | Effective tillering 15-20.                              | 90          |                                                          |             |
|                           | Yield is high (average yield is 5890 kg/ha)             | 100         | Drought causes unfilled grain during panicle initiation. | 100         |
| BINA -7                   | Short duration (110-115 days)                           | 100         | BPH infestation.                                         | 100         |
|                           | Market demand is high.                                  | 100         | Uneven plant type.                                       | 100         |
|                           | Strong stem and drought tolerant.                       | 100         |                                                          |             |
|                           | Yield is near to BRAC-576.                              |             | Unfilled grain due to heat.                              | 100         |
| BRRI dhan57               | Short duration (130-135 days)                           |             | Blast susceptible (Neck blast)                           | 100         |
|                           | Medium plant height                                     |             | BPH and stem borer infestation.                          |             |
|                           | No lodging problem                                      |             | Left over rice is not in good condition.                 |             |
|                           | Short duration (105-110 days)                           |             | Yield is low (4978 kg/ha)                                |             |
|                           | Slander grain. Short plant height                       |             | BPH susceptible.                                         |             |
|                           | Market price is 1000-1100 tk/40 kgs.                    |             |                                                          |             |
|                           | Market demand is medium.                                |             |                                                          |             |

**Table 17. Adoption (%) of different T. Aman rice varieties in different unions of Tanore Upazila under Rajshahi district, 2023-24.**

| Variety      | Kalma | Mundumala<br>powrosova | pachondor | Saranji | Talakanda | kamargaoun | Tanore<br>powrosova | Badhair | Chanduria | Ave.   |
|--------------|-------|------------------------|-----------|---------|-----------|------------|---------------------|---------|-----------|--------|
| BRRI         | 70    | 70                     | 32        | 20      | 35        | 20         | 15                  | 70      | 88        | 46.67  |
| BRRI dhan34  | 0     | 0                      | 0         | 0       | 0         | 10         | 0                   | 0       | 0         | 1.11   |
| BRRI dhan49  | 0     | 0                      | 4         | 0       | 0         | 0          | 0                   | 0       | 3         | 0.77   |
| BRRI dhan51  | 70    | 70                     | 25        | 20      | 35        | 10         | 15                  | 70      | 85        | 44.44  |
| BRRI dhan93  | 0     | 0                      | 3         | 0       | 0         | 0          | 0                   | 0       | 0         | 0.33   |
| Hybrid:      | 0     | 0                      | 0         | 0       | 0         | 60         | 0                   | 0       | 0         | 6.67   |
| Sonar Bangla | 0     | 0                      | 0         | 0       | 0         | 60         | 0                   | 0       | 0         | 6.67   |
| Indian:      | 30    | 30                     | 65        | 80      | 65        | 20         | 80                  | 30      | 12        | 45.78  |
| Swarna-5     | 30    | 0                      | 65        | 0       | 65        | 20         | 80                  | 15      | 12        | 31.89  |
| Sumon Swarna | 0     | 20                     | 0         | 70      | 0         | 0          | 0                   | 0       | 0         | 10.00  |
| Lal Swarna   | 0     | 10                     | 0         | 10      | 0         | 0          | 0                   | 5       | 0         | 2.78   |
| Guti Swarna  | 0     | 0                      | 0         | 0       | 0         | 0          | 0                   | 10      | 0         | 1.11   |
| Other MVs:   | 0     | 0                      | 3         | 0       | 0         | 0          | 5                   | 0       | 0         | 0.89   |
| BINA dhan17  | 0     | 0                      | 3         | 0       | 0         | 0          | 0                   | 0       | 0         | 0.33   |
| Others       | 0     | 0                      | 0         | 0       | 0         | 0          | 5                   | 0       | 0         | 0.56   |
|              | 100   | 100                    | 100       | 100     | 100       | 100        | 100                 | 100     | 100       | 100.00 |

Source: FGD survey, 2024.

**Table 18. Adoption (%) of different Boro rice varieties in different unions of Tanore Upazila under Rajshahi district, 2023-24.**

| Variety Name | Kalma | Mundumala powrosova | Pachondor | Saranjai | Talanda | kamargaon | Tanore powrosova | Badhair | Chanduria | Aver.  |
|--------------|-------|---------------------|-----------|----------|---------|-----------|------------------|---------|-----------|--------|
| BRRI dhan57  | 0     | 0                   | 0         | 0        | 0       | 10        | 0                | 0       | 0         | 1.11   |
| Indian:      | 65    | 50                  | 60        | 30       | 5       | 40        | 10               | 80      | 30        | 41.11  |
| Zira         | 65    | 50                  | 60        | 30       | 5       | 40        | 10               | 80      | 30        | 41.11  |
| Other MVs:   | 35    | 50                  | 40        | 65       | 95      | 50        | 90               | 20      | 70        | 57.22  |
| 65 dhan      | 35    | 0                   | 10        | 5        | 45      | 20        | 30               | 5       | 0         | 16.67  |
| BRAC 576     | 0     | 50                  | 0         | 60       | 50      | 30        | 60               | 15      | 50        | 35.00  |
| BINA dhan7   | 0     | 0                   | 0         | 0        | 0       | 0         | 0                | 0       | 20        | 2.22   |
| BINA dhan14  | 0     | 0                   | 30        | 0        | 0       | 0         | 0                | 0       | 0         | 3.33   |
| others       | 0     | 0                   | 0         | 5        | 0       | 0         | 0                | 0       | 0         | 0.56   |
|              | 100   | 100                 | 100       | 100      | 100     | 100       | 100              | 100     | 100       | 100.00 |

Source: FGD survey, 2024.

# PRODUCERS' WELFARE LOSS IN BANGLADESH: AN ASSESSMENT OF RICE MARKET DISTORTION

M C Rahman, M A Islam, M S Rahaman, M S Islam

Rice farmers in the country often face significant welfare losses due to market price fluctuations. Despite the importance of rice production, farmers frequently struggle with declining farm gate prices, which are often lower than the investment in paddy production. This market disparity, influenced by factors such as government policies, middlemen exploitation, and international price competition, puts immense pressure on smallholder farmers, reducing their income and overall well-being. Understanding the dynamics behind these welfare losses is essential for developing sustainable agricultural policies and interventions aimed at improving farmers' economic resilience. Therefore, this research aimed to assess the paddy producers' welfare loss based on actual market price and government declared procurement price in the Boro season.

## Methodology

Data sources and description

Estimating rice supply function: The data used in this study has been gathered from different

recognized sources. Annual data on rice supply, cultivated area, yield, chemical fertilizer, and pesticide use have been collected from the Bangladesh Bureau of Statistics. The agricultural credit disbursement data have been gathered from Bangladesh Economic Review. Data on the costs of paddy production have been collected from the Agricultural Economics Division of Bangladesh Rice Research Institute. The time series data on these variables covered the period 1982-2022.

## Producers' welfare change estimation.

The paddy farm gate price and procurement price data have been gathered from the Department of Agricultural Marketing and the Ministry of Food, Bangladesh respectively. As the government procurement programme had been running from 2000 onward only for the Boro season, we have estimated producers' surplus change in the Boro season based on the declared procurement price and actual farm gate price during 2000-2022.

Rice supply function and welfare change were estimated following relevant mathematical equations.

## Results

The findings of this study ensuring paddy price positively influence rice supply in Bangladesh. Other positively influential factors are rice area, yield, pesticide use, and agricultural credit (Table



19). The government should ensure these factors for maintaining surplus rice production. Moreover, farmers had to sell paddy for less than the declared procurement price, which impacted their surplus. However, from the initiation of the COVID-19 pandemic, farmers are getting better price (more than the declared procurement price) and gaining surplus. Therefore, to be farmer-oriented, ensuring

better farm gate price is essential.

The two-step generalized method of moments (GMM) results shows that rice supply is positively influenced by factors like paddy market price, cultivated rice area, pesticide use, and agricultural credit.

**Table 19. Estimated regression results of OLS and Two-step GMM.**

| Explanatory variable                 | OLS                 |          | Two-step GMM         |           |
|--------------------------------------|---------------------|----------|----------------------|-----------|
|                                      | Coeff.              | SE       | Coeff.               | Robust SE |
| Total supply of rice (Dep. variable) |                     |          |                      |           |
| Independent variables:               |                     |          |                      |           |
| Log average paddy market price       | 0.121***            | 0.042861 | 0.189***             | 0.048455  |
| Log total rice area                  | 0.632**             | 0.308705 | 0.609**              | 0.309155  |
| Log average yield                    | 0.691***            | 0.183546 | 0.806***             | 0.156252  |
| Log total pesticide use              | 0.083***            | 0.020651 | 0.071***             | 0.019075  |
| Log chemical fertilizer use          | 0.048 <sup>NS</sup> | 0.037875 | 0.011 <sup>NS</sup>  | 0.055861  |
| Log agricultural credit use          | 0.047*              | 0.024446 | 0.051*               | 0.027982  |
| Constant                             | 1.943 <sup>NS</sup> | 2.99903  | 2.3352 <sup>NS</sup> | 3.08449   |
| Diagnostic statistic:                |                     |          |                      |           |
| F test (6,34)                        | 903.89***           |          | -                    |           |
| Adj R2                               | 0.993               |          | -                    |           |
| Period of observation (year)         | 41                  |          | 40                   |           |

The welfare changes analysis reveals that over the estimated period, the rice producers lost an average 54.37 million BDT/season of their surplus based on the procurement price (Fig. 1).

However, after initiating the COVID-19 pandemic, the producers are getting a better surplus (on an average of 4.35 million BDT/season).

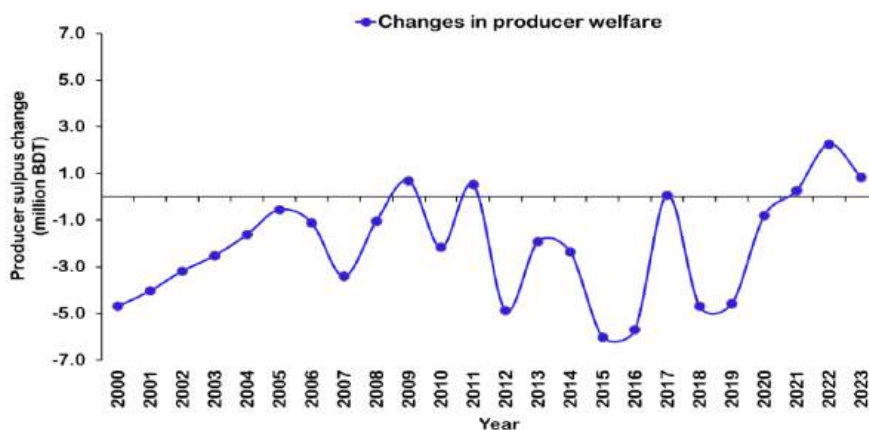


Fig. 1. Welfare impact of rice producers due to market distortion in Bangladesh.

## ESTIMATION OF COSTS AND RETURN OF MV RICE CULTIVATION AT THE FARM LEVEL

M S Islam, M A Islam, M C Rahman, M S Rahaman, L Deb, S A Jui, D M Salman, S A Mou

Cost and return analysis is essential for researchers and planners to develop technologies and policies that increase farmers' returns by reducing costs. This study has been undertaken to assess the level of inputs used, the cost of rice cultivation at the farm and profitability of MV Aus, MV T. Aman, and MV Boro rice cultivation at the farm level

Farmers used more seed than recommend amount (Table 20). They are dependent on hired labour due to shortage of family labour. Farmers did

not use balanced and recommended fertilizer dose because of improper knowledge. Most farmers used power threshers on a custom-hired basis for threshing paddy. The costs of production of T. Aman, Aus and Boro rice production were 1,35,598, 1,35,058 and 1,51,633Tk/ha respectively (Table 21). Per kg production cost in T. Aman, Aus, and Boro season was, 25, 24, and 26 Tk/kg, respectively. The gross margin per hectare for Boro rice was Tk 63,490, followed by T. Aman (Tk 61,194) and Aus (Tk 56,513). The benefit-cost ratio (BCR) based on full-cost calculation was highest for Boro (1.26) and T. Aman (1.26), followed by Aus (1.24), reflecting the profitability of rice cultivation in all three seasons (Table 22)

**Table 20. Per hectare input used for MV rice cultivation in different seasons of Bangladesh, 2023-24.**

| Input Items                                            | Season    |           |           |
|--------------------------------------------------------|-----------|-----------|-----------|
|                                                        | T. Aman   | Aus       | Boro      |
| Human Labour (man-day/ha):                             | 110       | 121       | 110       |
| Hired                                                  | 37        | 39        | 41        |
| Family                                                 | 15        | 16        | 14        |
| Hired contract (transplanting, weeding and harvesting) | 58        | 67        | 55        |
| Seed (kg/ha):                                          | 41        | 42        | 44        |
| Fertilizer (kg/ha):                                    |           |           |           |
| Urea                                                   | 144 (150) | 151 (125) | 230 (250) |
| TSP                                                    | 74 (56)   | 74 (44)   | 84 (94)   |
| MoP                                                    | 110 (75)  | 87 (67)   | 97 (123)  |
| DAP                                                    | 92 (56)   | 81 (44)   | 64 (94)   |
| Gypsum                                                 | 35 (50)   | 38 (33)   | 38 (62)   |
| ZnSo4                                                  | 5 (7)     | 6 (7)     | 6 (10)    |
| MgSo4                                                  | 5         | 5         | 5         |
| Boron                                                  | 4         | 4         | 4         |
| Vitamin                                                | 2         | 1         | 3         |

Note: Data in parentheses indicate average BRRI recommended fertilizer doses (Adhunik Dhaner Chas)

**Table 21. Per hectare cost of MV rice cultivation in different season of Bangladesh, 2023-24.**

| Input-wise cost                            | Season  |       |       |
|--------------------------------------------|---------|-------|-------|
|                                            | T. Aman | Aus   | Boro  |
| Seed                                       | 3557    | 2348  | 5045  |
| Seedling development                       | 3157    | 3815  | 3930  |
| Land preparation (ploughing and laddering) | 11542   | 12315 | 12565 |
| Human labour:                              | 49296   | 54389 | 49332 |

| Input-wise cost                                         | Season  |        |        |
|---------------------------------------------------------|---------|--------|--------|
|                                                         | T. Aman | Aus    | Boro   |
| Hired                                                   | 16685   | 17348  | 18523  |
| Family                                                  | 6532    | 7018   | 6163   |
| Hired contract (transplanting, weeding, and harvesting) | 26078   | 30023  | 24646  |
| Fertilizer cost                                         | 9304    | 9729   | 11065  |
| Irrigation                                              | 6309    | 6091   | 16955  |
| Pesticide:                                              | 5024    | 4437   | 4447   |
| Herbicide                                               | 1353    | 1239   | 1192   |
| Insecticide and fungicide                               | 3671    | 3198   | 3254   |
| Power thresher                                          | 5739    | 4656   | 4449   |
| Total variable cost                                     | 97729   | 101651 | 114114 |
| Interest on operating capital                           | 1501    | 1611   | 1823   |
| Land rent                                               | 35466   | 30890  | 34890  |
| Total fixed cost                                        | 37869   | 33407  | 37520  |
| Total cost                                              | 135598  | 135058 | 151633 |

Source: Field Survey, 2023-24

**Table 22. Per hectare profitability of MV rice cultivation in different seasons in Bangladesh, 2023-24.**

| Item                                    | Season  |        |        |
|-----------------------------------------|---------|--------|--------|
|                                         | T. Aman | Aus    | Boro   |
| 1 Total costs (TK./ha) (2+3)            | 135598  | 135058 | 151633 |
| 2 Total variable costs (TK./ha)         | 97729   | 101651 | 114114 |
| 3 Total fixed cost (TK./ha)             | 37869   | 33407  | 37520  |
| 4 Yield (kg/ha)                         | 5407    | 5614   | 5949   |
| 5 Market value of paddy (TK./ha) (4*11) | 150104  | 148942 | 167452 |
| 6 Market value of straw (TK./ha)        | 8820    | 9222   | 10152  |
| 7 Gross benefit (GB) (TK./ha) (5+6)     | 158924  | 158164 | 177604 |
| 8 Gross margin (GM) (TK./ha (7-2)       | 61194   | 56513  | 63490  |
| 9 Gross profit ratio ((GM*100)/GB)      | 38      | 35     | 35     |
| 10 Net return (TK./ha) (7-1)            | 23325   | 23106  | 25971  |
| 11 Cost of production (TK./kg)          | 25      | 24     | 26     |
| 12 Selling price of grain (TK./kg)      | 28      | 27     | 28     |
| 13 BCR (full cost basis) (7/1)          | 1.26    | 1.24   | 1.26   |
| 14 BCR (cash cost basis) (7/2)          | 1.75    | 1.64   | 1.67   |

Source: Field Survey, 2023-24

## **Agricultural Statistics Division**

|            |                                                                                                                              |
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## SUMMARY

T. Aman varieties- BRRI dhan49, BRRI dhan87 and BRRI dhan93 were found stable. None of the varieties were found to be unstable during T. Aman season. Among the aromatic rice BRRI dhan5, BRRI dhan34, BRRI dhan37 and BRRI dhan38 were found as below average stable in T. Aman season.

The district-wise analysis of rice yield trends in Bangladesh reveals a general improvement in rice production over time, with some districts consistently performing well, while others continue to face challenges. Aus and Aman rice yields have shown more sporadic improvements compared to Boro rice, which faced more significant yield losses in certain years. Total rice yield trends indicate relative stability in recent years, which is encouraging for long-term food security planning in the country.

The highly significant genotype  $\times$  environment interaction effects for grain yield confirmed that genotypes responded differently to the variation in environmental conditions for long, medium, and short-duration Aman varieties. The greater portion of the total variation was explained by the environmental main effect, indicating that the environments were diverse and a major part of the variation in grain yield was reflected by environmental changes. In the Aman season, BR11 and BRRI dhan30 recorded the highest average grain yielder and ideal genotypes among long-duration varieties. BRRI dhan103, BRRI dhan94, BRRI dhan51, and BRRI dhan49 were the most stable genotypes with above-average yield in medium duration, where BRRI dhan87, BRRI dhan72, BRRI hybrid dhan6, BRRI hybrid dhan4 and BRRI dhan95 were the most stable genotypes and above average yielder for short duration.

Rice area increased about one and half folds but the production increased about four folds during 1971-72 to 2022-23. Although the growth rate of rice area was 3.96 in year 1972-73 but in 2022-23 is - 0.005. Similarly, growth rate of rice production was

1.30 in year 1972-73 but in 2022-23 is 0.03.

BRRI dhan101 to BRRI dhan104- all these varieties are suitable mainly in north-western part of Bangladesh but BRRI dhan102 is also suitable in all over the western part of Bangladesh.

More or less throughout the year eastern side of Bangladesh known as is high rainfall and low temperature area and western side is low rainfall and high temperature area. Spatial distribution of minimum temperature and total rainfall are more or less same.

About 5.91 Mha of rice were farmed overall in 2023 during Aman season and the highest Aman production district was Naogaon. In 2022 total Aman area was 5.82 Mha. Thus, total Aman area has been increased a little bit in the year 2023. In 2023-24 total Boro area was about 4.93 Mha in Bangladesh. Naogaon district produced the highest Boro production in 2023-24.

Average total precipitation (average by RCP 2.6, 4.5, 6.0, and 8.5 models) of Bangladesh of August 2050 will be decreased in comparison to average total precipitation of 2010-2018 period, only exceptions are Khulna, Rajshahi, Mymensingh divisions.

Mustard-Fallow-T. Aman cropping pattern total suitable area is 1.8Mha. Mustard-Boro-B. Aman corriping pattern cover total suitable area 1.32 Mha. Mustard-Jute-T. Aman is suitable area is 0.99 Mha.

Though among the random-forest, support vector, linear-regression and ensemble model we found ensemble model is the best fitted model for yield prediction but still model is not good fitted model. So, the study should continue to improve the model.

The continuous rice farming stayed steady, there was a notable increase in the more recent rice cultivation zones, which were mostly homesteads, urban areas, non-rice crops, and fallow areas. This impressive expansion indicates that despite socioeconomic and environmental constraints, rice farming has become more popular in the area.

In the reporting year, two types of training were conducted under 'Capacity Building through Training' programme. A total of 50 participants were trained through the trainings programmes. The participants of these training were scientists and SA, FM and AFM of BRRI.

Nine activities have been done in the reporting year 2023-24 under the project Computer programming, Software Development and Digitization. A new web application has been developed for visualizing and analyzing the rice disease surveillance data. Another web application 'digital tour distance calculation system for BRRI HQ' have been developed as a new program. Seven web applications have been updated and continuously run in the whole reporting year named (1) update the web application to calculate the stability index for BRRI stability model (2) Unique platform for BRRI developed all the Management Information Systems (3) Quota Management System (4) Salary Management System (5) Labour Management System (6) Budget Management Software and (7) CL Application Management Software for BRRI HQ.

ICT cell of this division has developed 'Rice profile' mobile app for smart profiling of rice varieties in disaster-prone zones of Bangladesh and sensor-based rice pest management through artificial intelligence (AI) technology 'Rice Solution' mobile App. It has also, developed 'BRRI Rice doctor' mobile and web apps both English and Bengali version with the help of different divisions of BRRI. Developed a new website for national and international seminars and symposiums of BRRI dynamic view connectivity, Bangla search and inner banner system for BRKB web apps. Besides, modified the RKB mobile apps and disseminate of modern rice technology and its management information at the farmer door step through RKB Mobile Apps. We developed Vehicle Requisition Management System (VRMS) of BRRI. So that, the requester informed through SMS on basis of

demanding vehicle for official or personal purpose as well as driver get confirmation SMS for their upcoming duty. Also, we developed 'BRRI Alapon' Telephone Directory Mobile App. We organized five-day-long, two-day-long, day-long 'Public Service Innovation' training workshops in the reporting year. A total of 400 participants were trained through the innovation, SPS trainings and e-Nothi in-house trainings.

## STABILITY ANALYSIS OF BRRI VARIETIES

PI: -M I H, CI: M S K, N M F R, M A Q, M A A, M A A M, M S R, K M I, M H K One Scientist from each RS

The main objectives of the study were to determine the stability index of BRRI released varieties, maintain season, year and location-wise database and identify the bio-physical and socio-economic factors causing instability. Experiments are being conducted in T. Aman season with BRRI released rice varieties since 2001-2023 at Gazipur and different regional stations. The collaborative regional stations in the T. Aman season are Rajshahi, Rangpur, Cumilla, Sonagazi, Barishal, Satkhira and Kushtia . The numbers of varieties are 49 in T. Aman. The design was RCB with three replications and the effective plot size (harvest area) was  $3 \times 2$  m<sup>2</sup>, leaving the two-border row from each side. Recommended crop management practices were followed. Stability analyses of the experimental data were performed by using a newly developed model. The model deals with the performance of the genotypes across the geographical locations differing in land, soil and other biotic and abiotic factors over the years characterizing fluctuation of weather variable, floods, drought etc.

Among T. Aman varieties, BRRI dhan49 and BRRI dhan87 were found stable with stability index 2.101 and 2.015 respectively. while BR3, BRRI dhan33, BRRI dhan39, BRRI dhan56, BRRI dhan57, BRRI dhan62, BRRI dhan70, BRRI dhan90 and BRRI dhan91 appeared to be below average stable. BR4, BR10, BR11, BR22, BR23, BR 25,

BRRi dhan30, BRRi dhan31, BRRi dhan32, BRRi dhan40, BRRi dhan41, BRRi dhan44, BRRi dhan46, BRRi dhan49, BRRi dhan51, BRRi dhan52, BRRi dhan53, BRRi dhan54, BRRi dhan66, BRRi dhan71, BRRi dhan72, BRRi dhan73, BRRi dhan75, BRRi dhan76, BRRi dhan77, BRRi dhan78, BRRi dhan79, BRRi dhan80, BRRi dhan93, BRRi dhan94, BRRi dhan95, BRRi hybrid dhan4 and BRRi hybrid dhan6 were found having average stability among T. Aman varieties. Among the aromatic rice BRRi dhan5, BRRi dhan34, BRRi dhan37 and BRRi dhan38 were found as below average stable in T. Aman season.

#### DEVELOPMENT OF MACHINE LEARNING MODEL FOR PREDICTING RICE YIELD LOSS CONCERNING METEOROLOGICAL FEATURES IN BANGLADESH

PI: M A A M, CI: M I H, M A Q, and M A A

#### District-wise rice yield trend in Bangladesh

Understanding the district-wise trend of rice yields across different seasons in Bangladesh is crucial for shaping government policies and ensuring food security. Utilizing 17 years of time series data, we investigated the relationship between rice yield and time across various districts for the Aus, Aman, and Boro seasons, as well as total rice production. Our analysis revealed notable spatial and temporal variations in rice yields. For Aus rice, the majority of districts showed a positive trend in yield over time, with significant improvements observed in 60 districts ( $p \leq 0.05$ ). Only Rangamati, Cox's Bazar, and Khulna exhibited a negative trend. Aman rice yields improved in all districts, with 54 districts showing statistically significant gains. Boro rice displayed a positive yield trend in 46 districts, though Joypurhat and Pabna exhibited declining yields over time. When analyzing total rice yield across all seasons, 48 districts showed a significant positive trend, indicating overall improvements in rice production in Bangladesh.

#### Spatial-temporal distribution of standardized yield residual series (SYRS)

We employed the Standardized Residual Yield Series (SYRS) method after detrending the time series data to capture variations in rice yield. The SYRS helped to identify periods of yield loss ( $\text{SYRS} \leq -0.51$ ) and yield increments for each season across districts, allowing us to understand fluctuations over the study period (Fig. 1 and 2).

#### Aus season

In the Aus season, yield losses ranged from 2 to 7 years out of the 17-year study period, depending on the district. The most significant yield losses, occurring in seven years, were recorded in districts like Barishal, Barguna, Chuadanga, Khagrachari, Maulvibazar, Noakhali, Sirajganj, and Thakurgaon. Across all 64 districts, 21 districts experienced a five-year yield loss, while 18 districts had a four-year loss, two districts a three-year loss, and one district a two-year loss (Fig 1). The SYRS analysis revealed that high yield losses peaked during 2009-10 and 2015-16, when eight districts faced significant reductions in yields. Other moderate yield losses were concentrated in 2007-08 and 2014-15, affecting 10 and 9 districts respectively. In contrast, certain years, such as 2012-13 and 2008-09, saw many districts with stable or normal yields. The years 2013-14 and 2017-18 also witnessed notable yield improvements, with 13 and 10 districts showing substantial growth, though high yield increments were sporadic across the study period (Fig. 2).

#### Aman season

The analysis of Aman rice showed yield losses ranging from 3 to 8 years across districts. Nineteen districts recorded a six-year loss, 24 districts had a five-year loss, 12 districts experienced a four-year loss, and six districts faced a three-year yield loss. Year 2007-08 showed the highest number of districts (23) experiencing high-yield losses. Other years with notable yield losses include 2018-19 (5 districts) and

2019-20 (six districts). Moderate yield losses also peaked in 2007-08, affecting 12 districts, and 10 districts in 2019-20 and 2016-17 (Fig. 1). However, yield performance stabilized in later years, with normal yields observed in 32 districts in 2017-18 and 31 districts in 2018-19. Yield increments, while less frequent, were concentrated in certain years, such as 2011-12 and 2012-13, when 19 and 15 districts respectively, showed low yield increments. Significant yield improvements were rare but noticeable in 2009-10, when 13 districts reported high yield increments. Overall, the Aman rice trend suggests a gradual stabilization in yield performance in recent years, despite significant yield losses in earlier years (Fig. 2).

### Boro Season

Boro rice showed yield losses ranging from 3 to 8 years. Gaibandha district faced the highest loss, with eight years of yield reduction. Other districts, including four districts with seven-year losses, 20 districts with six-year losses, and 16 districts with five-year losses, also experienced significant declines. The year 2006-07 was a particularly challenging one for Boro rice, with 22 districts reporting high yield losses (Fig. 1). Smaller peaks in

yield loss occurred in 2018-19 and 2020-21, affecting five and four districts, respectively. Moderate yield losses were also more common in 2006-07 and 2018-19, while other years saw fewer districts with such losses. Low yield losses were most widespread in 2015-16 and 2021-22. In terms of yield increments, 2007-08 was a standout year, with 14 districts showing high yield gains, followed by smaller improvements in subsequent years. Stability in Boro rice production was most evident in 2016-17 and 2019-20, when 32 and 33 districts respectively, reported normal yields (Fig. 2).

### Total season

Overall, Magura district experienced the most substantial total rice yield loss, with eight years of decline (Fig. 1). Five other districts faced seven-year losses, and several others saw varying degrees of yield reductions. Significant yield losses for total rice production were observed in 2006-07, affecting 20 districts. In contrast, 2015-16 and 2019-20 saw the most stability, with 33 and 32 districts respectively, reporting normal yields. While high yield increments were rare, they peaked in 2013-14, with 12 districts showing large gains (Fig. 2).

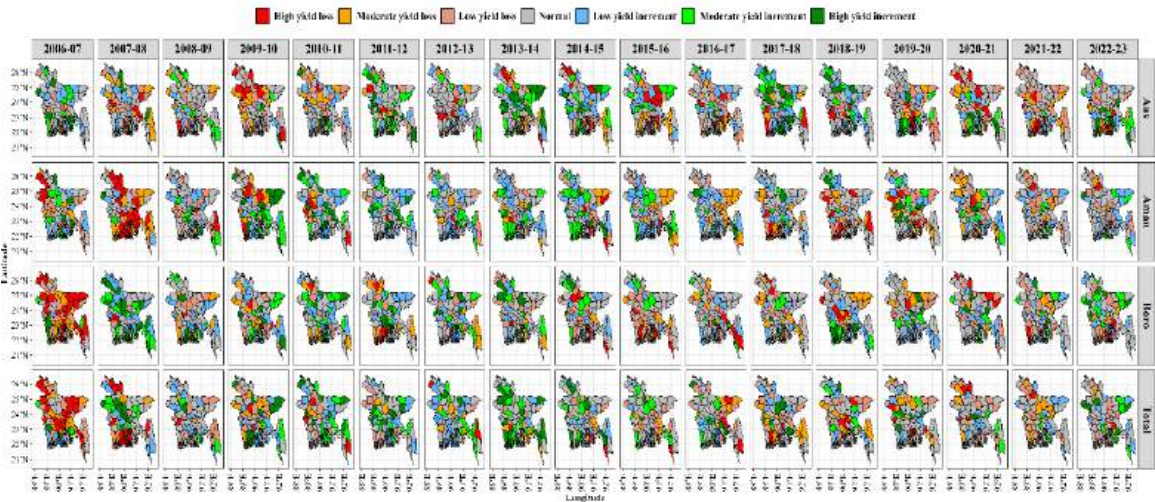


Fig 1. Spatio-temporal changes in standardized residual yield series (SYRS) for different rice season (a) Aus, (b) Aman (c) Boro and (d) total rice in Bangladesh from 2006-07 to 2022-23.



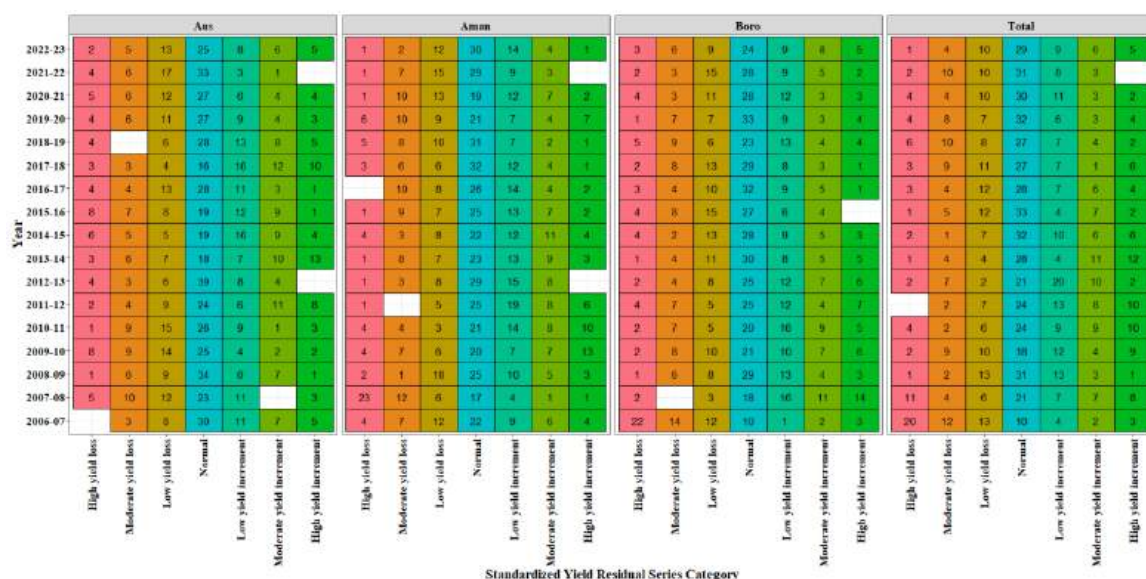


Fig 2. Heatmap of the frequency (no. of districts) of different types of yield loss/gain of 64 districts of Bangladesh during 2006-07 to 2022-23 in Aus, Aman, Boro and Total season.

## GENOTYPE $\times$ ENVIRONMENT INTERACTION OF BRRI VARIETIES

PI: M A A M, CI: M I H, M A Q and M A A

The major objective of the study was to identify BRRI released rice genotypes that have both high mean yield and stable yield performance across different environments for different ecosystem of Bangladesh. The experiment was conducted in multi-environment trials for T. Aman 2023. Forty-nine BRRI released T. Aman rice varieties were evaluated in nine environmental conditions of Bangladesh, such as Barishal, Bhanga, Cumilla, Gazipur, Kushtia, Rajshahi, Rangpur, Satkhira and Sonagazi. The experimental sites covered all ecosystems of Bangladesh. The experiments were carried out in randomized complete block design (RCBD) with three replications and evaluated for rice grain yield. Each experimental plot comprised of 3m  $\times$  2m. Standard agronomic practices were followed and plant protection measures were taken according to ADC, BRRI (2023). AMMI model was used to quantify the effect of different factors (genotype, location) of the experiment. The model further provides graphical representation of the numerical results (GGE biplot analysis) with a

straight-forward interpretation of the underlying causes of  $G \times E$ .

## ANOVA of combined analysis

The combined analysis revealed that the yield of rice genotypes was significantly influenced by the environment and contributed 69.11, 65.74, and 62.28% of the total variation for short, medium, and long duration, respectively in the Aman season. Additionally, the relative contribution of the genotype sum of squares was found to be 18.51, 14.75, and 9.48% for long, short, and medium durations respectively. Genotype by environment ( $G \times E$ ) contributed the most 15.55% to the total variation for medium duration, followed by 14.08% and 12.06% for long and short duration. Greater portion of the total variation was explained by the environmental main effect, indicating that the environments were diverse and a major part of the variation in grain yield was reflected by environmental changes. The highly significant genotype  $\times$  environment interaction effects for grain yield confirmed that genotypes responded differently to the variation in environmental conditions.

### Performance and stability of rice genotypes across tested environments

The GGE biplot explained 84.97%, 78.81%, and 72.62% of the total variation of the environments for long, short and medium duration respectively. In long duration, BR11 recorded the highest average grain yield (5.43 t/ha), with BR11 and BRRI dhan30 identified as the most stable and ideal genotypes. For medium duration, genotypes like BRRI dhan103 and BRRI dhan94 were highly stable, producing above-average yields. In short duration, BRRI dhan87, BRRI dhan72, and BRRI hybrid dhan4 showed high yields and stability, making them the most suitable genotypes for these conditions. (Fig. 3).

### Identification of which-won-where and mega-environment

One of the most attractive features of a GGE biplot is its ability to show the which-won-where pattern of a genotype by environment dataset. This plot consists of a polygon with perpendicular lines, called equality lines, drawn onto its sides. These lines divide the polygon into various sectors. Genotypes located on the vertices of the polygon are the best performers in one or more environments falling

within a particular sector. The GGE biplot revealed distinct mega-environments for each duration type. In long duration, two mega-environments were identified, where BR11 and BR10 were the top-performing genotypes. For medium duration, the analysis divided the environments into three mega-environments, with BRRI dhan94, BRRI dhan103, and BRRI dhan52 as the winning genotypes in different regions. For short duration, four mega-environments emerged, with BRRI dhan95, BRRI dhan72, BRRI dhan87, and BRRI hybrid dhan6 leading in performance across various locations.

### Evaluation of test environments

For long duration, Kushtia was identified as the most representative and ideal testing environment. In medium duration, Rangpur and Kushtia stood out as optimal environments for genotype evaluation due to their discriminating ability and representativeness. In short duration, Kushtia and Cumilla were considered highly representative, making them ideal environments for testing short-duration genotypes. The analysis highlighted that environments like Rajshahi and Satkhira, with longer vectors, were more discriminating, offering valuable insights into genotype performance.

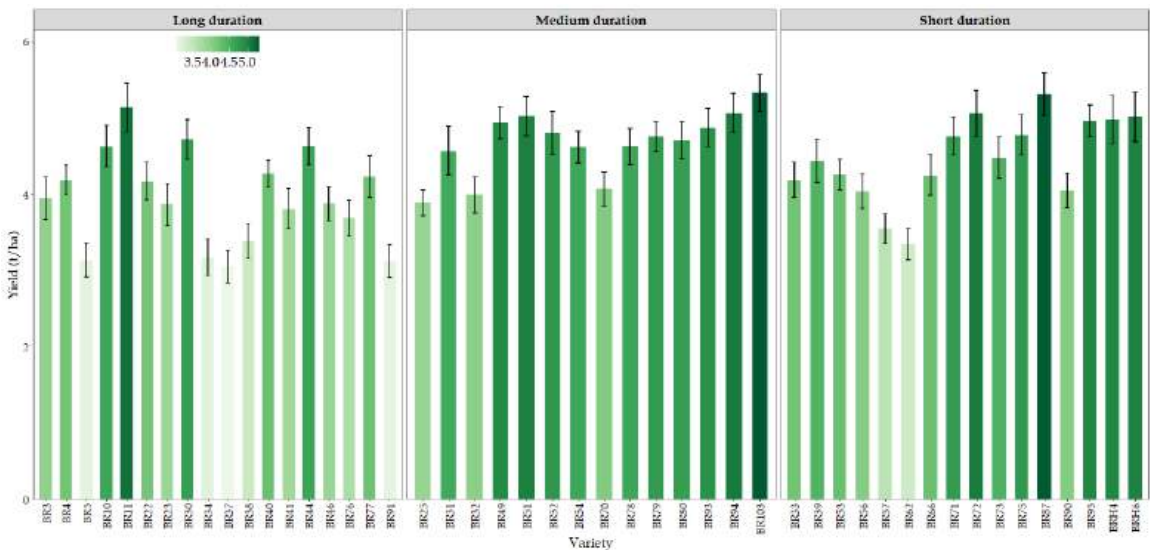


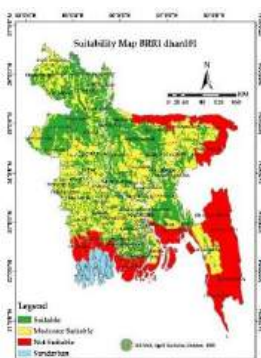
Fig. 3. Grain yield performance of BRRI released T. Aman rice varieties during 2023.

## MAINTENANCE OF RICE AND RELATED DATABASE

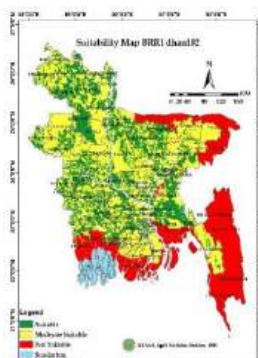
PI: M I H, CI: M A Q, M A A, M A A M and M A

Secondary data of rice and other important crops are collected periodically from Bangladesh Bureau of Statistics (BBS), Agricultural Marketing Directorate, Bangladesh Meteorological Department (BMD), Bangladesh Water Development Board (BWDB), Bangladesh Agricultural Development Corporation (BADC) and other sources periodically and recorded accordingly. Databases are being updated regularly and uploaded at BRRI website. Rice area increased about one and half folds but the production increased about four folds during 1971-72 to 2022-23. Although the growth rate of rice area was 3.96 in year 1972-73 but in 2022-23 is -0.005. Similarly, growth rate of rice production was 1.30 in year 1972-73 but in 2022-23 is 0.03.

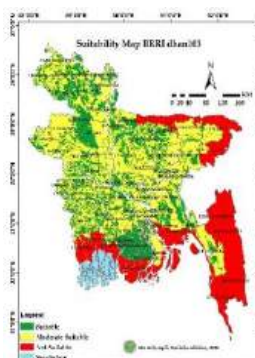
## SUITABILITY MAPPING OF BRRI RELEASED VARIETIES



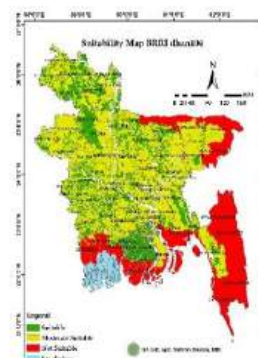
Map 1. Suitability map of BRRI dhan101.



Map 2. Suitability map of BRRI dhan102.



Map 3. Suitability map of BRRI dhan103.



Map 4. Suitability map of BRRI dhan104.

## CLIMATE MAPPING OF TEMPERATURE AND RAINFALL OF BANGLADESH

PI: M A A, CI: M A, M I H, M A Q and M A A M

Data on daily maximum and minimum temperature and rainfall of 42 weather stations of BMD for the year 2022 were used for the study. Year and station

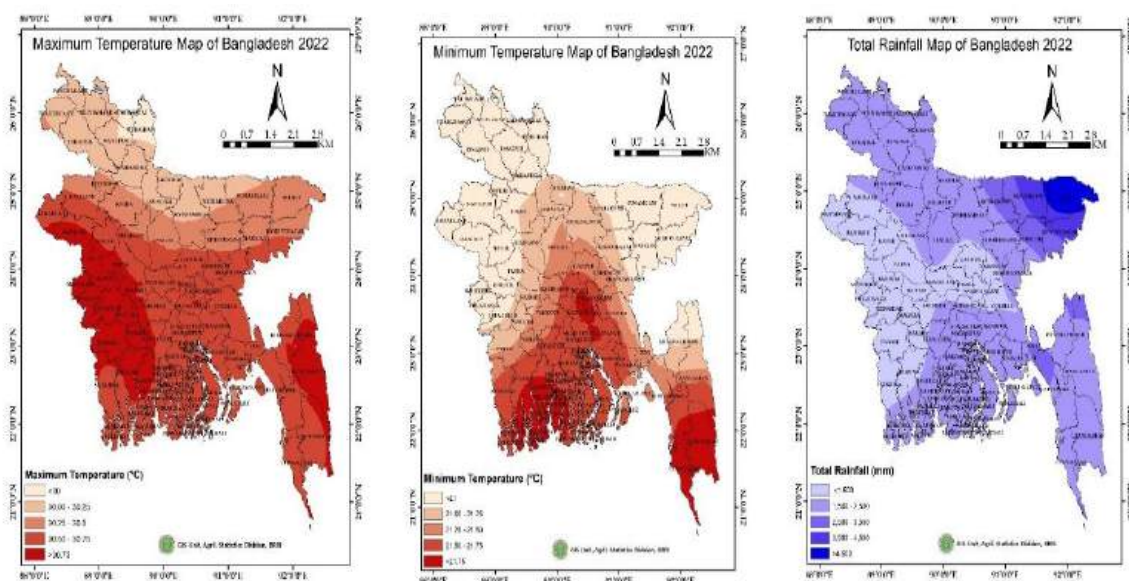
PI: M A A, CI: M A, B K, M I H, M A Q and M A A M

The objectives of the study were to construct edaphic suitability maps for newly released BRRI varieties and also find out variety wise suitable areas for production. Soil physical properties namely, land type, top soil texture, relief, soil consistency, soil moisture, soil permeability, soil reaction, soil salinity, drainage and slope were considered to determine areas suitable for growing respective rice varieties. So, proactivity will increase if we cultivate rice varieties according to their suitable area. In Boro season, suitable area for BRRI dhan101, BRRI dhan102 and BRRI dhan104 are more or less same. These varieties are mainly suitable in north-west part of Bangladesh. BRRI dhan102 is also suitable in all over the western part of Bangladesh. Map-1, 2 and 4 are showing suitability maps of BRRI dhan101, BRRI dhan102 and BRRI dhan104 respectively. In Aman season, BRRI dhan104 is appropriate for north-west and some part of central southern area. Map 3 shows the suitability map of BRRI dhan103.

wise maximum value of maximum temperature and minimum value of minimum temperature and total rainfall were determined. Then by using geo-statistical tools of Arc GIS10.8 software maps were prepared. In 2022, maximum temperature was high in central western part of Bangladesh and lower in

south-eastern and north-western regions. Map 5 shows the maximum temperature map of Bangladesh for 2022. Minimum temperature was lower in north-western and high was in eastern region. Map 6 shows the minimum temperature map

of Bangladesh for 2022. Total rainfall were the highest in north-east corner and south-east, lowest were central and western parts of Bangladesh. Map 7 shows the total rainfall sites of Bangladesh for 2022.



Map 5. Max.temp. of Bangladesh in 2022 Map 6. Min.temp. of Bangladesh in 2022 Map 7. Total rainfall of Bangladesh in 2022.

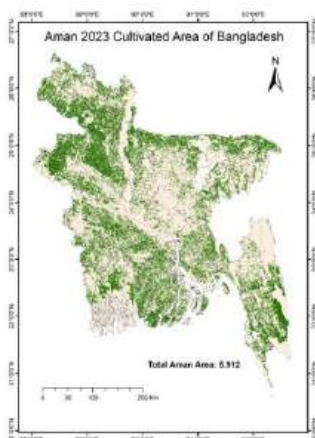
## SEASON WISE RICE AREA MAPPING OF BANGLADESH

PI: M A A, CI: M I H, M A Q and M A A M

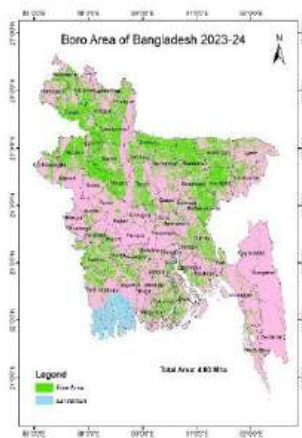
Remote sensing and GIS are considering as powerful tools for crop mapping, monitoring and yield forecasting. Identification of crop types and mapping are the first steps of satellite remote sensing-based crop monitoring and yield forecasting system. Satellite Images were collected from Moderate Resolution Imaging Spectroradiometer (MODIS) data portal of NASA. Time series and level 03 product image of Normalized Difference of Vegetation Index (NDVI), Effective vegetation index (EVI) and Land Surface Water Index (LSWI) were collected according to the respective rice

growing season. Whenever rice crop is initial stage i.e. transplanting time its vegetation index are very low and peak vegetative stage i.e. PI or booting stage its vegetation index are very high and in ripening or harvest time its vegetation index become again low. This algorithm was applied in agriculture area of Bangladesh and threshold value developed by ground truth data collected through GPS reading of various rice field all over the Bangladesh. Then Aman 2023 and Boro 2023-24 season rice map (Map 8 and 9) were prepared. The total area of rice grown in Aman in 2023 was about 5.91 Mha. The total area of rice grown in Boro in 2023-24 was about 4.93 Mha.





Map 8. Aman 2022 cultivated area map.



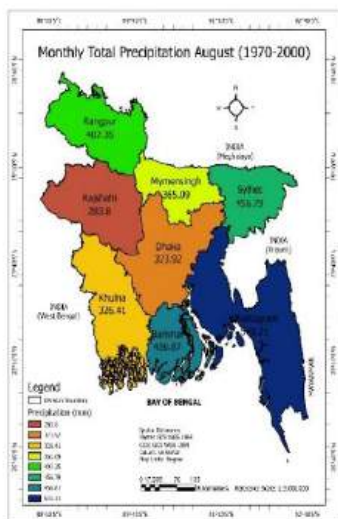
Map 9: Boro 2023-24 Area Map of Bangladesh.

## PROJECTED CLIMATIC FACTORS (2050) MAPS OF BANGLADESH

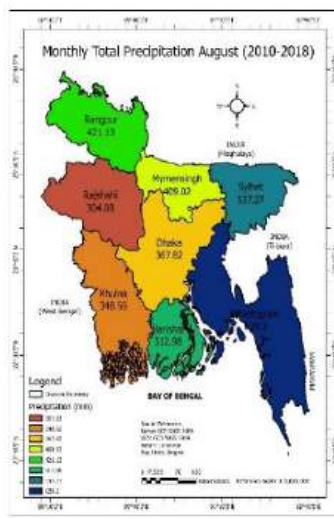
PI: M A A, CI: M I H, B K, N M F, M A Q and  
M A A M

In this study, we used the most recurrently used source of freely available, high resolution, downscaled, bias-corrected, and long-term climate raster dataset with global coverage, WORLDCLIM

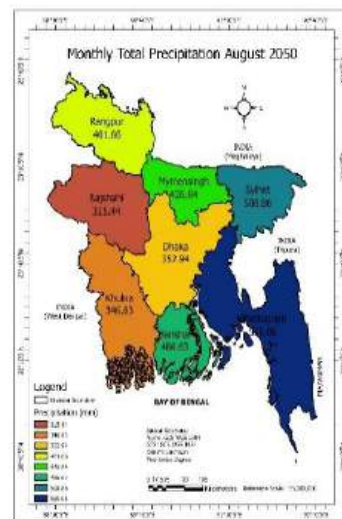
1.4, for past (1970-2000) and future (2040-2060 or 2050), its updated version 2.1 (Fick and Hijmans 2017) present (2010-2018) for precipitation. All the data are in raster with a high spatial resolution of 2.5 arc minutes. Whole country and division-wise precipitation map (Map 10 to 15) for the past (1970-2000), present (2000-2018) and future (2040-2060 or 2050) prepared using Arc GIS software.



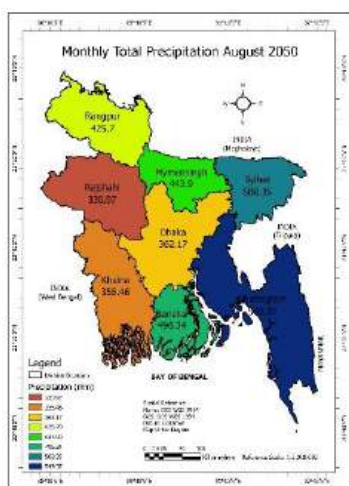
Map 10. August month average of total precipitation from 1970-2000.



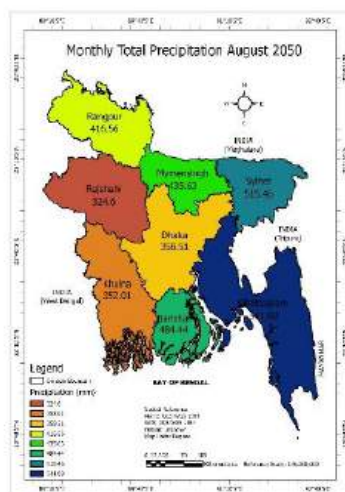
Map 11. August month average of total precipitation from 2010-2018.



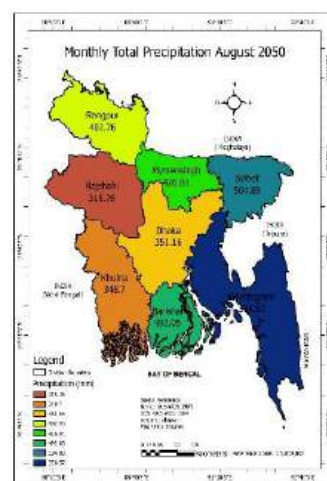
Map 12. August month average of total precipitation for the year 2050 according to RCP 2.6.



Map 13. August month average of total precipitation for the year 2050 according to RCP 4.5.



Map 14. August month average of total precipitation for the year 2050 according to RCP 6.0.



Map 15. August month average of total precipitation for the year 2050 according to RCP 6.0.

Average total precipitation (average by RCP 2.6, 4.5, 6.0, and 8.5 models) of Bangladesh of August month in 2050 will be decreased in comparison to average total precipitation of 2010-2018 period, only exceptions are Khulna, Rajshahi, Mymensingh divisions.

## SUITABILITY MAPPING OF VARIOUS CROPPING PATTERN

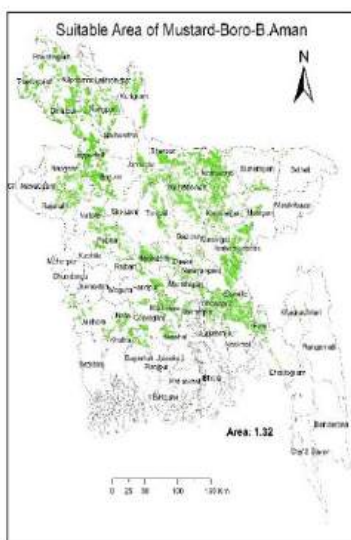
PI: M A A, CI: R A, BK, M I H, M A Q and M A A M

Cropping pattern is important in agricultural system. Various physical and chemical properties of soil varies spatially, on the other hand various cropping pattern are suitable for some specific physical condition. As we need to high production with limited land, so it will be very helpful if we have cropping pattern wise suitability map based on soil properties. Soil physical properties and climatic

parameter maps (shape file) were be considered to determine suitable growing area for particular cropping pattern. Arc GIS software were used to prepare suitability maps. The suitability scale category 1 to 3 will be assigned to each soil and climate characteristic in relation to particular cropping pattern cultivation by the recommendation of relevant expert. Suitable areas from different soil and climatic properties will be intersected. Finally, the suitability map were generated. Mustard-Fallow-T. Aman cropping pattern is suitable in north-west part of Bangladesh (Map 16) and total suitable area is 1.8 Mha. Mustard-Boro-B. Aman corriping pattern cover total suitable area 1.32 Mha and these suitable area in central side of Bangladesh (Map 17). Mustard-Jute-T. Aman is suitable in north-west and central northern sides of Bangladesh (Map 18) and total suitable area is 0.99 Mha.



Map 16. Suitability map of Mustard-Boro-T.Aman.



Map 17. Suitability Map of Mustard-Boro-B.Aman.



Map 18. Suitability Map of Mustard-Jute-T.Aman.

## RICE YIELD ESTIMATING USING UNMANNED AERIAL VEHICLES (UAV) DATA

PI: M A A, CI: M I H, M M M K, R A, A D, M A Q and M A A M

Using remote sensing and UAV data to estimate the crop yield is less expensive and time-consuming than alternative methods, and it is ideal for extensive and ongoing vegetation monitoring with the least amount of effort. Hence the objectives of this study are to develop a mathematical model between rice yield and UAV images and to develop a rice yield estimation model that takes less time, labour, and cost. A UAV were operated, to capture image over BRRI stability analysis plot various time in a rice season synchronizing the growth stage of the rice. Various vegetation indices like, NDVI, SAVI etc

were produced. We conducted some machine learning model like, Random-forest, Support Vector and Linear-regression and ensemble the models in google colab platform using python script, between NDVI and observed yield. Here, 80% data used as training sample and rest of the data were used for model validation. Finally, Validated the model. Among the Random-forest, Support Vector, Linear-regression and ensemble model mean square error (MSE) are 0.609, 0.690, 0.617 and 0.606 respectively, thus we have choosed ensemble model for yield prediction. Though among the random-forest, support vector, linear-regression and ensemble model we found ensemble model (Fig. 4) is the best fitted model for yield prediction but still it is not good fitted model. So, the study should be continue to improve the model.

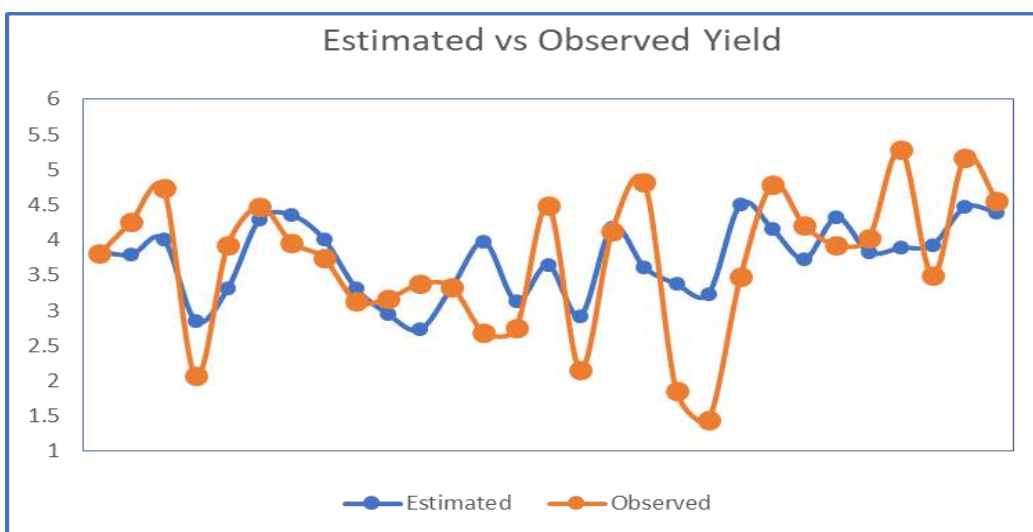


Fig. 4. Observed yield vs estimated yield by ensemble model.

#### DELINEATION OF RICE AREA CHANGES IN COSTAL AREA OF BANGLADESH USING REMOTE SENSING DATA AND MACHINE LEARNING APPROACH

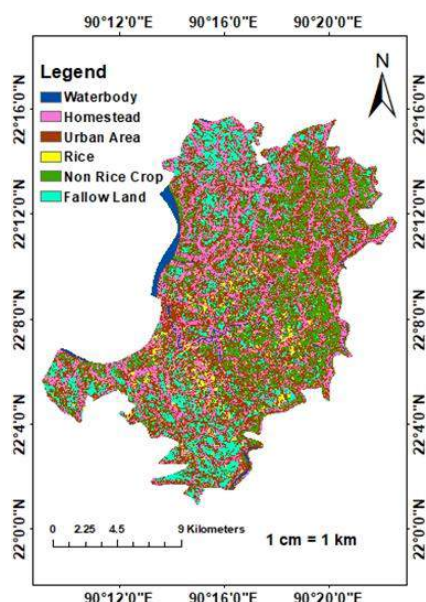
PI: M A A, CI: M I H, M M M K, R A, A D, M A Q and M A A M

The Rice Area of Bangladesh is not the same over time. Various environmental and socio-economic causes of the rice area vary over time. Moreover, recently governments have many interventions to increase the rice area, especially in coastal regions like the Barishal and Khulna divisions. Thus, it is important to know the effect of their programme through delineating the rice area changes over time. Amtali upazila is in the southeastern part of Barguna district of Bangladesh. For this study, Sentinel 2A, 10m spatial resolution satellite imagery data were utilized to assess the land use land cover (LULC) changes during the Boro season in Babuganj upazila of the Barishal district. In Bangladesh Boro rice is cultivated from December to May. In March Boro rice comes in peak vegetative stages i.e. maximum

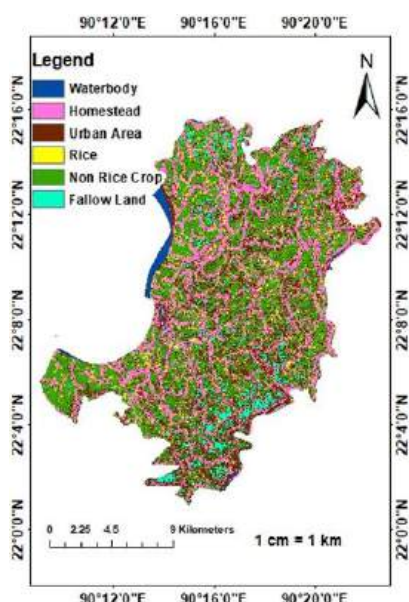
tillering/booting stages. The collected images were stacked together to form an RGB image, which was then utilised to produce a preliminary land use land cover map (LULC) for each year (2019 and 2023). To achieve more accurate and detailed classification, the images were analyzed and training data were produced based on colour, texture, tone, and structure, which allowed for the identification of different land cover types. Then maximum likelihood supervised image classification was used to prepare final land use land cover maps. From land use land cover map of 2019 and 2023 (Map 19 and 20) the land cover changes can be detected precisely. The Rice area has increased sufficiently in 2023.

The biggest change was in the area of non-rice crops, which increased by 113.72 percent. The second biggest change was in the area of rice, which increased by 71.98 percent. This is likely due to many factors, including the increasing demand for food, the expansion of irrigation systems, and the development of new agricultural technologies.





Map 19. Land use land cover of Babuganj upazila 2019 .



Map 20. Land Use land cover of Babuganj upazila 2022.

## CAPACITY BUILDING THROUGH TRAINING

PI: M I H, CI: M A A M, M A Q, N M F R and M A A

To set up the experiments, collecting, compiling, reporting, analyzing and presenting of the experimental data and increase the accuracy of the findings and developing skills on research two types of training programmes were conducted in 2023-24. The topics were planning experiments, problem data, field experimentation, experimental design, factorial experiment, CRD, RCBD, LSD, SPD, Strip PD, SSPD, Strip SPD and augmented design in the training of ‘Experimental Data Analysis’. Another topic was the ‘Experimental field layout, data collection and data preparation’ under this training programme.

A total of 60 participants were trained through the training programmes. Through the training on ‘Experimental Data Analysis’ 10 participants were trained. The participants were CSO, PSO, SSO and SO of BRRI. The second training programme was ‘Experimental field layout, data collection and data

preparation’. A total of 50 participants including FA, AFM and SA were trained through this training

## DEVELOP A DYNAMIC WEB APPLICATION FOR VISUALIZING AND ANALYZING THE RICE DISEASE SURVEILLANCE DATA

PI: M A Q CI: M I H, S M M R and scientists from Plant Pathology Division

Plant Pathology Division collect disease data through ODK (an online platform). We are engaged with Dr. Ashik Iqbal Khan, PSO, Plant Pathology Division for collecting the data in the online platform. Using this data, we want to develop a digital platform that visualize and analyze the data dynamically.

## Methodology and Software Development Progress

Developing of a web application integrating R/python and Batch Script (background software) with XAMPP server, MySQL Database, HTML, PHP, JQuery and JavaScript programming

languages is progress. The disease surveillance data will be used for this dynamic web application. The

system is not hosted yet. Fig. 5 shows the Home page, Menu bar with some views.

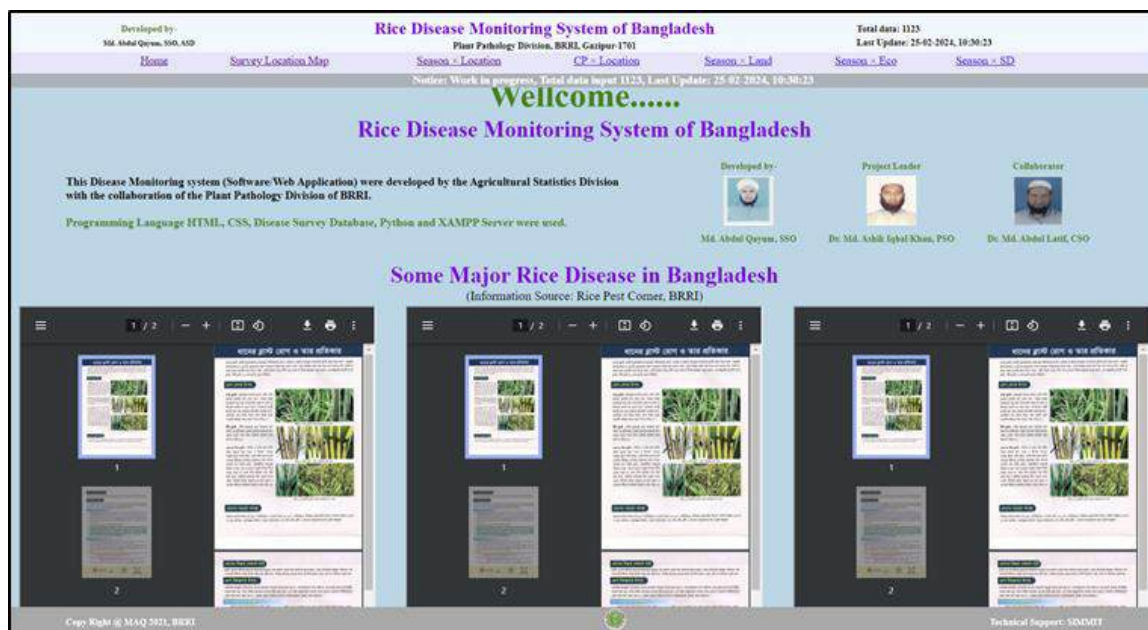


Fig. 5. Pictorial view of the visualizing and analyzing the rice disease surveillance data Software

## UPDATE THE WEB APPLICATION TO CALCULATE THE STABILITY INDEX FOR BRRI STABILITY MODEL

PI: M A Q CI: M I H, S M M R, M A A and M A A M

In the Genotype (Variety) development and release process Stability Analysis is one of the most important characteristics for the genotypes. Assuming this importance Agricultural Statistics Division of BRRI developed a Stability model that was a great achievement of the division. But the analysis procedure to find out the stability index of genotypes is very laborious and time consuming. We already developed a computer programme using R software to calculate the stability index for BRRI stability model and update the developed web application integrating R and Batch Script (background software) with XAMPP, HTML, PHP, JQuery and JavaScript. For using this web

application, user needs the arrangement of the data in the specific format to calculate the stability index for BRRI stability model. This software is not hosted yet.

## UPDATE THE PLATFORM FOR BBRI DEVELOPED MANAGEMENT INFORMATION SYSTEM (MIS)

PI: M A Q, CI: M I H and S M M R

BRRI developed many web applications such as (1) Salary Management System, Version (2) Labour Management System, Version (3) Budget Management Software (4) Quota Management Software (5) CL Application Management Software (6) Stability Analysis for BRRI Model Calculation Software (7) Rice Disease Monitoring System Software and (8) Tour Distance Calculation System Software. Also try to develop (9) Tour bill management system. All the above developed software hosted in different Servers with different

addresses. So sometime user face difficulty to find them. Also need more link to include in the BRRI website. So, the time demand to develop a unique platform for all the BRRI developed MIS Software. Under this activity we developed a unique platform for all the developed software so that one can easily find out and use their needed software.

## Methodology and Development Progress

This unique platform developed by using XAMPP, HTML, PHP, Javascript (JS) and JQuery. The platform is ready and host in the BRRI LAN (172.16.100.106/MIS\_BRRI). Fig. 6 shows screenshot of the unique platform.

### \*\*\* BRRI Developed MIS Platform \*\*\*

**These management information system (Software/Web Application) were directed by the Agricultural Statistics Division with the collaboration of the related Division/Section/Cell.**



**N.B.: These Software/Web Application access only within BRRI HQ Local Area Network (LAN) and the responsible person can access only the relevant software.**



Fig. 6: Pictorial view of the unique platform for BRRI developed all MIS Software.

## INFORMATION AND COMMUNICATION TECHNOLOGY (ICT) ACTIVITIES

### Smart profiling of rice varieties for disaster-prone zones of Bangladesh

The 'Rice Profile' mobile app is delivering the detailed information of suitable variety for selected areas using 'Select suitable rice variety' menu of 'Rice Profile' mobile app providing desired individual information of division, district and

upazila as input. Already we have included seven rice type information out of 17 rice type into the mobile app. We have also prepared location-specific map using remote sensing and GIS. It has a capacity to develop an easy comparison of the varieties for a specific environment and quickly picking up the preferred one (s). The information of 14 regions under DAE with districts and upazila of Bangladesh has also included (Fig. 7).



Fig. 7: Rice Profile mobile app.

### Sensor-based rice pest management through artificial intelligence (AI) technology of BRRI

BRRI Rice doctor mobile and web application already developed where BRRI released rice varieties, modern rice cultivation, insect and pest, disease and agricultural machinery technologies information has included. But it is an interactive tool for farmers, extension workers, scientists/researches, teachers, students and other users when the hi-tech will be initiated. It has introduced hi-tech solution through artificial

intelligence (AI) for controlling disease and insect by image analysis. This app got ‘Smart Bangladesh Award-2023’ by honourable Prime Minister under ICT Division as Govt.-technical-Group category. It’s automatically providing the necessary solutions to rice disease and pest related problem with proper management within one to one and a half minutes through AI and image analysis technology. It has already stored and trained approximately 10000 images of several disease and insect through AI and MLM technology (Fig. 8).



Fig. 8. Sensor-based rice pest management mobile app.



## Develop a new website for BRRI

A website is a collection of web pages and related content that is identified by a common domain name and published on at least one web server. Hyperlinking between web pages guides the navigation of the site, which often starts with a home page. Some websites require user registration or subscription to access the content. Examples of subscription websites include many business sites, news websites, academic journal websites, gaming websites, file-sharing websites, message boards, web-based email, social networking websites, websites providing real-time data, as well as sites

providing various other services. Bangladesh Rice Research Institute arranges national and international seminars and symposiums. Having a website makes it very easy for people to find information and also submit their papers, abstracts and posters for attaining national and international seminars and symposiums. They can read up about BRRI, discover what BRRI does, and answer a bunch of questions they have. By having a website people will be able to get information about BRRI when they search on a search engine like Google, Yahoo or Bing. The website has been used to get information and submit their papers, abstracts, posters and others (Fig. 9).



Fig. 9. New website for BRRI.

## “BRRI Alapon” Telephone Directory Mobile App

The BRRI Telephone Directory Mobile app named as ‘BRRI Alapon’ according to the monthly progress review meeting of innovation team since September’ 2020. This mobile app developed for BRRI officials to communicate with each other through this app like imo, Viber, Whatsup, WeChat etc. The app has features like chat, online calls, group messaging and location sharing. ‘BRRI Alapon’ available in Apple’s App Store (iStore) and Google play store for Android phone user. Anybody can call and exchange messages more securely using this app. App to app call, email and SMS is

completely free for user. Database already been developed for this app. All types of data have been collected from divisions, sections and regional stations of BRRI in developing the telephone directory mobile app.

## Vehicle requisition management system of BRRI

Vehicle requisition management system (VRMS) is a transportation pool management activity of BRRI are complex and updating the allottee individually in time which is tedious work. The designated official of Transport Division is needed to work after office to manage the official vehicle requests and to convey the confirmation to the requester and driver over the

phone. VRMS ease the allotment work using a simple requisition management system that doesn't require any advanced computing skills and the confirmation sent using SMS and email. So that, the requester informed through SMS on basis of demanding vehicle for official or personal purpose as well as driver get confirmation SMS for their upcoming duty. The database has already developed and architecture design has been finalized. The information of all vehicle of BRRI (driver's name, mobile number and vehicle reg. number etc.) has been collected from transport section.

### **BRRI Rice Doctor mobile and web app**

BRRI Rice doctor mobile and web application which is about rice varieties, modern rice cultivation practices, insect-pest and disease related dynamic diagnosis tools. It can also be useful for scientists, researchers, teachers, students and private input dealers. An English and Bengali version of Rice Doctor mobile apps and web apps has been developed to solve all the problems and solutions for rice cultivation. The apps also include a push notification and a Bangla text to speech option to facilitate users to view up-to-date information by sending text messages to specific problems. The 'Feedback' option has been added to provide the necessary advice to improve the quality of the app (Fig. 10).



Fig. 10. BRRI Rice Doctor mobile apps.

### **BRRI web portal management**

BRRI web portal ([www.portal.gov.bd](http://www.portal.gov.bd)) is developed, managed and updated by ICT Cell of Agricultural Statistics Division. BRRI web portal/website is being uploaded regularly by latest information. BRRI web portal is in Bangla and English languages. In this reporting year, we updated more than 1,365 pages and uploaded more than 6,643 pages and uploaded more than 6720 (six thousand seven hundred and twenty) documents like PDF, JPG, report, word and other files on the BRRI website.

### **BRRI networks update, maintenance and extension**

BRRI networks Facebook group is a big forum for all the scientists, officers and staffs of BRRI. ICT Cell created this Facebook group to post research related work for noble work of rice and related activities, various problems and their solutions, official interactions in this forum. The Facebook group of 'BRRI Network' link is <https://www.facebook.com/groups/1409267722690061/>. Thus, the BRRI Network is continuing with regular updating posted by everybody of this group. At present, more than 4,100 individuals have joined this group. It is increasing gradually. It has stored at least, 1200 and more photos of all national programme and research activities of BRRI head

quarter and all the regional stations. It has also uploaded around 240 necessary PDF and word file document for all the members.

### **Personal data sheet database**

We have created Personal data sheet (PDS) database for all scientists, officers, staffs as per requirement of the Ministry of Agriculture (MoA). It has been increased up to 339 users in the BRRI PDS database. In this reporting year, we have approved more than 2,437 information and general information also updated by personal user without help of admin approval. PDS database is updated regularly with the latest information.

### **ICT and related fair**

ICT Cell of Agricultural Statistics Division has been participated in several ICT and related fairs such as Digital World Fair, Development Fair, Tatha Mela and World Food Fair etc.

### **SUPPORT SERVICES**

The scientists of this division are also engaged in helping scientists of other disciplines in planning experiments, statistical data analysis and interpretation of results. Fifty-five different types of analyses were performed during the reporting period. A number of maps were prepared using GIS and supplied to the scientists of other divisions whenever required. Overall, ICT cell of Agricultural Statistics Division has taken initiative in accordance with government perspectives but BRRI Networks facebook group is first introduced among all National Agricultural Research System (NARS) and also first among all research institutes. The ICT Cell of Agricultural Statistics Division provides e-Nothi management system, e-Tender and other internet related support services to other divisions and sections.

## **Farm Management Division**

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## SUMMARY

Different kinds of research and development as well as management activities conducted by Farm Management Division can be discussed under three broad headings namely research, seed production and support services. Summary of these activities are described as follows-

An experiment was conducted at the West Byde of BRRI HQ farm, Gazipur during T. Aman 2023 season to find out the best planting time of fine rice varieties for higher yield and quality. In case of the tested fine rice varieties, 15 August transplanted plants produced the highest grain yield in BRRI dhan34 (3.45 t ha<sup>-1</sup>), BRRI dhan90 (4.84 t ha<sup>-1</sup>) and Binadhan-13 (3.27 t ha<sup>-1</sup>) followed by 30 August and 30 July transplanting and the lowest in 1 July transplanting.

A laboratory experiment was conducted at BRRI HQ, Gazipur in Farm Management division, Grain Quality and Nutrition division as well as BRRI Central laboratory from June 2023 to December 2023 to examine the effect of storage times in different container on quality of rice. In case of seed quality, germination percentage and seedling vigour index were decreased with increased storage times at different storage container but in grain quality, milling outturn (%), head rice recovery (%), milled rice length (mm), breadth (mm), cooking time (min) and moisture content (%) were increased with increased storage times at different storage container. Content of amylose (%) and protein (%) and alkali spreading value were decreased with increased storage times at different storage container. Vitamins (B-complex) were significantly different with different storage container at different storage times. Vitamins were decreased with increased storage times at different storage container.

The average wage rate per day (8.0 hrs) was Tk. 579-663 at different locations around BRRI HQ and regional stations by conducted a survey of

labourers' wage rate throughout the year. The highest wage rate of labourers was in May (Tk. 750-850 per day) due to harvesting and post-harvest operations of Boro rice and transplanting of Aus rice.

Farm Management division produced 14,406 kg TLS was produced in Aus, T. Aman and Boro seasons, respectively. In addition, 1,080 kg mixed rice were produced during this period.

In total 12,558 kg breeder seed was produced under the supervision of FMD during 2023-24.

In total 15,855 kg seed was distributed by FMD during the reporting period.

Including regional stations, BRRI had 668 labors of which 577 regular and 91 irregulars. In BRRI HQ, total number of laborers was 428 of which 380 regular and 91 irregular labors.

Total labour utilization in different divisions and sections of BRRI HQ was 1,93,370 man days of which 59.25 % and 40.75 % were utilized for research and support service, respectively.

In total Tk 11,10,47,190 was paid to the labourers as labour wage in which Tk 6,65,65,040 and Tk 4,44,82,150 were for research work, support service works, respectively.

Including regional stations of BRRI in total Tk 98, 09,273 was given to 17 labourers as financial benefits for retirement and also Tk 20,206 was given to 11 laborers as medical financial benefits for injury in working time during the fiscal year 2023-24.

BRRI has 284.40 ha of land of which 190.68 ha in research purposes, 51.44 ha in general cultivable and 42.28 ha in an office and residential area. In total 89.81 ha of land were utilized by different research divisions in different seasons at BRRI HQ.

This division manages the BRRI flower garden to maintain the aesthetic view. This division effectively carried out activities of mosquito control, graveyard management and playground

management and helped in other support services and management activities of BRRI.

#### DETAILED ACTIVITIES

The Farm Management Division (FMD) was established at the inception of BRRI in 1970. This division is one of the components of the Socio-economics and Policy Programme Area of BRRI and carries out research as well as management and support services for the institute, such as, HYV rice seed production (breeder seed and truthfully labelled seed), fixing of labour wages, weed management methods and economics, water management (irrigation and drainage), maintenance of the BRRI office premises and field management, garden management and beautification of BRRI office areas, graveyard management, land and labour management for smooth conduct of field research at BRRI etc.

#### RICE PRODUCTION MANAGEMENT

##### **Influence of different dates of transplanting on growth, yield performance and quality of fine rice varieties**

This experiment was conducted at the West Bye of BRRI farm, Gazipur during T. Aman 2023 season to find out the best planting time of fine rice varieties for higher yield and quality. The treatments were A. Transplanting dates:  $T_1 = 1$  July,  $T_2 = 15$  July,  $T_3 = 30$  July,  $T_4 = 15$  August,  $T_5 = 30$  August,  $T_6 = 15$  September; and B. Varieties:  $V_1 =$  BRRI dhan34,  $V_2 =$  BRRI dhan90 and  $V_3 =$  Binadhan-13. The treatments were distributed in strip-plot design with three replications (Transplanting dates in main plot and variety in sub plot) and spacing 20 cm  $\times$  20 cm. Twenty-day-old seedlings were transplanted on selected dates. All other intercultural operations were done as and when necessary. Yield and yield components data were taken at maturity stage. The collected data were analyzed using Statistix10 Software.

#### **Yield and Yield components in T. Aman**

Plant height and filled grain/panicles of tested varieties showed significant difference irrespective of transplanting date. The highest plant height was observed in 1 July transplanting of all tested varieties than the other transplanting dates (15 July, 30 July, 15 August, 30 August and 15 September) (Table 1). The highest number of panicles hill<sup>-1</sup> were found in BRRI dhan34, BRRI dhan90 and Binadhan-13 at 15 August transplanting followed by 30 August transplanting. The lowest was found in 1 July transplanting. The highest filled grain panicles<sup>-1</sup> were observed in BRRI dhan34, BRRI dhan90 and Binadhan-13 at 15 August transplanting and the lowest was in 1 July transplanting at all tested varieties (Table 1).

Transplanting of 15 August produced the highest grain yield in BRRI dhan34, BRRI dhan90 and Binadhan-13 followed by 30 August and 30 July transplanting and the lowest in 1 July transplanting. After 30 August and before 30 July the yield of all the tested fine rice varieties was decreasing. The highest harvest index (HI) was present in BRRI dhan34, BRRI dhan90 and Binadhan-13 at 30 August transplanting and the lowest in 1 July transplanting. The highest growth duration was present in 1 July transplanting in all the tested varieties and the lowest in 15 September. Binadhan-13 produced the highest growth durations in all transplanting dates followed by BRRI dhan34 and the lowest was in BRRI dhan90 (Table 2).

Milling outturn and head rice recovery percentage had significant differences of transplanting dates and varieties. BRRI dhan34 produced the highest milling outturn (72.56%) and head rice recovery percentage (67.82%) followed by BRRI dhan90 with 15 August transplanting. The lowest milling outturn and head rice recovery percentage were present in 15 July transplanting at all tested varieties especially Binadhan-13. 15 August transplanting, BRRI dhan34 produced the highest protein content (10.07%) than BRRI dhan90

(9.77%) and the lowest in Binadhan-13 at different transplanting dates (Table 3).

From the above results, it may be concluded that during T. Aman season, for tested fine rice varieties 30 July to 15 August transplanting produced statistically identical yield. Milling outturn (%), head rice (%) and protein content (%) produced higher in 30 July to 15 August transplanting.

### **Effect of storage times in different storage technologies on quality of rice**

The laboratory experiment was conducted at BRRi HQ, Gazipur in Farm Management division, Grain Quality and Nutrition Division and BRRi Central Laboratory from June 2023 to February 2024 to examine the effect of storage times in different container on quality of rice. For this purpose, we set up different storage times of fresh harvested paddy (0 month), 3, 6 and 9 months and different storage technologies of  $C_1$  = Plastic Container,  $C_2$  = Jute Sack,  $C_3$  = Plastic Bag,  $C_4$  = Motka and  $C_5$  = Grain Pro Bag. Samples were taken in 60 random treatments (3 replication  $\times$  4 storages time  $\times$  5 storage container) at 12% moisture content from BRRi dhan84 variety. The treatments were distributed in completely randomized design (CRD) with three replications. The un-parboiled paddy was used for this experiment. BRRi dhan84 would be stored in the five storage technologies and milling quality was assessed at every 3-month interval up to 9 months from storage time. The collected data were analyzed using R Software programmer.

Seed quality parameters i.e. germination percentage (GM %) and seedling vigour index (SVI) were significantly affected due to different storage times and technologies. The highest GM% (96.66) and SVI (14.87) were observed in Grain Pro Bag at three months storage time and the lowest (68% and 7.30) in Jute Sacks at nine months' storage times. GM% and SVI decreased with time of storage durations at different storage technologies (Table 4).

During storage time of rice, a number of physicochemical properties changes that causes impact on rice cooking and eating quality. However, the main components of rice like starch, protein and lipids remains unchanged during storage time and only structural changes take place along with change in flavours and texture. Fresh harvest paddy was found that initially milling outturn was 69.18% and head rice recovery was 58.88% (based on milled rice). After storage times, the highest milling outturn (68.79%) and head rice recovery (60.13%) were found in nine months' storage time at plastic container followed by grain pro bag, plastic bag and the lowest in jute sacks at different storage times (Fig. 1).

Amylose and protein content decreased with storage times at different storage technologies. The highest amylose content (26.99%) was present in Jute sack and protein content (8.7%) was present in Grain Pro Bag with three months' storage times. The lowest amylose and protein content were present in nine months' storage time at different storage technologies (Fig. 1).

Initially, fresh harvested milled rice alkali spreading value and cooking time were 5.1 and 18.00 minute. Alkali spreading value decreased with storage times at different storage technologies. Highest alkali spreading value was present in three months storage times at different storage technologies and the lowest in nine months storage times at different storage technologies. Cooking time increased with time storage durations at different storage technologies. The highest cooking time was found in nine months' storage times at different storage technologies and the lowest in three months' storage times at different storage technologies (Fig. 1).

Moisture content was significantly affected due to the different storage times and technologies. The highest moisture content was found in nine months' storage times at different storage technologies and the lowest in three months' storage durations at different storage technologies. The

results showed that good moisture content was maintained in plastic container followed by Grain Pro Bag and it was the lowest in Jute Sacks (Fig. 1).

Storage times increased with decreased vitamins B-complex at different storage technologies. The highest vitamins B1 (0.22 mg/100 g) and B2 (0.045 mg/100 g) were contained in plastic container at 3 months' storage time (Fig. 2).

Initially, fresh harvested milled rice vitamin B3 and B6 were contained 5.71 mg/100g and 0.26 mg/100g. The highest vitamin B3 (5.66 mg/100g) and B6 (0.25 mg/100g) were contained in plastic container at 3 months' storage time and the lowest (5.11 mg/100g and 0.21 mg/100g) in plastic bag at 9 months' storage time (Fig. 2).

The highest vitamin B9 (20 mg/100g) was contained in plastic container and Grain pro bag at three months storage times and the lowest (6 mg/100 g) in plastic bag at 9 months storage times (Fig. 2).

## LABOUR MANAGEMENT SYSTEM

### Monitoring labor wage rate at different locations of Bangladesh.

A survey was conducted throughout the year to find out the labourers' wage rate at different locations around BRRI HQ such as Joydebpur, Chowrasta, Salna, Board Bazar and Konabari, Tongi areas. It was observed that the average wage rate per day (8.0 hrs) was Tk 579-663. The highest wage rate of labourers was in May (Tk 750-850 per day) due to harvesting and post-harvest operations of Boro rice and transplanting of Aus rice. Another higher rate was during July-August (Tk 650-750) due to harvesting and post-harvest operations of Aus rice and transplanting of Aman rice. The third higher wage rate was observed during December-January (Tk 600-750 per day) due to the peak period for harvesting and post-harvest operation of T. Aman rice and transplanting of Boro rice. The highest wage rate with food was observed in Cumilla and Barishal

(650-750 Tk per day) followed by Bhanga and Rajshahi (650-700 Tk per day).

## RICE SEED PRODUCTION

### Performance of different rice varieties in seed production plots during 2023-24

In total 5, 16 and 9 varieties were cultivated in BRRI research field for the purpose of TLS production during Aus, T. Aman and Boro seasons, respectively in 2023-24. The varieties were harvested at 80-90% maturity and yields ( $t\ ha^{-1}$ ) were adjusted to 14% moisture content. Yield of the varieties ranged from  $3.82\ t\ ha^{-1}$  to  $5.26\ t\ ha^{-1}$ ,  $2.61\ t\ ha^{-1}$  to  $6.15\ t\ ha^{-1}$  and  $6.12\ t\ ha^{-1}$  to  $8.42\ t\ ha^{-1}$  in Aus, T. Aman and Boro varieties, respectively. Among the Aus varieties, BRRI dhan98 produced the highest yield ( $5.26\ t\ ha^{-1}$ ) where as BRRI dhan87 produced the highest yield ( $6.15\ t\ ha^{-1}$ ) in T. Aman followed by BRRI dhan103 ( $6.11\ t\ ha^{-1}$ ) and BRRI dhan89 produced the highest yield ( $8.42\ t\ ha^{-1}$ ) in Boro season followed by BRRI dhan29 ( $7.21\ t\ ha^{-1}$ ) (Table 5).

### Truthfully Labeled Seed (TLS) and Breeder Seed Production

In different rice seasons of the reporting period, FMD produced about 14,406 kg TLS (Table 6) and total 12,558 kg breeder seed (Table 7).

### Seed Distribution

For popularizing and dissemination of BRRI rice varieties, 15,855 kg truthfully labeled seed was distributed by FMD during the reporting period. In total 3992, 4,568 and 7,295 kg seeds were distributed during Aus, T. Aman and Boro seasons, respectively. These seeds were distributed to DAE, researchers, different research divisions and regional stations of BRRI, seed producers, different agricultural organizations and agencies, BRRI employees and also farmers.

## SUPPORT SERVICES

FMD carries out research as well as management and support services for the institute, such as, HYV rice seed production (breeder seed and truthfully labelled seed), fixing of labour wages, weed management methods and economics, water

management (irrigation and drainage), maintenance of the BRRI office premises and field management, garden management and beautification of BRRI office areas, graveyard management, land and labour management for smooth conduct of field research at BRRI etc. (Table 8-12).

**Table 1. Effect of transplanting dates and varieties on plant height (cm), number of panicles hill<sup>-1</sup> and filled grain panicles<sup>-1</sup> in T. Aman 2023 at BRRI HQ farm, Gazipur.**

| Variety           | Plant height (cm)                     |        |        |        |        |        |
|-------------------|---------------------------------------|--------|--------|--------|--------|--------|
|                   | Transplanting dates                   |        |        |        |        |        |
|                   | 1 Jul                                 | 15 Jul | 30 Jul | 15 Aug | 30 Aug | 15 Sep |
| BRRI dhan34       | 144.67                                | 136.67 | 134.33 | 123.67 | 114.00 | 111.67 |
| BRRI dhan90       | 112.00                                | 111.00 | 110.67 | 110.33 | 110.00 | 110.00 |
| Binadhan-13       | 157.33                                | 155.67 | 155.00 | 154.33 | 153.33 | 152.67 |
| LSD (0.05)        | 3.10                                  | 3.10   | 3.10   | 3.10   | 3.10   | 3.10   |
| CV (Variety)      | 0.66                                  | 0.66   | 0.66   | 0.66   | 0.66   | 0.66   |
| CV (Time)         | 0.59                                  | 0.59   | 0.59   | 0.59   | 0.59   | 0.59   |
| CV (variety*Time) | 0.77                                  | 0.77   | 0.77   | 0.77   | 0.77   | 0.77   |
|                   | Number of panicles hill <sup>-1</sup> |        |        |        |        |        |
|                   |                                       |        |        |        |        |        |
|                   |                                       |        |        |        |        |        |
| BRRI dhan34       | 7.50                                  | 8.00   | 8.58   | 9.66   | 9.58   | 9.25   |
| BRRI dhan90       | 8.08                                  | 8.75   | 9.00   | 9.33   | 9.00   | 8.25   |
| Binadhan-13       | 7.90                                  | 8.41   | 8.50   | 9.33   | 8.25   | 7.83   |
| LSD (0.05)        | 3.85                                  | 3.85   | 3.85   | 3.85   | 3.85   | 3.85   |
| CV (Variety)      | 13.12                                 | 13.12  | 13.12  | 13.12  | 13.12  | 13.12  |
| CV (Time)         | 12.85                                 | 12.85  | 12.85  | 12.85  | 12.85  | 12.85  |
| CV (variety*Time) | 11.74                                 | 11.74  | 11.74  | 11.74  | 11.74  | 11.74  |
|                   | Filled grain panicles <sup>-1</sup>   |        |        |        |        |        |
|                   |                                       |        |        |        |        |        |
|                   |                                       |        |        |        |        |        |
| BRRI dhan34       | 173.44                                | 174.22 | 200.22 | 216.96 | 197.03 | 141.32 |
| BRRI dhan90       | 267.94                                | 272.77 | 288.77 | 294.37 | 239.12 | 233.55 |
| Binadhan-13       | 102.24                                | 114.22 | 115.59 | 116.39 | 115.85 | 98.02  |
| LSD (0.05)        | 57.01                                 | 57.01  | 57.01  | 57.01  | 57.01  | 57.01  |
| CV (Variety)      | 7.20                                  | 7.20   | 7.20   | 7.20   | 7.20   | 7.20   |
| CV (Time)         | 10.18                                 | 10.18  | 10.18  | 10.18  | 10.18  | 10.18  |
| CV (variety*Time) | 8.13                                  | 8.13   | 8.13   | 8.13   | 8.13   | 8.13   |

**Table 2. Effect of transplanting dates and varieties on grain yield (t ha<sup>-1</sup>), harvest index (%) and growth duration in T. Aman 2023 at BRRI HQ farm, Gazipur.**

| Variety           | Grain yield (t ha <sup>-1</sup> ) |        |        |        |        |        |
|-------------------|-----------------------------------|--------|--------|--------|--------|--------|
|                   | Transplanting dates               |        |        |        |        |        |
|                   | 1 Jul                             | 15 Jul | 30 Jul | 15 Aug | 30 Aug | 15 Sep |
| BRRI dhan34       | 3.15                              | 3.31   | 3.34   | 3.45   | 3.40   | 3.39   |
| BRRI dhan90       | 4.56                              | 4.70   | 4.80   | 4.84   | 4.74   | 4.44   |
| Binadhan-13       | 2.56                              | 2.87   | 3.03   | 3.27   | 3.24   | 2.98   |
| LSD (0.05)        | 0.68                              | 0.68   | 0.68   | 0.68   | 0.68   | 0.68   |
| CV (Variety)      | 4.40                              | 4.40   | 4.40   | 4.40   | 4.40   | 4.40   |
| CV (Time)         | 6.09                              | 6.09   | 6.09   | 6.09   | 6.09   | 6.09   |
| CV (variety*Time) | 5.20                              | 5.20   | 5.20   | 5.20   | 5.20   | 5.20   |
| Variety           | Harvest index (%)                 |        |        |        |        |        |
|                   | Transplanting dates               |        |        |        |        |        |
|                   | 1 Jul                             | 15 Jul | 30 Jul | 15 Aug | 30 Aug | 15 Sep |
| BRRI dhan34       | 0.38                              | 0.39   | 0.38   | 0.39   | 0.40   | 0.38   |
| BRRI dhan90       | 0.42                              | 0.42   | 0.42   | 0.41   | 0.48   | 0.45   |
| Binadhan-13       | 0.32                              | 0.35   | 0.37   | 0.39   | 0.39   | 0.35   |
| LSD (0.05)        | 0.04                              | 0.04   | 0.04   | 0.04   | 0.04   | 0.04   |
| CV (Variety)      | 3.16                              | 3.16   | 3.16   | 3.16   | 3.16   | 3.16   |
| CV (Time)         | 3.75                              | 3.75   | 3.75   | 3.75   | 3.75   | 3.75   |
| CV (variety*Time) | 3.20                              | 3.20   | 3.20   | 3.20   | 3.20   | 3.20   |
| Variety           | Growth durations                  |        |        |        |        |        |
|                   | Transplanting dates               |        |        |        |        |        |
|                   | 1 Jul                             | 15 Jul | 30 Jul | 15 Aug | 30 Aug | 15 Sep |
| BRRI dhan34       | 160.33                            | 151.67 | 134.00 | 123.33 | 120.67 | 116.33 |
| BRRI dhan90       | 132.67                            | 116.00 | 112.33 | 110.67 | 109.67 | 109.00 |
| Binadhan-13       | 178.33                            | 164.67 | 148.33 | 135.00 | 129.00 | 121.33 |
| LSD (0.05)        | 1.37                              | 1.37   | 1.37   | 1.37   | 1.37   | 1.37   |
| CV (Variety)      | 0.55                              | 0.55   | 0.55   | 0.55   | 0.55   | 0.55   |
| CV (Time)         | 0.30                              | 0.30   | 0.30   | 0.30   | 0.30   | 0.30   |
| CV (variety*Time) | 0.32                              | 0.32   | 0.32   | 0.32   | 0.32   | 0.32   |

**Table 3. Effect of transplanting dates and varieties on grain qualities in T. Aman fine rice varieties 2023 at BRRI HQ farm, Gazipur.**

| Variety           | Grain quality       |        |        |        |        |        |
|-------------------|---------------------|--------|--------|--------|--------|--------|
|                   | Milling outturn (%) |        |        |        |        |        |
|                   | 1 Jul               | 15 Jul | 30 Jul | 15 Aug | 30 Aug | 15 Sep |
| BRRI dhan34       | 72.36               | 72.38  | 72.51  | 72.56  | 72.38  | 71.20  |
| BRRI dhan90       | 68.92               | 69.90  | 70.20  | 70.61  | 69.97  | 69.22  |
| Binadhan-13       | 68.89               | 68.39  | 69.04  | 69.80  | 68.24  | 67.96  |
| LSD (0.05)        | 1.31                | 1.31   | 1.31   | 1.31   | 1.31   | 1.31   |
| CV (Variety)      | 0.62                | 0.62   | 0.62   | 0.62   | 0.62   | 0.62   |
| CV (Time)         | 0.51                | 0.51   | 0.51   | 0.51   | 0.51   | 0.51   |
| CV (variety*Time) | 0.58                | 0.58   | 0.58   | 0.58   | 0.58   | 0.58   |
| Variety           | Head rice (%)       |        |        |        |        |        |
|                   | Transplanting dates |        |        |        |        |        |
|                   | 1 Jul               | 15 Jul | 30 Jul | 15 Aug | 30 Aug | 15 Sep |
| BRRI dhan34       | 66.45               | 66.91  | 67.69  | 67.82  | 67.65  | 66.05  |

| Variety           | Grain quality       |        |        |        |        |        |
|-------------------|---------------------|--------|--------|--------|--------|--------|
|                   | Milling outturn (%) |        |        |        |        |        |
|                   | 1 Jul               | 15 Jul | 30 Jul | 15 Aug | 30 Aug | 15 Sep |
| BRRi dhan90       | 65.63               | 67.16  | 67.69  | 67.45  | 66.53  | 66.51  |
| Binadhan-13       | 54.04               | 54.68  | 55.48  | 55.90  | 55.49  | 55.08  |
| LSD (0.05)        | 1.99                | 1.99   | 1.99   | 1.99   | 1.99   | 1.99   |
| CV (Variety)      | 0.84                | 0.84   | 0.84   | 0.84   | 0.84   | 0.84   |
| CV (Time)         | 1.15                | 1.15   | 1.15   | 1.15   | 1.15   | 1.15   |
| CV (variety*Time) | 0.78                | 0.78   | 0.78   | 0.78   | 0.78   | 0.78   |
|                   | Protein content (%) |        |        |        |        |        |
|                   | BRRi dhan34         | 10.01  | 10.05  | 10.06  | 10.07  | 9.96   |
|                   | BRRi dhan90         | 9.75   | 9.76   | 9.76   | 9.77   | 9.66   |
|                   | Binadhan-13         | 8.21   | 8.22   | 8.40   | 8.62   | 8.43   |
|                   | LSD (0.05)          | 0.32   | 0.32   | 0.32   | 0.32   | 0.32   |
|                   | CV (Variety)        | 1.60   | 1.60   | 1.60   | 1.60   | 1.60   |
|                   | CV (Time)           | 0.74   | 0.74   | 0.74   | 0.74   | 0.74   |
|                   | CV (variety*Time)   | 1.15   | 1.15   | 1.15   | 1.15   | 1.15   |

**Table 4. Seed quality of rice at different storage times and storage technologies**

| ST                  | Seed quality           |                |                |                |                |                |                               |                |                |                |                |                |
|---------------------|------------------------|----------------|----------------|----------------|----------------|----------------|-------------------------------|----------------|----------------|----------------|----------------|----------------|
|                     | Germination (%)        |                |                |                |                |                | Seedling Vigor Index (10 DAS) |                |                |                |                |                |
|                     | Storage Container (SC) |                |                |                |                |                |                               |                |                |                |                |                |
|                     | C <sub>0</sub>         | C <sub>1</sub> | C <sub>2</sub> | C <sub>3</sub> | C <sub>4</sub> | C <sub>5</sub> | C <sub>0</sub>                | C <sub>1</sub> | C <sub>2</sub> | C <sub>3</sub> | C <sub>4</sub> | C <sub>5</sub> |
| FH                  | 93                     | -              | -              | -              | -              | -              | 12.51                         | -              | -              | -              | -              | -              |
| 3M                  | -                      | 93             | 84.33          | 86.66          | 88             | 96.66          | -                             | 12.58          | 10.89          | 12.41          | 12.42          | 14.87          |
| 6M                  | -                      | 91             | 81             | 84             | 85             | 92             | -                             | 12.45          | 10.86          | 12.23          | 11.87          | 12.95          |
| 9M                  | -                      | 86             | 68             | 76             | 82.66          | 85.66          | -                             | 9.62           | 7.30           | 9.54           | 9.57           | 10.09          |
| lsd <sub>0.05</sub> | 1.95                   |                |                |                |                |                | 0.23                          |                |                |                |                |                |
| cv (%)              | 1.38                   |                |                |                |                |                | 1.24                          |                |                |                |                |                |

ST = Storage time, SC = Storage container, FH = Fresh harvested, M = Month C<sub>0</sub> = No container, C<sub>1</sub> = Plastic container, C<sub>2</sub> = Jute sacks, C<sub>3</sub> = Plastic bag, C<sub>4</sub> = Motka and C<sub>5</sub> = Grain pro bag

**Table 5. Yield response of different BRRi varieties in TLS production plot of FMD during 2023-2024 season.**

| Variety      | Plant Height (cm) | Tiller m <sup>-2</sup> (no.) | Grain panicle <sup>-1</sup> (no.) | TGW (g) | Yield (t ha <sup>-1</sup> ) |
|--------------|-------------------|------------------------------|-----------------------------------|---------|-----------------------------|
| Aus 2023     |                   |                              |                                   |         |                             |
| BRRi dhan48  | 112               | 298                          | 81                                | 23.94   | 4.19                        |
| BRRi dhan82  | 116               | 221                          | 92                                | 23.19   | 3.82                        |
| BRRi dhan83  | 109               | 243                          | 76                                | 23.51   | 4.10                        |
| BRRi dhan98  | 106               | 304                          | 96                                | 22.87   | 5.26                        |
| BRRi dhan106 | 127               | 299                          | 91                                | 24.45   | 4.92                        |
| T. Aman 2023 |                   |                              |                                   |         |                             |
| BR22         | -                 | 209                          | 133                               | 20.23   | 4.83                        |
| BE23         | -                 | 226                          | 149                               | 26.28   | 5.89                        |
| BRRi dhan34  | -                 | 211                          | 123                               | 11.24   | 2.61                        |
| BRRi dhan46  | -                 | 247                          | 99                                | 20.11   | 5.19                        |
| BRRi dhan51  | -                 | 235                          | 148                               | 23.95   | 4.45                        |
| BRRi dhan52  | -                 | 267                          | 158                               | 24.34   | 5.02                        |

| Variety        | Plant Height<br>(cm) | Tiller m <sup>-2</sup><br>(no.) | Grain panicle <sup>-1</sup><br>(no.) | TGW<br>(g) | Yield<br>(t ha <sup>-1</sup> ) |
|----------------|----------------------|---------------------------------|--------------------------------------|------------|--------------------------------|
| BRRi dhan70    | -                    | 245                             | 103                                  | 19.6       | 4.23                           |
| BRRi dhan71    | -                    | 233                             | 141                                  | 17.65      | 3.89                           |
| BRRi dhan79    | -                    | 208                             | 116                                  | 24.21      | 5.15                           |
| BRRi dhan80    | -                    | 253                             | 99                                   | 23.93      | 4.23                           |
| BRRi dhan87    | -                    | 334                             | 151                                  | 24.56      | 6.15                           |
| BRRi dhan90    | -                    | 238                             | 297                                  | 11.36      | 5.36                           |
| BRRi dhan93    | -                    | 125                             | 154                                  | 20.43      | 4.86                           |
| BRRi dhan94    | -                    | 132                             | 156                                  | 21.22      | 5.09                           |
| BRRi dhan95    | -                    | 172                             | 139                                  | 21.25      | 6.04                           |
| BRRi dhan103   | -                    | 256                             | 162                                  | 23.85      | 6.11                           |
| Boro 2023-2024 |                      |                                 |                                      |            |                                |
| BRRi dhan28    | 94                   | 312                             | 107                                  | 21.92      | 6.47                           |
| BRRi dhan29    | 98                   | 281                             | 123                                  | 23.11      | 7.21                           |
| BRRi dhan50    | 83                   | 279                             | 97                                   | 19.11      | 6.12                           |
| BRRi dhan67    | 105                  | 281                             | 112                                  | 21.93      | 6.54                           |
| BRRi dhan81    | 96                   | 277                             | 114                                  | 23.68      | 6.97                           |
| BRRi dhan84    | 100                  | 322                             | 119                                  | 23.00      | 6.64                           |
| BRRi dhan88    | 102                  | 334                             | 108                                  | 23.98      | 6.93                           |
| BRRi dhan89    | 109                  | 316                             | 115                                  | 24.34      | 8.42                           |
| BRRi dhan105   | 103                  | 316                             | 131                                  | 24.98      | 6.90                           |
| Certified      |                      |                                 |                                      |            |                                |

**Table 6. TLS production of different rice varieties during 2023-2024.**

| Variety     | Season |         |      | Total (kg) |
|-------------|--------|---------|------|------------|
|             | Aus    | T. Aman | Boro |            |
| BR22        | -      | 490     | -    | 490        |
| BR23        | -      | 495     | -    | 495        |
| BRRi dhan28 | -      | -       | 302  | 302        |
| BRRi dhan29 | -      | -       | 205  | 205        |
| BRRi dhan34 | -      | 300     | -    | 300        |
| BRRi dhan46 | -      | 243     | -    | 243        |
| BRRi dhan48 | 270    | -       | -    | 270        |
| BRRi dhan50 | -      | -       | 410  | 410        |
| BRRi dhan51 | -      | 470     | -    | 470        |
| BRRi dhan52 | -      | 385     | -    | 385        |
| BRRi dhan67 | -      | -       | 230  | 230        |
| BRRi dhan70 | -      | 160     | -    | 160        |
| BRRi dhan71 | -      | 340     | -    | 340        |
| BRRi dhan79 | -      | 310     | -    | 310        |
| BRRi dhan80 | -      | 60      | -    | 60         |
| BRRi dhan81 | -      | -       | 180  | 180        |
| BRRi dhan82 | 195    | -       | -    | 195        |
| BRRi dhan83 | 365    | -       | -    | 365        |
| BRRi dhan84 | -      | -       | 350  | 350        |
| BRRi dhan87 | -      | 130     | -    | 130        |
| BRRi dhan88 | -      | -       | 890  | 890        |
| BRRi dhan89 | -      | -       | 850  | 850        |
| BRRi dhan90 | -      | 320     | -    | 320        |
| BRRi dhan92 | -      | -       | 300  | 300        |
| BRRi dhan93 | -      | 108     | -    | 108        |
| BRRi dhan94 | -      | 102     | -    | 102        |
| BRRi dhan95 | -      | 95      | -    | 95         |



| Variety           | Season   |          |          | Total (kg) |
|-------------------|----------|----------|----------|------------|
|                   | Aus      | T. Aman  | Boro     |            |
| BRRI dhan96       | -        | -        | 240      | 240        |
| BRRI dhan98       | 2585     | -        | -        | 2585       |
| BRRI dhan103      | -        | 605      | -        | 605        |
| BRRI dhan106      | 500      | -        | -        | 500        |
| BRRI dhan107      | -        | -        | 841      | 841        |
| Seed (total) (kg) | 3,915    | 4,613    | 4,798    | 13,326     |
| Non seed (kg)     | -        | -        | -        | -          |
| Mixed rice (kg)   | 280      | -        | 800      | 1080       |
| Grand total(kg)   | 4,195 kg | 4,613 kg | 5,598 kg | 14,406 kg  |

**Table 7. Breeder seed production of different varieties during 2023-2024.**

| Variety             | Season |         |         | Total (kg) |
|---------------------|--------|---------|---------|------------|
|                     | Aus    | T. Aman | Boro    |            |
| BRRI dhan30         | -      | 580     | -       | 580        |
| BRRI dhan75         | -      | 1,813   | -       | 1,813      |
| BRRI dhan98         | -      | 3,320   | -       | 3,320      |
| BRRI dhan92         | -      | -       | 2,776   | 2,776      |
| Bangabandhu dhan100 | -      | -       | 4,069   | 4,069      |
| Total (kg)          | -      | 5,713kg | 6,845kg | 12,558 kg  |

**Table 8. Land and labour strength of BRRI, in the date of 1 July 2023.**

| Stations<br>Name    | Total<br>Land<br>(Ha) | Research<br>purposes<br>Land (Ha) | General<br>cultivable<br>land (ha) | Office &<br>residential<br>land (Ha) | Labour (No.) |    |       |           |    |       | Total |
|---------------------|-----------------------|-----------------------------------|------------------------------------|--------------------------------------|--------------|----|-------|-----------|----|-------|-------|
|                     |                       |                                   |                                    |                                      | Regular      |    |       | Irregular |    |       |       |
|                     |                       |                                   |                                    |                                      | M            | F  | Total | M         | F  | Total |       |
| BRRI HQ,<br>Gazipur | 76.83                 | 55.00                             | 9.83                               | 12.00                                | 309          | 71 | 380   | 38        | 10 | 48    | 428   |
| Cumilla             | 24.68                 | 18.95                             | 3.00                               | 2.73                                 | 12           | 1  | 13    | 9         | 1  | 10    | 23    |
| Habiganj            | 35.03                 | 20.03                             | 9.00                               | 6.00                                 | 19           | 2  | 21    | 11        | 0  | 11    | 32    |
| Sonagazi            | 45.77                 | 31.22                             | 10.50                              | 4.05                                 | 31           | 2  | 33    | 2         | 0  | 2     | 35    |
| Barishal            | 39.17                 | 27.59                             | 8.60                               | 2.98                                 | 18           | 3  | 33    | 2         | 0  | 2     | 35    |
| Rajshahi            | 13.24                 | 6.00                              | 2.00                               | 5.24                                 | 21           | 3  | 24    | 4         | 0  | 4     | 28    |
| Bhanga              | 11.46                 | 8.04                              | 2.00                               | 1.42                                 | 16           | 2  | 18    | 1         | 0  | 1     | 18    |
| Rangpur             | 6.07                  | 3.34                              | 0.50                               | 2.23                                 | 29           | 2  | 31    | 3         | 0  | 3     | 34    |
| Satkhira            | 20.00                 | 12.86                             | 4.51                               | 2.63                                 | 20           | 1  | 21    | 3         | 0  | 3     | 34    |
| Kushtia             | 4.05                  | 2.55                              | 0.50                               | 1.00                                 | 10           | 0  | 10    | 0         | 0  | 0     | 10    |
| Sirajganj           | 4.05                  | 2.55                              | 0.50                               | 1.00                                 | 4            | 0  | 4     | 5         | 1  | 6     | 10    |
| Gopalganj           | 4.05                  | 2.55                              | 0.50                               | 1.00                                 | 1            | 0  | 1     | 4         | 0  | 4     | 5     |
| Total               | 284.4                 | 190.68                            | 51.44                              | 42.28                                | 490          | 87 | 577   | 79        | 12 | 91    | 668   |

M = Male, F = Female

**Table 9. Division wise labour utilization, wages and land utilization**

| Division                                      | Number of labour days<br>utilized |                   | Wages             | Land area used (ha) |         |       |       |
|-----------------------------------------------|-----------------------------------|-------------------|-------------------|---------------------|---------|-------|-------|
|                                               | Total                             | Percentage<br>(%) | Incurred<br>(Tk.) | Aus                 | T. Aman | Boro  | Total |
| (A) Research                                  |                                   |                   |                   |                     |         |       |       |
| Plant Breeding                                | 15368                             | 7.95              | 9007450           | 2.38                | 13.09   | 12.02 | 27.49 |
| Hybrid Rice                                   | 6910                              | 3.57              | 4081350           | 3.72                | 4.61    | 3     | 11.33 |
| Biotechnology                                 | 5793                              | 3.00              | 3412300           | 0.42                | 0.82    | 0.77  | 2.01  |
| Genetic Resources and<br>Seed                 | 8290                              | 4.29              | 4882925           | 1.22                | 6.2     | 5.88  | 13.3  |
| Entomology                                    | 5232                              | 2.71              | 2818650           | 1.2                 | 1.42    | 1.17  | 3.79  |
| Plant Pathology                               | 3963                              | 2.05              | 2299475           | -                   | 1.45    | 1.46  | 2.91  |
| Agronomy                                      | 4865                              | 2.52              | 2870050           | 0.23                | 1.66    | 1.53  | 3.42  |
| Plant Physiology                              | 5642                              | 2.92              | 3406150           | -                   | 0.6     | 0.61  | 1.21  |
| Soil Science                                  | 6516                              | 3.37              | 3931490           | 0.31                | 2.37    | 2.37  | 5.05  |
| Rice Farming System                           | 4123                              | 2.13              | 2469175           | 1.22                | 1.27    | 1.25  | 3.74  |
| Grain Quality and<br>Nutrition                | 3027                              | 1.57              | 1797900           | 0.12                | 0.53    | 0.49  | 1.14  |
| Rice analytical<br>laboratory                 | 394                               | 0.2               | 228750            | -                   | -       | -     | -     |
| Adaptive Research                             | 3951                              | 2.03              | 2322925           | -                   | 1.24    | 1.21  | 2.45  |
| Training                                      | 1762                              | 0.91              | 1056250           | -                   | -       | -     | -     |
| Agricultural Economics                        | 1193                              | 0.62              | 715800            | -                   | -       | -     | -     |
| Farm Machinery and<br>Post-Harvest Technology | 7801                              | 4.02              | 4515200           | 0.29                | 0.53    | 0.55  | 1.37  |
| Workshop Machinery<br>and Maintenance         | 4282                              | 2.21              | 2511050           | -                   | -       | -     | -     |
| Irrigation and Water<br>Management            | 2870                              | 1.48              | 1718400           | -                   | 0.71    | 0.69  | 1.4   |
| Agricultural Statistics                       | 2754                              | 1.42              | 1616275           | 0.06                | 0.5     | 0.49  | 1.05  |
| Farm Management                               |                                   |                   |                   |                     |         |       |       |
| a) Research                                   | 19879                             | 10.28             | 10903475          | -                   | 0.06    | 0.03  | 0.52  |
| b) Seed production                            |                                   |                   |                   | 1.49                | 3.47    | 3.10  | 8.15  |
| Total                                         | 114615                            | 59.25             | 66565040          |                     |         |       |       |
| (B) Support Services                          |                                   |                   |                   |                     |         |       |       |
| Farm Management                               |                                   |                   |                   |                     |         |       |       |
| a) Common Services                            | 12294                             | 6.36              | 10460000          | -                   | -       | -     | -     |
| b) Garden Management                          | 6991                              | 3.62              | 11092125          | -                   | -       | -     | -     |
| Building and<br>Construction                  | 18799                             | 9.72              | 528300            | -                   | -       | -     | -     |
| Publication and Public<br>Relation            | 850                               | 0.44              | 917700            | -                   | -       | -     | -     |
| Director General Office                       | 1589                              | 0.82              | 633075            | -                   | -       | -     | -     |
| Director Research Office                      | 1020                              | 0.53              |                   | -                   | -       | -     | -     |
| Administration and<br>Support Service         |                                   |                   |                   |                     |         |       |       |
| a) Administration                             | 4143                              | 2.14              | 3984550           | -                   | -       | -     | -     |
| b) Audit                                      | 457                               | 0.24              | 5019225           | -                   | -       | -     | -     |
| c)Transport                                   | 8539                              | 4.42              | 273900            | -                   | -       | -     | -     |
| d) Store                                      | 1887                              | 0.98              | 1099200           | -                   | -       | -     | -     |
| e)Hostel                                      | 6377                              | 3.3               | 3759050           | -                   | -       | -     | -     |
| f) Security                                   | 7459                              | 3.86              | 4498625           | -                   | -       | -     | -     |
| g) Planning and<br>Evaluation                 | 5046                              | 2.61              | 272100            | -                   | -       | -     | -     |
| h) Medical                                    | 949                               | 0.49              | 560125            | -                   | -       | -     | -     |
| Accounts and Finance                          | 2355                              | 1.22              | 1384175           | -                   | -       | -     | -     |
| Total                                         | 78755                             | 40.75             | 44482150          | -                   | -       | -     | -     |
| Grand Total (A+B)                             | 193370                            | 100               | 111047190         | 12.66               | 40.53   | 36.62 | 89.81 |

**Table 10. Retirement benefits of labourers during 2023-24.**

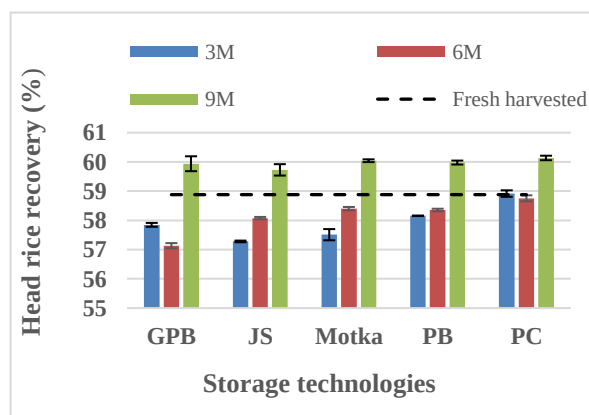
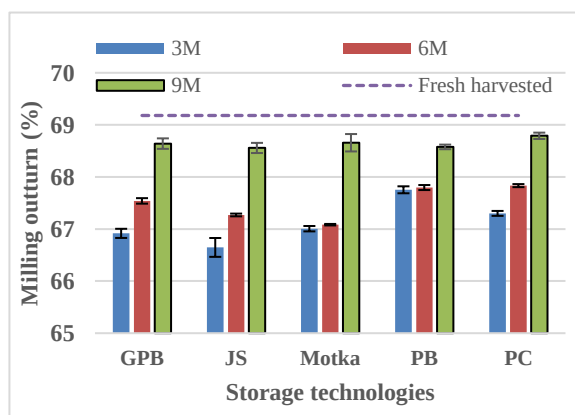
| Working place | Male | Female | Amount (Tk.) |
|---------------|------|--------|--------------|
| BRRRI HQ      | 11   | -      | 69,80,273    |
| BRRRI R/S     | 6    | -      | 28,29,000    |
| Total         | 17   | -      | 98,09,273    |

**Table 11. Medical financial benefits of labourers in working time injury during 2023-24.**

| Working place | Male | Female | Amount (Tk.) |
|---------------|------|--------|--------------|
| BRRRI HQ      | 11   | -      | 69,80,273    |
| BRRRI R/S     | 6    | -      | 28,29,000    |
| Total         | 17   | -      | 98,09,273    |

**Table 12. Sale proceeds of FMD during 2023-24**

| Items                  | Amount (Tk) |
|------------------------|-------------|
| Dead tree and branches | 19,500      |
| Green Coconut          | 1480        |
| Straw                  | 1,58,900    |
| Plam shells            | 1,000       |
| Betel nut              | 7,500       |
| Jackfruit              | 30          |
| Ripe mango             | 200         |
| Wood nuts              | 8,000       |
| Trolley fare           | 1,600       |
| Truthful level seed    | 21,200      |
| Total                  | 2,19,400    |



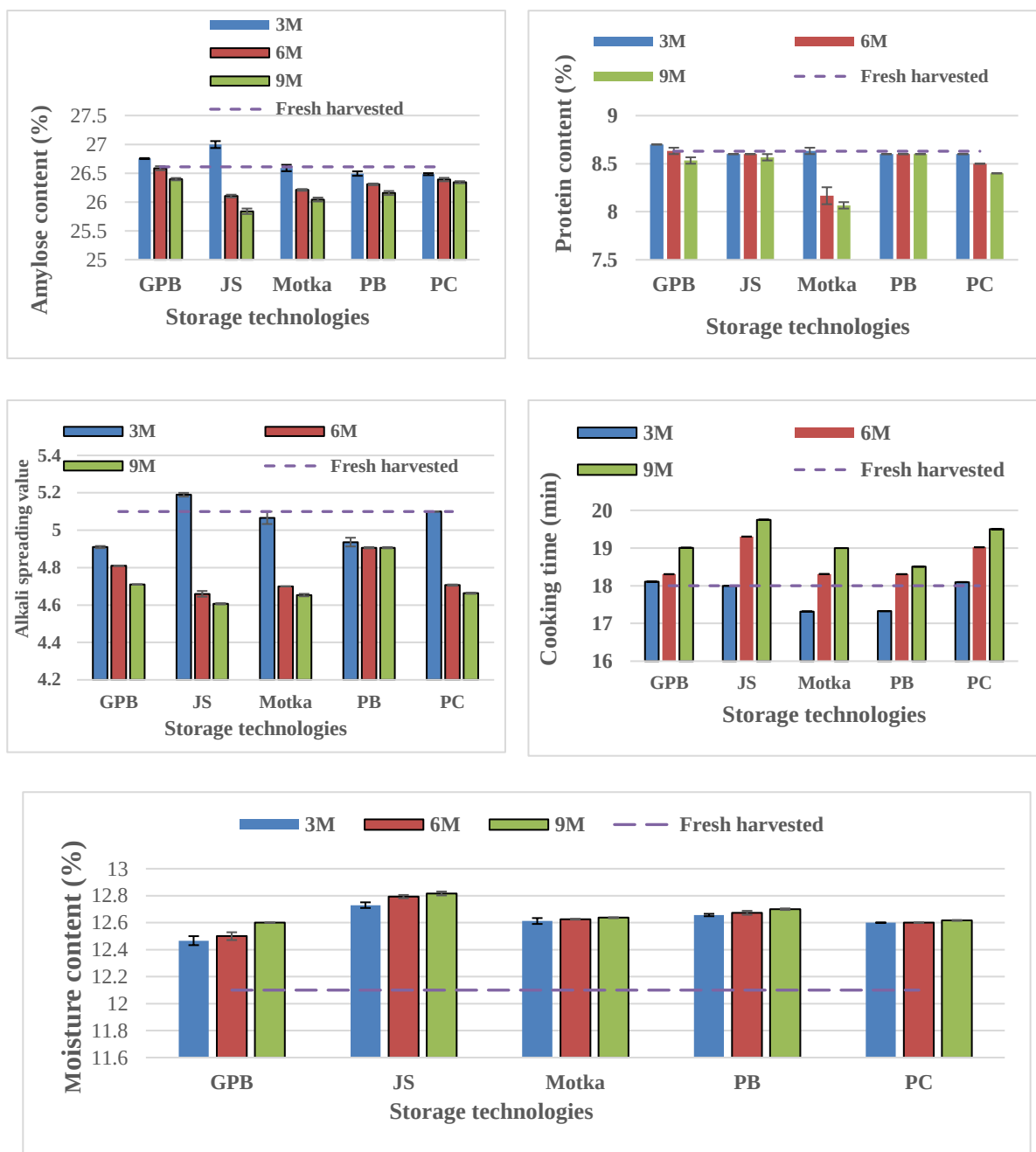


Fig.1.Physical properties of rice at different storage time and storage technologies

GPB = Grain Pro Bag, JS = Jute Sacks, PB = Plastic Bag, PC = Plastic Container & M = Mont

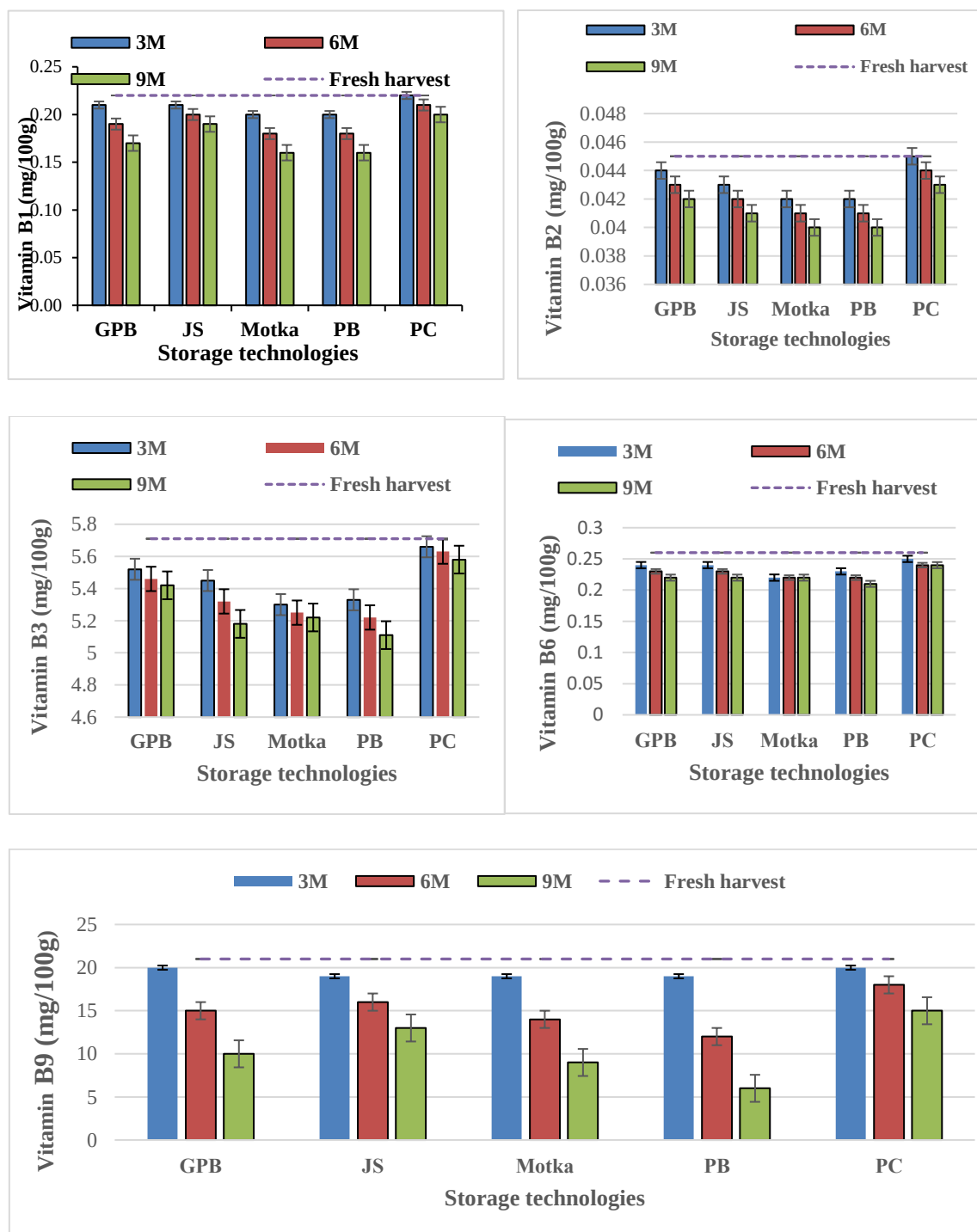


Fig. 2. Vitamins (B-Complex) of rice at different storage time and storage technologies

GPB = Grain Pro Bag, JS = Jute Sacks, PB = Plastic Bag, PC = Plastic Container & M = Mon

# **Farm Machinery and Postharvest Technology Division & Workshop Machinery and Maintenance (WMM) Division**

|            |                                                       |
|------------|-------------------------------------------------------|
| <b>260</b> | <b>Summary</b>                                        |
| <b>262</b> | <b>Agricultural machinery development and testing</b> |
| <b>267</b> | <b>Milling and processing technology</b>              |
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## SUMMARY

A Head feed combine harvester with a dimension of 4250 mm×2030 mm×2580 mm, 4-cylinder engine power of 77 hp, and a cutting width of 1450 mm was designed, developed, and fabricated considering ground pressure, forward speed, ease of operation, land condition, and business viability at the FMPHT divisional research workshop and Alim Industries Ltd, Sylhet with the help of other local agricultural machinery manufacturers. Laboratory and field tests of the combine harvester in load and no-load conditions were done in the workshop and rice fields, respectively. Forward speed during harvesting speed ranged from 3.0 – 4.0 kmh<sup>-1</sup>. The field capacity of the harvester was obtained at 1.0 - 1.20acreh<sup>-1</sup> and fuel consumption at 10-11 lh<sup>-1</sup>. The developed combine harvester is suitable to operate in the fragmented farmland.

The design and development of a BRRI automatic rice seed sow machine to raise mat-type seedlings for mechanical transplanting. This machine was fabricated at the FMPHT divisional research workshop and the Uttaron Engineering Workshop in Kalitola, Dinajpur. The BRRI Auto Seed Sower machine was tested in the FMPHT research workshop. It was fine-tuned to accommodate various soil textures and sizes of paddy seeds. The seed distribution rate can be finely tuned with a brush adjustment meter, allowing 120 to 160 grams of sprouted seeds to be placed in each tray. With the auto seed sower machine, a worker can sow seeds in 1,680 trays per hour. After sowing the sprouted seeds, each tray's topsoil layer (5-6 mm) can be covered with loose soil.

A head feed thresher was manufactured utilizing locally available materials at the FMPHT Divisional workshop, BRRI HQ, Gazipur. The study was intended to develop, fabricate, and test the 2<sup>nd</sup> version of the prototype of the head feed thresher's performance. The preliminary test of the machine

was done in the Boro 2023-24 season at the FMPHT Division, BRRI HQ, to determine the mechanical errors of the machine. At that time, it was found that the machine had no significant faults. A few faults were found, and modifications were done to eliminate those faults. Machine capacity was adequate, but the cleaning facility did not perform satisfactorily. Some improvements were made, and a comprehensive test will be organized in the upcoming season. Another prototype development will be required to improve the machine's performance and other functionalities

The FMPHT Division undertook a project to design and develop a two-stage rice mill to enhance rice milling efficiency and increase head rice recovery. A detailed AutoCAD design was created to guide the manufacturing process. The mill's key components include a cyclone separator, de-husker, rubber roll polisher, and length grader. A 25-horsepower motor will power the mill, and the fabrication is being carried out at Salam Engineering Workshop in Dinajpur. The primary structural elements and roller attachment have been completed and are ready for testing. The project is anticipated to be fully finished within six months, and the final test results and performance evaluation will be presented at future internal review meetings

The FMPHT Division at BRRI has developed a Grain Collector to enhance the efficiency and cost-effectiveness of grain collection. This initiative aimed to fabricate and disseminate a grain collector that would outperform traditional methods. The performance data from the trials demonstrated the grain collector's effectiveness. On average, the collector collected 13 kg of grain per operation, with 118 seconds required to fill a gunny bag. The Grain Collector operation rate was approximately 0.32 kg per second. This compares favourably with traditional grain collection method, which require about two workers to fill a gunny bag in five minutes, with an operational cost of 8 Taka

per bag. The grain collector necessitates only one worker, significantly reducing labour requirements and operational costs to 4 Taka per gunny bag. Moreover, it considerably reduces the time spent filling a gunny bag to approximately 1.32 minutes. These improvements highlight the grain collector's efficiency in streamlining the grain collection process, enhancing productivity, and offering substantial cost savings. It is recommended that the grain collector be further developed to improve efficiency, with continued fabrication efforts at the FMPHT Divisional Workshop. The performance evaluation should be conducted in the next season to assess its effectiveness in real-world conditions and ensure continued improvements

The FMPHT Division of the BRRI has developed a twisting-type manual paddy de-husker designed for small-scale and laboratory rice processing. This innovative tool offers an efficient, user-friendly, and cost-effective solution for removing husks from paddy. The de-husker's fabrication uses nylon, Teflon, and wood to prioritize ergonomic design, durability, and ease of operation. Three rice varieties, BRRI dhan81, BRRI dhan89, and BRRI dhan96, were used to test the machine's performance. The results demonstrated that the de-husker fabricated with Teflon achieved the highest brown rice yield (up to 79.81%) and the lowest broken rice content (2.52%). This indicates that Teflon is the most effective material for producing high-quality rice with minimal grain breakage. While nylon de-huskers also yielded high results (up to 74%), they exhibited higher broken rice content (up to 42%), suggesting lower suitability for applications where grain integrity is essential. Wood-made de-huskers offered moderate performance, providing a balance of yield and quality but with higher broken content than Teflon. In conclusion, the Teflon-made twisting-type manual paddy de-husker developed by BRRI is an

ideal solution for small-scale and laboratory rice processing.

A solar-powered sprayer was developed at the WMM Division to create a sustainable and eco-friendly sprayer. The field tests conducted at different times of the day provided valuable insights into the sprayer's performance. The battery voltage remained relatively stable, ranging from 11.24 V to 11.70 V, indicating consistent power availability throughout the day. The discharge rate was also consistent, ranging from 1.41 to 1.55 l/min during operation time. The sprayer performance over a 0.048 ha area revealed that the average discharge rate was 90.05 liters per hour, with an application rate varying from 20.83 to 104.16 l/ha. The field capacity averaged 1.96 ha/h. The solar-operated sprayer has some drawbacks that need to be addressed. One significant issue is the sprayer's weight, which may limit its ease of use in the field.

A self-propelled mobile solar panel carrier was developed with a capacity of 3 kW, representing a versatile and eco-friendly solution for the on-demand use of solar energy. The prototype, fabricated using locally sourced materials, boasts an array of twenty 150-watt solar panels and a state-of-the-art solar inverter that efficiently converts direct current (DC) to alternating current (AC). The system's inverter operates at an input voltage of 300V (MPPT), delivering an output power of 3000VA. The carrier was further enhanced by integrating four 12-volt 130 Ah batteries, ensuring a reliable power supply to the carrier itself and auxiliary equipment. An MMPT battery charger, designed for optimal performance with a 48 Volt input at 300 V (MPPT) and a 10 Amp charging current, complements the system's energy storage capabilities. Initial testing focused on the carrier's ability to drive electric motors of varying horsepower, with two and 1-horsepower motors being able to run all day. The system uses 2 hp motor-driven BRRI open drum thresher, 0.5 hp



motor-driven BRRI winnower, 2 hp motor-driven BRRI mini rice mill, 0.5 hp motor-driven BRRI-Auto seed sower machine, 2 hp motor-driven BRRI straw-chopper etc. was initially run and tested.

The study focused on developing a mat-type seedling system for rice using hydroponic techniques and evaluating its suitability for mechanical transplanting. A vertical tray chamber was designed for space-efficient seedling cultivation. The experiment utilized the BRRI dhan83 rice variety. It involved various media (without any medium and rice husk), solution rates (Yoshida solution at 1X, 2X, and 3X concentrations), and seed rates (120 gm, 150 gm, 180 gm, and 210 gm) arranged in a randomized complete block design with three replications. Key parameters measured included seedling height, stem thickness, mat quality, and mat strength. It is observed that seedlings were generally taller with increased seed and solution rates. The height of 12 cm, deemed optimal for mechanical transplanting, was achieved with all combinations of media, solution, and seed rates. The quality of the seedling mat improved with increased seed rates. Media type 1 (without any medium) produced stronger mats than media type 2 (rice husk), especially at higher seed rates.

A total of 40 batches of two-day residential training programmes were conducted under the financial and technical support of the SFMRA project of the FMPHT Division from 2023 to 2024. Participants of the training programme attended from all BRRI RS and their adjacent area and 815 participants were trained. Among them, 550 were male, and 265 were female. Participants were trained on the operation, repair, and maintenance of different agricultural machinery and technologies like transplanters, combine harvesters, diesel engines, Power weeders, prilled urea applicators, self-propelled reapers, power tillers, tractors, etc, theoretically and practically in the threshing floor

and the main field. At the end of the training, a post-evaluation and trainees' reactions regarding the training were collected. Certificates, leaflets, and a set of tools were distributed among the participants. Trainees opined that they are now more confident about using agricultural machinery.

## AGRICULTURAL MACHINERY DEVELOPMENT AND TESTING

### **Design, development, and performance evaluation of a BRRI head feed combine harvester**

Consideration of engine power, ground pressure, cutting width, harvesting capacity, harvesting loss, plot area, land condition, ease of operation, plot size, land condition, and business viability of the imported combine harvester, a prototype of head feed combine harvester was fabricated in Alim Industries Ltd, Sylhet with the help of other local agricultural machinery manufacturers. The prototype was fabricated using locally available raw materials, including the crawler, gearbox, and engine. Rubber track/crawler and engine were imported with the help of a local agricultural machinery importer. The gearbox has also been imported and used but with some modifications.

The research is done following a conceptual framework that includes an in-depth performance analysis of an available combine harvester used at the field level, design considerations related to Bangladesh's condition, fabrication using locally available quality material, testing with load and unloading conditions, fine-tuning, evaluation, and finalization of the machine (Fig. 1).

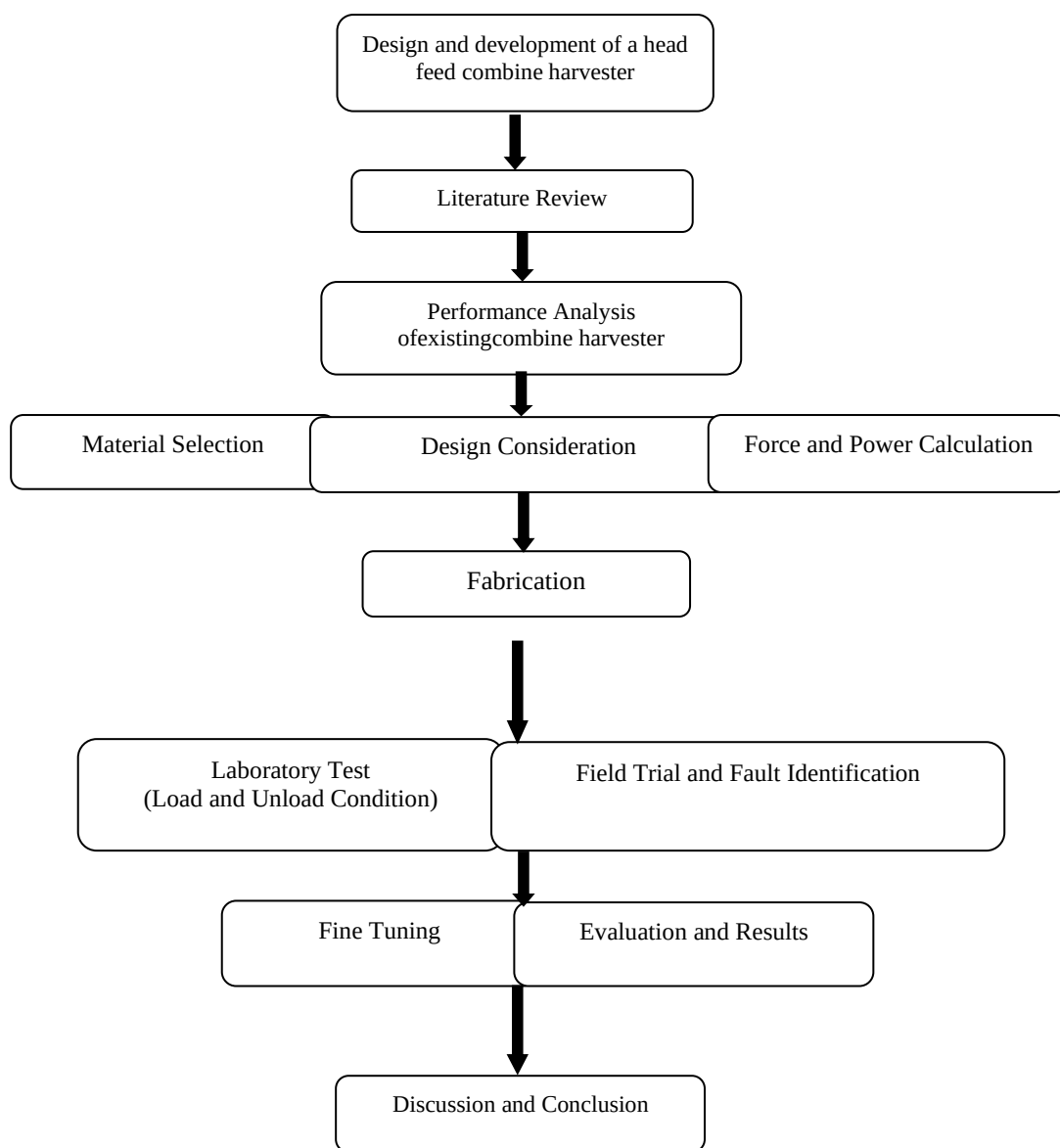


Fig. 1. Conceptual framework.

The field performance of the BRR head feed combine harvester was done during the Aman 2023 season at the BADC farm and farmers' field in Sylhet district and the West Byed research plot at Bangladesh Agricultural Research Institute (Plate 1).

All the members present at the field test expressed satisfaction with the effectiveness of the head feed combine harvester. Table 1 summarizes specifications and results of the field test.



Plate 1. Field performance of the developed BRRI head feed combine harvester.

**Table 1. The specification of the BRRI head feed combine harvester.**

| Particular                         | Unit                                  |
|------------------------------------|---------------------------------------|
| Model                              | BRRI HCH2023                          |
| Dimension, mm (L×W×H)              | 4250×2030×2580                        |
| Cutting width, mm                  | 1450                                  |
| Rubber track (Crawler)             | 400×90×51                             |
| Engine power, hp                   | 77, 4 cylinder                        |
| Grain tank, kg                     | 500-550                               |
| Hydraulic cylinder, kg             | 2000                                  |
| Fuel tank capacity, L              | 60                                    |
| Total weight, kg                   | 2900                                  |
| Ground clearance, mm               | 250                                   |
| Forward speed, km/h                | 3-4                                   |
| Sensor indicator                   | Grain tank, fuel tank, straw delivery |
| Harvesting capacity, acre          | 1-1.2                                 |
| Fuel consumption, Lh <sup>-1</sup> | ~10                                   |
| Total harvesting loss, %           | Less than 1%                          |

### **Performance of a BRRI Automatic Seed Sower Machine**

An automatic seed sower machine was designed and fabricated according to design. Jigs, fixtures, and molds for the main basement, soil hopper base, seed hopper base, water tank base, and motor basement were developed for quick replication. Calibration for different soil types and various sizes of paddy seeds

was achieved by adjusting the lever. The prototype's performance was tested in the FMPHT divisional research workshop, Uttaron Engineering at Dinajpur, and farmers' fields. The machine has a bed soil hopper, seed hopper, and topsoil hopper with capacities of 80 kg, 10 kg and 30 kg, respectively (Plate 2).



Plate 2. Laboratory trial of BRRRI Auto Seed Sower Machine.

The machine is easy to fabricate using locally available materials in a local workshop, and it can be operated by both men and women with minimal training. The distribution of bed soil is precisely adjusted using a lever. The seed distribution rate can be finely tuned with a brush adjustment meter, allowing 120 to 160 grams of sprouted seeds to be placed in each tray. With the auto seed sower machine, a worker can sow seeds in 1,680 trays per hour, a significant improvement compared to the 50-60 trays done manually. After sowing the sprouted seeds, each tray's topsoil layer (5-6 mm) can be covered with loose soil. However, the machine should not be used if the germinated seeds are more than one-day-old or if the radical length is more than 2 mm. The developed machines have been given to the 'Mechanized Village' and regional stations of BRRRI for field-level extension and preparing seedling trays for mechanical transplanting.

### **Design and development of a head feed power thresher**

A head feed power thresher prototype was fabricated using locally available materials in the FMPHT

divisional workshop, BRRRI, Gazipur. The main components of this thresher include two drums, a feeding tray, a cleaning blower/fan, a chassis, a horizontal screw conveyer, a belt-type inclined conveyer, and a collecting chute. The materials used to create a prototype of the head feed thresher are:

- MS sheet, flat bar, angle bar, shaft bar, GI pipe, nuts and bolts, gear, belts, pulley
- Wire-loop threshing drum
- Feeding mechanism
- Belt-pulley/gear arrangement to transmit engine power

The machine consists of several critical components, including the engine, feeder table, gripper/feeding chain, threshing drum, concaves, oscillating grate, blower/fan, and paddy outlet (Fig. 2). The machine operates as follows: the tops of the crops are fed into the machine for threshing by hand or gripper chain while the straw is separated. The machine has a light working load and low energy consumption. It is also designed for easy separation of rice and straw due to the half-feed mode.





moisture content, resulting in both efficiency loss. The higher stripping and impacting pressures applied to the grains, which tend to enhance the threshing operation and boost threshing and cleaning efficiencies, were responsible for improving the percentage of threshing and cleaning efficiencies by increasing drum speed. Lower cleaning and threshing efficiency are the result of higher moisture content. These outcomes were ascribed to the high moisture content and high elastic conditions, which slightly impact the threshing materials.



Plate 3: performance test of the head feed thresher.

The straw remains intact after threshing in the head feed option. However, the blower's capacity was insufficient to clean the moist cheaply. The variable plant height resulted in an un-separated paddy of approximately 3~4% for the head feed option. Still, the un-separated paddy for the full feed options was less than 1% for both.

### Identified problems

- ❖ The bundle of rice is not fixed; it is torn
- ❖ There is some un-threshed paddy in place of paddy bundles
- ❖ Some pieces of straw remain with the threshed paddy
- ❖ Cleaning efficiency is low
- ❖ The vibration of the machine is high.

## MILLING AND PROCESSING TECHNOLOGY

### Design and development of a two-stage rice mill

The FMPHT Division has successfully designed and developed a two-stage rice mill, significantly enhancing rice milling efficiency and head rice recovery. The mill, fabricated at the Salam Engineering Workshop, incorporates a cyclone separator, de-husker, rubber roll polisher, and length grader. Powered by a 25-horsepower motor, the system utilizes a belt and pulley system for power distribution and a bucket and hopper mechanism for paddy loading and processing (Fig. 3). This advanced technology offers a compact, efficient, and cost-effective solution for small and medium-scale rice milling operations, particularly in rural areas. The two-stage process involves husking and polishing, resulting in higher-quality rice with minimal grain breakage. By carefully removing the husk and bran layers, the mill produces a higher yield of whole grains, meeting consumer preferences for white, polished rice.

The two-stage rice mill's evaluation focused on key performance indicators such as milling recovery, head and broken rice recovery, husk and bran percentages, Degree of milling (DoM), brown rice percentage, and electricity consumption. The two-stage rice mill represents a significant advancement in rice milling technology, offering improved efficiency, quality, and sustainability.

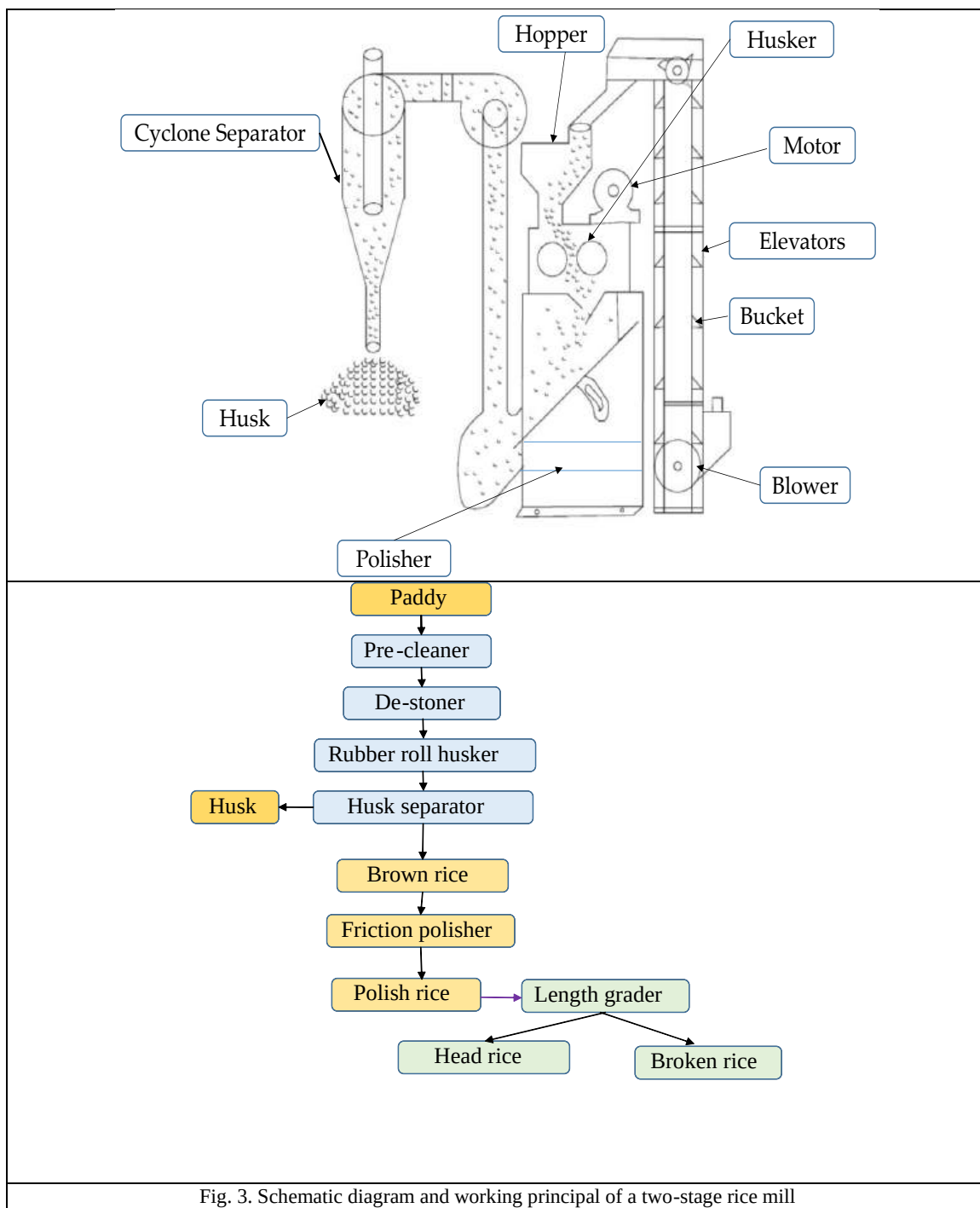


Fig. 3. Schematic diagram and working principle of a two-stage rice mill



**Main Body:** The main frame and body are made with a 1.8 mm MS sheet. The length: 600 mm, width: 495 mm, height: 1125 mm.



Roller attachment. This parts attachment included the tyeter, roller shaft, bearing block

## Design and Development of Grain Collector

The FMPHT Division at BRRI developed a Grain Collector to enhance the efficiency and cost-effectiveness of grain collection. The fabrication began with detailed design drawings created using AutoCAD, specifying all dimensions and sections of the device (Fig. 4). Mild Steel (MS) sheets were selected for the structural framework, Stainless Steel (SS) sheets for components exposed to moisture, and

aluminum sheets for lightweight parts. MS bars, flat bars, and pipes were used for structural support, while nuts, bolts, and bearings were crucial for assembly and smooth operation. The fabrication involved cutting and welding these materials to form the hopper and collection mechanism, which were then assembled and tested rigorously. After painting for corrosion protection, the collector underwent performance testing to ensure it met design specifications.



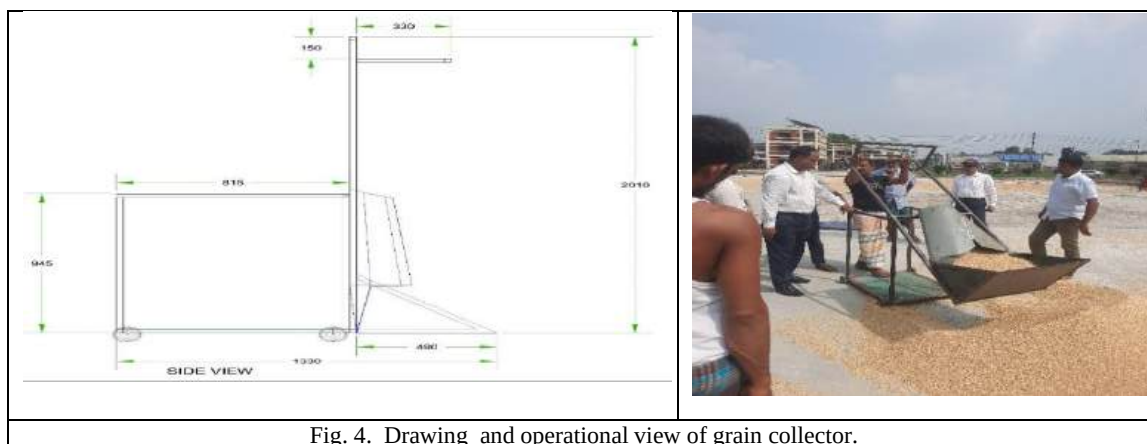


Fig. 4. Drawing and operational view of grain collector.

Field performance was evaluated by measuring the amount of grain collected per operation, the time required to fill a gunny bag and labour requirements. On average, the collector gathered 19.2 kg of grain per operation, with a filling time of 1.96 minutes for a standard 40 kg gunny bag (Tables 2 and 3). This represents a significant improvement over traditional methods, which typically require two workers and five minutes to fill a bag. The collector also reduced labour costs from 8.0 Tk to 4.0 Tk per bag. The trials

highlighted the collector's operational efficiency, with minimal performance variation, underscoring its potential as a more efficient, cost-effective solution for modern agricultural operations. While initial tests were promising, further detailed evaluations are recommended to optimize the design and expand its use. These tests should enhance performance across grain types and field conditions to ensure broad applicability and reliability in diverse agricultural settings.

**Table 2. Performance of grain collector.**

| Trial   | Collected grain/operation (kg) | Grain to fill a gunny bag (kg) | Time/operation (sec) | Total time required/Fill a gunny bag (min) | Capacity (kg/min) |
|---------|--------------------------------|--------------------------------|----------------------|--------------------------------------------|-------------------|
| 1       | 12.5                           | 37.0                           | 42                   | 1.98                                       | 18.6              |
|         | 13                             |                                | 36                   |                                            |                   |
|         | 11.5                           |                                | 41                   |                                            |                   |
|         | 13.5                           |                                | 38                   |                                            |                   |
| 2       | 14                             | 39.5                           | 43                   | 1.96                                       | 19.8              |
|         | 12                             |                                | 37                   |                                            |                   |
|         | 13                             |                                | 41                   |                                            |                   |
|         | 12.5                           |                                | 37                   |                                            |                   |
| 3       | 14                             | 39.5                           | 39                   | 1.95                                       | 19.8              |
|         |                                |                                |                      |                                            |                   |
| Average |                                | 38.66                          | 39.33                | 1.96                                       | 19.2              |

**Table 3. Comparison between Grain collectors and traditional system.**

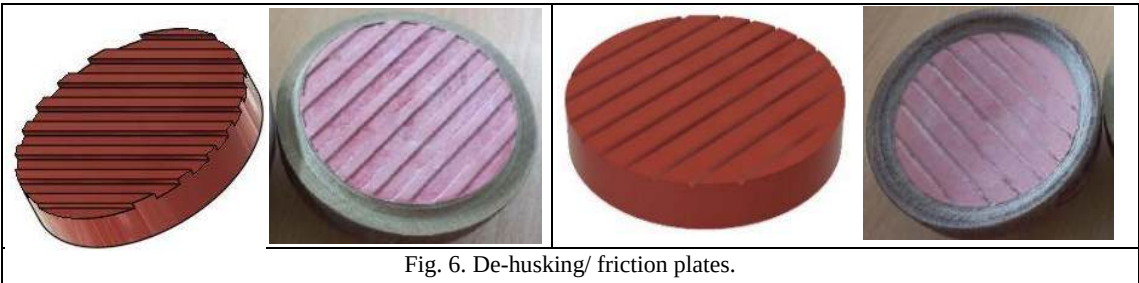
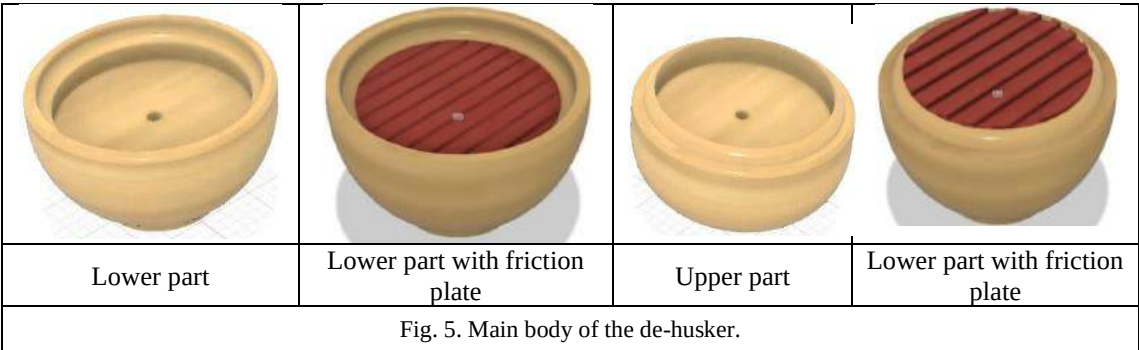
| Items                                          | Grain collector | Traditional |
|------------------------------------------------|-----------------|-------------|
| Labor requirement to fill a Gunny bag (Number) | 1               | 2           |
| Time required to fill gunny bag (min)          | 1.32            | 5           |
| Operational cost (Taka/bag)                    | 4.0             | 8.0         |

### Design and development of twisting-type manual paddy de-husker

The FMPHT Division of the BRRI, a leading institution in agricultural research, has developed a

twisting-type manual paddy de-husker designed explicitly for small-scale and laboratory rice processing. This innovative tool highlights the Division's expertise and provides an efficient, user-friendly, and cost-effective solution for husk removal. The de-husker is constructed from nylon, Teflon, and wood and emphasizes ergonomic design, durability, and ease of use. Performance evaluations were conducted using three rice

varieties: BRRI dhan81, BRRI dhan89, and BRRI dhan96. The de-husker features an upper and lower section, each equipped with rubber de-husking or friction plates with a rough texture (Figs. 5 and 6). These plates are essential for effectively removing husks from paddy grains during manual operations. The materials were chosen for their durability and ease of fabrication, ensuring reliable performance and cost-effective production.

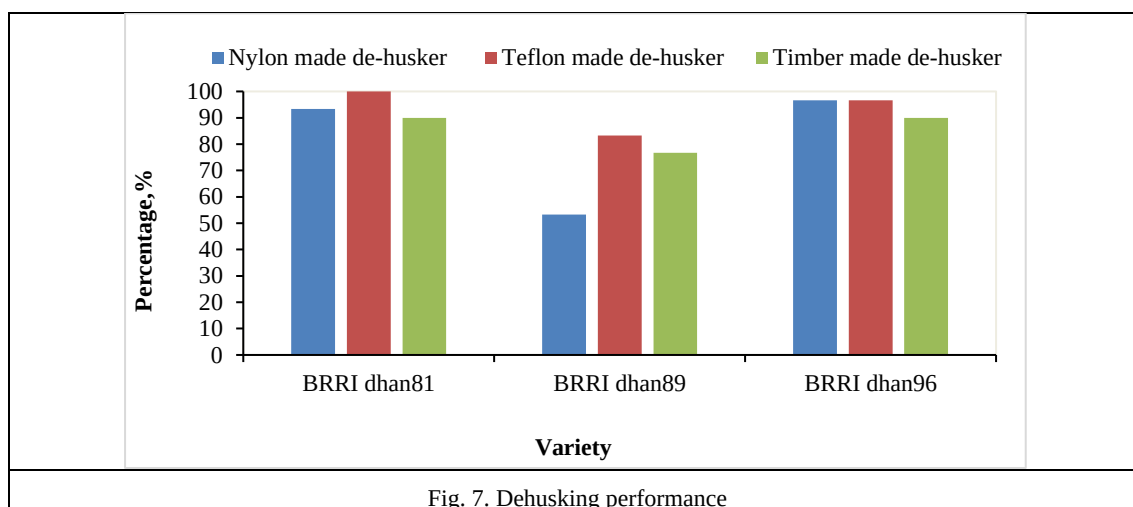


### Performance evaluation

The de-husker's performance was assessed by its efficiency in removing husks and recovering head rice. This analysis focused on three types of de-husker materials—nylon, Teflon, and wood—and their effectiveness in processing three varieties of un-parboiled rice: BRRI dhan81, BRRI dhan89, and BRRI dhan96.

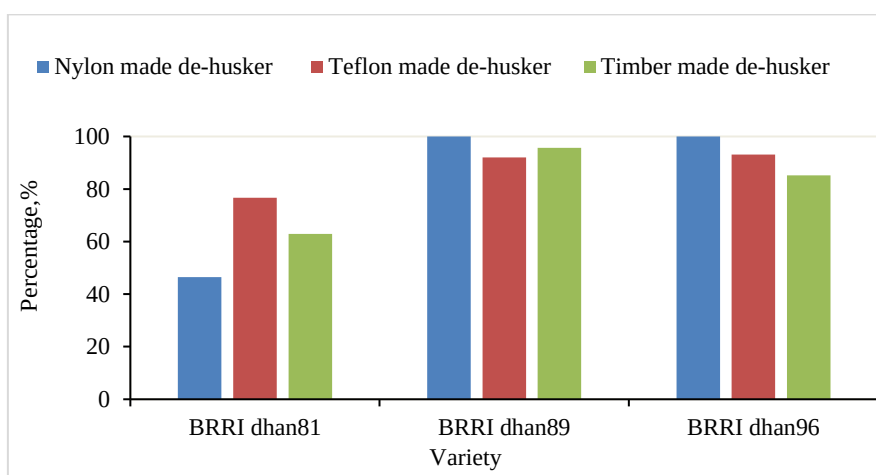
**Performance of developed de-huskers.** The evaluation of three types of de-huskers—nylon, Teflon, and timber—was conducted to process three

varieties of raw rice. Teflon demonstrated the highest de-husking efficiency for BRRI dhan81, achieving 79.81%, with a low count of un-milled paddy, indicating its effectiveness in removing husks without leaving many unprocessed grains. Nylon exhibited a wide range of efficiencies, with the lowest for BRRI dhan89 at 49.38%, which also had a high un-milled paddy count of 12.66%. Although not as efficient as Teflon, timber provided reasonable de-husking percentages, ranging from 67.97% to 68.16%, along with moderate levels of un-milled paddy (Fig. 7).



**Head rice yield:** An evaluation of three types of de-huskers—nylon, Teflon, and timber—was conducted to process three varieties of raw rice. The head rice yield, which measures the proportion of intact grains after de-husking, was highest for the nylon de-husker with BRRI dhan96 at 69.37%,

closely followed by Teflon with BRRI dhan89 at 67.68%. This indicates that both materials reduce grain breakage, particularly for certain rice varieties. The timber de-husker showed a lower overall head rice yield, with the highest yield for BRRI dhan96 at 64.18% (Fig. 8).



## RENEWABLE ENERGY

### Design and development of solar-powered operated sprayer

The solar operated sprayer was designed and fabricated in the Workshop Machinery and Maintenance Division, BRRI, Gazipur. The solar operated sprayer was fabricated in WMM workshop (Plate 3). The 12V motor and nozzle were mounted on the tank, while the solar panel was positioned to

ensure optimal sunlight exposure. The 15W solar panel was connected to a 12V battery, which powers the motor. The sprayer operates by harnessing solar energy to charge the 12V battery through the 15W solar panel. The charged battery then powers the 12V motor, which drives the nozzle to spray liquid from the 16L tank (Table 4). Figure 9 shows schematic diagram of the total system developed for the experimental work .

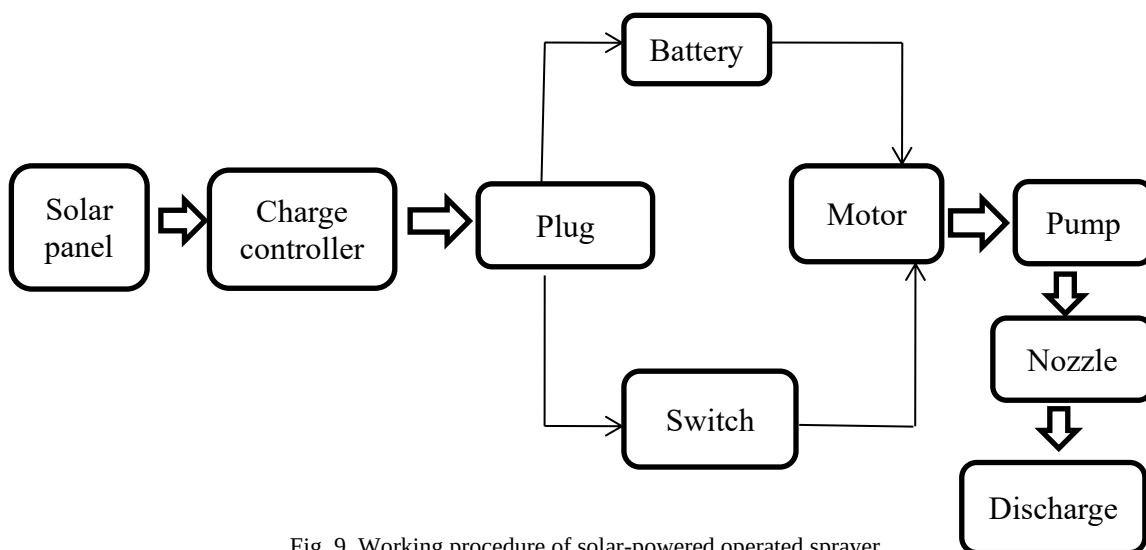


Fig. 9. Working procedure of solar-powered operated sprayer

### Performance evaluation

The performance evaluation of the solar-operated sprayer was conducted in two distinct phases to comprehensively assess its functionality and

efficiency: a lab test at the WMM Divisional Workshop and a field trial at BRRI Farm in Gazipur (Plate 4).



Plate 4. Field performance test of solar-operated sprayer

Table 4. Specifications of Solar operated sprayer.

| Item                 | Specifications           |
|----------------------|--------------------------|
| Type of sprayer      | Solar operated           |
| Capacity of the tank | 16 L                     |
| Solar panel power    | 15 W                     |
| Solar panel size     | (35 cm x 34 cm x 1.5 cm) |
| Battery voltage      | 12 V                     |
| Battery current      | 1.7 A                    |
| Pump flow            | 3 l/min                  |
| Pump voltage         | 12 V (DC)                |
| Pump current         | 3 A                      |
| Pump Max pressure    | 0.45 MPa                 |
| Nozzle               | 0.75 mm                  |
| Connecting wire      | 4 mm                     |
| Net weight           | 4 kg                     |

The sprayer's discharge rate generally fluctuates throughout the day but remains relatively stable (Table 5). The sprayer performs better around midday and slightly declines in the morning and late

afternoon due to less optimal solar energy availability. It ranged from 1.49 to 1.55 liters per minute, with the highest rate at 1:00 PM (1.55 l/min) and the lowest at 5:00 PM (1.49 l/min).

**Table 5. Field performance of solar-operated sprayer.**

| Day time (Period) | Battery voltage (V) | Volume (liter) | Time (min) | Discharge (Q) (l/min) |
|-------------------|---------------------|----------------|------------|-----------------------|
| 9.00 AM           | 11.24               | 1.00           | 0.65       | 1.54                  |
| 11.00 AM          | 11.46               | 2.00           | 1.42       | 1.41                  |
| 1.00 PM           | 11.70               | 3.00           | 1.93       | 1.55                  |
| 3.00 PM           | 11.67               | 4.00           | 2.62       | 1.53                  |
| 5.00 PM           | 11.51               | 5.00           | 3.36       | 1.49                  |

### Solar energy utilization for small agricultural machinery

A self-propelled mobile solar panel carrier was designed to utilize solar energy for small agricultural machinery with the following technical specifications (Table 6). The developed solar-powered carrier can bear loads exceeding 600 kg,

including twenty 150-watt solar panels. This carrier promises increased load-bearing capacity, speed, and operational efficiency improvements over Mishuk rickshaw motor-used carriers. The panel frame folder's total opening and full set-up time upon the carrier required 10-12 minutes with three people.

**Table 6. Features of solar panel.**

| Item description                           | Value       |
|--------------------------------------------|-------------|
| Rated Max Power, Pmax (Model: XH150P (36)) | 150Wp       |
| Tolerance                                  | 0-3%        |
| The voltage at pmax (Vmp)                  | 18. 0V      |
| Current at pmax (mp)                       | 8. 34A      |
| Open-circuit voltage (Voc)                 | 22. 1V      |
| Short-circuit current (Isc)                | 9.05A       |
| Nominal operating cell temp (NOCT)         | 47°C ±2°C   |
| Maximum system voltage                     | 1000 VDC    |
| Maximum series fuse rating                 | 10A         |
| Dimensions, mm                             | 1490*660*30 |

The observed voltage range of 375 to 598 volts aligns with the expected output for high-performance solar panels (Fig. 10). Notably, the peak voltage and electricity generation coincided with the maximum solar irradiation at 1:30 pm, consistent with the sun's zenith, which results in the most direct sunlight exposure. The decline in voltage and electricity output towards the evening, reaching a minimum at 6 pm, is attributable to the reduced

solar irradiation as the sun sets. The increase in motor speed around noon, when the solar irradiation is at its peak, demonstrates the potential for maximum operational efficiency (Fig. 11). Conversely, the decrease in motor speed with diminishing sunlight exposure underscores the need for efficient energy storage solutions to maintain consistent performance.

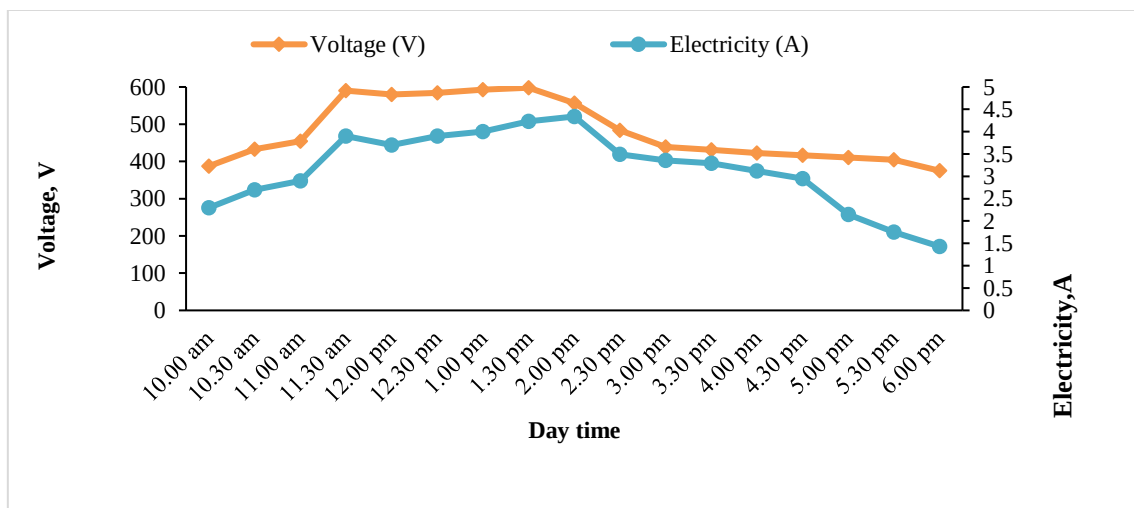


Fig. 10. Voltage without load condition.

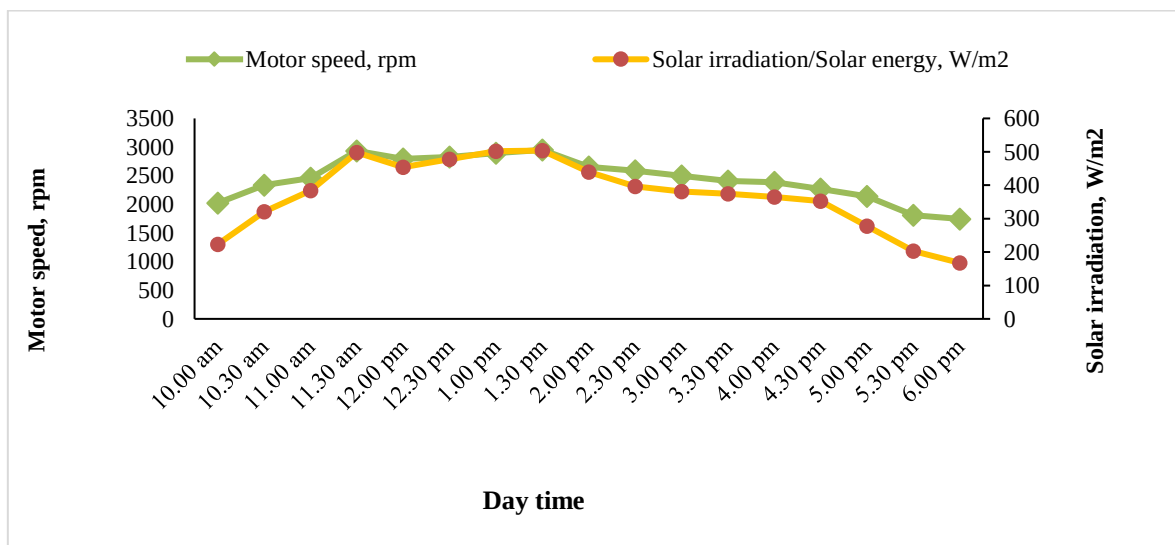


Fig. 11. The motor speed with solar irradiation without load condition.

During the reporting period, BRRI developed and tested five small agricultural machinery (an Open drum thresher, winnower, mini rice mill, auto seed sower, and power chopper).

**BRRI open drum thresher operation.** The machine was powered by a 4 HP diesel engine. Later, it was powered by a 2 hp AC motor and solar energy. This will reduce the dependence on fossil fuels, eliminate the need for a manual handle, and simplify the machine's starting process. The AC motor's rated speed of 2900 rpm demonstrated its

efficiency and capability to handle the demands of threshing operations (Plate 5a).

**BRRI Winnower operation.** The solar-powered BRRI Winnower is a remarkable innovation in agricultural technology. Shifting to a solar-powered 0.5 hp AC motor (220 volts) significantly reduces dependence on non-renewable energy sources (Plate 5b). Its impressive 1400 rpm rated speed demonstrates its robust performance in winnowing operations.



**BRRi mini rice mill operation.** The BRRi mini rice mill is an innovative agricultural machine designed to enhance the efficiency of rice processing (Plate 5c). It integrates milling and grinding units, typically powered by a 3hp motor using alternating current (AC). This dual functionality allows for the seamless processing of rice and wheat, streamlining the operations for small-scale farmers or businesses.

**BRRi chopper machine operation.** The BRRi solar-powered chopper machine demonstrates innovative steps in agricultural technology. By harnessing solar energy, this machine offers a sustainable alternative

**BRRi auto seed sower machine operation.** The solar-powered BRRi auto seed sower machine represents a significant advancement in agricultural machinery, particularly in sustainable practices (Plate 6a). By utilizing a solar-powered 0.5 hp AC motor, this equipment not only conserves energy but also supports the global shift towards renewable energy sources.

to traditional AC-powered equipment (Plate 6b). Using a 2hp or 1.5 kW motor, operating at a rated 2900 rpm, aligns with the global shift towards renewable energy sources.



Plate 6a. Solar-powered BRRi auto seed sower machine.



Plate 6b. Solar-powered BRRi chopper.

## PRECISION AGRICULTURE

### Development of mat type seedling raising using hydroponic technique

In recent years, the possibilities of hydroponic techniques have received considerable attention. In hydroponics, plants are grown with their roots immersed in a water solution containing necessary minerals. Normally, commercially valuable crops are grown using this technique in a controlled

environment. Still, in recent years, research has been going on to develop seedlings in various crops such as grass and wheat. A long mat with hydroponically grown rice seedlings with a mat size of 58cm in length and 28 cm in width was designed to develop a labour-saving rice transplanting system (Kohei T,



1999). The application of hydroponic systems in rice production has not been extensively studied. So, there is insufficient data on the effect of doses of various micronutrients, liquid fertilizer, and the strength of the root mat. So, there is a scope for work on this topic.

Sun-dried seeds were cleaned to remove impurities and immersed in the water before incubation to

remove unfilled grain and other impurities. Seed germination percentage was checked (>95%). Healthy seeds were picked by a specific gravity method. The pre-soaked seeds were weighed according to treatment and soaked in water overnight before sowing, and the partially sprouted seedling trays were put in the wet nursery two days after incubation (Plate 7).

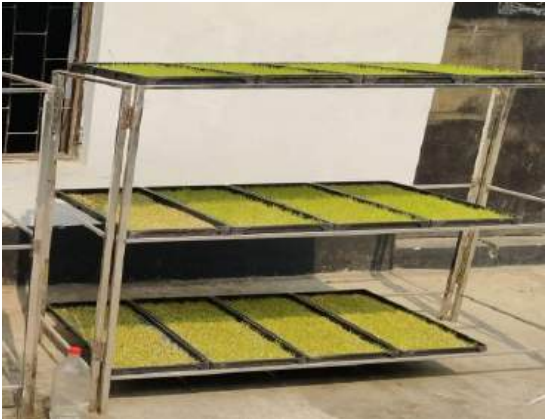


Plate 7. Experimental set-up.

Three factors, media (Factor A), solution rate (Factor B), and seed rate (Factor C), were arranged in a randomized complete block (RCB) design with three

replications (Table 7). Yoshida solution was sprayed at three doses (1X, 2X, and 3X) at an 8-hour interval.

**Table 7. List of the three main factors characters of the experiment.**

| Media (Factor A)       | Solution Rate (Factor B) | Seed Rate (Factor C) |
|------------------------|--------------------------|----------------------|
| Without any media (M1) | X1                       | 120 gm               |
| Rice husk (M2)         | X2                       | 150 gm               |
|                        | X3                       | 180 gm               |
|                        | X3                       | 210 gm               |

The agronomic characteristics of seedling density per unit area, leaf length (Only the 1<sup>st</sup> leaf length was measured under this study), and stem thickness were measured after ten seedlings were randomly selected by hand from each treatment combination. Vernier caliper was used to measure the stem thickness of 14-day-old seedlings. The rolling quality of the seedling mat was measured in terms of scores: 10 for excellent (no crack during rolling), 8

for good (single and minor crack), 6 for medium (more than one crack but possible to roll up: medium crack), 4 for bad (more than one crack and difficult to roll up: major crack), 2 for very bad (more than one and large size crack and very difficult to roll up: extreme crack) and 1 for not possible to roll up in any way (Plate 8). Mat strength was measured by the pulling capability that Kg expressed.





Plate 8. Mat quality.

Table 8 displays the seedling height (cm) at different media with different solutions and seed rates. Many researchers recommended a seedling height of 12 for mechanical transplanting. In most cases, seedling height increased by increasing the seed and solution

rates. A highly significant effect was found for all single effects, but no significant combined effect was seen. A seedling height of 12 cm is suitable for a transplanter machine.

**Table 8. Seedling height.**

| Treatment | M1                  |                     |                      | M2                   |                      |                      |
|-----------|---------------------|---------------------|----------------------|----------------------|----------------------|----------------------|
|           | S1                  | S2                  | S3                   | S1                   | S2                   | S3                   |
| R1        | 12.60 <sup>l</sup>  | 12.61 <sup>l</sup>  | 12.80 <sup>ijk</sup> | 17.01 <sup>g</sup>   | 17.01 <sup>fg</sup>  | 17.33 <sup>abc</sup> |
| R2        | 12.66 <sup>kl</sup> | 12.77 <sup>jk</sup> | 12.90 <sup>hij</sup> | 17.11 <sup>ef</sup>  | 17.21 <sup>cde</sup> | 17.33 <sup>abc</sup> |
| R3        | 12.68 <sup>kl</sup> | 12.95 <sup>hi</sup> | 12.95 <sup>hi</sup>  | 17.16 <sup>def</sup> | 17.32 <sup>bc</sup>  | 17.43 <sup>ab</sup>  |
| R4        | 12.73 <sup>kl</sup> | 12.76 <sup>jk</sup> | 13.00 <sup>h</sup>   | 16.92 <sup>fg</sup>  | 17.28 <sup>cd</sup>  | 17.51 <sup>a</sup>   |

According to Table 9, M1 had the thickest stems, followed by M2. The highest steam thickness was observed at 1.94 at M2 with seed rate R1 and solution S3, and the lowest was observed at 1.65 at

M1 with seed rate R4 for solution S1 and S2. Stem thickness decreased as the seed rate increased, and stem thickness increased as the solution rate increased.

**Table 9. Seedling stem thickness.**

| Treatment | M1                   |                      |                      | M2                   |                      |                     |
|-----------|----------------------|----------------------|----------------------|----------------------|----------------------|---------------------|
|           | S1                   | S2                   | S3                   | S1                   | S2                   | S3                  |
| R1        | 1.74 <sup>ghij</sup> | 1.80 <sup>cde</sup>  | 1.85 <sup>abcd</sup> | 1.83 <sup>bcd</sup>  | 1.91 <sup>ab</sup>   | 1.94 <sup>a</sup>   |
| R2        | 1.73 <sup>ghij</sup> | 1.73 <sup>ghij</sup> | 1.80 <sup>cde</sup>  | 1.78 <sup>efg</sup>  | 1.85 <sup>abc</sup>  | 1.86 <sup>abc</sup> |
| R3        | 1.68 <sup>jk</sup>   | 1.7 <sup>ghij</sup>  | 1.77 <sup>efg</sup>  | 1.76 <sup>efgh</sup> | 1.79 <sup>cde</sup>  | 1.80 <sup>cde</sup> |
| R4        | 1.65 <sup>k</sup>    | 1.65 <sup>k</sup>    | 1.71 <sup>ghij</sup> | 1.71 <sup>ghij</sup> | 1.73 <sup>ghij</sup> | 1.77 <sup>efg</sup> |

From Table 10, mat quality increased with an increase in the seed rate except seed rate R4 in the case of media 1. At media 2, mat quality increased with the seed rate in all cases. Mat strength increased with an increase in the seed rate, and a better result was found for media one than media 2 (Table 11).

Based on mat quality and mat strength, M1: S1: R3 and M1:S2:R3 combinations were better for raising mat-type seedlings suitable for mechanical transplanting.

**Table 10. Mat quality of a seedling block.**

| Treatment | M1                  |                     |                     | M2                  |                     |                     |
|-----------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|
|           | S1                  | S2                  | S3                  | S1                  | S2                  | S3                  |
| R1        | 4.00 <sup>fg</sup>  | 4.00 <sup>fg</sup>  | 4.33 <sup>efg</sup> | 4.66 <sup>efg</sup> | 4.00 <sup>fg</sup>  | 4.66 <sup>efg</sup> |
| R2        | 6.33 <sup>bcd</sup> | 6.00 <sup>cde</sup> | 6.66 <sup>bcd</sup> | 6.00 <sup>cde</sup> | 6.00 <sup>cde</sup> | 6.00 <sup>cde</sup> |
| R3        | 8.33 <sup>ab</sup>  | 8.66 <sup>a</sup>   | 8.00 <sup>ab</sup>  | 6.00 <sup>cde</sup> | 6.00 <sup>cde</sup> | 6.66 <sup>bcd</sup> |
| R4        | 8.33 <sup>ab</sup>  | 8.00 <sup>ab</sup>  | 8.66 <sup>a</sup>   | 6.33 <sup>bcd</sup> | 6.66 <sup>bcd</sup> | 6.66 <sup>bcd</sup> |

**Table 11. Mat strength of a seedling block.**

| Seed Rate | M1                 |                    |                    | M2                 |                    |                    |
|-----------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|
|           | S1                 | S2                 | S3                 | S1                 | S2                 | S3                 |
| R1        | .99 <sup>kl</sup>  | 1.10 <sup>jk</sup> | 1.13 <sup>jk</sup> | .98 <sup>lm</sup>  | .86 <sup>m</sup>   | .95 <sup>kl</sup>  |
| R2        | 1.63 <sup>ef</sup> | 1.68 <sup>de</sup> | 1.63 <sup>ef</sup> | 1.02 <sup>k</sup>  | 1.20 <sup>ij</sup> | 1.28 <sup>i</sup>  |
| R3        | 2.09 <sup>ab</sup> | 2.10 <sup>ab</sup> | 2.05 <sup>bc</sup> | 1.46 <sup>gh</sup> | 1.49 <sup>gh</sup> | 1.50 <sup>gh</sup> |
| R4        | 2.12 <sup>ab</sup> | 2.23 <sup>a</sup>  | 2.11 <sup>ab</sup> | 1.64 <sup>ef</sup> | 1.70 <sup>d</sup>  | 1.68 <sup>de</sup> |

The study concludes that hydroponic techniques can effectively produce mat-type rice seedlings suitable for mechanical transplanting, with media type 1 showing superior performance in terms of mat quality and strength. Further research could explore transplanting the developed mat-type seedling in the field using a rice transplanter to enhance overall seedling performance.

## INDUSTRIAL AND FARM LEVEL EXTENSION

### Training on operation, repair, and maintenance of BRRI-developed farm machinery

Proper operation and maintenance increase the self-life of a machine, and as a result, more income-generating activities (IGA) were observed, thus increasing the machine's productivity. To build up trained manpower on farm machinery in the rural areas, the SFMRA project of Farm Machinery and Postharvest Technology Division of BRRI conducted a two-day long residential training programme at BRRI HQ, Gazipur, Chuadanga, Bottoil of Kushtia, and Dinajpur district.

#### Two-day-long residential training

Two-day long residential training was conducted under the financial and technical support of the SFMRA project of the FMPHT Division to introduce BRRI developed and other agricultural machines at farmer's level to develop skilled operators on agricultural machinery at farm levels and to build up awareness about the use and benefit

of using agricultural machines. The training was conducted at the BRRI HQ in Gazipur, Chuadanga, Bottoil of Kushtia, and Dinajpur district.

A total of 20 participants attended each training programme. Participants were selected by direct consultation with BRRI RSs and respective DAE offices by maintaining selection criteria. Priorities were given to choose the participants based on experience operating agricultural machinery. Lectures and practical sessions were arranged by BRRI scientists, DAE personnel (AD, DD, UAO and Agril. Engg.), and Academicians (University professors). Knowledge was shared with the participants on the operation and maintenance of BRRI-developed machinery and technologies as well as other agricultural machinery. During the practical session, machinery was operated by the participants to gather experience in agricultural machinery operations in no load condition in the drying yard/road. After a successful operation in the drying yard/ road, participants were taken to the main field to perform practical operations on agricultural machinery.

#### Major activities are done by the participants of the training programme

The following BRRI-developed machinery, technologies and other agricultural machinery were introduced and practically operated by the trainees during the training programme;

- Demonstration on seedling raising technique for mechanical rice transplanter
- Operation and maintenance of mechanical rice transplanter
- Operation and maintenance on BRRRI prilled urea applicator
- Operation and maintenance of BRRRI manual and power weeder
- Operation and maintenance on whole feed combine harvester
- Operation and maintenance of self-propelled rice/wheat reaper
- Operation and maintenance on BRRRI open drum thresher
- Operation and maintenance on BRRRI closed drum thresher
- Operation and maintenance on BRRRI winnower
- Hands-on repair and maintenance of diesel engine
- Practical field operation of agricultural machinery at the farm level.

A total of 40 batches of the residential training programme were conducted, and 815 participants were trained in the programme. Among them, 550 were male, and 265 were female. Participants in the training programme were from the BRRRI RS adjacent areas and its jurisdiction district. An inaugural session was held on the 1<sup>st</sup> day of the training programme, and after that, a pre-evaluation of the trainees was done. Lectures and mostly practical sessions were arranged in all the locations plate 9. The step-by-step procedure to raise seedlings in the tray was shown practically to the participants. After this, machines like mechanical rice transplanter, combine harvester, self-propelled reaper, BRRRI open drum thresher, BRRRI closed drum thresher, BRRRI prilled urea applicator, BRRRI power and manual weeder, BRRRI winnower, and power tiller were operated preliminary in no load condition in threshing floor/road and after that these machines were operated by the trainees in the field one after one. At the end of the training, a post-evaluation and trainee's reactions regarding the training were collected. Certificates, leaflets, and a set of tools were distributed among the participants.



a) Inauguration of a training programme



b) Operation of manual seed sower machine

Plate 9. Pictorial view of hands-on training.

Formal training was a very effective tool, as the trainees were isolated from their homes and could concentrate fully in the classroom. The trainees wanted one week instead of two days of training to

improve their skills in farm machinery. Trainees opined that they are now more confident about using the machinery, and the hand tools will be helpful for their work.

## **Adaptive Research Division**

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## SUMMARY

Advanced Lines Adaptive Research Trials (ALART) were conducted at farmers' fields throughout the varied agro-ecological zones of the country depending on ALART categories and representative areas. A total of 38 advanced breeding lines were tested under 15 different categories of ALARTs during the reporting period, which included two rice growing seasons- Aman and Boro. Considering the yield and yield contributing characters and farmers' choice, only five breeding materials were recommended for Proposed Variety Trial (PVT). Two advanced lines such as V1= BR10230-7-19-2B and V2= BR9392-6-2-1B were recommended for PVT from the Deep Water Rice materials for deep flooded (1 to 2-meter water depth) condition during B. Aman season. The cold tolerant genotype BR11894-R-R-R-169 was selected for PVT during Boro season in Haor area of the country. Another breeding line such as R (path) 13800-BC3-134-25 was recommended for PVT as Bacterial Blight as well as Blast resistance line. One advanced line; V3= BRH13-9-5-2B was recommended for PVT Superior High Yielding Rice during Boro season. A total of 200 Head to Head Adaptive Trial (HHAT) were conducted through Public Private Partnership (PPP) during the reporting period in Aman 2023 under TRB project. Among the Flash flood submergence tolerant var. IR16F1148 produced the highest mean yield (5.66 t/ha) having the GD 140 days followed by BRRI dhan52 producing grain yield 5.22 t/ha with 147 days growth duration and other tested varieties BRRI dhan51, BRRI dhan79 produced statistically similar yield, which can overcome early flash flood, a major problem in flash flood prone areas. Seed Production and Dissemination Programme (SPDP) were conducted by using different BRRI released recent varieties under core programme, PARTNER, LSTD and TRB project. Seventeen different rice varieties were used in these demonstrations. Nearly 1,245 tons of grains were produced and 300 tons were retained as seeds by the farmers. About 70,000 farmers gained awareness and knowledge about BRRI varieties through demonstrations, knowledge sharing, field

days, field visit and interactions with farmers and extension personnel. Among them, about 26,000 farmers were motivated to adopt BRRI varieties.

ARD conducted 44 batches of farmers' training at different locations of the country, in which 1409 trainees participated on modern rice production technologies. A total of 23 field days were arranged at different locations of the country. At BRRI farm, 5,270 kg quality seeds of newly released BRRI varieties were produced.

## TECHNOLOGY VALIDATION

### **Advanced Line Adaptive Research Trial (ALART)**

**B. Aman 2023 Re-ALART (DWR).** Two advanced lines bred for deep flooded (one to two meter water depth) condition i.e., V1= BR10230-7-19-2B, V2= BR9392-6-2-1B with V3= Fulkori (ck.) and V4=Local popular variety (local check) as checks were retested in nine different locations such as Faridpur (Sadar), Gopalganj (Moksedpur), Munshiganj (Louhajang), Habiganj (Baniachang), Manikganj (Harirampur), Rajshahi (Tanore), Sirajganj (Tarash 2 trial), BRRI, Gazipur (Shibbari Deep water tank) during B. Aman 2023. Local check varieties were location specific. The Local check varieties used in this trial were Boirol, Hijol digha, However, severe damage at Rajshahi, Manikganj, and Gazipur made data collection impossible at those sites, and results from Manikganj, Cumilla, and Habiganj (rat damage) were excluded due to unsuitable conditions. The analysis focused on data from Faridpur, Gopalganj, Sirajganj, and Munshiganj. Water depth at Sirajganj reached 110 cm (128 DAS). Grain yield varied among genotypes, with V2=BR9390-6-2-1B achieving the highest yield (1.50 t/ha), followed by V4=Local check (1.48 t/ha). Growth duration ranged from 163 to 171 days, though it was less critical for deep water rice, which is highly photosensitive. Plant height ranged from 208 to 234 cm, a key trait for deep water rice. Despite these insights, both advanced lines failed to adapt to increasing water depth, and irregularities at Sirajganj, Munshiganj, and Gazipur led to a lack of farmer interest. Consequently, none of the advanced lines were recommended for PVT.

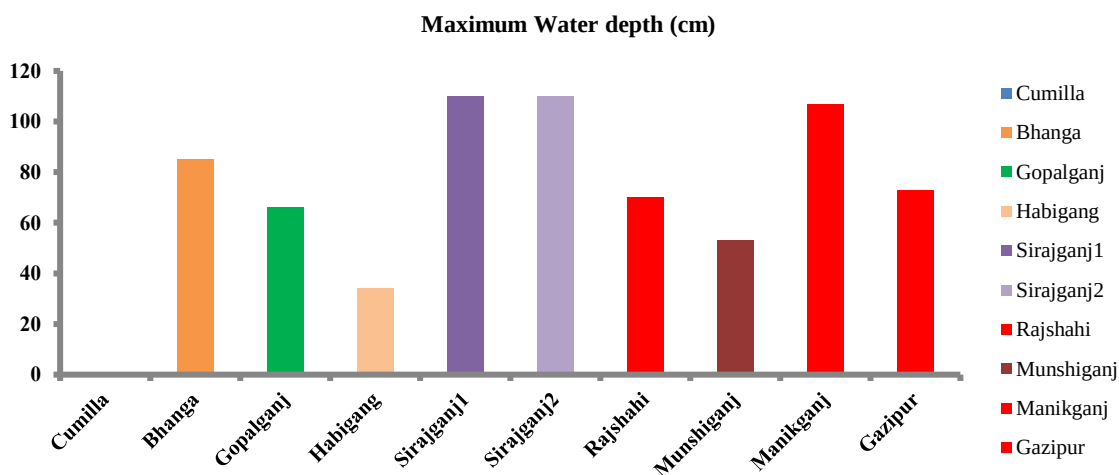


Fig.1 Maximum water depth measurement of all trials ALART (DWR) during B. Aman 2023.

**Table 1. Grain Yield (t/ha), growth duration (days), thousand grain weight (g) and plant height (cm) of some rice genotypes under Re-ALART (DWR) during B. Aman 2023.**

| Genotype            | Locations          |      |      |      |      | Mean yield | GD   | PHT  | TGW   |
|---------------------|--------------------|------|------|------|------|------------|------|------|-------|
|                     | L1                 | L2   | L3   | L4   | L5   |            |      |      |       |
|                     | Grain yield (t/ha) |      |      |      |      |            |      |      |       |
| V1=BR10230-7-19-2B  | 1.20               | 1.79 | 1.48 | 1.20 | 1.51 | 1.44       | 163  | 208  | 25.25 |
| V2=BR9390-6-2-1B    | 1.36               | 1.94 | 1.47 | 1.06 | 1.69 | 1.50       | 166  | 216  | 25.21 |
| V3=Fulkori (ck.)    | 1.27               | 1.62 | 1.43 | 1.03 | 1.04 | 1.28       | 165  | 231  | 24.65 |
| V4=Loc ck           | 1.88               | 1.45 | 1.54 | 1.40 | 1.15 | 1.48       | 171  | 234  | 25.36 |
| LSD <sub>0.05</sub> |                    |      | 0.24 |      |      | 0.11       | 0.27 | 5.76 | 0.58  |

L1=Bhanga, L2=Gopalganj, L3=Sirajganj1, L4=Sirajganj2, L5=Munshiganj, GD: Growth duration (day); TGW: Thousand grain weight (g); PHT: Plant height (cm).

**T. Aman 2023, ALART (SHR-1, BRRI dhan49 type).** Two advanced lines i.e. BRH13-2-14-2-1B and BR13-7-9-3-2B were evaluated along with BRRI dhan49 as check at farmers' field in ten different locations. Two trial sites out of ten locations were damaged. The trial site of Gopalganj (Sadar) was fully damaged by BPH and Rat and was abandoned by ALART monitoring team. V2=BR-13-7-9-3-2B was fully damaged by rat in Rajshahi (Godagari) trial site. Therefore, the results of these two locations were excluded and the rest results (eight locations) were analyzed for decision making. On average of eight locations, both the advanced lines i.e., BRH-13-2-14-2-1B and BR-13-

7-9-3-2B produced 3.99 and 3.88 t/ha respectively (Table 2). Which was statistically similar with the check variety BRRI dhan49 (4.08 t/ha), but numerically lower than the check variety. The mean growth duration of both the advanced lines BRH-13-2-14-2-1B and BR-13-7-9-3-2B were 133 days which was two days lower than the check variety (135 days). Most of the farmers didn't show their interest on both the advanced lines due to its lower grain yield, irregularities in flowering and maturity and phenotypic acceptance. Considering yield, disease and insect reactions, phenotypic acceptance, uniformity of flowering and maturity and farmers' preference none of the advanced lines was found suitable for PVT.

**Table 2. Grain yield (t/ha), Growth duration (days), thousand grain weight (g) and plant height (cm) of some rice genotypes under ALART (SHR-1, BRRI dhan49 type) during T. Aman 2023.**

| Genotype             | Location                         |      |      |      |      |      |      |      |      | GD<br>Mean | TGW<br>Mean | PHT<br>Mean |
|----------------------|----------------------------------|------|------|------|------|------|------|------|------|------------|-------------|-------------|
|                      | Grain yield (tha <sup>-1</sup> ) |      |      |      |      |      |      |      |      |            |             |             |
|                      | L1                               | L2   | L3   | L4   | L5   | L6   | L7   | L8   | Mean |            |             |             |
| V1= BRH-13-2-14-2-1B | 3.99                             | 3.58 | 3.36 | 5.1  | 3.32 | 3.21 | 5.34 | 4.08 | 3.99 | 133        | 22.65       | 116         |
| V2= BR-13-7-9-3-2B   | 3.83                             | 3.49 | 3.87 | 3.88 | 4.39 | 2.93 | 4.87 | 3.79 | 3.88 | 133        | 20.5        | 114         |
| V3= BRRI dhan49 (ck) | 5.26                             | 4.05 | 3.44 | 3.71 | 4.09 | 2.75 | 5.41 | 3.95 | 4.08 | 135        | 19.97       | 105         |
| LSD <sub>0.05</sub>  | 0.66                             |      |      |      |      |      |      |      | 0.23 | 0.33       | 0.51        | 1.67        |

L1-Kushtia, L2-Gazipur, L3-Patuakhali, L4-Bogura, L5-Rangpur, L6-Satkhira, L7-Sonagazi and L8-Cumilla, GD: Growth duration (day); TGW: Thousand Grain weight (g); PHT: Plant height (cm).

#### **T. Aman 2023, ALART (SHR-2, Swarna type).**

Two superior high yielding rice (SHR) genotypes BR9396-6-2-2B and BRH9392-6-2-1-3-4 along with BRRI dhan94 as checks were tested at farmers' field in ten locations. Grain yield of tested lines BRH9392-6-2-1-3-4(4.91 tha<sup>-1</sup>) and BR9396-6-2-2B (4.74 tha<sup>-1</sup>) is statistically similar with the check variety BRRI dhan94 (4.71 tha<sup>-1</sup>). Average

growth duration of tested lines were two days higher than the standard check BRRI dhan94. Thousand grain weight of the two advanced lines were (25.41 and 23.81 gm) significantly higher than check variety BRRI dhan94 (21.10 gm). Considering Grain yield growth duration and grain size, none of the advanced lines were recommended for PVT.

**Table 3. Grain yield (t/ha), growth duration (day), thousand grain weight (g) and plant height (cm) of some rice genotypes under ALART (SHR-2, Swarna type) during T. Aman 2023.**

| Genotype             | Location                         |      |      |      |      |      |      |      |      |      |      | GD   | TGW   | PHT  |
|----------------------|----------------------------------|------|------|------|------|------|------|------|------|------|------|------|-------|------|
|                      | Grain yield (tha <sup>-1</sup> ) |      |      |      |      |      |      |      |      |      |      |      |       |      |
|                      | L1                               | L2   | L3   | L4   | L5   | L6   | L7   | L8   | L9   | L10  | Mean |      |       |      |
| V1=BRH9392-6-2-1-3-4 | 6.59                             | 4.13 | 3.28 | 5.11 | 4.31 | 6.63 | 5.29 | 5.35 | 2.93 | 5.51 | 4.91 | 138  | 25.41 | 124  |
| V2= BR9396-6-2-2B    | 7.49                             | 4.27 | 4.10 | 5.01 | 2.97 | 5.67 | 5.22 | 5.21 | 2.78 | 4.69 | 4.74 | 138  | 23.81 | 128  |
| V3= BRRI dhan94(ck)  | 7.40                             | 3.93 | 3.55 | 5.19 | 4.45 | 5.89 | 4.95 | 5.00 | 3.56 | 3.17 | 4.71 | 136  | 21.10 | 119  |
| LSD <sub>0.05</sub>  |                                  |      |      |      |      |      |      |      |      |      | 0.22 | 0.26 | 0.38  | 1.58 |

L1- Rajshahi, L2- Cumilla L3- Barishal, L4- Sonagazi, L5- Bogura, L6- Gopalganj, L7- Ranjpur, L8- Kushtia, L9- BRRI Gazipur L10- Satkhira, GD: Growth duration (day); TGW: Thousand grain weight (g); PHT: Plant height (cm).

**T. Aman 2023 ALART (Antioxidant).** Two advanced lines: V1=BR12836-4R-63 and V2=BR12836-4R-312 from Plant Breeding Division along with BRRI dhan34 (ck) and BRRI dhan70 (ck) were tested at farmers' field in ten locations. Mean grain yield of tested lines V1=BR12836-4R-63 (3.1 t/ha) and V2=BR12836-4R-312 (3.4 t/ha) were lower than the standard check BRRI dhan70 (3.6 t/ha) but slightly higher than the standard check BRRI dhan34 (2.9 t/ha). Average growth duration of the tested lines were 1-

4 days lower than the standard check BRRI dhan70 but 5-8 days lower than the standard check BRRI dhan34. The tested entries were found irregular in flowering and maturity in several locations. Sheath blight, neck blast, leaf blast, brown spot, false smut and BLB were recorded in all the tested lines including the standard check in almost all of the locations. Stem borer, brown plant Hopper (BPH), rice bug infestations were recorded in all tested lines including standard check in almost all of the locations.

**Table 4. Grain yield (t/ha), growth duration (day), thousand grain weight (g) and plant height (cm) of some rice genotypes under ALART (Antioxidant) during T. Aman 2023.**

| Genotype            | Location           |     |     |     |     |     |     |     |     |     |      | GD   | TGW  | PHT  |      |
|---------------------|--------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
|                     | Grain yield (t/ha) |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
|                     | L1                 | L2  | L3  | L4  | L5  | L6  | L7  | L8  | L9  | L10 | Mean |      |      |      |      |
| V1=BR12836-4R-63    | 3.2                | 3.0 | 3.9 | 3.1 | 3.8 | 1.6 | 3.7 | 3.0 | 3.7 | 1.9 | 3.1  | 133  | 19.3 | 115  |      |
| V2=BR12836-4R-312   | 3.5                | 2.9 | 4.1 | 4.0 | 5.0 | 1.9 | 5.1 | 2.3 | 3.2 | 2.2 | 3.4  | 130  | 23.4 | 113  |      |
| V3=BRRI dhan34 (Ck) | 2.5                | 2.3 | 3.2 | 3.4 | 3.7 | 2.2 | 3.3 | 2.2 | 3.1 | 2.9 | 2.9  | 138  | 13.4 | 130  |      |
| V4=BRRI dhan70 (Ck) | 4.2                | 3.7 | 3.7 | 3.8 | 5   | 3   | 3.5 | 2.7 | 3.7 | 2.9 | 3.6  | 134  | 20.3 | 139  |      |
| LSD <sub>0.05</sub> | 0.69               |     |     |     |     |     |     |     |     |     |      | 0.70 | 2.27 | 2.36 | 4.72 |

L1- Satkhira, L2- Bogura, L3- Cumilla, L4- Sonagazi, L5- Gopalganj, L6- Barisal, L7- Rajshahi, L8- Rangpur, L9- Kushtia, L10- BRRI HQ, GD: growth duration (day); TGW: thousand grain weight (g); PHT: plant height (cm).

**Boro 2024, ALART (CTR-Haor).** Two advanced lines; TP16199 and BR11894-R-R-R-R-169 from plant breeding division along with BRRI dhan28 (ck) and BRRI dhan67 (ck) were tested at farmers' field in ten locations. The tested entry BR11894-R-R-R-R-169 gave higher yield compared to the check varieties (Table 5). The tested entries were uniform in flowering and maturity. Considering all the characteristics, BR11894-R-R-R-R-169 entry was recommended for PVT.

**Table 5. Grain yield (t/ha), growth duration (day), thousand grain weight (g) and plant height (cm) of some rice genotypes under ALART (CTR-Haor) during Boro 2024.**

| Genotype               | Location           |      |      |      |      |      |      |      |      |      |      | GD   | TGW   | PHT  |
|------------------------|--------------------|------|------|------|------|------|------|------|------|------|------|------|-------|------|
|                        | Grain yield (t/ha) |      |      |      |      |      |      |      |      |      |      |      |       |      |
|                        | L1                 | L2   | L3   | L4   | L5   | L6   | L7   | L8   | L9   | L10  | Mean |      |       |      |
| V1= TP16199            | 7.30               | 6.76 | 8.71 | 6.18 | 7.27 | 6.28 | 5.95 | 6.80 | 7.15 | 6.74 | 6.91 | 151  | 22.80 | 120  |
| V2=BR11894-R-R-R-R-169 | 8.09               | 9.03 | 9.39 | 8.29 | 7.98 | 6.91 | 5.59 | 6.59 | 7.78 | 7.00 | 7.66 | 148  | 22.70 | 115  |
| V3= BRRI dhan28 (ck)   | 5.17               | 6.13 | 5.71 | 7.83 | 6.17 | 5.96 | 5.86 | 5.79 | 5.81 | 5.56 | 6.00 | 146  | 22.30 | 98   |
| V4= BRRI dhan67 (ck)   | 8.19               | 7.34 | 7.80 | 7.39 | 7.29 | 6.80 | 6.22 | 6.83 | 6.26 | 6.15 | 7.03 | 146  | 21.80 | 113  |
| LSD <sub>0.05</sub>    | 0.72               |      |      |      |      |      |      |      |      |      |      | 0.21 | 0.53  | 3.21 |

L1-Baniachong, Habiganj, L2- Ajmeriganj, Habiganj, L3- Nabiganj, Habiganj, L4-Taherpur, Sunamganj, L5- Santiganj, Sunamganj, L6-Itna, Kishoreganj, L7-Mithamoin, Kishoreganj, L8-Madan, Netrakona, L9-Khaliajuri, Netrakona, L10-BRRI Gazipur, GD: growth duration (day); TGW: Tthousand grain weight (g); PHT: plant height (cm).

**Boro 2024, ALART (FBR-Bio):** Three advanced lines: BR (Bio) 13028-AC24-1-2, BR (Bio) 13028-AC24-2-3 and BR (Bio) 13028-AC24-2-4 from Biotechnology Division along with BRRI dhan86 (ck) and BRRI dhan96 (ck) were tested at farmers' field in ten locations. Growth duration was almost similar. All the tested entries produced almost similar yield compared to the check varieties (Table 6). The tested entries were not uniform in flowering and maturity in some locations. Considering all the characteristics, none of the tested entries were recommended for PVT.



**Table 6. Grain yield (t/ha), growth duration (day), thousand grain weight (g) and plant height (cm) of some rice genotypes under ALART (FBR-Bio) during Boro 2024.**

| Genotype                  | Location           |      |      |      |      |      |      |      |      |      |      | GD   | TGW   | PHT  |      |
|---------------------------|--------------------|------|------|------|------|------|------|------|------|------|------|------|-------|------|------|
|                           | Grain yield (t/ha) |      |      |      |      |      |      |      |      |      |      |      |       |      |      |
|                           | L1                 | L2   | L3   | L4   | L5   | L6   | L7   | L8   | L9   | L10  | Mean |      |       |      |      |
| V1=BR(Bio) 13028-AC24-1-2 | 5.77               | 7.20 | 6.31 | 6.97 | 7.42 | 6.85 | 5.66 | 6.35 | 5.40 | 7.51 | 6.54 | 145  | 21.43 | 116  |      |
| V2=BR(Bio) 13028-AC24-2-3 | 5.03               | 6.60 | 5.65 | 6.82 | 6.30 | 6.37 | 5.23 | 5.85 | 4.96 | 7.23 | 6.00 | 145  | 19.28 | 101  |      |
| V3=BR(Bio) 13028-AC24-2-4 | 6.14               | 4.95 | -    | 6.29 | 5.87 | 5.58 | 5.68 | 6.11 | 4.10 | 4.93 | 5.52 | 143  | 21.75 | 103  |      |
| V4= BRRI dhan86 (ck)      | 5.21               | 5.26 | -    | 6.32 | 6.26 | 6.79 | 5.78 | 5.99 | 5.90 | 6.93 | 6.05 | 142  | 22.05 | 95   |      |
| V5= BRRI dhan96 (ck)      | 5.89               | 7.67 | 6.15 | 6.48 | 7.03 | 6.81 | 5.85 | 6.34 | 6.13 | 5.67 | 6.40 | 144  | 19.45 | 93   |      |
| LSD <sub>0.05</sub>       | 0.63               |      |      |      |      |      |      |      |      |      |      | 0.21 | 0.22  | 0.34 | 1.46 |

L1-Kushtia, L2- Faridpur, L3Cumilla, L4-Feni, L5- Gopalganj, L6-Rajshahi, L7-Sirajganj, L8-Rangpur, L9-Satkhira, L10-BRRI Gazipur, GD: growth duration (day); TGW: thousand grain weight (g); PHT: plant height (cm).

**Boro 2024, ALART (FBR-SD).** Two advanced lines i.e., BR11903-5R-56 and IR18A2119 were evaluated along with two check varieties BRRI dhan88 and BRRI dhan96 in ten different locations of the country during Boro 2023-24 at farmers' field. The trials were replicated thrice in each location. On average of ten locations, both the advanced lines i.e., BR11903-5R-56 and IR18A2119 produced significantly higher grain yield (7.02 and 7.04 t/ha) than both the check varieties i.e., BRRI dhan88 (6.73 t/ha) and BRRI dhan96 (6.63 t/ha) (Table 7).

Mean growth duration over 10 locations of the two advanced lines was same and this was 147 days which was 3 to 4 days higher than both the check varieties (Table 7). On average thousand grain

weight of both the advanced lines BR11903-5R-56 and IR18A2119 was 22.83 23.77 gram respectively which was significantly higher than the two check varieties i.e., BRRI dhan88 and BRRI dhan96 (21.58 and 20.96 gram) (lsd value 0.98). The highest sterility% was found in the advanced line IR18A2119 (27%) followed by BR11903-5R-56 (26%). Sterility% in both the advanced lines was significantly higher than the check variety BRRI dhan96 (Table 7). Most of the farmers didn't show their interest on both the advanced lines due to its lower grain yield, higher growth duration and phenotypic acceptance. Considering growth duration, grain yield, disease and insects reactions, phenotypic acceptance and farmers' preference none of the advanced lines found suitable for PVT.

**Table 7. Grain yield (t/ha), growth duration (day), thousand grain weight (g) and Pplant height (cm) of some rice genotypes under ALART (FBR-SD) during Boro 2024.**

| Genotype             | Location                         |      |      |      |      |      |      |      |      |      |      | G D  | TGW   | PHT  |      |
|----------------------|----------------------------------|------|------|------|------|------|------|------|------|------|------|------|-------|------|------|
|                      | Grain yield (tha <sup>-1</sup> ) |      |      |      |      |      |      |      |      |      |      |      |       |      |      |
|                      | L1                               | L2   | L3   | L4   | L5   | L6   | L7   | L8   | L9   | L10  | Mean |      |       |      |      |
| V1 = BR11903-5R-56   | 9.15                             | 7.3  | 7.86 | 6.65 | 6.06 | 7.68 | 6.75 | 6.03 | 6.25 | 6.44 | 7.02 | 147  | 22.83 | 104  |      |
| V2 = IR18A21 19      | 8.52                             | 6.97 | 7.67 | 8.08 | 5.77 | 7.77 | 6.88 | 5.99 | 6.4  | 6.32 | 7.04 | 147  | 23.77 | 98   |      |
| V3= BRRI dhan88 (ck) | 8.43                             | 7.18 | 7.23 | 6.7  | 5.65 | 7.96 | 6.5  | 5.36 | 6.32 | 5.95 | 6.73 | 144  | 21.58 | 93   |      |
| V4= BRRI dhan96 (ck) | 8.54                             | 6.46 | 6.7  | 6.28 | 6.21 | 7.68 | 6.6  | 5.66 | 6.2  | 5.98 | 6.63 | 143  | 20.96 | 91   |      |
| LSD <sub>0.05</sub>  | 0.69                             |      |      |      |      |      |      |      |      |      |      | 0.25 | 1.43  | 0.98 | 2.54 |

L1-Faridpur, L2- Cumilla, L3- Gopalganj, L4- Habiganj, L5- Kushtia, L6- Rajshahi, L7- Rangpur and L8- Sirajganj, L8-Sirajganj, L9- Feni and L10-West Byed, GD: growth duration (day); TGW: thousand grain weight (g); PHT: plant height (cm).

**Boro 2024, ALART (FBR-LD).** One advanced line BR11318-5R-84 developed by Breeding Division of BRRI was evaluated against one check variety BRRI dhan92 in ten different locations of the country during Boro 2023-24 at farmers' field. The trials were replicated thrice in each location. Yield components, growth duration and plant height varied significantly by the interaction of rice genotypes and different locations. Irrespective of 10 locations, the advanced line BR11318-5R-84 produced the mean grain yield 8.08 t/ha which was statistically similar but numerically higher than the check variety BRRI dhan92 (7.85 t/ha) (Table 8). Mean growth duration over 10 locations of the advanced line BR11318-5R-84 was 161 days which was significantly higher (two days) than the check variety BRRI dhan92 (159 days) (Table 8). Although grains of the two tested entries are medium slender, an average thousand grain weight of the advanced line was 21.33 gram which was significantly lower than the check variety BRRI dhan92 (23.25 g; lsd value 0.85). Mean filled grains/panicle of advanced line BR11318-5R-84 was numerically higher (136) than the check variety BRRI dhan92 (128; Lsd value 10.6) (Table 8). However, filled grains/panicle didn't differ significantly between advanced line BR11318-5R-84 and the BRRI dhan92 (ck.). Most of the farmers didn't show their interest on the advanced line due to its higher growth duration and phenotypic acceptance. Considering growth duration, grain yield, disease and insects reactions, phenotypic acceptance and farmers' preference the advanced line was recommended for PVT.

**Table 8. Grain yield (t/ha), growth duration (day), thousand grain weight (g) and plant height (cm) of some rice genotypes under ALART (FBR-SD) during Boro 2024.**

| Genotype             | Location                         |      |      |      |      |      |      |      |      |      |      | G D  | TGW   | PHT  |
|----------------------|----------------------------------|------|------|------|------|------|------|------|------|------|------|------|-------|------|
|                      | Grain yield (tha <sup>-1</sup> ) |      |      |      |      |      |      |      |      |      |      |      |       |      |
|                      | L1                               | L2   | L3   | L4   | L5   | L6   | L7   | L8   | L9   | L10  | Mean | Mean | Mean  | Mean |
| V1= BR11318-5R-84    | 8.52                             | 7.79 | 8.82 | 7.97 | 6.95 | 8.56 | 9.4  | 6.97 | 7.15 | 8.62 | 8.08 | 161  | 21.33 | 113  |
| V2= BRRI dhan92 (ck) | 8.44                             | 7.43 | 8.01 | 7.61 | 7.05 | 7.74 | 9.51 | 6.56 | 8.10 | 8.08 | 7.85 | 159  | 23.25 | 113  |
| LSD <sub>0.05</sub>  | 0.94                             |      |      |      |      |      |      |      |      |      | 0.24 | 1.32 | 0.85  | 1.86 |

L1-Faridpur, L2- Cumilla, L3- Gopalganj, L4- Habiganj, L5- Kushtia, L6- Rajshahi, L7- Rangpur and L8- Sirajganj, L8-Sirajganj, L9- Feni and L10-West byde, Gazipur, GD: growth duration (day); TGW: thousand grain weight (g); PHT: plant height (cm).

**Boro 2024, ALART (BB+Blast).** Three advanced lines: R (path) 13800-BC3-134-8, R (path) 13800-BC3-134-25 and R (path) 13800-BC3-224-44 from Plant Pathology Division along with BRRI dhan89 (ck) and BRRI dhan92 (ck) were tested at farmers' field in ten locations. Growth duration was almost

similar. Both the R (path) 13800-BC3-134-8 and R (path) 13800-BC3-134-25 entries produced statistically higher yield compared to the check varieties (Table 9). The tested entries were found uniform in flowering and maturity in all locations.

Both the entries were found less susceptible to bacterial leaf blight and blast disease. Considering all the characteristics, R (path) 13800-BC3-134-25 line was recommended for PVT.

**Table 9. Grain Yield (t/ha), growth duration (day), thousand grain weight (g) and plant height (cm) of some rice genotypes under ALART (BB+Blast) during Boro 2024.**

| Genotype                   | Location           |     |     |      |     |     |     |     |     |     |      | GD   | TGW  | PHT  |
|----------------------------|--------------------|-----|-----|------|-----|-----|-----|-----|-----|-----|------|------|------|------|
|                            | Grain yield (t/ha) |     |     |      |     |     |     |     |     |     |      |      |      |      |
|                            | L1                 | L2  | L3  | L4   | L5  | L6  | L7  | L8  | L9  | L10 | Mean | Mean | Mean | Mean |
| V1=R(path)13800-BC3-134-8  | 5.8                | 5.1 | 157 | 23.0 | 9.0 | 7.6 | 7.9 | 6.9 | 6.6 | 9.9 | 7.43 | 157  | 23.0 | 107  |
| V2=R(path)13800-BC3-134-25 | 5.6                | 4.8 | 157 | 22.7 | 9.3 | 7.7 | 8.7 | 7.8 | 7.6 | 9.5 | 7.61 | 157  | 22.7 | 105  |
| V3=R(path)13800-BC3-224-44 | 5.9                | 5.0 | 159 | 23.7 | 7.5 | 7.3 | 6.8 | 7.2 | 6.4 | 8.7 | 7.02 | 159  | 23.7 | 109  |
| V4= BRRI dhan89 (check)    | 5.5                | 3.9 | 158 | 23.7 | 6.8 | 7.1 | 6.2 | 7.6 | 7.2 | 8.4 | 6.61 | 158  | 23.7 | 110  |
| V5= BRRI dhan92 (check)    | 5.4                | 4.3 | 160 | 22.9 | 7.9 | 6.8 | 6.8 | 7.9 | 7.9 | 7.7 | 6.83 | 160  | 22.9 | 111  |
| LSD <sub>0.05</sub>        | 1.66               |     |     |      |     |     |     |     |     |     | 0.25 | 0.17 | 0.44 | 1.36 |

L1- Satkhira, L2- Sirajganj, L3Cumilla, L4-Feni, L5- Habiganj, L6-Barishal, L7- Netrakana, L8-Rangpur, L9-Kishoreganj, L10-BRRI Gazipur, GD: growth duration (day); TGW: thousand grain weight (g); PHT: plant height (cm).

**Boro 2024, ALART (BB).** Three advanced lines: BR (path) 13800-BC3-8-1, BR (path) 13800-BC3-8-9 and BR (path) 13800-BC3-224-28 from plant pathology division along with BRRI dhan89 (ck) and BRRI dhan92 (ck) were tested at farmers' field in ten locations. Growth duration was almost similar. All the tested entries produced almost similar yield compared to the check variety BRRI

dhan92 (Table 10). The tested entries were found uniform in flowering and maturity in all locations. Both the entries found, all the tested entries produced almost similar yield compared to the check varieties susceptible to bacterial leaf blight and blast disease. Considering all the characteristics, none of the tested entries was recommended for PVT.

**Table 10. Grain yield (t/ha), growth duration (day), thousand grain weight (g) and plant height (cm) of some rice genotypes under ALART (BB) during Boro 2024.**

| Genotype                     | Location           |     |     |      |     |     |     |     |     |     |      | GD   | TGW  | PHT |      |
|------------------------------|--------------------|-----|-----|------|-----|-----|-----|-----|-----|-----|------|------|------|-----|------|
|                              | Grain yield (t/ha) |     |     |      |     |     |     |     |     |     |      |      |      |     |      |
|                              | L1                 | L2  | L3  | L4   | L5  | L6  | L7  | L8  | L9  | L10 | Mean |      |      |     |      |
| V1=BR (path)13800-BC3-8-1    | 4.8                | 6.1 | 9.0 | 22.9 | 7.2 | 7.6 | 7.2 | 7.3 | 7.4 | 7.3 | 7.0  | 157  | 23.0 | 103 |      |
| V2=BR (path)13800-BC3-8-9    | 4.8                | 6.2 | 9.4 | 22.4 | 8.5 | 4.1 | 8.4 | 6.9 | 6.7 | 9.0 | 7.0  | 158  | 22.7 | 106 |      |
| V3=BR (path)13800-BC3-224-28 | 5.4                | 5.6 | 9.1 | 23.4 | 8.0 | 5.1 | 6.0 | 8.3 | 6.7 | 8.9 | 7.0  | 159  | 23.7 | 107 |      |
| V4= BRRI dhan89 (check)      | 5.7                | 5.1 | 9.1 | 23.1 | 6.7 | 4.6 | 6.0 | 6.8 | 7.0 | 8.5 | 6.4  | 158  | 23.7 | 109 |      |
| V5= BRRI dhan92 (check)      | 4.9                | 4.7 | 8.9 | 23.2 | 7.8 | 4.6 | 6.9 | 7.8 | 7.6 | 9.4 | 6.8  | 157  | 22.9 | 112 |      |
| LSD <sub>0.05</sub>          | 1.70               |     |     |      |     |     |     |     |     |     |      | 0.27 | 0.33 | 0.8 | 1.55 |

L1- Satkhira, L2- Sirajganj, L3Cumilla, L4-Feni, L5- Habiganj, L6-Barishal, L7- Netrakona, L8-Rangpur, L9-Kishoreganj, L10-BRRI, Gazipur, GD: growth duration (day); TGW: thousand grain weight (g); PHT: Plant height (cm).

**Boro 2024, ALART (SHR-1, Zira type).** Three advanced lines: BRH15-24-7B, BR9392-1-7-5B and BR17-23-8-2-7B from Plant Breeding Division along with BRRI dhan88 (ck) were tested at farmers' field in ten locations. The mean growth duration of tested lines were 4-5 days higher than the standard check BRRI dhan88. Among the genotypes the highest mean grain yield (7.43 t/ha) was obtained in V3= BR17-23-8-2-7B followed by V1= BRH15-24-7B (7.02 t/ha), BRRI dhan88 (ck)

(7.00 t/ha), and V2= BR9392-1-7-5B (6.96 t/ha). The tested entries were found irregular in flowering and maturity in all locations. Leaf blast and Neck blast were not found severely in any location. Considering yield, growth duration, disease reactions and phenotypic acceptance, none of the tested line was recommended for advanced trial or proposed variety trial (PVT). Irregular maturity of grains in a single panicle was observed.

**Table 11. Grain yield (t/ha), growth duration (day), thousand grain weight (g) and plant height (cm) of some rice genotypes under ALART (SHR-1, Zira type) during Boro 2024.**

| Genotype             | Location           |      |      |      |      |      |      |      |      |      |      | GD   | TGW  | PHT  |      |
|----------------------|--------------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
|                      | Grain yield (t/ha) |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
|                      | L1                 | L2   | L3   | L4   | L5   | L6   | L7   | L8   | L9   | L10  | Mean |      |      |      |      |
| V1= BRH15-24-7B      | 6.97               | 7.68 | 6.84 | 8.22 | 6.28 | 5.73 | 6.46 | 7.13 | 7.05 | 7.82 | 7.02 | 149  | 18.8 | 93   |      |
| V2= BR9392-1-7-5B    | 7.61               | 7.77 | 5.84 | 7.69 | 5.93 | 6.26 | 6.00 | 7.83 | 6.71 | 7.99 | 6.96 | 149  | 19.6 | 92   |      |
| V3= BR17-23-8-2-7B   | 8.34               | 7.96 | 6.71 | 8.06 | 7.18 | 6.40 | 6.44 | 7.98 | 7.01 | 8.26 | 7.43 | 148  | 17.9 | 97   |      |
| V4= BRRI dhan88 (ck) | 7.61               | 7.68 | 5.46 | 8.65 | 6.23 | 6.45 | 6.31 | 8.28 | 6.31 | 6.99 | 7.00 | 144  | 21.3 | 95   |      |
| LSD <sub>0.05</sub>  | 0.72               |      |      |      |      |      |      |      |      |      |      | 0.22 | 0.22 | 0.34 | 1.46 |

L1- BRRI Gazipur, L2- Paba, Rajshahi, L3- Sadar, Kushtia, L4- Bhanga, Faridpur, L5- Kamarkhanda, Sirajganj, L6- Sadar, Satkhira, L7- Adorsha Sadar, Cumilla, L8- Mithapukur, Rangpur, L9- Sonagazi, Feni, L10- Sadar, Gopalganj, GD: growth duration (days); TGW: thousand grain weight (g); PHT: Plant height (cm).

**Boro 2024, ALART (SHR-2, Katary type).** Three advanced lines: V1= BRH11-7-17-10B; V2= BRH9-3-2B and V3= BRH13-9-5-2B from Plant Pathology Division along with BRRI dhan81 (ck) were tested at farmers' field in ten locations. The mean growth duration of tested lines were 5-6 days higher than the standard check BRRI dhan81. Among the genotypes highest mean grain yield (7.33 t/ha) was obtained in V3= BRH13-9-5-2B followed by V2= BRH9-3-2B (7.27 t/ha), V1=

BRH11-7-17-10B (7.24 t/ha), and BRRI dhan81 (ck) (6.57 t/ha) (Table 12). The tested entries were found irregular in flowering and maturity in all locations. Leaf blast and neck blast were not found severely in any location. Considering yield, growth duration, disease reactions and phenotypic acceptance, V3= BRH13-9-5-2B line is recommended for advanced trial or Proposed variety trial (PVT). Irregular maturity of grains in a single panicle was also observed.

**Table 12. Grain yield (t/ha), growth duration (day), thousand grain weight (g) and plant height (cm) of some rice genotypes under ALART (SHR-2, Katary type) during Boro 2024.**

| Genotype          | Location           |      |      |      |      |      |      |      |      |      |      | GD  | TGW  | PHT |
|-------------------|--------------------|------|------|------|------|------|------|------|------|------|------|-----|------|-----|
|                   | Grain yield (t/ha) |      |      |      |      |      |      |      |      |      |      |     |      |     |
|                   | L1                 | L2   | L3   | L4   | L5   | L6   | L7   | L8   | L9   | L10  | Mean |     |      |     |
| V1=BRH11-7-17-10B | 8.15               | 7.63 | 7.04 | 7.98 | 6.76 | 5.51 | 6.52 | 8.71 | 6.66 | 7.42 | 7.24 | 149 | 19.0 | 99  |
| V2= BRH9-3-2B     | 8.59               | 7.89 | 6.76 | 7.87 | 7.10 | 6.08 | 6.08 | 8.29 | 6.19 | 7.83 | 7.27 | 150 | 18.6 | 99  |
| V3=BRH13-9-5-2B   | 8.39               | 7.83 | 6.83 | 7.94 | 7.05 | 5.72 | 6.33 | 8.54 | 6.53 | 8.13 | 7.33 | 149 | 18.4 | 99  |

| Genotype             | Location           |      |      |      |      |      |      |      |      |      |      | GD   | TGW  | PHT  |
|----------------------|--------------------|------|------|------|------|------|------|------|------|------|------|------|------|------|
|                      | Grain yield (t/ha) |      |      |      |      |      |      |      |      |      |      | Mean | Mean | Mean |
|                      | L1                 | L2   | L3   | L4   | L5   | L6   | L7   | L8   | L9   | L10  | Mean | Mean | Mean | Mean |
| V4= BRRI dhan81 (ck) | 8.20               | 7.23 | 5.30 | 8.05 | 5.80 | 4.46 | 6.21 | 7.85 | 6.08 | 6.54 | 6.57 | 144  | 21.6 | 98   |
| LSD <sub>0.05</sub>  | 0.69               |      |      |      |      |      |      |      |      |      |      | 0.22 | 0.37 | 1.25 |

L1- BRRI Gazipur, L2- Paba, Rajshahi, L3- Sadar, Kushtia, L4- Bhanga, Faridpur, L5- Kamarkhanda, Sirajganj, L6- Sadar, Satkhira, L7- Adorsha Sadar, Cumilla, L8- Mithapukur, Rangpur, L9- Sonagazi, Feni, L10- Sadar, Gopalganj, GD: growth duration (days); TGW: thousand grain weight (g); PHT: Plant height (cm).

**Boro 2024, ALART (PQR).** Five advanced breeding lines such as V1= BR10645-6-4-8-1-2, V2= BR10646-3-2-2-4-3, V3= BR10648-12-1-3-4-1, V4=Zira, Nachol and V5=Katari, Shibganj having premium quality rice developed by Plant Breeding Division for Boro season were evaluated in ten different locations of the country along with the three check varieties- BRRI dhan104, BRRI dhan107 and BINA dhan25. The highest mean grain yield was found in check variety BRRI dhan107, which was 6.98 t/ha and the check variety BRRI dhan103 produced 6.93 t/ha. Both these varieties produced significantly higher yield than the tested entries; V2= BR10646-3-2-2-4-3, V3=

BR10648-12-1-3-4-1, V4=Zira, Nachol and V5=Katari, Shibganj. None of the tested entries produced significantly higher grain yield than the check varieties BRRI dhan104, BRRI dhan107 nor BINA dhan25. Droopy and curled leaves were observed in the tested entries. Sheath blight infestation were observed in all entries at three locations. Thousand grain weight of all the entries were statistically similar as checks and grain quality was not preferable. Considering yield, disease and insect reactions, phenotypic acceptance, uniformity of flowering and maturity and farmers' preference, none of the advanced lines found suitable for PVT.

**Table 13. Grain yield (t/ha), growth duration (day), thousand grain weight (g) and plant height (cm) of some rice genotypes under ALART (PQR) during Boro 2024.**

| Genotype               | Location                          |      |      |      |      |      |      |      |      |      |      | GD   | TGW   | PHT  |
|------------------------|-----------------------------------|------|------|------|------|------|------|------|------|------|------|------|-------|------|
|                        | Grain yield (t ha <sup>-1</sup> ) |      |      |      |      |      |      |      |      |      |      | Mean | Mean  | Mean |
|                        | L1                                | L2   | L3   | L4   | L5   | L6   | L7   | L8   | L9   | L10  | Mean | Mean | Mean  | Mean |
| V1= BR10645-6-4-8-1-2  | 6.16                              | 7.14 | 6.59 | 7.58 | 6.58 | 7.21 | 6.10 | 4.91 | 9.68 | 6.74 | 6.87 | 153  | 21.46 | 106  |
| V2= BR10646-3-2-2-4-3  | 5.39                              | 6.88 | 5.53 | 7.47 | 6.83 | 6.52 | 6.39 | 5.93 | 7.83 | 6.18 | 6.50 | 145  | 21.94 | 112  |
| V3= BR10648-12-1-3-4-1 | 5.30                              | 5.80 | 5.29 | 6.36 | 6.45 | 6.12 | 5.80 | 5.14 | 8.04 | 5.94 | 6.02 | 149  | 21.06 | 106  |
| V4=Zira, Nachol        | 5.96                              | 6.31 | 6.41 | 6.58 | 7.96 | 6.46 | 3.87 | 5.31 | 8.57 | 7.35 | 6.48 | 151  | 21.08 | 102  |
| V5=Katari, Shibganj    | 5.47                              | 6.73 | 6.53 | 5.44 | 6.45 | 6.63 | 5.78 | 5.92 | 7.98 | 6.86 | 6.38 | 154  | 20.67 | 108  |
| V6=BRRI dhan104 (ck)   | 6.79                              | 6.90 | 6.52 | 6.67 | 7.05 | 6.83 | 6.29 | 6.50 | 8.24 | 7.54 | 6.93 | 154  | 21.70 | 99   |
| V7=BRRI dhan107 (ck)   | 5.47                              | 7.07 | 5.91 | 7.33 | 7.67 | 7.42 | 7.56 | 6.35 | 7.72 | 7.28 | 6.98 | 155  | 24.79 | 105  |
| V8=BINA dhan25 (ck)    | 6.52                              | 6.75 | 5.87 | 7.76 | 8.07 | 6.91 | 4.53 | 5.68 | 6.73 | 7.28 | 6.61 | 154  | 21.02 | 128  |
| LSD (0.05)             | 0.49                              |      |      |      |      |      |      |      |      |      |      | 0.15 | 0.33  | 1.67 |

L1- Sadar, Kushtia; L2- Sadar, Cumilla; L3- Paba, Rajshahi; L4- Mithapukur, Rangpur; L5- Kamarkhand, Sirajganj; L6- Sadar, Gopalganj; L7- Baniachang, Habigonj; L8- Sonagazi, Feni; L9- Bhanga, Faridpur; L10- BRRI, Gazipur. GD: Growth duration (day); TGW: thousand grain weight (g); PHT: Plant height (cm).

**Boro 2024, ALART (Late Boro).** One advanced rice line, V1 = BR11845-4R-62, was tested alongside three check varieties: V2 = BINA dhan25

(ck), V3 = BRRI dhan28 (ck), and V4 = BRRI dhan98 (ck) across 10 different locations, including Rangpur (Sadar), Dinajpur (Parbotipur),

Nilphamari (Sadar), Lalmonirhat (Sadar), Natore (Singra), Sirajganj (Tarash), Joypurhat (Sadar), Kushtia (Sadar), Manikganj (Saturia), and Gazipur (BRRI HQ) during the Boro season of 2023. The trials were replicated three times at each location. Among the four tested rice genotypes, the check variety V4 = BRRI dhan98 produced a mean yield of 6.95 tons/ha, which was significantly higher than the advanced line V1 = BR11845-4R-62, which yielded an average of 6.55 tons/ha. V2 (BINA dhan14) recorded a mean yield of 6.11 tons/ha, while V3 = BRRI dhan28 had an average yield of 6.34 tons/ha. Plant growth was excellent for all

entries, and their phenotypic appearance was good during the vegetative stage. However, flowering and maturity were not uniform in the advanced line V1 = BR11845-4R-62. Other characteristics, such as growth duration, plant height, and thousand grain weight (g), did not show any advantage. Moreover, farmers preferred the check variety BRRI dhan98 among the lines for its higher grain yield. Based on the ALART monitoring committee report, farmers' preferences, and data analysis, the advanced line V1 = BR11845-4R-62 was not recommended for PVT.

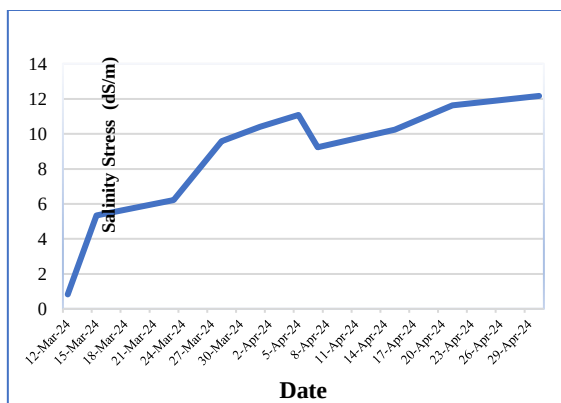
**Table 14. Grain yield (t/ha), growth duration (days), thousand grain weight (g) and plant height (cm) of some rice genotypes under ALART (Late Boro) during Boro 2024.**

| Genotype            | L1                 | L2   | L3   | L4   | L5   | L6   | L7   | L8   | L9   | L10  | Mean |      |      |       |
|---------------------|--------------------|------|------|------|------|------|------|------|------|------|------|------|------|-------|
|                     | Grain yield (t/ha) |      |      |      |      |      |      |      |      |      | GY   | GD   | PHT  | TGW   |
| V1=BR11845-4R-62    | 7.10               | 7.10 | 6.55 | 7.52 | 6.14 | 7.27 | 7.35 | 6.12 | 6.81 | 3.55 | 6.55 | 115  | 103  | 25.47 |
| V2=BINA dhan14      | 6.46               | 5.96 | 6.87 | 7.10 | 5.80 | 6.59 | 6.03 | 6.26 | 5.82 | 4.24 | 6.11 | 111  | 99   | 22.55 |
| V3=BRRI dhan28(ck)  | 6.61               | 6.78 | 7.21 | 7.19 | 5.83 | 6.67 | 7.45 | 6.27 | 5.41 | 4.02 | 6.34 | 112  | 114  | 22.29 |
| V4=BRRI dhan98(ck)  | 7.30               | 6.40 | 7.17 | 7.17 | 5.82 | 6.76 | 7.57 | 6.32 | 8.78 | 6.22 | 6.95 | 115  | 107  | 24.00 |
| LSD <sub>0.05</sub> | 0.61               |      |      |      |      |      |      |      |      |      | 0.19 | 0.26 | 0.77 | 0.25  |

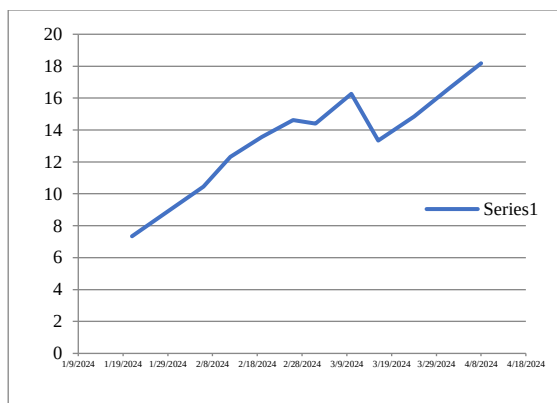
L1=Rangpur, L2=Dinajpur, L3=Nilphamari, L4=Lalmonirhat, L5=Natore, L6=Gaibandha, L7=Bogura, L8=Kushtia, L9=Manikganj, L10=Gazipur, GD: growth duration (day); TGW: thousand grain weight (g); PHT: Plant height (cm).

**Boro 2024, ALART (STR):** Four advanced lines i.e., BR11712-4R-44, BR11712-4R-93, BR11712-4R-12, BR11712-4R-6 along with BRRI dhan67 (ck) and BRRI dhan89 (ck) as checks were tested at farmers' field in ten locations under saline tidal environment. In Feni upazila of Sonagazi district, the lines BR11712-4R-6 and BRRI dhan67 (ck) were completely damaged by leaf blast, while BRRI dhan89 (ck) in Bagerhat (Sadar) and Satkhira (Kaliganj) was entirely damaged due to salinity (7 ds/m and 18.18 ds/m). In Satkhira (Kaliganj), BRRI dhan67 (ck) grains failed to fill completely due to high salinity. Among the 10 locations studied, high salinity levels were observed in four areas: Bagerhat (Sadar), Noakhali (Sadar), Satkhira (Kaliganj), and Satkhira (Shamnagar). These locations experienced low crop yields due to elevated salinity. The highest salinity level recorded was 18.18 dS/m in Satkhira (Kaliganj), while the lowest was 0.82 ds/m in Noakhali (Sadar). In the saline prone areas, all the tested lines produced higher yields in Noakhali (Sadar) (3.94 t/ha),

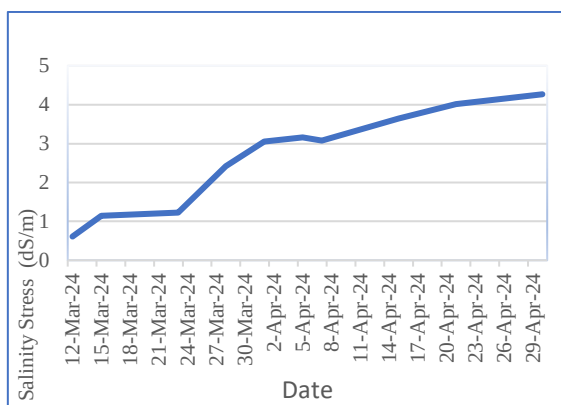
compared to the lower yields in Satkhira (Shamnagar) (0.9 t/ha). In contrast, the remaining 6 locations, including Barishal (Sadar), BRRI (HQ), Noakhali (Companiganj), Patuakhali (Kolapara), Satkhira (Sadar), and Sonagazi (Feni), exhibited low salinity levels, resulting in higher yields. In the non-saline prone areas, all tested lines produced higher yields in BRRI (HQ) (8.26 t/ha) compared to the lower yields in Noakhali (Companiganj) (7.39 t/ha). V1= BR11712-4R-44 produced the similar grain yield with all the tested entries including the standard check BRRI dhan67 except susceptible check BRRI dhan89. Growth duration of all the advanced lines (Saline area 140-150 days), without salinity (143-149 days) was significantly lower than the check variety BRRI dhan89. Considering grain yield, growth duration, salinity status, phenotypic acceptance, insect and disease incidence all the advanced line V1= BR 11712-4R-44, was recommended for proposed variety trial.



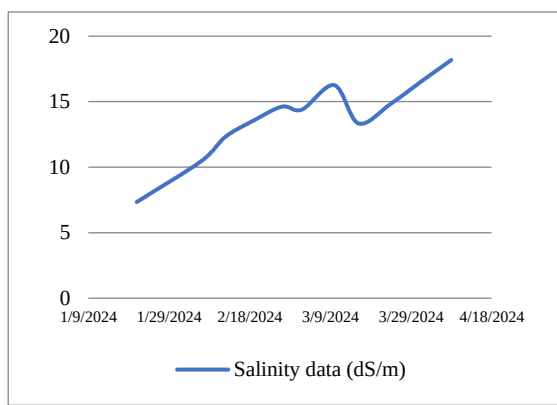
Salinity Stress Alart Boro 2024 at Sadar, Noakhali



Salinity stress ALART Boro 2024 at Sadar, Bagerhat



Salinity stress ALART Boro 2024 at Feni, Sonagazi



Salinity stress ALART Boro 2024 at Shamnagar, Satkhira

**Table 15. Grain yield (t/ha), growth duration (day), thousand grain weight (g) and plant height (cm) of some rice genotypes under ALART (STR) during Boro 2024 (Saline area).**

| Genotype             | Location                         |      |      |      |      | GD   | TGW   | PHT   |
|----------------------|----------------------------------|------|------|------|------|------|-------|-------|
|                      | Grain yield (tha <sup>-1</sup> ) |      |      |      |      |      |       |       |
|                      | L1                               | L2   | L3   | L4   | Mean |      |       |       |
| V1= BR11712-4R-44    | 2.81                             | 3.4  | 2.03 | 1.02 | 2.32 | 140  | 17.42 | 91.5  |
| V2=BR11712-4R-93     | 2.01                             | 3.94 | 2.05 | 0.9  | 2.23 | 142  | 18.86 | 98.5  |
| V3=BR11712-4R-12     | 2.88                             | 3.13 | 2.04 | 1.06 | 2.28 | 144  | 17.86 | 96.25 |
| V4=BR11712-4R-6      | 2.55                             | 3.71 | 1.64 | 1.22 | 2.28 | 141  | 20.62 | 82    |
| V5= BRRI dhan67 (ck) | 2.48                             | 3.23 | 1.9  | 1.55 | 2.29 | 142  | 18.81 | 90.5  |
| V6= BRRI dhan89 (ck) |                                  | 2.52 |      | 0.2  | 1.36 | 150  | 19.84 | 88.5  |
| LSD <sub>0.05</sub>  |                                  | 0.43 |      |      | 0.21 | 0.56 | 0.55  | 2.73  |

L1- Bagerhat, L2- Noakhali, L3- Satkhira (kaliganj), L4- Satkhira (Shamnagar), GD: growth duration (day); TGW: Thousand grain weight (g); PHT: Plant height (cm).

**Table 16. Grain yield (t/ha), growth duration (day), thousand grain weight (g) and plant height (cm) of some rice genotypes under ALART (STR) during Boro 2024 (Non Saline area).**

| Genotype             | Location                         |      |      |      |      |      |      | GD   | TGW   | PHT  |
|----------------------|----------------------------------|------|------|------|------|------|------|------|-------|------|
|                      | Grain yield (tha <sup>-1</sup> ) |      |      |      |      |      |      | Mean | Mean  | Mean |
|                      | L1                               | L2   | L3   | L4   | L5   | L6   | Mean | Mean | Mean  | Mean |
| V1= BR11712-4R-44    | 6.96                             | 8.26 | 7.39 | 5.65 | 7.23 | 6.39 | 6.98 | 144  | 21.95 | 111  |
| V2=BR11712-4R-93     | 7.41                             | 8.07 | 6.64 | 5.47 | 6.18 | 5.88 | 6.61 | 145  | 24.12 | 128  |
| V3=BR11712-4R-12     | 6.28                             | 7.34 | 6.24 | 4.57 | 5.56 | 6.40 | 6.06 | 147  | 22.00 | 120  |
| V4=BR11712-4R-6      | 7.10                             | 8.09 | 5.89 | 4.48 | 7.52 |      | 6.62 | 143  | 24.41 | 98   |
| V5= BRRI dhan67 (ck) | 4.53                             | 5.96 | 5.72 | 5.03 | 7.48 |      | 5.74 | 142  | 23.12 | 114  |
| V6= BRRI dhan89 (ck) | 6.27                             | 6.79 | 6.13 | 4.95 | 5.14 | 5.64 | 5.82 | 149  | 21.68 | 110  |
| LSD <sub>0.05</sub>  |                                  |      | 0.94 |      |      |      | 0.42 | 0.44 | 0.68  | 2.51 |

L1- Barishal, L2- BRRI (H/Q), L3- Noakhali, L4- Patuakhali, L5- Satkhira (Sadar) and Sonagazi (Feni), GD: growth duration (day); TGW: thousand grain weight (g); PHT: Plant height (cm).

**Head to Head Adaptive Trial (HHAT) during T. Aman 2023.** A total of 200 Head to Head Adaptive Trials (HHAT) with eight categories according to rice eco-system were conducted throughout the country during T. Aman 2023 under TRB project through public and private partnership (PPP). The trials were categorized in eight different groups considering the agro-ecology and used rice variety. The major groups were: 1. Long growth duration rice variety (Swarna-Growing areas), 2. Long growth duration rice variety (Dinajpur areas), 3. Long growth duration rice variety (Rangpur areas), 4. Long growth duration rice variety (Mymensingh areas), 5. Short growth duration rice variety, 6. Coastal Ecosystem (CE), 7. Flash Flood Submergence (FFS), 8. Tidal Submergence (TS). In Swarna rice growing areas, BRRI dhan87 and BRRI dhan94 were found as better performer than the others. BRRI dhan87 produced the highest grain yield 5.70 t/ha followed by BRRI dhan94 (5.67 t/ha). In Dinajpur areas, BRRI dhan80 was found as highest yielder (4.80 t/ha) having growth duration 132 days followed by BRRI dhan90 (4.43 t/ha) Whereas, Kataribhog produced the lowest yield (3.49 t/ha). In Rangpur areas, BRRI dhan87 produced the highest grain yield (5.77 t/ha) having also the shortest growth duration 146 days only followed by BR11 which produced (5.29 t/ha). In Mymensingh areas, BRRI dhan87 produced the highest grain yield (5.93 t/ha) having also the shortest growth duration 132 days only (Table 13, Fig. F9). BRRI dhan49

and BRRI dhan94 produced the statistically similar yield and the similar growth duration respectively. In coastal ecosystem (CE) areas, the average highest yield was BRRI dhan79 was recorded 5.50 t/ha followed by BR23 producing grain yield 4.91 t/ha with the longest 146 days growth duration. BRRI dhan73 performed less in coastal ecosystem, which produced grain yield 4.29 t/ha having only 126 days growth duration. Among the Flash flood submergence tolerant variety IR16F1148 produced the highest mean yield (5.66 t/ha) having the GD 140 days followed by BRRI dhan52 producing grain yield 5.22 t/ha with 147 days growth duration and other tested varieties BRRI dhan51, BRRI dhan79 produced statistically similar yield, which can overcome early flash flood, a major problem in flash flood prone areas. Tidal submergence tolerant variety BRRI dhan52 produced the highest mean yield 5.04 t/ha having the GD 143 days followed by BR11 producing grain yield 5.01 t/ha with 144 days growth duration, which can overcome tidal submergence, a major problem in southwest part of Bangladesh.

## TECHNOLOGY DISSEMINATION

**Seed production and dissemination programme (SPDP) during T. Aus.** Seed production and dissemination programme (SPDP) during T. Aus 2023 were conducted in 29 upazilas of 11 districts of the country under core programme (GoB). BRRI



dhan98 was used as cultivar in this programme. The minimum yield of BRRI dhan98 was 3.4 t/ha, the maximum yield was 6.2 t/ha and the average yield was 5.2 t/ha. Farmers retained seed after harvesting, minimum and maximum 30 kg and 200 kg seed retained by the farmers respectively. A total of 39,698 kg grains were produced from all demonstrated plots and 4,530 kg quality seeds were retained by the farmers as seed for the next year cultivation.

**Special Seed Production and Dissemination Programme at Bhola.** A special seed production and dissemination program (SPDP) in B. Aus 2023 was conducted in six upazilas of Bhola district under GoB. BRRI dhan83 was used in the programme. The minimum yield of BRRI dhan83 was 2.6 t/ha, the maximum yield was 4.1 t/ha and the average yield was 3.3 t/ha. Minimum total production 342 kg, maximum 550 kg seed were produced. A total of 5,327 kg grains were produced from all the demonstrated plots and 495 kg quality seeds were retained by the farmers as seed for the next year cultivation.

**Seed Production and Dissemination Programme of B. Aus rice in the hill districts.** SPDP in B. Aus 2023 were conducted in six upazilas of three Hill Tract districts under GoB. BRRI dhan83 was used in the programme. The hilly people cultivate rice in the shifting cultivation system, generally known as Jhum cultivation. A total of 57 demonstrations were conducted in the six upazilas. A total of 28,087 kg grains were produced from all the demonstrated plots and 3,956 kg quality seeds were retained by the farmers as seed for the next year cultivation. About 2,689 farmers acquired awareness and knowledge about the varieties through field visits, discussion and knowledge sharing. A total of 1051 farmers were motivated and showed their interest to cultivate these varieties in the next year.

**Seed Production and Dissemination Programme (SPDP) in the valley of the hill districts.** SPDP in T. Aus 2023 were conducted in the Valley of six upazilas of three districts. BRRI dhan98 was used in the programme. The minimum yield of BRRI

dhan98 was 3.9 t/ha, the maximum yield was 6.2 t/ha and the average yield was 5.1 t/ha. A total of 9,539 kg grains were produced from all the demonstrated plots and 880 kg quality seeds were retained by the farmers as seed for the next year cultivation. About 658 farmers acquired awareness and knowledge about the varieties through field visits, discussion and knowledge sharing.

**Special dissemination programme of BRRI hybrid dhan7.** Special dissemination programme of BRRI hybrid dhan7 in T. Aus 2023 were conducted in 28 upazilas of 12 districts under core programme. BRRI hybrid dhan7 was used in the programme. A total of 56 demonstrations were conducted. The minimum yield of BRRI hybrid dhan7 was 4.7 t/ha, the maximum yield was 7.1 t/ha and the average yield was 5.8 t/ha. A total of 1,044 farmers were motivated and showed their interest to cultivate these varieties in the next year.

**Seed Production and Dissemination Programme (SPDP) during T. Aman 2023.** Trials were conducted in 25 upazilas of 12 districts on SPDP. Thirteen modern rice varieties were used in the programme. Among the varieties, BRRI dhan103 produced the highest mean grain yield 5.7 t ha<sup>-1</sup> followed by BRRI dhan78, 94 and 95 (4.9 t ha<sup>-1</sup>) followed by BRRI dhan75 (4.8 t ha<sup>-1</sup>). The lowest mean rice grain yield was 3.5 t ha<sup>-1</sup> in BRRI dhan76 followed by 4.5 t ha<sup>-1</sup> in BRRI dhan79 and BRRI dhan90 respectively. However, mean rice grain yield of BRRI dhan71 was 4.7 t ha<sup>-1</sup> which was intermediate among the demonstrated rice varieties. The highest grain yield of BRRI dhan103 varied from 2.5-8.7 t ha<sup>-1</sup> in different locations depending on soil fertility, salinity, cropping pattern and management practices. Total grain production of BRRI dhan52, BRRI dhan71, BRRI dhan75, BRRI dhan76, BRRI dhan78, BRRI dhan79, BRRI dhan80, BRRI dhan87, BRRI dhan90, BRRI dhan93, BRRI dhan94, BRRI dhan95 and BRRI dhan103 were 22,065 kg, 23,353 kg, 23,612 kg, 17,574 kg, 40,084 kg, 22,292 kg, 42,695 kg, 26,556 kg, 22,342 kg, 42,512 kg, 64,588 kg, 24,456 kg and 30,566 kg respectively. The retained seeds by the participant and

associated farmers of BRRI dhan52, BRRI dhan71, BRRI dhan75, BRRI dhan76, BRRI dhan78, BRRI dhan79, BRRI dhan80, BRRI dhan87, BRRI dhan90, BRRI dhan93, BRRI dhan94, BRRI dhan95 and BRRI dhan103 were 2,917 kg, 3,285 kg, 2,874 kg, 1,145 kg, 3,236 kg, 2,240 kg, 4,627 kg, 2,955 kg, 3,297 kg, 7,488 kg, 11,635 kg, 3,065 kg and 6,402 kg respectively. A total of 4,02,695 kg grains were produced from all demonstrated plots and 55,166 kg quality seeds were retained by the farmers as seed for the next year cultivation. About 26,760 farmers acquired awareness and knowledge about the varieties through field visits, discussion and knowledge sharing. A total of 9,192 farmers were motivated and showed their interest to cultivate these varieties in the next year.

**Special dissemination programme on BRRI hybrid dhan4 and BRRI hybrid dhan6.** Special dissemination programme on BRRI hybrid dhan4 and BRRI hybrid dhan6 in T. Aman 2023 were conducted in 28 upazilas under 12 districts. The minimum yield of BRRI hybrid dhan4 was 4.0 t/ha, the maximum yield was 6.5 t/ha and the average yield was 5.5 t/ha. From the minimum and maximum yield, the yield was categorized into three categories (4.0-4.5 t/ha, 4.6-5.5 t/ha and 5.6-6.5 t/ha). Yield category (5.6-6.5 t/ha) was found the highest, it was 57.1% locations followed by yield category (4.6-5.5 t/ha) was found 35.7% locations and the lowest yield category (4.0-4.5 t/ha), it was 7.1% locations. From these demonstrations many of the farmers gained knowledge about BRRI hybrid dhan4, minimum 3 and maximum 170 and the average 41 farmers gained knowledge about the variety. About 1,135 farmers acquired awareness and gained knowledge about the varieties through field visits, discussion and knowledge sharing. A total of 436 farmers were motivated and showed their interest to cultivate BRRI hybrid dhan4 in the next year. The minimum yield of BRRI hybrid dhan6 was 4.1 t/ha, the maximum yield was 6.6 t/ha and the average yield was 5.8 t/ha. From the minimum and maximum yield, the yield was categorized into three categories (4.0-4.5 t/ha, 4.6-5.5 t/ha and 5.6-6.6

t/ha). Yield category (5.6-6.6 t/ha) was found 75.0% locations followed by yield category (4.0-4.5 t/ha) was found 14.2% locations. A total of 408 farmers were motivated and showed their interest to cultivate BRRI hybrid dhan6 in the next year.

**Seed production and dissemination programme (SPDP) during T. Aman 2023 in the hill districts:** SPDPs in T. Aman 2023 were conducted in the Valley of six upazilas of three districts under GoB. Three modern rice varieties such as BRRI dhan80, BRRI dhan87 and BRRI dhan103 were used in the program. Among the varieties, BRRI dhan80 produced the highest mean grain yield 5.3 t ha<sup>-1</sup> followed by BRRI dhan103 (5.1 t ha<sup>-1</sup>) and the lowest mean rice grain yield was 5.0 t ha<sup>-1</sup> in BRRI dhan87. The mean rice grain yield of BRRI dhan87 was 5.0 t ha<sup>-1</sup> which was intermediate yield among the demonstrated rice varieties. The highest grain yield of BRRI dhan80 varied from 5.1-5.6 t ha<sup>-1</sup> in different locations depending on soil fertility, salinity, cropping pattern and management practices. Total grain production of BRRI dhan80, BRRI dhan87 and BRRI dhan103 were 2,825 kg, 22,136 kg and 12,610 kg respectively. The retained seeds by the participant and associated farmers of BRRI dhan80, BRRI dhan87 and BRRI dhan103 were 195 kg, 1,681 kg and 1,101 kg respectively. A total of 37,571 kg grains were produced from all demonstrated plots and 2,977 kg quality seeds were retained by the farmers as seed for the next year cultivation. In total 1,424 farmers gained knowledge about the varieties through field visits and discussion. A total of 725 farmers were motivated and showed their interest to cultivate these varieties in the next year.

**Seed Production and dissemination programme (SPDP) through cropping pattern.** SPDPs through cropping pattern in T. Aman 2023 were conducted in the eight upazilas of four districts under GoB. Two modern rice varieties; BRRI dhan75 and BRRI dhan103 were used in the programme. Between the varieties, BRRI dhan103 produced the highest mean grain yield 5.5 t ha<sup>-1</sup> followed by BRRI dhan75 (5.0 t ha<sup>-1</sup>). Total grain production of BRRI dhan75 and BRRI dhan103

were 4,685 kg and 5,184 kg respectively. The retained seeds by the participant and associated farmers of BRRI dhan75 and BRRI dhan103 were 1,592 kg and 1,859 kg respectively. A total of 98,691 kg grains were produced from all the demonstrated plots and 3,451 kg quality seeds were retained by the farmers as seed for the next year cultivation. About 665 farmers acquired awareness and knowledge about the varieties through field visits, discussion and knowledge sharing. A total of 232 farmers were motivated and showed their interest to cultivate these varieties in the next year.

#### **Seed production and dissemination programme (SPDP) under TRB:**

A total of 30 SPDPs were conducted in 20 upazilas of eight districts under TRB project during T. Aman 2023. BRRI dhan71, BRRI dhan75, BRRI dhan87, BRRI dhan94 and BRRI dhan95 were demonstrated in the SPDPs. Among the varieties, BRRI dhan95 produced the highest mean grain yield  $6.0 \text{ t ha}^{-1}$  followed by BRRI dhan87 ( $5.7 \text{ t ha}^{-1}$ ). The highest grain yield of BRRI dhan95 varied from  $5.8\text{--}6.3 \text{ t ha}^{-1}$  in different locations depending on soil fertility, salinity, cropping pattern and management practices. Total grain production of BRRI dhan71, BRRI dhan75, BRRI dhan87, BRRI dhan94 and BRRI dhan95 were 8,046 kg, 6,060 kg, 9,207 kg, 2,235 kg and 5,642 kg respectively. The retained seeds by the participant and associated farmers of BRRI dhan71, BRRI dhan75, BRRI dhan87, BRRI dhan94 and BRRI dhan95 were 1,845 kg, 1,603 kg, 1,920 kg, 320 kg and 445 kg respectively. A total of 31,190 kg grains were produced from all demonstrated plots and 6,133 kg quality seeds were retained by the farmers as seed for the next year cultivation.

#### **Seed production and dissemination programme (SPDP) under PARTNER project.**

The trials in Boro 2024 were conducted in 36 upazilas of 13 districts under PARTNER project. Six modern rice varieties such as BRRI dhan99, Bangabondhu dhan100, BRRI dhan101, BRRI dhan102, BRRI dhan104 and BRRI dhan105 were used in the programme. Plot size of each variety was three bighas area in a cluster in each block of each

upazila. A total of 400 demonstrations were established in four districts of Bangladesh. Among the varieties, BRRI dhan102 produced the highest mean grain yield  $7.5 \text{ t ha}^{-1}$  followed by Bangabondhu dhan100 and BRRI dhan105 ( $6.8 \text{ t ha}^{-1}$ ) and the lowest mean rice grain yield was  $6.5 \text{ t ha}^{-1}$  found in BRRI dhan104. The highest grain yielder was BRRI dhan102. Its yield varied from  $4.7\text{--}9.0 \text{ t ha}^{-1}$  in different locations depending on soil fertility, salinity, cropping pattern and management practices. Total grain production of BRRI dhan99, Bangabondhu dhan100, BRRI dhan101, BRRI dhan104 and BRRI dhan105 were 67,333 kg, 68,109 kg, 68,575 kg, 75,469 kg, 65,677 kg and 1, 26,473 kg respectively. The retained seeds by the participant growers and associated farmers of BRRI dhan99, Bangabondhu dhan100, BRRI dhan101, BRRI dhan104 and BRRI dhan105 were 11,462 kg, 11,412 kg, 9,451 kg, 10,027 kg, 6,060 kg and 12,730 kg. A total of 4,71,636 kg grains were produced from all the demonstrated plots and 61,142 kg quality seeds were retained by the farmers as seed for the next year cultivation. A total of 4,976 farmers were motivated and showed their interest to cultivate these varieties in the next year.

#### **Special dissemination programme on BRRI hybrid dhan8.**

Special dissemination programme on BRRI hybrid dhan8 in Boro 2024 was conducted in 36 upazilas of 13 districts under PARTNER project. Plot size of each variety was three bigha for one demonstration, this three bigha area in each upazila was in a cluster. Around 37 demonstrations were conducted in the different locations. The minimum yield of BRRI hybrid dhan4 was  $5.0 \text{ t/ha}$ , the maximum yield was  $9.9 \text{ t/ha}$  and the average yield was  $7.9 \text{ t/ha}$ . From the minimum and maximum, the yield was categorized into three categories ( $5.0\text{--}6.5$ ,  $6.6\text{--}8.0$  and  $8.1\text{--}10.0 \text{ t/ha}$ ). The yield category ( $8.1\text{--}10.0 \text{ t/ha}$ ) was found the highest 51.4% locations followed by the yield category  $6.6\text{--}8.0 \text{ t/ha}$ , it was 29.7% locations and the lowest yield category was  $5.0\text{--}6.5 \text{ t/ha}$ , it was 18.9% of locations. A total of 693 farmers were motivated and showed their interest to cultivate BRRI hybrid dhan8 in the next year.

**Seed production and dissemination programme (SPDP) under LSTD project.** SPDPs in Boro 2023-24 were conducted in eight upazilas of four districts. Seven modern rice varieties; BRRI dhan67, BRRI dhan74, BRRI dhan84, BRRI dhan88, BRRI dhan89, BRRI dhan92 and Bongabondhu dhan100) were used in the programme. Among the varieties, BRRI dhan92 produced the highest mean grain yield 7.3 t ha<sup>-1</sup> followed by BRRI dhan89 (7.2 t ha<sup>-1</sup>) and the lowest mean rice grain yield was 5.6 t ha<sup>-1</sup> in BRRI dhan74 followed by 5.7 t ha<sup>-1</sup> in BRRI dhan67. Total grain production of BRRI dhan67, BRRI dhan74, BRRI dhan84, BRRI dhan88, BRRI dhan89, BRRI dhan92 and Bangabondhu dhan100 were 51,629 kg, 96,984 kg, 1,43,356 kg, 1,90,832 kg, 2,47,020 kg, 3,05,318 kg and 58,292 kg respectively. The retained seeds by the participant growers and associated farmers of BRRI dhan67, BRRI dhan74, BRRI dhan84, BRRI dhan88, BRRI dhan89, BRRI dhan92 and Bangabondhu dhan100 were 4,765 kg, 9,570 kg, 14,335 kg, 18,875 kg, 24,375 kg, 31,115 kg and 7,765 kg respectively. A total of 10,93,431 kg grains were produced from all demonstrated plots and 1,10,800 kg quality seeds were retained by the farmers as seed for the next year cultivation. About 42,739 farmers acquired awareness and knowledge about the varieties through field visits, discussion and knowledge sharing. A total of 18,650 farmers were motivated and showed their interest to cultivate these varieties in the next year.

## FARMERS' TRAINING AND PROMOTIONAL ACTIVITIES

**Farmers' training.** Farmers' trainings were arranged under GoB, PARTNER and LSTD projects. During the reporting period 44 farmer's training were arranged by the Adaptive Research Division (ARD) at different locations of the country

collaborated with DAE in which 1,340 farmers and 69 SAAOs participated and updated their knowledge regarding modern rice production technology.

**Field day.** ARD conducted a total of 23 field days at different locations of the country under PARTNER and LSTD projects. Around 2,300 participants including farmers, local leaders and DAE personnel participated in the field days. These programmes also generated much enthusiasm about modern rice production technologies and BRRI varieties, which helped rapid dissemination of technologies. Field days were arranged on best performing SPDPs for the purpose of rapid dissemination of demonstrated rice varieties as well as required and recommended management practices among the target farmers, neighbouring farmers, DAE personnel, public representative, local leaders and NGOs workers.

**Seed production at BRRI farm.** A total of 5,270 kg quality seeds of different BRRI varieties were produced at BRRI farms during the reporting period for the enrichment of own seed stock during T. Aman and Boro seasons.

**Farmers' Seed Centre.** Three farmers' seed centers were established during the reporting period. TRB-BRRI provided six plastic drums in each center. Eighty kg seed could be stored in each drum.

**Seed support programme.** During the reporting period a total of 1,175 kg of seeds were distributed among the different stakeholders such as farmers, NGO workers and BRRI employees. Complete production packages were also provided among the stakeholders so that they can adopt all required and recommended practices for the cultivation of supplied varieties.



## **Training Division**

**300    Summary**

**300    Capacity building and technology transfer**

**304    Effectiveness of imparted rice production training**

## SUMMARY

Training Division has conducted 50 training programmes in the reporting year with course duration from five days to one month. Need based course curriculum was developed for these courses. Total number of participants was 1340. The participants were Sub-Assistant Agriculture officer (SAAO), Agriculture Extension Officer (AEO) of the Department of Agriculture Extension (DAE), Scientists, scientific assistant, farm manager of BRRI, Officers of different seed companies of the country, LA and Research assistant of BRRI and Seed/Fertilizer/Pesticide/dealers. The highest number of participants was from the DAE. All the training programmes were successfully completed. Most of the BRRI's speakers' performance was very good to excellent.

## CAPACITY BUILDING AND TECHNOLOGY TRANSFER

### **Training on modern rice production technologies (Regular)**

Sixteen training courses on modern rice production technologies were conducted during the reporting period. The main objective of the course was to train the grass root level extension workers (SAAO) of DAE. The course curriculum was designed based on the priority of field problems related to rice production and rice based technologies. Duration of the course was one week. A total of 399 SAAOs were trained. Among the participants 354 and 45 were male and female respectively (Table 1).

Eight training courses on hybrid rice and seed production technology for SAAO of DAE was conducted during the reporting period. Duration of the course was five days. A total of 207 SAAOs were trained. Among the participants 176 and 31 were male and female respectively (Table 2).

One training programme on hybrid rice and seed production technology was conducted at that time for BRRI scientists. A total of 21 BRRI scientists were trained. Among the participants 11 and 10

were male and female respectively (Table 3). The course duration was five days.

Three training programmes on hybrid rice and seed production technology for Scientific Assistant (SA) and Farm Managers (FM) of BRRI were successfully completed at that time. Duration of the course was five days. ninety-five participants were trained through this course. Table 4 presents the particulars of the trainings.

One training programme on hybrid rice and seed production technology for seed company officers was successfully completed at that time. Duration of the course was five days. Twenty participants were trained through this course. Table 5 presents the particulars of the trainings.

### **One month rice production training course**

Four training programs on 'Modern rice production technologies and integrated pest management' for the Agriculture Extension Officer (AEO) of DAE was conducted during the reporting year. A total of 116 officers were trained through these courses. Among the participants 89 and 27 were male and female respectively (Table 6). The duration of these courses were one month.

Another Training programme on Bioinformatics for future rice of BRRI scientists were conducted during the reporting period. Seventy participants in three batches were trained through this course. Table 7 presents the particulars of the trainings.

Two training programmes on Modern rice production technologies for the personnel of Solidaridad Network Asia (SNA) were conducted. A total of 52 officers in two batches were trained through these courses. Among the participants 42 and 10 were male and female, respectively (Table 8) and the duration of the course was six days.

Two training programmes on "Modern rice production technology, Data Collection and Entry" for SA and Farm Managers of BRRI under PARTNER project were completed at that time. Duration of the course was fourteen days. Sixty participants were trained through this course. Table 9 presents the particulars of the training.

Training on ‘Modern Rice Production technology, handling of lab equipment and maintenance’ under PARTNER project for LA and Research Assistants of BRRI was conducted during the reporting period. Thirty participants in one batch were trained through this course. Duration of the course was fourteen days. Table 10 presents the particulars of the trainings.

Six training programs on ‘Safe use of agrochemicals for SEED/Fertilizer/Pesticides Dealers’ under PARTNER project were conducted during the reporting period. Duration of the course was three days. A total of 180 dealers were trained. All of them are male participants (Table 11).

Training on ‘Research data management using spread sheet’ for BRRI scientists were conducted during the reporting period. Thirty participants in

one batch were trained through this course. Duration of the course was six days. Table 12 presents the particulars of the trainings.

Two training programs on ‘Modern Rice Production Technology’ for SAAO of DAE under LSTD project were conducted during the reporting period. Duration of the course was five days. A total of 60 SAAOs were trained. Among the participants 34 and 26 were male and female respectively (Table 13).

During the reporting period, 50 training programmes have been conducted by the Training Division. Through this training a total of 1,340 participants were trained. Table 14 presents the summaries of the trainings.

**Table 1. Particulars of one-week modern rice production training course for SAAO of DAE.**

| Batch no. | Duration         | No. of participants |      |        |
|-----------|------------------|---------------------|------|--------|
|           |                  | Total               | Male | Female |
| 1         | 5-10 Aug 23      | 25                  | 21   | 4      |
| 2         | 5-10 Aug 23      | 25                  | 24   | 1      |
| 3         | 19-24 Aug 23     | 25                  | 23   | 2      |
| 4         | 19-24 Aug 23     | 25                  | 23   | 2      |
| 5         | 26-31 Aug 23     | 25                  | 19   | 6      |
| 6         | 26-31 Aug 23     | 25                  | 19   | 6      |
| 7         | 02-07 Sep 23     | 25                  | 22   | 3      |
| 8         | 02-07 Sep 23     | 25                  | 20   | 5      |
| 9         | 09-14 Sep 23     | 25                  | 23   | 2      |
| 10        | 09-14 Sep 23     | 25                  | 24   | 1      |
| 11        | 16-21 Sep 23     | 25                  | 25   | 0      |
| 12        | 23-28 Sep 23     | 25                  | 23   | 2      |
| 13        | 23-28 Sep 23     | 25                  | 21   | 4      |
| 14        | 30 Sep-05 Oct 23 | 25                  | 25   | 0      |
| 15        | 16-21 Oct,23     | 24                  | 24   | 0      |
| 16        | 16-21 Oct,23     | 25                  | 18   | 7      |
| Total     |                  | 399                 | 354  | 45     |

**Table 2. Particulars of five days hybrid rice and seed production technology training course for SAAO of DAE.**

| Batch no. | Duration       | No. of participants |      |        |
|-----------|----------------|---------------------|------|--------|
|           |                | Total               | Male | Female |
| 1         | 05-09 Nov 2023 | 23                  | 20   | 3      |
| 2         | 12-16 Nov 23   | 22                  | 21   | 1      |
| 3         | 19-23 Nov 23   | 28                  | 20   | 8      |
| 4         | 19-23 Nov 23   | 28                  | 26   | 2      |
| 5         | 26- 30 Nov 23  | 28                  | 24   | 4      |
| 6         | 26- 30 Nov 23  | 28                  | 24   | 4      |



| Batch no. | Duration   | No. of participants |      |        |
|-----------|------------|---------------------|------|--------|
|           |            | Total               | Male | Female |
| 7         | 3-7 Dec 23 | 23                  | 14   | 9      |
| 8         | 3-7 Dec 23 | 27                  | 27   | 0      |
| Total     |            | 207                 | 176  | 31     |

**Table 3. Particulars of five days hybrid rice and seed production technology training course for scientists of BRRI.**

| Batch no. | Duration       | No. of participants |      |        |
|-----------|----------------|---------------------|------|--------|
|           |                | Total               | Male | Female |
| 1         | 25 - 29 May 24 | 21                  | 11   | 10     |

**Table 4. Particulars of five days hybrid rice and seed production technology training course for SA, FM of BRRI.**

| Batch no. | Duration          | No. of participants |      |        |
|-----------|-------------------|---------------------|------|--------|
|           |                   | Total               | Male | Female |
| 1         | 29 Oct- 02 Nov 23 | 32                  | 27   | 5      |
| 2         | 05-09 Nov 2023    | 28                  | 28   | 0      |
| 3         | 12-16 Nov 23      | 35                  | 33   | 2      |
| Total     |                   | 95                  | 88   | 7      |

**Table 5. Particulars of five days hybrid rice and seed production technology training course for seed company officers.**

| Batch no. | Duration            | No. of participants |      |        |
|-----------|---------------------|---------------------|------|--------|
|           |                     | Total               | Male | Female |
| 1         | 29 Oct - 2 Nov 2023 | 20                  | 20   | 0      |

**Table 6. Particulars of one month training on modern rice production technologies and integrated pest management in changing climate for DAE officers (PARTNER).**

| Batch no. | Duration              | Participants (no.) |      |        | Designation |
|-----------|-----------------------|--------------------|------|--------|-------------|
|           |                       | Total              | Male | Female |             |
| 1         | 14 Jan - 12 Feb 2024  | 30                 | 22   | 8      | AEO, AAO    |
| 2         | 19 Feb-19 Mar 2024    | 28                 | 21   | 7      | AEO, AAO    |
| 3         | 16 Apr - 15 May 2024  | 27                 | 21   | 6      | AEO, AAO    |
| 4         | 16 May – 15 June 2024 | 31                 | 25   | 6      | AEO, AAO    |
| Total     |                       | 116                | 89   | 27     |             |

**Table 7. Training on bioinformatics for future rice for BRRI scientists (PARTNER).**

| Batch no. | Duration            | Participants (no.) |      |        | Designation |
|-----------|---------------------|--------------------|------|--------|-------------|
|           |                     | Total              | Male | Female |             |
| 1         | 13 – 18 May 2024    | 30                 | 17   | 13     | SO          |
| 2         | 20 Apr – 3 May 2024 | 30                 | 19   | 11     | SO          |
| 3         | 4 - 9 May 2024      | 10                 | 09   | 01     | SSO, SO     |
| Total     |                     | 70                 | 45   | 25     |             |

**Table 8. Particulars of one-week modern rice production training course for the personnel of Solidaridad Network Asia.**

| Batch no. | Duration              | No. of participants |      |        |
|-----------|-----------------------|---------------------|------|--------|
|           |                       | Total               | Male | Female |
| 1         | 16 -21 Sept 2023      | 30                  | 25   | 5      |
| 2         | 30 Sept – 05 Oct 2023 | 22                  | 17   | 5      |
| Total     |                       | 52                  | 42   | 10     |

**Table 9. Training on modern rice production technology, data collection & entry for SA and farm managers of BRRI (PARTNER).**

| Batch no. | Duration            | Participant (no.) |      |        | Designation |
|-----------|---------------------|-------------------|------|--------|-------------|
|           |                     | Total             | Male | Female |             |
| 1         | 24 Feb- 08Mar, 2024 | 30                | 27   | 3      | SA, FM      |
| 2         | 9-22 March, 2024    | 30                | 28   | 2      | SA, FM      |
| Total     |                     | 60                | 55   | 5      |             |

**Table 10. Training on modern rice production technology, handling of lab equipment and maintenance for LA and research Assistants of BRRI (PARTNER).**

| Batch no. | Duration        | Participants (no.) |      |        | Designation |
|-----------|-----------------|--------------------|------|--------|-------------|
|           |                 | Total              | Male | Female |             |
| 1         | 04-17 May, 2024 | 30                 | 22   | 8      | LA, RA      |
| Total     |                 | 30                 | 22   | 8      |             |

**Table 11. Training course on safe use of agrochemicals for Seed/Fertilizer/pesticides dealers (PARTNER).**

| Batch no. | Duration              | Participant (no.) |      |        |
|-----------|-----------------------|-------------------|------|--------|
|           |                       | Total             | Male | Female |
| 1         | 02-04 Jan 2024        | 30                | 30   | 0      |
| 2         | 31 Mar – 02 Apr, 2024 | 30                | 30   | 0      |
| 3         | 19-21 May 2024        | 30                | 30   | 0      |
| 4         | 19-21 May 2024        | 30                | 30   | 0      |
| 5         | 08-10 Jun 2024        | 30                | 30   | 0      |
| 6         | 08-10 Jun 2024        | 30                | 30   | 0      |
| Total     |                       | 180               | 180  | 0      |

**Table 12. Training on Research data management using spread sheet for BRRI scientists.**

| Batch no. | Duration       | Participants (no.) |      |        | Designation |
|-----------|----------------|--------------------|------|--------|-------------|
|           |                | Total              | Male | Female |             |
| 1         | 13-18 Jan 2024 | 30                 | 17   | 13     | SO          |
| Total     |                | 30                 | 17   | 13     |             |

**Table 13. Training on modern rice production technology for SAAO of DAE (LSTD).**

| Batch no. | Duration       | No. of participants |      |        |
|-----------|----------------|---------------------|------|--------|
|           |                | Total               | Male | Female |
| 1         | 23-27 Jun 2024 | 30                  | 21   | 9      |
| 2         | 23-27 Jun 2024 | 30                  | 13   | 17     |
| Total     |                | 60                  | 34   | 26     |

**Table 14. Total training conducted by Training Division.**

| Name of the training                                       | No. of training | Duration | No. of participants |    |       | Designation                     | Fund                |
|------------------------------------------------------------|-----------------|----------|---------------------|----|-------|---------------------------------|---------------------|
|                                                            |                 |          | M                   | F  | Total |                                 |                     |
| Training on modern rice production                         | 16              | 1 week   | 354                 | 45 | 399   | SAAO, DAE                       | GOB                 |
| Training on modern rice production                         | 2               | 1 week   | 42                  | 10 | 52    | Solidaridad Network Asia of NGO | GOB                 |
| Hybrid rice and seed production technology training course | 8               | 5 days   | 176                 | 31 | 207   | SAAO, DAE                       | Hybrid rice Project |

| Name of the training                                                                                             | No. of training | Duration | No. of participants |     |       | Designation                       | Fund                |
|------------------------------------------------------------------------------------------------------------------|-----------------|----------|---------------------|-----|-------|-----------------------------------|---------------------|
|                                                                                                                  |                 |          | M                   | F   | Total |                                   |                     |
| Hybrid rice and seed production technology training course                                                       | 3               | 5 days   | 88                  | 7   | 95    | SA, FM, BRRI                      | Hybrid rice Project |
| Hybrid rice and seed production technology training course                                                       | 1               | 5 days   | 20                  | 0   | 20    | Seed Company Officers             | Hybrid rice Project |
| Hybrid rice and seed production technology training course                                                       | 1               | 5 days   | 11                  | 10  | 21    | SO, SSO                           | Hybrid rice Project |
| One-month modern rice production technologies and integrated pest management in changing climate training course | 4               | 1 Month  | 89                  | 27  | 116   | AEO, DAE                          | PARTNER Project     |
| Training on bioinformatics for future rice.                                                                      | 4               | 2 weeks  | 60                  | 40  | 100   | SO, BRRI                          | PARTNER Project     |
| Modern rice production, data collection and entry training course                                                | 2               | 2 weeks  | 55                  | 5   | 60    | SA, FM BRRI                       | PARTNER Project     |
| Modern rice production, lab equipment maintenance training course                                                | 1               | 2 weeks  | 22                  | 8   | 30    | LA & Research Assistant of BRRI   | PARTNER Project     |
| Training course on safe use of agrochemicals                                                                     | 6               | 3 days   | 180                 | 0   | 180   | Seed/Fertilizer/Pesticide dealers | PARTNER project     |
| Modern rice production technology and cultivation training course                                                | 2               | 5 days   | 36                  | 24  | 60    | SAAO DAE                          | LSTD Project        |
| Total                                                                                                            | 50              |          | 1133                | 207 | 1340  |                                   |                     |

## EFFECTIVENESS OF IMPARTED RICE PRODUCTION TRAINING

It is important to determine the impact of different aspects of imparted rice production training for its better planning and execution in future. This study was conducted at the end of each batch to collect the relevant information. After the completion of

data collection, information was compiled and analyzed. This study reveals that all the training programmes on modern rice production were very much helpful for the trainees to build up their capacity for modern rice production related activities.

## **BRRI RS, Barishal**

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## SUMMARY

BRRI RS, Barishal is operating a strong breeding programme to develop suitable high yielding rice varieties for tidal submergence in T. Aman and favourable Boro seasons. To achieve the goal, forty-five new crosses were made, and fifty-six crosses were confirmed. A total of 5,500 progenies from F2 to F4 generation were harvested using FRGA technique during T. Aman 2023.

**During Boro 2022-23**, a total of 17,183 progenies from F2 to F5 generation were harvested using FRGA technique during Boro 2023-24. To explore the attributes of new generation rice (NGR) in exotic populations, 240 plants from 45 hybrid F2 population were selected for further evaluation in F3 nursery and 290 plant progenies from 1042 F7 hybrid populations were bulked for further evaluation in OYT nursery Boro 2024-25. Three observational yield trials (OYT) was conducted during Boro 2023-24. One OYT (OYT#1) consisting of 208 advanced breeding lines along with four checks and out of those 88 lines were selected for their better performances. Another OYT (OYT#2) consisting of 77 along with four checks and out of those 15 entries were selected based on yield and yield contributing traits. In OYT#FBC, 296 along with six checks were evaluated and out of those 10 entries outyielded the check varieties. One preliminary yield trial (PYT) conducted during T. Aman 2023. In PYT, sixteen advanced breeding lines along with five checks were evaluated and better performing six entries were selected for further trials. One preliminary yield trial (PYT) was conducted during Boro 2023-24. Eight advanced breeding lines along with three checks were evaluated and based on their better performance two lines were selected for further trials. Twenty regional yield trials (RYTs) were conducted during 2023-24. Out of those, eight RYTs for T Aman 2023 included zinc enriched rice, rainfed lowland rice, antioxidant rich black rice, salt tolerant rice, low amylose rice and tall materials, Twelve RYT for favourable Boro included Extra long slender, medium, semi medium and short duration, Bio, Zinc enriched rice, PQR, Tall, Blast\_LD, Blast\_MD, Blast\_SD and Barishal\_FBR. All the tested RYT materials were obtained from BRRI HQ, Gazipur excepting one

Barishal\_FBR-2. Three advanced yield trials (AYTs) were conducted during T. Aman 2023 and out of those two for tidal submergence tolerance and one for high yielding genotypes. Eight AYTs for the favourable Boro rice variety were conducted during Boro 2023-24 and those were from BRRI RS, Barishal. Seventeen hybrids of different companies and six checks viz BRRI dhan74, BRRI dhan89, BRRI dhan92, BRRI hybrid dhan3, BRRI hybrid dhan5 and BRRI hybrid dhan8 were evaluated at Charbadna farm, BRRI RS, Barishal during Boro 2023-24. None of the tested hybrids out yielded the highest yielded check variety BRRI hybrid dhan8 (8.55 t/ha). The growth duration range of the tested hybrid was 142-148 days whereas for check varieties it was observed 141-149 days.

A total of 373 local Aman germplasm were grown in six-line plots for characterization, utilization and maintenance during T. Aman 2023. Appearance of insect pests was lower than the previous reporting year. YSB, GLH, WLH, WBPH were found comparatively higher number than the other rice insect pests. The highest catch of natural enemies in light trap was recorded STPB, GMB, CDB, and EW. Insect pest peak was observed in October, November and December 2023 and another little peak was observed in March 2024. Natural enemy abundance was found higher in October, November and December 2023 and March 2024. Zinc phosphate and Phostoxin bait found highest rat dead and its efficacy the also better compared to was other market available rodenticides at BRRI, RS the Charbadna farm in T. Aman, 2021. Yellow stem borer caught found no significance difference among different varieties with pheromone lure at the BRRI RS, Charbadna farm in Aus 2021. Boro 2021-22, BRRI RS Barishal. Charbadna and Sagardi farm rice production continued without insecticides applying, perching and sweeping technology. Complete sweeping in every field natural enemy released back again in the same plot and harmful insects were damaged. Pests and natural enemies were monitored in BRRI RS Barishal wing light trap. In Barishal T. Aman 2021 average bacterial leaf blight incidence (29.9%) was predominant. In Barishal Boro 2022 average narrow brown spot incidence (27.38%) was predominant. From the missing element trial it was revealed that for BRRI dhan67, nitrogen (N) was the

most limiting nutrient followed by potassium (K), in the tidal flooded soil. Overall findings suggest that all the nutrients (N, P, K, S and Zn) should be applied in required amount in T. Aman while in Boro, application of N and K must be ensured for optimum rice yield. The sediment from tidal water in Barishal regional station was found slightly alkaline (pH=7.8) and organic matter was high in amount (3.27%). Among inorganic nutrient, the amount of Sulphur was quite noticeable which was  $15.33 \mu\text{g g}^{-1}$ . To draw a conclusion, the experiment needs to be continued in the following years. Head to head trial for Boro varieties under TRB project in the Barishal region suggests that BRRI dhan74 could be popular and be disseminated among the farmers as newly released varieties.

A cropping pattern improvement experiment in Barishal, focusing on the inclusion of mungbean, pumpkin, and Aus rice, aimed to enhance productivity and resource use efficiency in the region. Mungbean, with its short growing period and ability to fix nitrogen, was introduced between rice crops, improving soil fertility and providing an additional income source. Pumpkin, a drought-tolerant crop, was integrated during the dry season, utilizing fallow or marginal lands for increased economic returns. Aus rice, tolerant to early flooding, was included in the pre-monsoon period, ensuring optimal use of the cropping calendar. These adjustments led to increased cropping intensity, better soil health, and improved income stability for farmers, contributing to more resilient and sustainable farming systems in the face of climate challenges.

In T. Aus 2023 BRRI dhan98 produced highest yield (5.33t/ha) followed by BRRI dha48 (4.57 t/ha). In T. Aman 2023, among the short duration varieties, the highest yield was in BRRI dhan95 (4.06 t/ha) followed by BRRI dhan87 (3.40 t/ha), for medium duration varieties, we found the highest yielding variety BRRI dhan49 (3.91t/ha) followed by BRRI dhan54(3.87t/ha) whereas we found the highest yielding variety BRRI dhan91(3.49 t/ha) followed by BR10 (2.44t/ha) among the long duration varieties instability analysis experiment at BRRI RS, Barishal. A total of six ALARTs, where three for T Aman 2023 (Anti oxidant enriched rice

SHR-1 and SHR-2) and three for Boro 2023-24 (BLB resistant rice, salt tolerant rice and blast + BLB resistant rice were conducted at different sites of the Barishal region. From the results of ALART, in T. Aman 2023, one entry BR13-7-9-3-2B (3.87 t/ha) showed superior yield performance than the check variety BRRI dhan49 (3.44 t/ha) in SHR-1 and the advanced line BR9396-6-2-2B (5.03 t/ha) showed superior yield performance than the check variety BRRI dhan94 (4.60 t/ha) in SHR-2. In Boro 2023-24: advanced line BR (path) 13800-BC3-8-1 (5.7 t/ha) and BR (path) 13800-BC3-224-28 (5.4 t/ha) showed better yield comparing with the highest yielded check variety BRRI dhan89 (4.90t/ha) in BLB resistant rice experiment. BR (path)13800-BC3-224-44 (8.2 t/ha) showed superior grain yield performance than the better check BRRI dhan89 (7.8 t/ha) in Blast + BLB resistant rice experiment where as the advanced lines BR11712-4R-44 (7.4 t/ha in Barishal Sadar, six t/ha in Kolapara) and BR11712-4R-93 (7.7 t/ha in Barishal Sadar, 5.7 t/ha in Kolapara) showed superior yield performance in both the locations than the better check BRRI dhan89 (6.7 t/ha in Barishal Sadar, 5.3 t/ha in Kolapara) in Salt Tolerant Rice experiment.

BRRI released HYVs were demonstrated under GoB and other projects to disseminate among the farmers. Most of the farmers were motivated about varieties BRRI dhan98 in Aus season, BRRI dhan52, BRRI dhan87 and BRRI hybrid dhan7 in Aman season whereas, BRRI dhan74, BRRI dhan 89, BRRI dhan92, BRRI hybrid dha3 and BRRI hybrid dhan8 in Boro season. In the reporting year, a total of 56,680 kg breeder seeds and 32,885 kg TLS seeds were produced in both Sagardi and Charbadna farm, BRRI, Barishal. Moreover, 47 trainings and 24 field days were conducted by BRRI RS, Barishal during the reporting year. Besides, a regional workshop was also arranged in BRRI RS, Barishal at that time.

## VARIETY DEVELOPMENT

### Hybridization and pedigree nursery

Development of varieties for tidal submergence. Twenty-nine new crosses were made using fifteen parents, and 1,324 F1 seeds were collected to develop tidal submergence tolerant rice varieties (Table 1). Out of thirty-three crosses twenty-five

were confirmed and registered in the BRRI RS Barishal cross-list with the station code BRBa251 to BRBa275. In Field RGA Nursery, segregating progenies from F2 to F4 generation were rapidly

advanced in the field condition in T. Aman 2023. In total 5,500 progenies were harvested using FRGA technique during T. Aman 2023.

**Table 1. List of F<sub>1</sub> seeds produced in T. Aman 2023.**

| Cross combination              | No. of seeds | Sl.  | Cross combination                                    | No. of seeds |
|--------------------------------|--------------|------|------------------------------------------------------|--------------|
| BRRI dhan103 / BRRI dhan87     | 7            | 16   | Shomogoda / BRRI dhan87                              | 79           |
| BRRI dhan103/ BRRI dhan89      | 24           | 17   | Shomogoda / BRRI dhan103                             | 22           |
| BRRI dhan87 / BRRI dhan89      | 17           | 18   | IR16F1097 / BRRI dhan52                              | 20           |
| BRRI dhan87 / BRRI dhan103     | 75           | 19   | IR16F1097 / BRRI dhan76                              | 80           |
| BRRI dhan79 / BRRI dhan52      | 100          | 20   | Shomogoda / BRBa13-47-2-4-1                          | 10           |
| BRRI dhan87 / BRRI dhan52      | 53           | 21   | Sahi Balam / BRRI dhan76                             | 9            |
| BRRI dhan79 / BRRI dhan77      | 142          | 22   | BRBa26-1-1-1-2 / BRRI dhan52                         | 18           |
| BRRI dhan52 / BRBa12-33-2-3-2  | 7            | 23   | (Moulota / BRRI dhan52) / BRRI dhan52 (Backcross)    | 47           |
| BRRI dhan103 / BRBa12-33-2-3-2 | 26           | 24   | BRRI dhan89 / BRRI dhan77                            | 3            |
| BRRI dhan52/ BRBa11-5-1-1-3    | 128          | 25   | BRBa26-1-1-1-2 / BR23                                | 6            |
| BRRI dhan103 / BRBa11-5-1-1-3  | 28           | 26   | BRBa26-1-1-1-2 / BRRI dhan76                         | 10           |
| Sahi Balam / BRRI dhan52       | 85           | 27   | BRBa26-1-1-1- 2/ BRRI dhan77                         | 60           |
| Sahi Balam/ BRRI dhan87        | 75           | 28   | (Kajolshail / BRRI dhan76) / BRRI dhan76 (Backcross) | 28           |
| Sahi Balam / BRRI dhan103      | 41           | 29   | (Kajolshail / BRRI dhan76) / BRRI dhan52 (Backcross) | 30           |
| Shomogoda / BRRI dhan52        | 94           |      |                                                      |              |
| Total                          |              | 1324 |                                                      |              |

### Breeding for favourable ecosystem

A total of 16 crosses were done using eight parents and 1391 F<sub>1</sub> seeds were obtained to develop high yielding Boro rice varieties during Boro 2023-24 (Table 2). Besides, 31out of 43 crosses were confirmed and registered in BRRI RS, Barishal cross list with station code BRBa276 to BRBa306 in Boro 2023-24. In Field RGA Nursery, segregating progenies from F2 and F5 generation were rapidly advanced in the field condition in Boro 2023-24. In total, 17,183 progenies were harvested using FRGA technique during Boro 2023-24.

A total of 240 plants from 45 hybrid F2 population were selected for further evaluation in F3 nursery and 290 plant progenies from 1,042 F7 hybrid population were bulked for further evaluation in OYT nursery Boro 2024-25.

### YIELD TRIAL 2023-24

**Observational yield trial (OYT) Boro 2023-24.** Three OYTs were conducted in Charbadna farm, Barishal during Boro 2023-24. The OYT-1was consisted of 208 entries along with four checks, BRRI dhan74, BRRI dhan89, BRRI dhan101and BRRI dhan102. Based on phenotypic acceptability

(4-5) and grain yield performance 88 genotypes were selected for further

evaluation. Selected genotypes out yielded (10.30-67.02%) over the highest yielding check variety BRRI dhan101 (5.5t/ha). The genotype BRBa76-7-3-1-1 produced the highest yield (9.19t/ha) with a growth duration of 139 days which is similar to the highest yielded check variety BRRI dhan101.

The OYT-2 was consisted of 77 entries along with four checks-BRRI dhan74, BRRI dhan89 and BRRI hybrid dhan8. Based on phenotypic acceptability (4-5) and grain yield performance 25 genotypes were selected for further evaluation. Selected genotypes out yielded (5.11-.33.33%) over the second highest check variety BRRI dhan89 (7.20t/ha) where as only 15 genotypes showed better yield performance over the highest yielded check BRRI hybrid dhandhan8 (8.40t/ha). The genotype H1340-4-3-1-2-B produced the highest yield (9.61t/ha) with a growth duration of 148 days, which is similar to the highest yielded check variety BRRI hybrid dhan8.

The OYT(FBC)-3 was consisted of 296 entries along with six checks, BRRI dhan28, BRRI dhan29, BRRI dhan88, BRRI dhan89, BRRI dhan92 and BRRI

ghan100. The growth duration of tested entries were found 129-148 days whereas the 130-148 days were found in the check varieties. The yield range was observed 1.98-8.28t/ha among the tested entries and 5.47-7.01t/ha were found in the checks. The entry

BR14007-2R-47 produced the highest yield (8.28 t/ha) with a similar growth duration of the highest yielded check variety BRRI dhan29 (7.01 t/ha; 143 days)

**Table 2. List of F<sub>1</sub> seeds produced in Boro 2023-24.**

| Cross combination           | No. of seeds |
|-----------------------------|--------------|
| NGR 350-2/ BRRI dhan74      | 27           |
| NGR 1256-1/BRRI dhan89      | 55           |
| NGR 1256-1/NGR 350-2        | 21           |
| NGR 1256-1/ BRRI dhan74     | 104          |
| NGR 1256-1/ BRBa21-13-2-2-1 | 43           |
| BRBa21-13-2-2-1/NGR 1256-1  | 90           |
| NGR 1256-1/NGR 324-1        | 110          |
| NGR 325-1 /NGR 350-2        | 65           |
| NGR 325-1 /NGR 1256-1       | 69           |
| BRBa21-13-2-2-1/NGR 350-2   | 126          |
| BRBa21-13-2-2-1/NGR 325-1   | 54           |
| NGR 325-1 / BRBa21-13-2-2-1 | 138          |
| NGR 325-1 /BRRI dhan102     | 131          |
| NGR 325-1 /BRRI dhan89      | 138          |
| NGR 1256-1/NGR325-1         | 155          |
| NGR 324-1/NGR325-1          | 65           |
| Total                       | 1391         |

### **Preliminary yield trial (PYT).**

One PYT was conducted during T. Aman 2023 which was consisted with 16 advanced breeding lines along with five checks, BRRI dhan23, BRRI dhan52, BRRI dhan76, and BRRI dhan87 were evaluated at Charbadna farm of BRRI RS, Barishal.

Among the tested materials growth duration was ranged from 128 to 157 days. The shortest plant height was observed in BRBa30-5-2-1-1 (111cm) while the longest plant height was found in BRBa29-5-4-2-1 (157cm). Effective number of tillers was ranged from 7 to 9. Six entries were selected comparing with better yielding check variety BRRI dhan87 (3.96/ha). The yield range of the tested entries was 2.79 to 4.24 t/ha. The highest yield was obtained from BRBa30-3-4-2-2 (4.24t/ha) followed by BRBa30-3-4-1-1-P2 (4.19t/ha) and BRBa31-1-2-1-1 (4.13t/ha) and the lowest yield was obtained from BRBa29-5-4-2-1 (2.79 t/ha). Due to natural calamities like high tidal effect during maximum tillering stage and Midhili prior to harvesting period caused lower yield of the advanced lines. The selected four entries will be tested again in T. Aman 2024.

One PYT was conducted during Boro 2023-24. The experiment consisting of eight advanced breeding lines along with three checks, BRRI dhan74, BRRI dhan101 and BRRI dhan102 were evaluated at Charbadna farm of BRRI RS.

Barishal. Among the tested materials, BRBa72-17-2-1-1-1 (7.30t/ha) and BRBa71-1-2-1-2-4-1 (7.3t/ha) produced similar yield with the highest yielded check BRRI dhan102 (7.30t/ha). The yield range was 6.2-7.3t/ha found in the tested entries whereas 6.8-7.3t/ha was found in the checks. The growth duration range of the tested entries which was 140-141 days whereas it was found 145 days in the checks. The plant height varied in the tested entries was 96-113 cm whereas it was 107 cm for BRRI dhan101.

### **Regional yield trial (RYT)-T. Aman 2023.**

**A RYT for zinc enriched rice** comprising of four entries along with four checks BRRI dhan49, BRRI dhan72, BRRI dhan87 and BRRI dhan93 was grown at Charbadna farm of BRRI RS, Barishal. None of the tested entries found to be out yielded over the checks. The yield range of the tested entries was



3.48-3.92t/ha whereas the yield range of the checks was 3.48-4.22t/ha. The growth duration range of the tested genotypes varied from 132-135 days whereas it was found for check varieties from 130 to 133 days.

**A RYT for tall** comprising four entries along with two checks BRRI dhan76 and BRRI dhan91 was grown at Charbadna farm of BRRI RS, Barishal. The average seedling height of the tested genotypes was 38-67 cm whereas average plant height was 119-150 cm. Except one entry BR9392-6-2-1B (2.70t/ha), all the tested entries found to be out yielded over the highest yielded check BRRI dhan76 (3.16t/ha). The growth duration range of the tested genotype was 133-139 days. Less yield found due to acute lodging at reproductive stage after Cyclone Midhili.

**A RYT for low amylose** comprising of three entries along with two checks BRRI dhan71 and BRRI dhan87 was grown at Charbadna farm of BRRI RS, Barishal. None of the tested entries found better comparing with check varieties. BRRI dhan71 (3.65t/ha) and BRRI dhan87 (4.32t/ha). The growth duration of the tested genotype varied from 115 to 128 days which is similar to the growth duration range of the check varieties. Lower yield was caused due to severe infestation of rats and birds at vegetative and reproductive stages respectively. Moreover the trial was flooded two times by high tide and remained submerged for a time.

**A RYT for salt tolerant rice** comprising of 12 entries along with two checks BRRI dhan73 and BRRI dhan87 was grown at Charbadna farm of BRRI RS, Barishal. The genotype BR13111-4R-63 (3.62t/ha) found as out yielded comparing with the highest yielded check variety BRRI dhan87 (3.61 t/ha). The growth duration of the tested genotypes varied from 112 to 127 days whereas the growth duration of the check variety was ranged from 118-130 days. Lower yield was caused due to severe infestation of rats and birds at vegetative and reproductive stages respectively. Moreover the trial was flooded by two times high tide and remained submerged for a couple of days in every time.

**A RYT for antioxidant#1 (Aromatic)** antioxidant rich black rice consisting of five entries along with two checks viz BRRI dhan34 and BRRI dhan70 was conducted at Charbadna farm during T.

Aman 2023. The yield range of the tested entries varied from 2.47t/ha to 2.75t/ha. None of the tested entries found better comparing with the check varieties.

The growth duration range was found 123-135 days. In case of most entries less yield was found due to lodging at reproductive stage after cyclone Midhili. Moreover the trial was flooded by two times high tide and remained submerged for few days in every time.

**A RYT for antioxidant#2** rich black rice consisting of seven entries along with two checks viz BRRI dhan49 and BRRI dhan87 was conducted at Charbadna farm during T. Aman 2023. The yield range of the tested entries was varied from 3.05t/ha to 4.10t/ha. Only one genotype i.e., BR12839-4R-137 found out yielded over the highest yielded check variety BRRI dhan87 (4.07t/ha). The growth duration range was found 120-132days. Less yield of the genotypes was found as the trial was flooded two times because of high tide and remained submerged for few days in every time.

**A RYT for rainfed lowland rice (RLR#1)** consisted of nine genotypes along with two checks viz BRRI dhan71 and BRRI dhan75 was evaluated at Charbadna farm of BRRI RS, Barishal. The yield range among the tested entries was varied from 3.29 to 4.09t/ha. Only one genotype i.e., BR12005-6R-14(4.09t/ha) found out yielded over the highest yielded check variety BRRI dhan71 (3.95t/ha). The growth duration range was found 117-132days.

**A RYT for rainfed lowland rice (RLR#2)** consisted of seven genotypes along with two checks viz BRRI dhan49 and BRRI dhan87 was evaluated at Charbadna farm of BRRI RS, Barishal. The yield range among the tested entries was varied from 3.15 to 4.33t/ha. Only one genotype i.e., BR11336-6R-10 (4.33t/ha) found out yielded over the highest yielded check variety BRRI dhan87 (4.28t/ha). The growth duration range was found 119-139 days. In case of most entries less yield was found due to lodging at reproductive stage after Cyclone Midhili.

#### **Regional yield trial (RYT)-Boro2023-24.**

**In RYT for favourable Boro (Bio),** Six entries along with two checks BRRI dhan86 and BRRI dhan96 were tested at BRRI Charbadna farm of BRRI RS, Barishal, during Boro 2023-24. The

growth duration range was 145-147 days and the yield range was 3.72-5.46 t/ha. Two tested entries were found out yielded over the highest yielded check variety BRRI dhan96 (5.41t/ha). The test line BR (Bio)13030-AC13-2-2 produced the highest yield (5.46t/ha) with a growth duration of 146 days.

**A RYT for favourable Boro (Extra Long Slender)** consisted of four genotypes along with two checks viz BRRI dhan63 and BRRI dhan104 was evaluated at Charbadna farm of BRRI RS, Barishal. None of the tested entries found out yielded over the highest yielded check BRRI dhan63 (5.38t/ha). The yield range of the tested entries was 4.70-5.15t/ha with a growth duration range of 146-151 days.

**A RYT for favourable Boro (Medium duration)** consisted of nine genotypes along with three checks viz BRRI dhan58, BRRI dhan89 and BRRI dhan102 was evaluated at Charbadna farm of BRRI RS, Barishal. Only one entry i.e., BR12517-5R-57(6.48t/ha)was found out yielded over the highest yielded check BRRI dhan89 (6.41t/ha). The yield range of the tested entries was 5.07-6.48t/ha with a growth duration range of 146-156 days.

**A RYT for favourable Boro (Short duration)** consisted of eight genotypes along with two checks viz BRRI dhan88 and BRRI dhan96 was evaluated at Charbadna farm of BRRI RS, Barishal. Two entries viz BR12671-4R-95 (5.95t/ha) and BR 12574-5R-52 (5.94t/ha) were found out yielded over the highest yielded check BRRI dhan88(5.48t/ha). The growth duration range of the tested entries found 144-146 days.

**A RYT for favorable Boro (Semi-medium duration)** consisted of ten genotypes along with four checks viz BRRI dhan58, BRRI dhan88, BRRI dhan89 and BRRI dhan102 was evaluated at Charbadna farm of BRRI RS, Barishal. Only one entry i.e., BR13027-BC1-3R-77 (6.4t/ha) was found out a yielded over the highest yielded check BRRI dhan89 (6.3t/ha). The yield range of the tested entries was 4.8-5.6t/ha with a growth duration range of 141-148 days.

**In RYT for zinc enriched rice**, six entries along with three checks BRRI dhan74, BRRI dhan89 and BRRI dhan100 was tested at BRRI Charbadna farm, Barishal, during Boro 2023-24. None of the tested entries found out yielded over the highest yielded check variety BRRI dhan74 (7.04t/ha).The

yield range of the tested entries was 4.86-6.80t/ha. The growth duration range of the tested entries was 146-151 days.

**A RYT\_PQR** consisting of sixteen lines along with five checks (BRRI dhan50, BRRI dhan63, BRRI dhan81, BRRI dhan104, Tepiboro) was conducted at Charbadna farm, Barishal, during Boro 2023-24. The average yield range of the tested entries were 1.58-5.42(t/ha) whereas the yield range of the check varieties varies from 3.03-5.79 t/ha. None of the tested entries found out yielded over the highest yielded check variety BRRI dhan50 (5.79 t/ha). The growth duration range of the tested entries found 138-163 days.

**A RYT for tall**, consisting of four genotypes along with one check BRRI dhan102 was tested at BRRI RS,Charbadna farm, Barishal, during Boro 2023-24. The average yield range of the tested entries was 4.73-6.74 t/ha. One entry i.e., BR 9396-6-2-2B (6.74 t/ha) was found out yielded over the check variety BRRI dhan102 (6.03 t/ha).The growth duration range of the tested entries was observed 138-149days whereas it was found in the check 144days.

**A RYT#2 for\_blast\_LD**, was conducted at two location of BRRI Charbadna farm, Barishal and in farmer's field at Kashipur, Barishal. Five lines along with one standard check BRRI dhan29 were tested under this trial during Boro 2023-24. In Charbadna farm, the average yield range of the tested entries was found 5.63-6.51t/ha. Except one, all the tested entries found out yielded over the check variety BRRI dhan29 (6.19 t/ha). The test line BR (Path) 15855-BC3-2HR-11 (6.51 t/ha) produced highest yield with a growth duration of151days which was more or less similar to the check variety. Whereas in farmer's field the average yield range of the tested entries was found 5.71-6.37t/ha. Three tested entries found out yielded over the check variety BRRI dhan29 (6.04t/ha). The test line BR (Path) 15855-BC3-2HR-11 (6.37 t/ha) produced highest yield with a growth duration of 152 days, which was two days longer than the check variety.

**A RYT#3 for\_blast\_MD**, was conducted at two locations of BRRI RS, Charbadna farm, Barishal and in farmer's field at Kashipur, Barishal. Two lines along with two standard checks BRRI dhan58 and BRRI dhan89 were tested under this trial during

Boro 2023-24. In Charbadna farm, the average yield range of the tested entries was found 5.80-6.11t/ha. None of the tested entries found out yielded over the highest yielded check variety BRRI dhan89(6.33t/ha). The growth duration range of the tested entries was 138-139 days. Whereas in farmer's field, the average yield range of the tested entries was found 5.88-6.06t/ha. None of the tested entries found out yielded over the highest yielded check variety BRRI dhan89(6.14t/ha). The growth duration range of the tested entries was 138-140 days.

**A RYT#4 for blast\_SD**, was conducted at two locations of BRRI Charbadna farm, Barishal and in farmer's field at Kashipur, Barishal. Five lines along with two standard checks BRRI dhan28 and BRRI dhan88 were tested under this trial during Boro 2023-24. In Charbadna farm, the average yield range of the tested entries was found 5.37-6.03t/ha. Only one tested entry i.e., BR (Path) 15641-3HR-15(6.03t/ha) found to be out yielded over the highest yielded check variety BRRI dhan88 (5.90t/ha). The growth duration range of the tested entries was 136-145 days. Whereas in farmer's field the average yield range of the tested entries was found 5.49-5.87t/ha. Only one tested entry i.eBR (Path) 15641-

3HR-15 (5.87t/ha) found to be out yielded over the highest yielded check variety BRRI dhan88(5.55t/ha). The growth duration range of the tested entries was 135-145 days.

**RYT\_FBR\_Barishal**. Ten entries along with two checks BRRI dhan74 and BRRI dhan102 were evaluated in twelve locations of the BRRI regional stations and BRRI, HQ during Boro, 2023-24. Among the tested materials, the plant height was ranged from 97.84 cm of NGR745-2to 105.03 cm of NGR750-1 a. NGR350-2 took the shortest period (146 days) at to get matured while NGR736-1, NGR745-3 and NGR745-2 took the longest period (153 days) to get matured. The highest average grain yield (9.02 t/ha) was found in NGR1161-3 at Bhanga and the lowest average grain yield (3.79t/ha) was found in NGR1161-3 at Cumilla. The check yields of BRRI dhan74 was ranged from 5.13 t/ha at Gazipur to 7.86 t/ha at Bhanga whereas another check variety BRRI dhan102 produced 4.77t/ha at Gazipur to 8.42t/ha at Bhanga. There was significant yield variation found among 11 test locations. On average, the test line NGR736-1 ( 7.11t/ha) performed the highest yield over the locations and seven tested entries performed 0.14 to 4.20% higher yield over the check variety BRRI dhan102 (6.82 t/ha) (Table 3).

**Table 3. Yield and ancillary characters of RYT\_FBR (Barishal) genotypes, Boro 2023-2024.**

| Designation        | Average PH (cm) | Average GD (day) | Yield (t/ha)      |                   |             |
|--------------------|-----------------|------------------|-------------------|-------------------|-------------|
|                    |                 |                  | Lowest (location) | Highest(location) | Avg.        |
| NGR350-2           | 98.03           | 146              | 5.66 (Gazipur)    | 7.98 (Rangpur)    | 7.02        |
| NGR472-2           | 98.58           | 150              | 4.54 (Gazipur)    | 8.91 (Bhanga)     | 6.98        |
| NGR736-1           | 100.32          | 153              | 5.53 (Gazipur)    | 8.02 (Bhanga)     | 7.11        |
| NGR745-3           | 99.35           | 153              | 5.41 (Gazipur)    | 8.30 (Bhanga)     | 6.95        |
| NGR994-1           | 99.71           | 152              | 5.21 (Gazipur)    | 8.36 (Bhanga)     | 7.01        |
| NGR745-2           | 97.84           | 153              | 4.83 (Cumilla)    | 8.39 (Bhanga)     | 6.90        |
| NGR749-2           | 98.67           | 152              | 4.53 (Cumilla)    | 8.21 (Bhanga)     | 6.83        |
| NGR750-1           | 105.03          | 151              | 5.39 (Gazipur)    | 8.09 (Rajshahi)   | 6.70        |
| NGR796-2           | 101.01          | 151              | 4.14 (Gazipur)    | 8.47 (Bhanga)     | 6.68        |
| NGR1161-3          | 99.99           | 150              | 3.79 (Cumilla)    | 9.02 (Bhanga)     | 6.48        |
| BRRI dhan74        | 94.7            | 146              | 5.13 (Gazipur)    | 7.86 (Bhanga)     | 6.64        |
| BRRI dhan102       | 104.0           | 153              | 4.77 (Gazipur)    | 8.42 (Bhanga)     | 6.82        |
| <b>LSD at 0.05</b> | <b>4.41</b>     | <b>4.08</b>      |                   |                   | <b>0.24</b> |
| <b>CV (%)</b>      | <b>2.67</b>     | <b>1.63</b>      |                   |                   | <b>2.13</b> |

L1= BRRI RS, Barishal; L2= BRRI RS, Bhanga; L3= BRRI RS, Cumilla; L4= BRRI HQ, Gazipur; L5= BRRI RS, Gopalganj; L6= BRRI RS, Habigonj; L7= BRRI RS, Kustia; L8= BRRI RS, Rajshahi; L9 = BRRI RS, Rangpur; L10= BRRI RS, Satkhira; L11= BRRI RS, Sirajgonj.

#### **Advanced yield trial (AYT)**

**AYT-1, T. Aus 2023.** Eight entries along with four checks BR27, BRRI dhan98, BRRI dhan106 and Gota IRRI were grown at two locations such as Charbadna farm, BRRI RS, Barishal and Karnakathi of Barishalsadar. Growth duration of the tested entries was ranged from 112 days to 120 days at Charbadna farm whereas it was found 101 days to 108 days at Karnakathi. . One entry BR12614-4R-158 produced higher yield (5.35t/ha) over the highest yielded check BBRI dhan98 (5.29 t/ha) with agrowth duration of 120 days which is 8 days longer than the highest yielded check at Charbadna firm and none of the entries was selected in Karnakathi.

**AYT-1, T. Aman 2023.** Twelve entries along with five checks BR23, BRRI dhan52, BRRI dhan72, BRRI dhan76and BRRI dhan87 were grown at Charbadna farm, BRRI, Barishal.Growth duration of the tested entries was ranged from 131 days to 136 days. Four entries produced higher yield over the highest yielded check BBRI dhan72 (4.20 t/ha).Due to natural calamities like high tide effect during maximum tillering stage and cyclone Midhili prior to harvesting period causing lower yield of the advanced lines. Here it is noted that the experiment will be tested again in T. Aman 2024.

**AYT-2, T. Aman 2023.** Twenty entries along with four checks BR23, BRRI dhan52, BRRI dhan76 and BRRI dhan77 were grown at Charbadna farm, BRRI RS, Barishal during T Aman 2023. Growth duration of the tested entries was ranged from 130 days to 137 days. Only one entry BRba11-33-1-5-1 found out yielded (3.81 t/ha) over the highest yielded check BR23 (3.71t/ha).Due to natural calamities like high tide effect during maximum tillering stage and cyclone Midhili prior to harvesting period causing lower yield of the advanced lines. Noted that the experiment will be retested in T. Aman 2024.

**AYT-3, T. Aman 2023.** Sixteen entries along with five checks BR23, BRRI dhan52, BRRI dhan72, BRRI dhan76 and BRRI dhan87 were grown at Charbadna farm, BRRI RS, Barishal during T. Aman 2023. Growth duration of the tested entries was ranged from 130 days to 135 days. None of the tested entries found out yielded over the check varieties. The yield range of the tested entries found 3.04-3.93 t/ha and the yield range of 3.38-4.24 t/ha was found in the check varieties.

**AYT-1,Boro 2023-24.** One advanced yield trial of favourable Boro rice consisted of 10 entries along with two checks BRRI dhan74 and BRRI dhan89 was evaluated at Sagardi Farm of BRRI RS, Barishal. The growth duration of the tested materials was ranged from 139 to 144 days whereas the growth duration of the check varieties ranged from 138 (BRRI dhan74) to 146 days (BRRI dhan89). The plant height of the tested entries was varied from 107 to 116 cm. The effective tiller of the tested entries was varied from 8 to 10 The yield range was 5.17t/ha (NGR 1203-1) to 6.32t/ha (NGR 1210-2). None of the tested entries found to be out yielded over the check varieties.

**AYT-2, Boro 2023-24.** Comprising of 14 entries along with twochecks BRRI dhan74 and BRRI dhan89 was grown at Sagardi farm, BRRI, RS, Barishal. The growth duration of the tested materials was ranged from 137 to 144 days whereas the growth duration of the check varieties ranged from 137 (BRRI dhan74) to 146 days (BRRI dhan89). The plant height of the tested entries was varied from 103 to 112 cm. The effective tiller of the tested entries was varied from 12 to 16. The yield range was 5.17t/ha (NGR 314-2) to 6.58t/ha (NGR 223-2, NGR 324-1). Four entries found out yielded over the highest yielded check variety (BRRI dhan89, 6.46t/ha) with a yield advantage of 1.53-1.86%.

**AYT-3, Boro 2023-24.** Comprising of 14 entries along with two checks BRRI dhan74 and BRRI dhan89 was grown at Sagardi farm, BRRI RS, Barishal. Among the tested entries, NGR 1254-1 (6.71/ha), NGR 1256-1 (6.67 t/ha), NGR 1148-1 (6.63/ha) produced the higher yield than the highest yielded check BRRI dhan89 (6.51/ha). Growth duration of tested entries was ranged from 134 to 143 days whereas in BRRI dhan89 it was 146 days. Plant height range of the tested entries was 107 to 113 cm whereas, in BRRI dhan89 it was107 cm.

**AYT-4, Boro2023-24.** Comprising of 14 entries along with two checks BRRI dhan74 and BRRI dhan89 was grown at Sagardi farm, BRRI RS, Barishal. The yield range of the tested entries was found 5.32-7.13 t/ha.The yield range of the check varieties was found 6.42 t/ha (BRRI dhan89) to 7.26 t/ha (BRRI dhan74). None of the tested entries found out yielded over the check varieties. Growth

duration of the tested entries was ranged from 138 to 143 days whereas, in BRRI dhan74 it was 138 days. Plant height range of the tested entries was 103 to 119 cm whereas, in BRRI dhan74 it was 100 cm. The range of the effective tiller number of the tested entries was 9-15.

**AYT-5, Boro 2023-24.** Comprising of 14 entries along with two checks BRRI dhan74 and BRRI dhan89 was grown at Sagardi farm, BRRI RS, Barishal. The growth duration of the tested materials was ranged from 136 to 142 days whereas the growth duration of the check varieties ranged from 137 (BRRI dhan74) to 148 days (BRRI dhan89). The plant height of the tested entries was varied from 107 to 113 cm. The effective tiller of the tested entries was varied from 11 to 14. The yield range was 5.39 t/ha (NGR 857-2) to 6.99 t/ha (NGR 1258-3). None of the tested entries found to be out yielded over the check varieties where only one tested entry that is NGR 1258-3 produced similar yield to the highest yielded check variety BRRI dhan74 (6.99 t/ha) with a growth duration of 140 days.

**AYT-6, Boro 2023-24.** Comprising of 14 entries along with two checks BRRI dhan74 and BRRI dhan89 was grown at Sagardi farm, BRRI RS, Barishal. The growth duration of the tested materials was ranged from 137 to 148 days whereas the growth duration of the check varieties ranged from 137 (BRRI dhan74) to 148 days (BRRI dhan89). The plant height of the tested entries was varied from 106 to 116 cm. The effective tiller of the tested entries was varied from 9 to 15. The yield range was 5.49 t/ha (NGR 416-1) to 6.43 t/ha (NGR 1161-3). None of the tested entries found to be out yielded over the check varieties. The highest yield was obtained from the check variety BRRI dhan74 (6.96 t/ha) with a growth duration of 137 days.

**AYT-7, Boro 2023-24.** Comprising of 14 entries along with two checks BRRI dhan74 and BRRI dhan89 was grown at Sagardi farm, BRRI RS, Barishal. The growth duration of the tested materials was ranged from 137 to 141 days whereas the growth duration of the check varieties ranged from 137 (BRRI dhan74) to 148 days (BRRI dhan89). The plant height of the tested entries was varied from 105 to 126 cm. The effective tiller of the tested entries was varied from 11 to 15. The yield range was 5.27 t/ha (NGR1-1-1-B) to 6.77 t/ha (BRBa 3-1-7). Only

one tested entry BRBa 3-1-7 (6.77 t/ha) found to be out yielded over the highest yielded check variety BRRI dhan74 (6.72 t/ha) with a growth duration of 137 days.

**AYT-8, Boro 2023-24.** One advanced yield trial of favourable Boro rice consisted of 10 entries along with three checks BRRI dhan74, BRRI dhan101 and BRRI dhan102 was evaluated at Charbadna Farm of BRRI RS, Barishal. The growth duration of the tested materials was ranged from 139 to 150 days whereas the growth duration of the check varieties ranged from 135 (BRRI dhan74) to 144 days (BRRI dhan102). The plant height of the tested entries was varied from 106 to 118 cm. The effective tiller of the tested entries was varied from 7 to 10. The yield range was 5.1-7.1 t/ha. Six entries viz BRBa21-4-1-2-1-P4 (7.1 t/ha), BRBa26-1-1-1-2 (7.1 t/ha), BRBa24-2-4-1-1-1-B (6.9 t/ha), BRBa23-11-5-2-1-P2 (6.75 t/ha), BRBa21-13-2-2-1 (6.71 t/ha) and BRBa23-5-3-3-5 (6.67 t/ha) found out yielded over the highest yielded check variety BRRI dhan74 (6.6 t/ha).

## CHARACTERIZATION AND UTILIZATION OF LOCAL GERMPLASMS

A total of 373 local Aman germplasms were grown during T. Aman 2023 with six-line in each plot for characterization, utilization and maintenance. Ten local germplasms viz Kajolshail, Moulata, Shornogoda, SahiBalam, Sadamota, Balam, Vojan, Horidhan, Thormucra, Shorni-masuri and Mothamota were utilized in hybridization in breeding programme for developing tidal submergence tolerant rice variety. Seeds were harvested and preserved for further evaluation and utilization.

## PERFORMANCE STUDY OF RELEASED HYBRIDS COMPARING WITH STANDARD CHECKS BORO 2023-24

Seventeen hybrids of different companies and six checks viz BRRI dhan74, BRRI dhan89, BRRI dhan92, BRRI hybrid dhan3, BRRI hybrid dhan5 and BRRI hybrid dhan8 were evaluated at Charbadna farm, BRRI RS, Barishal during Boro 2023-24. The yield range of the tested hybrids varied to 6.36 t/ha to 8.23 t/ha whereas it was found 6.20 t/ha to 8.55 t/ha for check varieties. None of the tested hybrids was found out yielded over the highest

yielded check variety BRRI hybrid dhan8 (8.55t/ha). The growth duration range of the tested hybrid was 142-148 days whereas for check varieties it was observed 141-149 days.

### INSECT PEST MANAGEMENT

Incidence of insect pests and natural enemies in light trap. Data were collected from July 2023 to June 2024 at Sagardi farm, BRRI RS, Barishal. Light trap was set up at east side of Sagardi farm in BRRI RS, Barishal. Everyday light trap was switched on in the

evening and switched off at dawn. After that dead insects were collected from the light trap, sorted and recorded manually. Appearance of insect pest was found lower than previous reporting year. The highest yellow stem borer (YSB) followed by green leafhopper (GLH), brown planthopper (BPH) and white brown planthopper (WBPH) was recorded in the reporting year. In case of natural enemy the highest staphylinid beetle (STPB) followed by green miridbug (GMB) and earwig (EW) was observed. Insect pest was trapped higher in the reporting year than natural enemy (Table 4).

**Table 4. Insect pests and natural enemy population in the period of July 2023 to June 2024.**

| Insect pest | Population | Natural enemy | Population |
|-------------|------------|---------------|------------|
| GLH         | 6125       | CDB           | 1043       |
| WLH         | 1729       | LBB           | 669        |
| ZLH         | 1566       | STPD          | 5989       |
| BPH         | 2509       | GMB           | 5016       |
| WBPH        | 1845       | Dam. fly      | 475        |
| YSB         | 7890       | SPD           | 285        |
| DHB         | 356        | EW            | 1098       |
| RLF         | 905        | TB            | 965        |
| CW          | 125        | Total         | 15540      |
| SHG         | 705        |               |            |
| LHG         | 53         |               |            |
| LHC         | 149        |               |            |
| MC          | 326        |               |            |
| RB          | 723        |               |            |
| Total       | 25006      |               |            |

The first peak of insect pest infestation was observed in October, November, December 2023 and January 2024 and the second peak in April, May and June 2024. Natural enemy abundance was found higher in January and February 2024. Although insect pest abundance was found throughout the reporting year but higher insect pest was observed in Boro season compared to T. Aman season

### DISEASE MANAGEMENT

#### Evaluation of new chemicals against rice blast

To evaluate the efficacy of fungicides against rice blast disease, 21 chemicals, including Trooper 75WP (check), were tested at the BRRI RS, Barishal during the Boro season of 2023-24. The variety US2 was used as the test variety. The experiment followed a randomized complete block design (RCBD) with three replications. Artificial inoculation was conducted by spraying spore

suspensions following standard protocols. Disease incidence was assessed by estimating the percentage of infected leaf area through visual inspection. The rate of disease reduction was calculated relative to the untreated control. Among the tested chemicals, only eight—Anti-Blast 38SC, Ezla 70WP, Magbo 75WDG, Fentazol 70WP (listed twice in error), Platinum 75WDG, 3 Star 75WDG, and Blast Off 75WDG—reduced disease by more than 80% compared to the untreated control. These fungicides should be further evaluated for recommendation to the Plant Protection Wing, DAE, for registration.

#### Judicial application of fungicides for blast disease management under field condition (PARTNER)

To validate and disseminate neck blast disease management practices in the Barishal region, six field trials were established at Jangalia village, Sadar upazila, Barishal. The plots selected for experimentation were those already transplanted by

farmers using their own varieties and had a history of blast infection. The effective blast control chemical Trooper 75WP (Tricyclazole 75%) was applied at a rate of 0.8 g/L of water during the heading stage and again seven days after heading (flowering). Each plot was divided into two sections: (1) treated with the recommended chemical and (2) untreated (no chemicals applied). Data on neck blast disease incidence (%) and yield from the entire plot

were collected at harvest. Disease reduction and yield advantages were calculated relative to the untreated control plots. The treatment resulted in more than a 70% reduction in neck blast disease incidence and over a 60% increase in yield (Table 5). This study demonstrates that the blast management practices developed by BRRI effectively reduce blast disease and increase rice yield.

**Table 5. Validation of neck blast disease management practices at Barishal region during Boro 2023-24.**

| Farmer | Neck blast incidence (%) |                |                                           | Yield (t/ha) |                |                                          |
|--------|--------------------------|----------------|-------------------------------------------|--------------|----------------|------------------------------------------|
|        | Treated plot             | Untreated plot | Disease reduction over untreated plot (%) | Treated plot | Untreated plot | Yield advantages over untreated plot (%) |
| F1     | 9.5                      | 70.5           | 86.5                                      | 6.3          | 3.0            | 113.0                                    |
| F2     | 8.5                      | 65.5           | 87.0                                      | 6.6          | 3.1            | 112.6                                    |
| F3     | 10.5                     | 35.5           | 70.4                                      | 6.2          | 3.7            | 67.0                                     |
| F4     | 12.5                     | 40.5           | 69.1                                      | 5.8          | 3.5            | 64.4                                     |
| F5     | 8.5                      | 65.5           | 87.0                                      | 6.5          | 2.8            | 134.5                                    |
| F6     | 7.5                      | 35.5           | 78.9                                      | 6.6          | 3.6            | 82.3                                     |

## CROP SOIL WATER MANAGEMANT

### Management of nitrogen nutrition of HYV rice during Aman season under tidal flood situation

The experiment was conducted to determine a suitable urea application method for Aman rice cultivated under tidal flood conditions. The experiment was conducted in Char Badna farm, BRRI RS, Barishal, during T. Aman 2023. The treatments included the following five urea application methods: (1) prilled urea (PU): 2 splits ( $\frac{1}{2}$  at 10 DAT +  $\frac{1}{2}$  at 7d before PI), (2) PU: 3 splits ( $\frac{1}{3}$ rd at 10 DAT +  $\frac{1}{3}$ rd at active tillering +  $\frac{1}{3}$ rd seven days before panicle initiation), (3) PU: full dose as basal, (4) PU: full dose after final recession of flood water, and (5) urea deep placement (UDP) (@10 DAT). In treatments 1 and 2, the application of urea was carried out in between the flood water recession and new water entry periods during the high tides in full moon and new moon. The design of the experiment was factorial RCB with three replications, with the factors being i) variety and ii)

urea application methods. The varieties were BRRI dhan52 (145 d) and BRRI dhan76 (165 d). The N application rate was 95 kg/ha. Other nutrients e.g., P-K-S-Zn were applied on soil test basis as a flat dose (10-65-11-2 kg/ha). Results showed that the application of PU @ 3 splits yielded the highest grain for both the varieties (Fig. 1). The full dose of PU as basal, recorded the lowest grain yield indicating a greater loss of the applied fertilizer. A varietal difference was recorded in response to urea application, with BRRI dhan76 being more responsive to late urea applications than BRRI dhan52. Deep urea placement yielded higher grain in shorter duration variety BRRI dhan52, than in BRRI dhan76 with longer duration. Further investigation will confirm the findings.

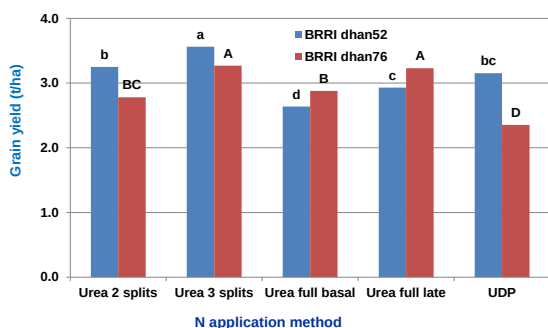


Fig. 1.Effect of urea application method on the grain yield of HYV rice in Char badna farm, BRRI RS, Barishal, T. Aman 2023.

### Effect of planting date on the growth and yield of newly developed BRRI varieties in Barishal region

The experiment was conducted in Charbadna farm in T. Aman 2023 season and Sagardi farm in Boro 2023-24 season of BRRI RS, Barishal aimed at identifying a suitable planting date for short and long duration T. Aman and Boro rice cultivars to maximize grain yield.

#### T. Aman 2023

The results showed that the short duration varieties BRRI dhan75, BRRI dhan 87 and BRRI dhan90 seeding 25 June produced higher grain (2.73 t/ha, 3.63 t/ha, 2.49 t/ha respectively) than the delayed transplanting. In case of long duration varieties BRRI dhan49, BRRI dhan93 seeding on 25 June produced better yield (3.40 t/ha, 3.43 t/ha respectively) and BRRI dhan52 was found higher yielded at 10 July seeding.

#### Boro 2023-24

The results showed that the short duration varieties BRRI dhan88 and BRRI dhan101 seeding on 1 December produced higher grain yield (6.95 t/ha, 8.08 t/ha respectively) and BRRI dhan96 showed better yield on 1 January seeding. In case of long duration varieties BRRI dhan89, BRRI dhan92 and BRRI dhan102 performed better yield (7.23 t/ha, 7.45 t/ha and 8.27 t/ha respectively) on 16 November seeding.

### Long-term missing element experiment for diagnosing limiting nutrient in tidal wetland soil

The trial was conducted in a permanent layout at Sagardi farm, BRRI R/S, Barishal during T. Aman

2023 and Boro 2023-24 with six treatments, namely NPKSZn, -N (PKSZn), -P (NKSZn), -K (NPSZn), -S (NPKZn) and -Zn (NPKS). The experiment design was RCB with four replications. The fertilizers rate were N-P-K-S-Zn @ 95-6-65-11-2 kg/ha in T. Aman2023 and 175-25-35-15-1.5 kg/ha in Boro 2023-24. The tested varieties were BRRI dhan76 in T. Aman and BRRI dhan74 in Boro season. Grain yield was recorded from 5 m<sup>2</sup> area at 14% moisture content. Data were subject to statistical analysis and mean separation were done by DMRT using STAR software.

#### T. Aman 2023

During T.Aman 2023, the highest grain yield (5.89 t/ha) of BRRI dhan76 was observed in the complete treatment in which recommended rates of N, P, K, S and Zn fertilizer were applied. Grain yield was significantly lower than the complete treatment due to the omission of N (diff. 1.62 t/ha) but in case of 317mission of other nutrient, no significant difference was found (Table 6). The finding also supports the fact that during T. Aman season the silt deposition from the tidal water enriches the fertility of soil. The lowest yield was recorded in -N plot followed by -K plot. Thus, it is observed from the yield data that recommended doses of N nutrient should be applied during T.Aman season to obtain optimum yield of BRRI dhan76 and to maintain soil nutrient levels in Sagardi farm soil.

**Table 6. Effect of long-term omission of nutrient elements on the yield of BRRI dhan76 and BRRI dhan89 during T. Aman 23 and Boro 2023-24 at BRRI RS farm, Sagardi, Barishal.**

| Treatment | Grainy yield(t/ha)*   |                     |
|-----------|-----------------------|---------------------|
|           | T.Aman<br>BRRI dhan76 | Boro<br>BRRI dhan74 |
| NPKSZn    | 5.89a                 | 6.62a               |
| (-N)      | 4.27b                 | 4b                  |
| (-P)      | 5.82a                 | 6.15a               |
| (-K)      | 5.41a                 | 6.3a                |
| (-S)      | 5.6a                  | 6.6a                |
| (-Zn)     | 5.49a                 | 6.02a               |
| CV(%)     | 5.24                  | 8.11                |

\*Means followed by same letter in a column are not significantly different.



### Stability analysis of BRRI released variety Aus 2023

Study was accomplished at Charbadna farm, BRRI RS, Barishal during Aus, 2023. Fourteen BRRI released varieties were tested following RCB design with three replications (Table 7). Size of unit plot was 3m x 3m, plot to plot distance was 40 cm, block to block distance was 60 cm and spacing was 20 × 20 cm. Twenty-seven day old seedlings were transplanted. Crop management practices were done according to BRRI recommended practice. Among the tested 14 varieties, BRRI dhan98 produced the highest yield (5.33 t/ha) followed by BRRI dhan48 (4.57 t/ha) and BRRI dhan26 (4.39 t/ha). The lowest yield was observed in BRRI dhan106 (3.1 t/ha).

**Table 7. Stability analysis of BRRI released variety in Aus 2023.**

| Variety           | GD (days)* | Yield (t/ha)* |
|-------------------|------------|---------------|
| BR21              | 112cde     | 3.52defg      |
| BR24              | 113cd      | 3.79cde       |
| BR26              | 117b       | 4.39b         |
| BRRI dhan106      | 127a       | 3.1g          |
| BRRI dhan27       | 119b       | 3.6defg       |
| BRRI dhan42       | 110de      | 3.7def        |
| BRRI dhan43       | 110e       | 3.14fg        |
| BRRI dhan48       | 117b       | 4.57b         |
| BRRI dhan65       | 111cde     | 3.76cde       |
| BRRI dhan82       | 112cde     | 3.46efg       |
| BRRI dhan83       | 118b       | 4.33bc        |
| BRRI dhan85       | 113c       | 4.07bcd       |
| BRRI dhan98       | 117b       | 5.33a         |
| BRRI hybrid dhan7 | 127a       | 4.1bcd        |
| CV(%)             | 0.9303     | 5.03          |

D S: 11Apr 2023; DT: 8 May 2023

\*Values followed by the same letter are not significantly different.

### T. Aman 2023

During T. Aman 2023, forty-eight (48) BRRI released varieties were tested in three groups, namely, short duration (15 nos), medium duration (22 nos) and long duration (11 nos) (Tables 8-10).

Among the tested short duration varieties, the highest yield was observed in BRRI dhan95 (4.06 t/ha) followed by BRRI dhan87 (3.4 t/ha), BRRI dhan71 (2.69 t/ha) and BRRI dhan53 (2.64 t/ha). The lowest yield was found in BRRI dhan62 (0.75 t/ha) (Table 8). In medium duration varieties, the highest yield was found in BRRI dhan49 (3.91 t/ha) followed by BRRI dhan54 (3.87 t/ha), and BRRI dhan103 (3.85 t/ha). The lowest yield was observed in BR3 (1.41 t/ha) (Table 9). Finally, in the long duration varieties, the highest yield was in BRRI dhan91 (3.49 t/ha) followed by BR10 (2.44 t/ha) and the lowest yield was in BRRI dhan37 (1.14 t/ha) (Table 10).

**Table 8. Stability analysis of BRRI released short duration variety in T. Aman, 2023.**

| Variety           | GD(days)* | Yield(t/ha)* |
|-------------------|-----------|--------------|
| BRRI dhan33       | 105cd     | 2.05cde      |
| BRRI dhan39       | 108b      | 1.52def      |
| BRRI dhan53       | 108bc     | 2.64bcd      |
| BRRI dhan56       | 108bc     | 1.89cde      |
| BRRI dhan57       | 106bcd    | 1.74cdef     |
| BRRI dhan62       | 103d      | 0.75f        |
| BRRI dhan66       | 108bc     | 2.11cde      |
| BRRI dhan71       | 108b      | 2.69bc       |
| BRRI dhan73       | 108b      | 2.04cde      |
| BRRI dhan75       | 106bcd    | 1.77cdef     |
| BRRI dhan87       | 122a      | 3.4ab        |
| BRRI dhan90       | 108bc     | 2.02cde      |
| BRRI dhan95       | 122a      | 4.06a        |
| BRRI hybrid dhan4 | 108bc     | 1.86cdef     |
| BRRI hybrid dhan6 | 104d      | 1.42ef       |
| CV(%)             | 1.02      | 17.58        |

DS: 11 Jul 2023; DT: 9 Aug 2023

\*Values followed by the same letter are not significantly different.

**Table 9. Stability analysis of BRRI released medium duration variety in T. Aman 2023.**

| Variety      | GD (day)* | Yield(t/ha)* |
|--------------|-----------|--------------|
| BR11         | 127b      | 3.03abcdef   |
| BR25         | 123ef     | 3.42abcd     |
| BR3          | 123ef     | 1.41g        |
| BR4          | 130a      | 3.39abcd     |
| BRRI dhan103 | 122f      | 3.85ab       |
| BRRI dhan30  | 130a      | 3abcdef      |
| BRRI dhan31  | 126bc     | 2.13fg       |
| BRRI dhan32  | 123ef     | 2.41defg     |
| BRRI dhan40  | 130a      | 3.79ab       |
| BRRI dhan44  | 127b      | 3.31abcde    |
| BRRI dhan49  | 123ef     | 3.91a        |
| BRRI dhan51  | 130a      | 3.82ab       |
| BRRI dhan52  | 125cd     | 3.35abcde    |
| BRRI dhan54  | 123ef     | 3.87a        |
| BRRI dhan70  | 124de     | 2.66cdef     |
| BRRI dhan72  | 123ef     | 2.77bcdef    |
| BRRI dhan77  | 127b      | 2.29efg      |
| BRRI dhan78  | 123ef     | 2.98abcdef   |
| BRRI dhan79  | 123def    | 3.49abcd     |
| BRRI dhan80  | 123ef     | 3.55abc      |
| BRRI dhan93  | 130a      | 3.65abc      |
| BRRI dhan94  | 130a      | 3.75ab       |
| CV(%)        | 0.5032    | 10.88        |

DS: 11 Jul 2023; DT: 9 Aug 2023

\*Values followed by the same letter are not significantly different.

**Table 10. Stability analysis of BRRI released long duration variety in T. Aman 2023.**

| Variety     | GD(day)* | Yield(t/ha)* |
|-------------|----------|--------------|
| BR10        | 137bc    | 2.44b        |
| BR22        | 145a     | 2.19bc       |
| BR23        | 129d     | 1.59de       |
| BR5         | 136c     | 1.23e        |
| BRRI dhan34 | 145a     | 1.49de       |
| BRRI dhan37 | 139b     | 1.14e        |
| BRRI dhan38 | 137bc    | 1.76cd       |

| Variety     | GD(day)* | Yield(t/ha)* |
|-------------|----------|--------------|
| BRRI dhan41 | 137bc    | 1.26e        |
| BRRI dhan46 | 118f     | 2.24b        |
| BRRI dhan76 | 130d     | 1.46de       |
| BRRI dhan91 | 125e     | 3.49a        |
| CV(%)       | 0.5557   | 8.81         |

DS: 11 Jul 2023; DT: 9 Aug 2023

\*Values followed by the same letter are not significantly different.

## Boro 2023-24

Fifty-two varieties were evaluated at Charbadna, Barishal during Boro 2023-24. The varieties were tested in two groups, namely short duration (26 nos.) and long duration (26 nos.) (Tables 11 and 12).

Among the tested short duration varieties, the highest yield was observed in BRRI dhan74 (5.21 t/ha) followed by BRRI dhan84 (5.15 t/ha) and BRRI dhan36 (5.08 t/ha). The lowest yield was found in BR6 (3.95 t/ha) (Table 11). In case of the long duration varieties, the highest yielder was BR17 (4.86 t/ha) followed by BRRI dhan58 (4.74 t/ha) and BRRI dhan99 (4.55 t/ha). The lowest yield was observed in BRRI dhan50 (3.47 t/ha) (Table 12).

**Table 11. Yield and ancillary characters of short duration genotypes, Boro 2023-24.**

| Variety      | GD (day)* | Yield(t/ha)* |
|--------------|-----------|--------------|
| BRRI dhan100 | 144de     | 4.28bcdef    |
| BR1          | 148a      | 3.95ef       |
| BR26         | 148a      | 4.08def      |
| BR6          | 144de     | 3.95f        |
| BRRI dhan101 | 148a      | 4.98ab       |
| BRRI dhan104 | 149a      | 4.23cdef     |
| BRRI dhan105 | 148a      | 4.36bcdef    |
| BRRI dhan27  | 148a      | 4.34bcdef    |
| BRRI dhan28  | 145cde    | 4.37bcdef    |
| BRRI dhan36  | 145cde    | 5.08a        |
| BRRI dhan45  | 145cde    | 4.17def      |
| BRRI dhan55  | 145cde    | 4.65abcdef   |

| Variety           | GD (day)* | Yield(t/ha)* |
|-------------------|-----------|--------------|
| BRRI dhan61       | 147ab     | 4.52abcdef   |
| BRRI dhan63       | 144de     | 4.34bcdef    |
| BRRI dhan67       | 148a      | 4.88abc      |
| BRRI dhan68       | 146bcd    | 4.57abcdef   |
| BRRI dhan74       | 148a      | 5.21a        |
| BRRI dhan81       | 144de     | 4.09def      |
| BRRI dhan84       | 144de     | 5.15a        |
| BRRI dhan86       | 143e      | 4.96ab       |
| BRRI dhan88       | 144de     | 4.14def      |
| BRRI dhan96       | 146bc     | 4.2cdef      |
| BRRI hybrid dhan2 | 148a      | 4.57abcdef   |
| BRRI hybrid dhan3 | 149a      | 4.03ef       |
| BRRI hybrid dhan5 | 144de     | 4.66abcde    |
| BRRI hybrid dhan8 | 148a      | 4.77abcd     |
| CV(%)             | 0.3728    | 4.98         |

DS: 25 Nov 2023; DT: 9 Jan 2024

\*Values followed by the same letter are not significantly different.

**Table 12. Yield and ancillary characters of long duration genotypes, Boro 2023-24, Barishal.**

| Variety      | GD (day)* | Yield(t/ha)* |
|--------------|-----------|--------------|
| BR12         | 164abcd   | 3.81efghi    |
| BR14         | 160fg     | 4.04defghi   |
| BR15         | 165ab     | 3.68ghi      |
| BR16         | 163bcde   | 3.75fghi     |
| BR17         | 158gh     | 4.86a        |
| BR18         | 162cdef   | 3.59hi       |
| BR19         | 164abcd   | 4.54abcd     |
| BR2          | 165ab     | 4.13cdefgh   |
| BR3          | 164abcd   | 4.65abc      |
| BR7          | 162def    | 4.3abcdef    |
| BR8          | 164abc    | 4.43abcd     |
| BR9          | 165ab     | 4.34abcde    |
| BRRI dhan102 | 165ab     | 3.78efghi    |

| Variety     | GD (day)* | Yield(t/ha)* |
|-------------|-----------|--------------|
| BRRI dhan29 | 164abcd   | 4.14cdefgh   |
| BRRI dhan35 | 162cdef   | 4defghi      |
| BRRI dhan47 | 157hi     | 4.21bcdefg   |
| BRRI dhan50 | 161ef     | 3.47i        |
| BRRI dhan58 | 161ef     | 4.74ab       |
| BRRI dhan59 | 156hi     | 4.36abcde    |
| BRRI dhan60 | 155i      | 4.35abcde    |
| BRRI dhan64 | 158gh     | 4.33abcdef   |
| BRRI dhan69 | 158gh     | 4.47abcd     |
| BRRI dhan89 | 162cdef   | 4.33abcdef   |
| BRRI dhan92 | 163bcde   | 4.47abcd     |
| BRRI dhan97 | 160fg     | 4.29abcdef   |
| BRRI dhan99 | 166a      | 4.55abcd     |
| CV(%)       | 0.4911    | 4.4          |

DS: 25 Nov 2023; DT: 9 Jan 2024

\*Values followed by the same letter are not significantly different.

**Boro 2023-24.** Grain yield of BRRI dhan74 ranged from 4 to 6.62 t/ha during Boro 2023-24 (Table 11). Unlike T. Aman season, a significant decrease (diff. 2.62 t/ha) in grain yield of BRRI dhan74 was observed only in the N omission plot during Boro season. Grain yield of the other treatments (with nutrient omission) showed statistically similar to the complete fertilizer but omission of K a high difference of grain yield observed. Thus, the study revealed that for BRRI dhan74, nitrogen (N) is the most limiting nutrient in Boro season in the tidal flooded soil.

Overall findings suggest that all the nutrients (N and K) should be applied in required amount in T.Aman while in Boro, application of N must be ensured for optimum rice yield.

#### **Study on site specific and cost -effective integrated weed management (IWM) techniques for modern rice varieties in Barishal region**

The experiment was conducted at Sagardi farm of BRRI RS, Barishal during Boro2023-24 season and Sagardi farm in boro2023-24 season of BRRI RS Barishal aimed at identifying a cost-effective weed

management practice. The single factor experiment consisted of seven weed management practices namely T<sub>1</sub>: Control (No weeding + No herbicide), T<sub>2</sub>: Weed free (as much HW needed), T<sub>3</sub>: Pre-emergence herbicide+ Post-emergence herbicide, T<sub>4</sub>: Pre-emergence herbicide + 1 Hand Weeding (HW) at 35-40 days after transplanting (DAT); T<sub>5</sub>: Post-emergence herbicide + 1HW at 40-45DAT

T<sub>6</sub>: 2HW (1<sup>st</sup> at 15-20DAT and 2<sup>nd</sup> at 40-45 DAT) and T<sub>7</sub>: Mechanical weeding by BRRI weeder (1<sup>st</sup> at 15-20DAT) + 1 HW at 35-40 DAT). In this study as pre-emergence herbicide, Pretilachlor50%EC (Rifit500EC), and post-emergence herbicide, Bensulfuron-Methyl12%+ Bispyribac Sodium18% WP(Cross-out30wp) were used according to recommended dose. BRRI dhan74 was tested in this experiment. The experiment was accomplished by following RCB design with three replications. Fertilizer and other management practices were accomplished by following BRRI recommendation. Yield and yield components data were collected following standard method. The data were analyzed following the STAR software.

This study found that the rice grain yield was affected by the weed control treatment and there was a massive difference in weeding cost difference among the treatments (Fig.2). The highest grain yield (8.61t/ha) was recorded in the treatment Post-emergence herbicide + 1HW at 40-45DAT followed by T<sub>4</sub>: Pre-emergence herbicide + one Hand weeding (HW) at 35-40 DAT (7.99 t ha<sup>-1</sup>) and T<sub>7</sub>: Mechanical weeding by BRRI weeder (1<sup>st</sup> at 15-20DAT) + 1 HW at 35-40 DAT (7.85 t ha<sup>-1</sup>). The lowest yield (4.02 t ha<sup>-1</sup>) was recorded in the treatment T<sub>1</sub>: Control (No weeding + No herbicide). In case of cost, highest (48,333Tk.) weed control treatment is T<sub>2</sub>: Weed free (as much HW needed followed by T<sub>6</sub>: 2HW ;1<sup>st</sup> at 15-20 DAT and 2<sup>nd</sup> at 40-45 DAT (34,456Tk.) and T<sub>7</sub>: Mechanical weeding by BRRI weeder at 15-20 DAT + 1 HW at 35-40 DAT (30,040Tk.). The lowest cost (0Tk./ha) weed control was estimated from T<sub>1</sub>: Control (No weeding + No herbicide) followed by T<sub>3</sub>: Pre-emergence herbicide+ Post-emergence herbicide (4,477 Tk./ha), T<sub>5</sub>: Post-emergence herbicide + 1HW at 40-45 DAT (7,320Tk./ha) and T<sub>4</sub>: Pre-

emergence herbicide + 1 Hand weeding (HW) at 35-40 DAT (8,633 Tk./ha).

On the basis of above result, it can be concluded that T<sub>5</sub>: Post-emergence herbicide + 1HW at 40-5 DAT is the most cost effective and efficient weed management practice.

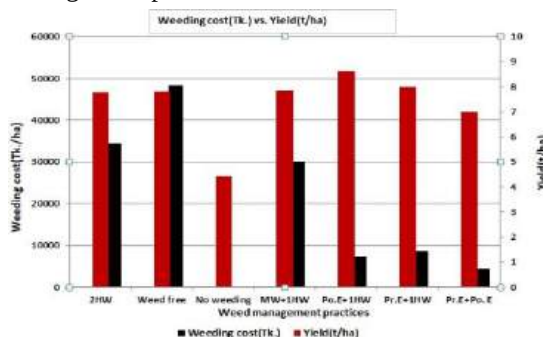


Fig. 2. Cost and effect of different weed management practices on yield of rice at Barishal region (HW = Hand weeding, MW = Mechanical weeding, Po. E = Post-emergence herbicide, Pr.E = Pre-emergence herbicide)

### Exploring sediment deposition from tidal water in Barishal regional station.

Tidal water with sediment samples flow was trapped from fixed points in Sagraadi farm, Barishal with a view to find out the organic and inorganic (nutritional) elements beneficial for plants in deposited silt and To find out the sediment deposition rate in agricultural land in Barishal Regional station. A pot was fixed in the experimental field. After a high tide and low tide, the pot was brought from the land and kept in the room for further deposition. After completion of the deposition, supernatant water was removed and the pot was kept for drying in room temperature. For the elemental analysis of the dried sediment, the sample was stored and sent to Soil Resource Development Institute (SRDI), Barishal.

Results showed that the good quality of sediment with plant nutrients indicated that the soils of the farm were enriched and nutrient status of sediment is higher than normal soil (Table 13). pH and salinity of sediment is higher (0.48 and 0.25DS/mrespectively) than soil. Organic matter, N,P, K, Sand Zn content is higher in sediment than soil (Table13).

**Table 13. Nutrient quality of sediments and soil of Sagardi Farm, Barishal in 2023-24.**

| Items                               | Sample category |       |
|-------------------------------------|-----------------|-------|
|                                     | Sediment        | Soil  |
| pH                                  | 7.45            | 6.97  |
| Salinity (EC) (ds/m)                | 2.16            | 1.91  |
| Organic matter (%)                  | 4.21            | 2.45  |
| Nitrogen (%)                        | 0.21            | 0.12  |
| Potassium (me%)                     | 55.25           | 17.47 |
| Phosphorus ( $\mu\text{g g}^{-1}$ ) | 0.57            | 0.28  |
| Sulphur ( $\mu\text{g g}^{-1}$ )    | 13.05           | 11.53 |
| Zinc ( $\mu\text{g g}^{-1}$ )       | 4.285           | 2.12  |

## RICE FARMING SYSTEMS

Under Rice farming systems programme area, different cropping pattern was meticulously observed and identified two cropping pattern for improvement. For increasing productivity of these pattern, several experiment was conducted in farmers field with the assistance of GoB and PARTNER fund.

### Suitable varietal combination for Fallow-T.Aus-T.Aman cropping pattern in Barishal region.

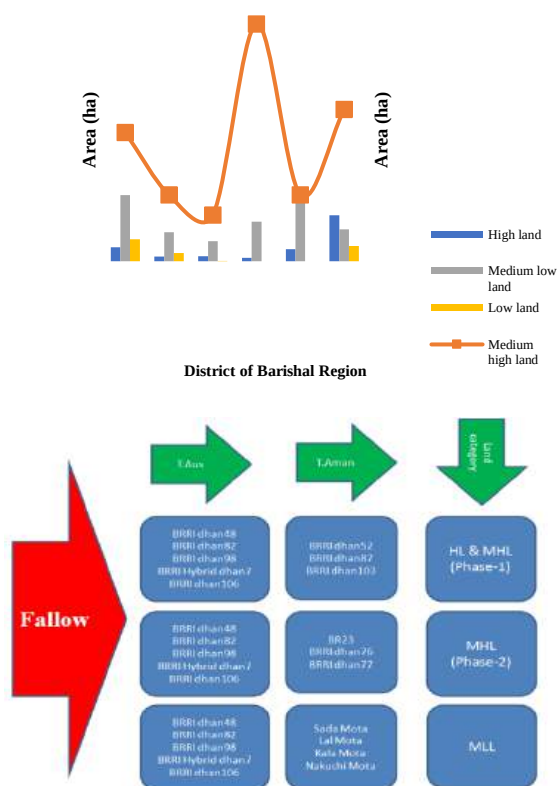
In Barishal region, *Aus* cultivation is remarkable in Barguna, Patuakhali, Jhalokathi and Bhola district following Fallow-Aus-T.Aman cropping pattern. Due to tidal surge and rainfed ecosystem farmers cultivated *Aus* and *Aman* in large area than *Boro* in these district. Tepu IRRI, Abdul Hye, Monsur IRRI, Gotaillya IRRI, Kalisaitta, Sri Balam, BR21, BR26, BRRI dhan27, BRRI dhan42, BRRI dhan43, BRRI dhan48, BRRI dhan55 are cultivated over years. Farmers practice direct seeded, transplant, dribbled and in some extent PTOS for *Aus* cultivation. Recently, BRRI released some modern *Aus* varieties which yield is much higher than cultivated local variety and growth duration is earlier to some local variety.

In Aus 2023, Four newly released variety BRRI dhan82, BRRI dhan98, BRRI dhan106 and BRRI hybrid dhan7 was evaluated in this pattern. BRRI

dhan106 was found highest yield provider variety followed by BRRI dhan98 and BRRI hybrid dhan7. BRRI dhan106 out yielded 11.7% over the yield of BRRI dhan48.

In Aman 2023, considered four land type (high land, medium high land: Phase-1, medium high land: Phase-2, medium low land) in Barishal region varieties were evaluated in four clusters.

In respect of productivity of this pattern, BRRI dhan98+BRRI dhan103 produced highest total yield 11.87 t/ha in high land, BRRI dhan106+BRRI dhan52 produced the highest total yield 11.21 t/ha where BRRI dhan106+BRRI dhan23 produced the highest total yield 10.26 t/ha in medium high land: Phase-2 and in medium low land, Aus eastablishtmet was not done due to heavy tidal surge, here Nakuchi mota produced 3.9 t/ha.





Location: Patuakhali sadar

Farmers Preference: BRRI dhan106>BRRI dhan98>BRRI dhan48>BRRI Hybri dhan7> BRRI dhan82

### Improvement of cropping pattern in the non-saline tidal ecosystem:

### Inclusion of Mungbean/Pumpkin in Fallow--Fallow-T. Aman cropping pattern.

Under PARTNER Project, one RFS site (Charamoddi) was selected for cropping pattern improvement in Bakerganj. Baseline survey was conducted firstly followed by field trial and demonstration. Inclusion of Mungbean/Pumpkin in Fallow-Fallow-T. Aman cropping pattern increased the total productivity. 8.47 REY was obtained from Mungbean-Fallow-T. Aman and 8.17 REY was obtained from Pumpkin-Fallow-T.Aman. (Mungbean yield: 1.6 t/ha, market price: 130 Tk Pumpkin yield: 325/bigha, market Price 40 Tk/kg)



Location: Charamoddi, Bakerganj, Barishal



Location: Charamoddi, Bakerganj, Barishal

### Inclusion of Aus in Mungbean-Fallow-T.Aman cropping pattern.

Under PARTNER Project, one RFS site (Dudhol Mou) was selected for cropping pattern improvement in Bakerganj. Baseline survey was conducted firstly followed by field trial and demonstration. Inclusion of Aus in Mungbean-Fallow-T. Aman cropping pattern increased the total productivity. 13.08 REY was obtained from Mungbean-Aus-T. Aman cropping pattern. (Mungbean yield: 1.65 t/ha, market price: 130 Tk/kg Aus yield- BRRI dhan48: 4.98 t/ha, BRRI dhan98: 5.21 t/ha)



Location: Dhudol mou, Bakerganj, Barishal

### TECHNOLOGY TRANSFER

Advanced line adaptive research trial (ALART)

### ALART in T. Aman 2023

**ALART, anti-oxidant enriched rice, T. Aman 2023.** An ALART was conducted in Shikarpur, Ujirpur, Barishal. Two advanced lines viz BR12836-



4R-63 and BR12836-4R-312 along with two check varieties BRRi dhan34 and BRRi dhan70 were evaluated. None of the advanced lines showed superior yield performance than the better check BRRi dhan70 (2.99 t/ha). The grain type, colour and texture were different than the check varieties.

**ALART, BRRi dhan49 type rice (SHR-1), T. Aman 2023.** Two advanced lines viz BRH13-2-14-2-1B and BR13-7-9-3-2B along with single check variety BRRi dhan49 were tested in Gabua, Patuakhalisadar, Patuakhali. Among the advanced lines and check variety the advanced line BR13-7-9-3-2B (3.87 t/ha) showed superior yield performance than the check variety BRRi dhan49 (3.44 t/ha). The highest growth duration was observed in the advanced line BRH13-2-14-2-1B (144 days) and the lowest growth duration was observed in the advanced line BR13-7-9-3-2B (136 days). Plant height varied from 95 cm to 107 cm among the entries.

**ALART, Swarna type rice (SHR-2), T. Aman 2023.** Two advanced lines viz BRH9392-6-2-1-3-4 and BR9396-6-2-2B along with single check variety BRRi dhan94 were tested in Lakkhipasha, Bakerganj, Barishal. Among the advanced lines and check variety the advanced line BR9396-6-2-2B (5.03 t/ha) showed superior yield performance than the check variety BRRi dhan94 (4.60 t/ha). The highest growth duration was observed in the check variety BRRi dhan94 (141 days) and the lowest growth duration was observed in the advanced line BRH9392-6-2-1-3-4 (133 days). Plant height varied from 109 cm to 115 cm among the entries.

#### **ALART in Boro 2023-24**

**ALART, bacterial blight resistant rice (BB), Boro 2023-24.** An ALART was conducted in Karamja, Barishal sadar, Barishal. Three advanced lines viz BR (path) 13800-BC3-8-1, BR (path) 13800-BC3-8-9 and BR (path) 13800-BC3-224-28 along with two check varieties BRRi dhan89 and BRRi dhan92 were evaluated. Among the entries, advanced line BR (path) 13800-BC3-8-1 (5.7 t/ha) showed the highest grain yield followed by the advanced line BR(path)13800-BC3-224-28 (5.4 t/ha). Growth

duration of the entries ranged from 139 days to 142 days. Plant height ranged from 108 cm to 123 cm, the tallest being BRRi dhan92 (123.5 cm) and the shortest being advanced line BR (path)13800-BC3-8-1 (108 cm).

**ALART, bacterial blight and blast resistant rice (BB+Blast), Boro 2023-24.** Three advanced lines viz BR (path)13800-BC3-134-8, BR (path)13800-BC3-134-25 and BR (path)13800-BC3-224-44 with two check varieties viz BRRi dhan89 and BRRi dhan92 were evaluated in Mangalhata, Barishal sadar, Barishal. Among the advanced lines, BR (path)13800-BC3-224-44 (8.2 t/ha) showed superior grain yield performance than the better check BRRi dhan89 (7.8 t/ha). Growth duration of the evaluated entries varied from 144 days to 150 days. BRRi dhan92 (150 days) had the highest growth duration and the advanced line BR(path)13800-BC3-224-44 (144 days) had the lowest growth duration. Plant height varied from 110 cm to 122 cm among the entries.

**ALART, salt tolerant rice (STR), Boro 2023-24.** Four advanced lines BR11712-4R-44, BR11712-4R-93, BR11717-4R-12 and BR11717-4R-12 along with two check varieties BRRi dhan67 and BRRi dhan89 were tested in two locations i.e. Barishalsadar, Barishal and Kolapara, Patuakhali. Among the advanced lines and check varieties, the advanced lines BR11712-4R-44 (7.4 t/ha in Barishal Sadar, 6 t/ha in Kolapara) and BR11712-4R-93 (7.7 t/ha in Barishal Sadar, 5.7 t/ha in Kolapara) showed superior yield performance in both locations than the better check BRRi dhan89 (6.7 t/ha in Barishal Sadar, 5.3 t/ha in Kolapara). In both locations, BRRi dhan89 showed the longest growth duration while the advanced line BR11717-4R-12 showed the shortest growth duration similar to BRRi dhan67. Plant height varied from 107 cm to 134 cm among the entries.

#### **Demonstration, seed production and scaling up of BRRi rice varieties during T. Aman 2023.**

New HYVs of BRRi i.e. BRRi dhan44, BRRi dhan52, BRRi dhan72, BRRi dhan76, BRRi dhan77, BRRi dhan87, BRRi dhan103, BRRi hybrid

ghan4 and BRRI hybrid dhan6 were demonstrated during T. Aman 2023, in 250 acres of land as block demonstration, which covered the 32 upazilas of six districts of Barishal Division under GOB, PARTNER and Hybrid rice project fund. Among them 140 acres of land were supported by seed and fertilizer and the rest 110 acres were demonstrated with free seed support. From the demonstrated varieties, BRRI RS Barishal tried to motivate farmers to replace their local varieties to BRRI released latest Aman varieties. The highest yield was obtained by BRRI hybrid dhan6 (6.5t/ha) followed by BRRI hybrid dhan4 (6.10 t/ha), BRRI dhan87(5.85 t/ha), BRRI dhan52 (5.21 t/ha) and BRRI dhan76 (4.55 t/ha). As Barishal region is under tidal submergence ecosystem and is difficult to grow BRRI hybrid dhan4 , BRRI hybrid dhan6 and BRRI dhan87 and its growth duration is about 125-130 days only. However, in medium lowland (Phase-1) specially Uzirpur; Gournadi, and Bhola Sadar it produced comparatively higher yield than the others. However, it was chosen by those farmers who wanted to do oil crop after Aman season. The other farmers' preferred BRRI dhan52 and BRRI dhan76 and wanted to cultivate these varieties for the next year along with neighbouring farmers.

### Boro 2023-24

A total of 1,250 demonstrations were conducted with supported through both seed and fertilizers by BRRI RS, Barishal. The activity covered 850 acres land of 42 upazilas of Barishal Division. BRRI released HYV (BRRI dhan67, BRRI dhan74, BRRI dhan84, BRRI dhan89, BRRI dhan92, BRRI dhan99, BRRI dhan100, BRRI dhan101, BRRI dhan102, BRRI dhan104, BRRI dhan105, BRRI hybrid dha3, BRRI hybrid dhan5and BRRI hybrid dhan8 were allocated for distribution. Farmers under the demonstration were advised for maximizing yield. At maturity, the crop cut data were collected for each variety of every demonstration plot. The hybrid varieties BRRI hybrid dhan8 produced the highest average yield (8.60t/ha) among the hybrid varieties. In HYV, BRRI dhan89 and BRRI dhan92 produced about same yield, which is 8.01 t/ha and 7.95 t/ha respectively. However, BRRI dhan74 attracted farmers a lot for its coarseness, tastiness

and zinc enriched virtue. Overall, its life duration is lower than BRRI dhan89 and BRRI dhan92. Among the saline tolerant varieties, Farmers preferred BRRI dhan67 due to its cold tolerance and high fertility percentage.

### Breeder seed and TLS production

For breeder seed production, single seedling was transplanted at 20x20 cm spacing. BRRI recommended practices for crop cultivation was followed. In Aus, 4,308 kg TLS seeds were produced in Charbadna farm, Barishal. In Aman 2023, a total of 26,560 kg breeder seeds and 7300 kg TLS seeds where in Boro 2023-24, a total of 30,120 kg breeder seeds and 21,277 kg TLS seeds were produced respectively (Table 14). Breeder seeds were shifted to Genetic Resources and Seed Division of BRRI HQ, Gazipur and TLS seeds were disseminated to farmers of the Barishal region for demonstration purposes besides conducting our own research.

**Table 14. Seed production status at BRRI RS, Barishal during 2023-24.**

| Season       | Seed catagory | Amount (kg) |
|--------------|---------------|-------------|
| Aman 2023    | Breeder       | 26,560      |
| Boro 2023-24 |               | 30,120      |
| Total        |               | 56,680      |
| Aus 2023     | TLS           | 4,308       |
| Aman 2023    |               | 7,300       |
| Boro 2023-24 |               | 21,277      |
| Total        |               | 32,885      |

### Farmers' field day, training under different projects/GoB and Workshop

Twenty-four field days were conducted in collaboration with DAE at different locations of Barishal region. Farmers, researchers, extension providers, NGO personnel, administrative people, public leaders were sincerely participated in this programmeme. Firstly, the participants gathered and visited the rice field together. A sample area of 10 m<sup>2</sup> was harvested followed by threshing, weighing by the presence. Later on, a fruitful discussion was held among the participants. It was perceived that a noticeable number (about 1,955 where 1,235 male



and 720 female) of female farmers were also present and participated on these field days. Farmers liked BRRI dhan52 for medium high land (Phase1-2) for its tolerance to submergence due to tidal surge, and BRRI dhan87 and BRRI hybrids for their higher yield in high land. Recommendations were as follows: 1. Surface water irrigation facility area has to be increased by canal digging, renovate and establish sluice gate. 2. Need integrated and co-ordinated works among all departments related to agriculture. Forty-seven farmers' training programmes were conducted during the reporting year at different upazilas of Barishal region under GoB fund, PARTNER and LSTD projects.

Recommendations were as follows: 1. Irrigation facility area has to be increased. 2. Need integrated and co-ordinated works among all departments

related to agriculture. 3. Need to improve the present cropping pattern (Aman-Fallow-Fallow or Boro-Fallow-Fallow) and another new crop has to be introduced in these cropping patterns. 4. Sweet water rivers in Barishal region should be used properly for irrigation purpose. 5. Maintenance and operation of sluice gate have to be managed properly. 6. Projects may be taken to increase irrigation command area. 7. Balance is needed between inbred and hybrid varieties. 8. High yielding rice varieties of BRRI have to be introduced for increasing cropping intensity. 9. Demonstration and training must be increased on saline tolerant varieties. 10. More agricultural machinery should be supplied to Barishal region to improve rice productivity.

## **BRRI RS, Bhanga**

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## SUMMARY

During the T. Aman 2023-24 season, a total of 18 crosses were carried out involving 12 different parents as part of various breeding programmes. Specifically, three crosses using five parents resulted in the production of 226 F<sub>1</sub> seeds for deepwater rice. For high-yielding Aman rice, six crosses using five parents produced 413 F<sub>1</sub> seeds. Additionally, six crosses using eight parents were made to develop anoxia-tolerant rice, yielding 434 F<sub>1</sub> seeds. Lastly, three crosses involving four parents generated 164 F<sub>1</sub> seeds aimed to develop short-duration Aus variety suitable for char land. Out of 21 crosses, 18 were successfully confirmed. Overall, 9,624 segregating progenies from 34 F<sub>2</sub>-F<sub>4</sub> generation crosses were advanced through the Field Rapid Generation Advance (FRGA) technique.

In the Boro 2023-24 season, 17 crosses were made, producing 1,096 F<sub>1</sub> seeds for developing high-input responsive Boro rice varieties tailored for a single Boro ecosystem. Out of 18 planned crosses, 14 were confirmed. In total, 12,432 segregating progenies from F<sub>2</sub>-F<sub>5</sub> generations were advanced through FRGA technique.

During the Aman 2023-24 season, at the BRRI RS, Bhanga, three sets of inbred trials were established and assessed as part of the proposed variety trial (PVT). A Re-ALART trial was also conducted during T. Aman 2023-24 in Talma, Faridpur, where two deepwater rice entries were compared with local varieties Fulkari and Laxmidigha. Additionally, a regional yield trial (RYT) for deepwater rice was conducted at the same location, evaluating three advanced lines against BRRI dhan91 and Laxmidigha.

During the Boro 2023-24 season at BRRI RS, Bhanga, several yield trials were performed. These included seven sets of PVT, six ALARTs, one on-farm cum ALART, 13 regional yield trials (RYTs), one multi-location trial (MLT), one advanced yield trial (AYT), and one observational yield trial (OYT). The ALARTs and on-farm cum ALART trials were established in a farmer's field at Purba, Hashamdia under the supervision of BRRI RS, Bhanga.

Experiment was conducted in Aus season on planting time of BRRI varieties to adjust planting

time for escaping the crop from the flood at Charland areas. BRRI dhan83 planted on 5 April produced significantly higher grain yield irrespective of planting time and variety.

Effect of planting time on the performance of modern rice varieties in Faridpur region was conducted in BRRI RS, Bhanga. During Boro 2023-24 season, transplanting BRRI dhan101 and BRRI dhan89 on 10 January resulted the highest grain yield for short and long-duration rice varieties respectively.

In Boro-Fallow-Fallow cropping pattern, the highest grain yield was found in pre-emergence herbicide followed by hand weeding plot which was statistically significant among the treatments and the lowest was recorded in control plot.

An experiment on effect of trichocompost for nutrient management in rice was conducted at BRRI RS, Bhanga during Boro 2023-24. The highest grain yield was found in trichocompost @ 1.5 t/ha + N and TSP full dose + MOP ½ treated plot followed by trichocompost @ 1.5 t/ha + N and TSP treated plot, BRRI recommended fertilizer treated plot and trichocompost @ 1.5 t/ha treated plot respectively but there was no significant difference between the treatments.

The experiment entitled effect of herbicide on Azolla infestation in Faridpur region was conducted at BRRI RS, Bhanga. The highest grain yield of 6.30 t/ha was found in incorporation of Azolla after full mat formation in the field followed by application of 2,4-D Amine herbicide treated plots, BRRI recommended practice and application of Penoxsulam herbicide treated plots respectively.

Stability analysis of BRRI released rice varieties was conducted at BRRI RS, Bhanga during Aman 2023 and Boro 2023-24. Among the T. Aman varieties, BRRI dhan95, BRRI dhan72 and BR22 produced the highest grain yield for short, medium and long duration rice varieties respectively. In Boro 2023-24, BRRI hybrid dhan8 produced the highest grain yield among the short duration Boro rice varieties while BRRI dhan92 yielded higher among the long duration rice varieties.

An on farm field trial was conducted to evaluate BRRI released T. Aman rice varieties under Wheat-Jute-T. Aman cropping pattern. Among the tested cropping patterns Wheat-Jute-T.

Aman (BRRI dhan103) produced the highest REY and GM followed by Wheat-Jute-T. Aman (BRRI dhan87).

An experiment was conducted to increase the cropping intensity and productivity of the existing Lentil-Jute-T. Aman cropping pattern in Faridpur region. Among the tested cropping patterns, the highest rice equivalent yield (26.21 t/ha) and MBCR (3.21) was found in CP<sub>2</sub> (Lentil+M. Melon (Relay)-Jute-T. Aman (BRRI dhan75)).

An experiment was conducted at Nagarkanda, Faridpur to intensify the single Boro area with the establishment of deep water Aman rice in the fallow period after Boro rice. Boro-Transplanted deep water rice produced about 24.45% higher rice yield than the existing Boro-Fallow-Fallow cropping pattern.

A total of 930 farmers and ninety SAAO's of greater Faridpur region were trained on modern rice production technologies through 34 training programmes under BRRI RS, Bhanga. A total of 670 (GoB funded), 350 (PARTNER funded) and 25 (LSTD project funded) demonstration trials using BRRI rice varieties were implemented through BRRI RS, Bhanga and 37 field days were conducted during 2023-24.

## VARIETY DEVELOPMENT

**Hybridization.** During Aman 2023-24, three crosses involving five parents produced 226 F<sub>1</sub> seeds as part of a deepwater rice development programme focusing on kneeing ability, nodal tillering, earliness, and good quality, awnless grain. Additionally, to develop high-yielding T. Aman rice varieties with water stagnation tolerance, anaerobic tillering, earliness, and good grain quality, six crosses using five parents generated 413 F<sub>1</sub> seeds. For anoxia-tolerant rice, six crosses using eight parents were made. In the Char land areas of the Faridpur region, the short-duration local landrace Parangi is popular during the Aus season but yielded poorly. To replace Parangi with a high-yielding short-duration Aus variety, a breeding programme was initiated, resulting three crosses using four parents were made and produced 164 F<sub>1</sub> seeds (Table 1). A total of 18 crosses were confirmed out of 21 crosses. In Boro 2023-24, a total of 17 crosses were made using 13 elite parents

with the objective of developing high input responsive Boro varieties for single Boro ecosystem and 1096 F<sub>1</sub> seeds were produced (Table 2). A total of 14 out of 18 crosses were confirmed as true hybrid.

**Progeny advancement through FRGA.** During Aman 2023-24, 9624 segregating progenies from 34 crosses of F<sub>2</sub>, F<sub>3</sub>, F<sub>4</sub> generation were advanced following field rapid generation advanced (FRGA) technique. Around 4,000 seeds of popular Boro hybrid varieties were sown and 1,672 F<sub>2</sub> progenies were harvested. Around 8,000 F<sub>2</sub> seeds from eight crosses were sown and 3,506 F<sub>3</sub> seeds were harvested. In total 2,438 progenies from seven crosses were advanced from F<sub>3</sub> to F<sub>4</sub> generation. A total 2008 progenies from ten crosses were advanced from F<sub>4</sub> to F<sub>5</sub> generation.

During Boro 2023-24, a total of 1,2432 segregating progenies from 48 crosses of F<sub>2</sub>-F<sub>5</sub> generation were advanced following FRGA technique. Under the programme of developing high yielding and high input responsive Boro rice varieties for single Boro ecosystem seeds of F<sub>2</sub> generation were sown and 6,654 progenies were advanced as F<sub>3</sub>. As for F<sub>3</sub> generation 1,672 progenies were grown and 1,652 progenies were harvested as F<sub>4</sub>. Another set of F<sub>3</sub> generation progenies were grown and 173 progenies were advanced as F<sub>4</sub>. In total 2,438 F<sub>4</sub> progenies were grown and 1,944 progenies were harvested as F<sub>5</sub>. A total of 2,284 F<sub>5</sub> progenies were grown and 1,699 progenies were harvested as F<sub>6</sub>. In LST, out of 142, in total 132 advanced lines were selected to promote as OYT.

**Proposed variety trial (PVT, T. Aman 2023-24).** Three sets of inbred trial were evaluated in PVT under the supervision of BRRI RS, Bhanga, Faridpur (Table 3).

In Set- I, test entry I-061 was tested against the check entry I-062 and produced higher yield (5.77 t/ha) than the check entry (5.02 t/ha). Growth duration of the test entry was 126 days whereas the check entry's GD was 133 days.

In Set- II, test entry I-065 was tested against the check entry I-066 and produced higher yield (4.45 t/ha) than the check entry (3.58 t/ha). The test entry had a growth duration of 126 days whereas the check entry's GD was 135 days.

In Set- III, test entry I-067 was tested against the check entry I-068 and produced higher yield (5.94 t/ha) than the check entry (5.37 t/ha). Growth duration of the test entry was 121 days whereas the check entry's GD was 108 days.

**Proposed variety trial (PVT, Boro 2023-24).** Seven sets (Set-I, II, III, IV, V, VI and VII) of inbred trial were carried out at BRRI RS, Bhanga, Faridpur during Boro 2023-24 (Table 4).

**Set-I.** One advanced breeding line I-075 along with check I-076 were tested. The line I-075 produced 5.8 t/ha which was 1.76 % higher yield than the check variety coded as I-076 (5.7 t/ha).

**Set-II.** Two materials were tested against one check in this set which were I-077, I-078 and I-079. All entries had the same growth duration. I-077, I-078 and I-079 produced 6.94 t/ha, 6.77 t/ha and 7.03 t/ha yield respectively.

**Set-III.** One advanced breeding line I-080 along with the check I-081 were tested. The line I-080 (7.42 t/ha) produced 3.64 % higher yield than the check I-081 (7.16 t/ha). Both the entries had similar growth duration 154 days.

**Set-IV.** One advanced breeding line I-082 along with check I-083 were tested. The line I-082 (7.4 t/ha) produced 7.25 % higher yield than the check I-083 (6.9 t/ha). The test entry and the check had almost the same growth duration.

**Set-V.** Two test materials and one check material were evaluated in this set, which were I-084, I-085 and I-086. All the entries had the same growth duration of 165 days. I-084, I-085 and I-086 produced 7.35 t/ha, 7.3 t/ha and 7.1 t/ha yield respectively.

**Set-VI.** Two test materials and one check material were evaluated in this set, which were I-087, I-088 and I-089. All the entries had the same growth duration of 154 days. I-087, I-088 and I-089 produced 6.9 t/ha, 7.4 t/ha and 7.1 t/ha yield respectively.

**Set-VII.** Two test materials and one check material were evaluated in this set, which were I-090, I-091 and I-092. Growth duration varied from 152-154 days. I-090, I-091 and I-092 produced 7.7 t/ha, 6.9 t/ha and 7.7 t/ha yield respectively.

**ALART (DWR) Aman.** During B. Aman 2023, one ALART of deep water rice was established in Talma, Faridpur under the supervision of BRRI RS, Bhanga. Two test entries were evaluated against two checks-Fulkari and Laxmidigha. Though the second test entry BR9890-6-2-1B produced slightly higher yield (1.356 t/ha) than the check Fulkari (1.266 t/ha), another local popular check variety Laxmidigha (1.883 t/ha) out yielded all the entries (Table 5). Growth duration of the test entries were 153 days. Maximum water depth was 85 cm.

**ALART\_FBR (SD) Boro.** Two advanced breeding lines BR11903-5R-56 and IR18A2119 were evaluated against two checks BRRI dhan88 and BRRI dhan96. The entry BR11903-5R-56 produced higher grain yield than the check varieties BRRI dhan88 and BRRI dhan96 (Table 6).

**ALART\_(PQR) Boro.** Three advanced breeding lines BR10645-6-4-8-1-2, BR10646-3-2-2-4-3 and BR10648-12-1-3-4-1 were evaluated against check varieties Zira Nachol, Katari Shibganj, BRRI dhan104, BRRI dhan107 and Binadhan-25. One advanced line BR10645-6-4-8-1-2 produced higher yield than all the check varieties (Table 7).

**On farm cum ALART (STR).** Five test entries were assessed in comparison to two standard checks BRRI dhan28 and BRRI dhan88 in favourable Boro condition. Among the test entries BR13106-4R-184, BR13111-4R-63, BR13113-4R-116, BR13113-4R-63, BR13122-4R-136 yielded a higher output of 8.40 t/ha, 8.57 t/ha, 8.77 t/ha and 8.50 t/ha respectively, surpassing the check varieties BRRI dhan28 (7.27 t/ha) and BRRI dhan88 (7.90 t/ha) (Table 8). The growth duration of the test entries varied from 159-163 days.

**ALART\_FBR (Bio).** Three advanced breeding lines BR (Bio)13028-AC24-1-2, BR (Bio)13028-AC24-1-3 and BR (Bio)13028-AC24-1-4 were evaluated against two checks BRRI dhan86 and BRRI dhan96. All the three entries produced lower yield compared to the checks. None of the tested entries out yielded than the checks varieties (Table 9).

**ALART\_FBR (LD).** One advanced line BR11318-5R-84 was evaluated against the standard check BRRI dhan92. The advanced line BR11318-

5R-84 produced significantly higher yield (8.52 t/ha) than the checks variety BRRI dhan92 (8.44 t/ha) (Table 10).

**ALART SHR\_1 (Zira type) Boro.** Three advanced lines BRH15-24-7B, BR9392-1-7-5B and BR17-23-8-2-7B with BRRI dhan88 as check were tested at farmers' field at Hasamdia, Bhanga, Faridpur. All the tested lines produced lower yield (8.21, 7.69 and 8.18 t/ha) than the check variety BRRI dhan88 (8.65 t/ha) (Table 11). Mean growth duration of the test entries was similar (149 days to 150 days) to the check variety BRRI dhan88 (149 days). Uniform flowering and maturity were observed in these lines. Due to lodging at early ripening stage and higher sterility, yield was affected in some lines.

**ALART SHR\_2 (Katari type) Boro.** Three advanced lines BRH11-7-17-10B, BRH9-3-2B and BRH13-9-5-2B with BRRI dhan81 as check were tested at farmers' field at Hasamdia, Bhanga, Faridpur. All the tested lines produced lower yield (7.99, 7.87 and 7.94 t/ha) than the check variety BRRI dhan81 (8.05 t/ha) (Table 12). Mean growth duration of the test entries was similar (151 days) to the check variety BRRI dhan81 (149 days). Uniform flowering and maturity were observed in these lines. Due to lodging at early ripening stage and higher sterility, yield was affected in some lines.

**RYT (DWR) Aman.** One regional yield trial of deep water rice was established in Talma, Nagarkanda, Faridpur during B. Aman 2024 under the supervision of BRRI RS, Bhanga. Three entries were evaluated against two checks-BRRI dhan91 and Laxmidigha. Growth duration of all the entries varied from 164 to 165 days and among all the entries local check Laxmidigha produced the highest yield of 1.83 t/ha. After 120 days of direct seeding, 85 cm water depth was observed which was the highest.

**RYT (FBR\_Barishal).** Ten advanced breeding lines along with two check varieties viz BRRI dhan74 and BRRI dhan102 were evaluated. Yield of all the test entries varied from 7.35 to 9.02 t/ha and growth duration varied from 151 to 158 days. Two test entries NGR 1161-3 (9.02 t/ha) and NGR 427-2 (8.91 t/ha), produced higher yield than

both the checks BRRI dhan102 (8.42 t/ha) and BRRI dhan74 (7.86 t/ha).

**RYT (FBR\_SD).** A total of eight advanced lines were evaluated against two check varieties BRRI dhan88 and BRRI dhan96. One advanced line BR12574-5R-52 (7.83 t/ha) produced higher yield than both the check varieties BRRI dhan96 (6.56 t/ha) and BRRI dhan88 (7.27 t/ha).

**RYT (FBR\_SMD).** Ten advanced lines were evaluated against four check varieties BRRI dhan58, BRRI dhan88, BRRI dhan89 and BRRI dhan102. One advanced line BR11894-R-R-R-R-105 (7.57 t/ha) produced higher yield than the check varieties-BRRI dhan58 (7.13 t/ha), BRRI dhan88 (6.72 t/ha), BRRI dhan89 (6.86 t/ha) and BRRI dhan102 (6.67 t/ha).

**RYT (FBR\_MD).** Nine advanced lines were evaluated against three check varieties BRRI dhan58, BRRI dhan89 and BRRI dhan102. One advanced line BR11894-5R-260 (7.50 t/ha) produced higher yield than both the check varieties BRRI dhan58 (7.41 t/ha), BRRI dhan89 (7.27 t/ha) and BRRI dhan102 (7.16 t/ha).

**RYT (FBR\_ELS).** Four advanced lines were evaluated against two check varieties BRRI dhan63 and BRRI dhan104. One advanced line BR9945-5R-21 (7.27 t/ha) produced higher yield than both the check varieties BRRI dhan63 (7.18 t/ha) and BRRI dhan104 (6.93 t/ha).

**RYT (BB and Blast).** Fourteen advanced lines were evaluated against one BB-resistant check variety BRRI dhan101 and two susceptible checks BRRI dhan88 and BRRI dhan89. Four advanced lines BR11866-5R-277, BR11867-5R-118, BR11867-5R-119 and BR12437-4R-164 produced higher yield (8.59, 8.71, 7.81 and 8.08 t/ha) than all the check varieties BRRI dhan88, BRRI dhan89 and BRRI dhan101 (6.52, 7.46, 7.43 t/ha).

**RYT (Blast\_LD).** Regional yield trial consisting of five genotypes along with one check variety (BRRI dhan29) was evaluated. Among five, three advanced lines BR (Path)15855-BC3-2HR-5, BR (Path)15855-BC2-3HR-8 and BR (Path)15855-BC2-3HR-47 produced higher yield (8.02, 8.03 and 7.97 t/ha) than the check variety BRRI dhan29 (7.89 t/ha).

**RYT (Blast\_MD).** Four advanced lines were evaluated against two standard check varieties BRRI dhan58 and BRRI dhan89. Advanced line Rod miniket-1 produced higher yield (8.05 t/ha) than both the checks BRRI dhan58 (6.52 t/ha) and BRRI dhan89 (7.77 t/ha). All the other tested lines BR (Path)15854-BC1-3HR-21, BR (Path)15641-4HR-31 and BR (Path)15853-BC1-3HR-3 produced higher yield (7.18, 7.30 and 7.38 t/ha) than the check variety BRRI dhan58 but lower than that of BRRI dhan89. The poor yield of check variety BRRI dhan58 was due to lodging.

**RYT (Blast\_SD).** Four advanced lines were evaluated against two checks BRRI dhan28 and BRRI dhan88 in RYT (Blast\_SD). Advanced lines BR (Path)15641-3HR-15 and BR (Path)15857-BC3-4HR-6 produced higher yield (6.88 and 7.06 t/ha) than the check variety BRRI dhan28 (6.78 t/ha). On the other hand, all the advanced lines produced lower grain yield than the check variety BRRI dhan88 (7.40 t/ha).

**RYT (Blast\_PQR).** Three advanced lines were evaluated against two standard check varieties BRRI dhan50 and BRRI dhan63. Advanced line BR (Path)15857-4HR-19 produced higher yield (6.85 t/ha) than both the check varieties BRRI dhan50 (6.16 t/ha) and BRRI dhan63 (6.84 t/ha). All the other tested lines BR (Path)15857-BC3-4HR-2 and BR (Path)15857-4HR-33 produced higher yield (6.38 and 6.68 t/ha) than check variety BRRI dhan50 but lower than BRRI dhan63.

**RYT (ZER) Boro.** Six advanced breeding lines were evaluated against three checks, and among the test entries three entries i.e. BR10552-1-1-3-4, BR10552-1-1-4-6 and BR10571-15-6-8-5 achieved higher yield 7.45 t/ha, 7.52 t/ha and 7.52 t/ha respectively than the check entries BRRI dhan74 (7.32 t/ha) and Bangabandhu dhan100 (7.33 t/ha). Another check BRRI dhan89 out yielded all the check entries and produced 8.17 t/ha. The growth duration of the test entries varied from 150 to 158 days.

**RYT (STR\_early maturing) Boro.** Twelve test entries along with three checks were evaluated in RYT\_STR. The growth duration of the test entries varied from 153-165 days. Among the three checks, BRRI dhan67 produced higher yield 7.53 t/ha than the two checks BRRI dhan28 (6.63

t/ha) and BRRI dhan88 (6.90 t/ha). Six test entries out yielded the higher yielding check BRRI dhan67.

**RYT (Tall Boro rice).** Five advanced breeding lines were evaluated against one standard check BRRI dhan102. The growth duration of the entries was very higher than the check and since the entries were very late almost all the entries suffered from severe rice bug attack along with stem borer attack at the reproductive stage resulting in very poor yield. The growth duration of the test entries varied from 163-178 days and yield varied from 3.79-5.09 t/ha whereas the check entry produced a yield of 7.04 t/ha.

**AYT (NUE).** The maximum grain yield was recorded in 100% N fertilizer followed by 75% and 50% N fertilizers. The lowest was observed in 0% N plots. Among the genotypes, BR29NILqRL6.1-03 produced higher grain yield than the other genotypes but less yield compared to BR29Ref-01. The lowest grain yield was found in BRRI dhan88 (Table 13).

**OYT (IRR).** A total of 443 advanced breeding lines were evaluated against four checks. Among them 96 most promising lines were selected for further evaluation. The growth duration of the materials varied from 141 days to 164 days. From each entry 2 m<sup>2</sup> area was harvested. Many entries had excellent plant stature and good grain type.

**MLT.** One MLT of disease resistant programme was established in BRRI RS, Bhanga during Boro 2023-24. The trial was split into three sets. Set 1 had 2m<sup>2</sup> plot size whereas Set-2 and Set-PL had plot size of 4m<sup>2</sup>. All the three sets had 20 cm × 20 cm spacing.

## Development of anoxia tolerant rice

### Experiment 1: Reconfirmation screening of anaerobic germination/anoxia tolerant rice germplasm in Bangladesh

The objective of the experiment was to identify donor for anaerobic germination tolerance in rice germplasm.

The experiment was conducted in control condition using 48 rice germplasm comprising of local landraces, AG1 and AG2 QTLs introgressed lines, some advanced lines suitable for direct

seeded condition and BRRI varieties. Seeds were sown directly in seedling tray where the holes were filled with soil. Randomized Complete Block Design was followed with three replications. Nine cm water level was maintained above the soil surface where the seeds were sown. Seedling survivability data were collected on 14 and 21 days after sowing.

The reconfirmation result was consistent with the previous screening result. The survivability (%) of the top four genotypes were Shishumoti (72-75%), Lal Aman (64-70%), Khirari (58-67%) and Indrasail (58.3-61.7%) (Table 14).

## RICE FARMING SYSTEMS RESEARCH

### **Experiment 1: Evaluation of different Aman rice varieties under Wheat-Jute-T. Aman cropping pattern in Faridpur region**

The study was conducted in farmers' field at Pirerchar, Bhanga, Faridpur during 2023-24 to find out the suitability of newly released Aman rice varieties under Wheat-Jute-T. Aman cropping pattern and increase system productivity. The tested cropping patterns were: CP<sub>1</sub>: Wheat-Jute-T. Aman (BRRI dhan71), CP<sub>2</sub>: Wheat-Jute-T. Aman (BRRI dhan75), CP<sub>3</sub>: Wheat-Jute-T. Aman (BRRI dhan87), CP<sub>4</sub>: Wheat-Jute-T. Aman (BRRI dhan103), CP<sub>5</sub>: Wheat-Jute-T. Aman (BRRI hybrid dhan6) and CP<sub>6</sub>: Wheat-Jute-T. Aman (BRRI dhan39) (Ck) in RCB design and dispersed farmers were considered as replication. Recommended fertilizer doses and other recommended management practices for rice and non-rice crops were followed. To compare system productivity, yield of non-rice crops was converted to rice equivalent yield (REY).

Table 15 Presents the individual crop yield and REY of respective cropping patterns. Considering the REY, there were significant difference ( $P \leq 0.01$ ) among the cropping patterns. The highest REY (18.57 t/ha) was observed in CP<sub>4</sub>: Wheat-Jute-T. Aman (BRRI dhan103) which is statistically similar with the CP<sub>3</sub>: Wheat-Jute-T. Aman (BRRI dhan87). CP<sub>1</sub>: Wheat-Jute-T. Aman (BRRI dhan71), CP<sub>2</sub>: Wheat-Jute-T. Aman (BRRI dhan75) and CP<sub>5</sub>: Wheat-Jute-T. Aman (BRRI hybrid dhan6) resulted statistically similar REY 17.73, 17.92 and 17.19 t/ha respectively. The

lowest significant REY (16.62 t/ha) was found from CP<sub>6</sub>: Wheat-Jute-T. Aman (BRRI dhan39) which is statistically similar to CP<sub>5</sub>: Wheat-Jute-T. Aman (BRRI hybrid dhan) (Table 15). From the economic analysis it was observed that the highest gross margin (GM) was obtained from CP<sub>4</sub> (2,68,470 Tk/ha) followed by CP<sub>3</sub> (2,54,430 Tk/ha) and CP<sub>2</sub> (2,49,000 Tk/ha). The lowest GM was observed in CP<sub>6</sub> (2,10,000 Tk/ha). The pattern CP<sub>4</sub>, CP<sub>3</sub> and CP<sub>2</sub> produced 27.84%, 21.16% and 18.57% higher GM compared to the existing pattern CP<sub>6</sub> (Table 16).

### **Experiment 2: Fine tuning of the improved cropping pattern technology Lentil+Muskmelon-Jute-T. Aman in Faridpur region**

The study was conducted in farmers' field at Pirerchar, Bhanga, Faridpur during 2023-24 to increase the system productivity and farmers' income under Lentil-Jute-T. Aman cropping pattern. The tested cropping patterns were: CP<sub>1</sub>: Lentil+M. Melon-Jute-T. Aman (BRRI dhan71), CP<sub>2</sub>: Lentil+M. Melon-Jute-T. Aman (BRRI dhan75), CP<sub>3</sub>: Lentil+M. Melon-Jute-T. Aman (Bina dhan-17) and CP<sub>4</sub>: Lentil-Jute-T. Aman (ck) in RCB design and dispersed farmers were considered as replication. Recommended fertilizer doses and other recommended management practices for rice and non-rice crops were followed. To compare system productivity, yield of non-rice crops was converted to rice equivalent yield (REY).

Table 17 shows the individual crop yield and REY of the respective cropping patterns. Considering the REY, there were significant difference ( $P \leq 0.01$ ) among the cropping patterns. All the tested cropping patterns (CP<sub>1</sub>: Lentil+M. Melon-Jute-T. Aman (BRRI dhan71), CP<sub>2</sub>: Lentil+M. Melon-Jute-T. Aman (BRRI dhan75), CP<sub>3</sub>: Lentil+M. Melon-Jute-T. Aman (Bina dhan-17) produced statistically similar REY 25.74, 26.21 and 25.36 t/ha, respectively (Table 17). The lowest significant REY (17.86 t/ha) was obtained from CP<sub>4</sub>: Lentil-Jute-T. Aman cropping pattern. From the economic analysis it was observed that the highest gross margin (GM) was obtained from CP<sub>2</sub> (4,18,370 Tk/ha) followed by CP<sub>1</sub> (4,04,170 Tk/ha) and CP<sub>3</sub> (3,92,670 Tk/ha). The lowest GM was observed in CP<sub>4</sub> (2,45,940 Tk/ha). The pattern CP<sub>2</sub>, CP<sub>1</sub> and CP<sub>3</sub> produced 70.11%, 64.33% and



59.66% higher GM compared to the existing pattern CP<sub>6</sub>. The highest marginal benefit-cost ratio (MBCR) was found in CP<sub>2</sub> (3.21) followed by CP<sub>1</sub> (3.02) and CP<sub>3</sub> (2.88) (Table 18)

### **Experiment 3: Validation of improved cropping pattern technology Boro-Transplanted deep-water Aman in the single Boro area of Faridpur region**

The study was conducted in farmers' field at Talma, Nagarkanda, Faridpur during 2023-24 to increase the system productivity and farmers' income under Boro-Fallow-Fallow cropping pattern. The tested cropping patterns were: CP<sub>1</sub>: Boro-Transplanted deepwater Aman, CP<sub>2</sub>: Boro-DS deepwater Aman and CP<sub>3</sub>: Boro-Fallow-Fallow (ck). Recommended fertilizer doses and other recommended management practices were followed.

Table 19 presents the Individual crop yield of respective cropping patterns. During Boro 2023-24, BRRI dhan89 yielded 8.10-8.37 t/ha in different cropping patterns. Deep water Aman rice variety (Laxmidigha) produced 1.86 and 1.77 t/ha grain yield in transplanted and direct seeded condition respectively. The highest total rice yield (10.23 t/ha) was found in Boro-T. deep water Aman cropping pattern followed by Boro-DS deep water Aman (9.87 t/ha) which is 24.45 and 20.7% higher than the existing Boro-Fallow-Fallow cropping pattern. The lowest total rice yield was found in Boro-Fallow-Fallow (8.22 t/ha) cropping pattern. From the economic analysis it was observed that the highest gross margin (GM) was obtained from Boro-T. DW Aman (1,62,100 Tk/ha) followed by Boro-DS DW Aman (1,60,550 Tk/ha) (Table 20). The lowest GM was observed in Boro-Fallow-Fallow (1,29,530 Tk/ha). Boro-T. DW Aman and Boro-DS DW Aman produced 25.37%, and 23.95% higher GM compared to the existing pattern Boro-Fallow-Fallow. The highest marginal benefit-cost ratio (MBCR) was found in Boro-DS DW Aman (1.69) followed by Boro-T. DW Aman (1.59) (Table 20).

## **CROP-SOIL-WATER MANAGEMENT**

### **Experiment 1: Effects of planting time on Aus rice in Charland area of Faridpur, Bangladesh**

The experiment was conducted at Shibchar, Madaripur in Aus 2023 with the objectives to achieve sustainable rice production under char land environment conditions and adjust planting time for escaping the crop from the flood. The varieties were BRRI dhan82, BRRI dhan83, BRRI dhan98, Porangi and planting times were 5 April, 15 April and 25 April by broadcast seeding in randomized complete block design. Fertilization was done according to modern rice cultivation technique. Insecticide and pesticide were applied when necessary.

The inbred varieties BRRI dhan83 produced maximum grain yield compared to the other three varieties in all the treatments (Table 21). The treatments had significant effect on grain yield and yield components but had no effect on thousand grain weight (Table 22). However, the minimum growth duration was found in local varieties Porangi compared to inbred varieties BRRI dhan82, BRRI dhan83 and BRRI dhan98 (Table 21). Considering all the treatments and conditions, the experiment should run minimum five years and the previous weather data should be studied to discover the optimum time range for Aus rice cultivation in Faridpur region.

### **Experiment 2. Effect of planting time on the performance of modern rice varieties in Faridpur region**

The experiment was conducted in Boro 2023-24 at BRRI RS, Bhanga. Newly released Boro varieties were evaluated along with the check in a time series of planting date. During Boro season planting dates 1 November, 16 November, 1 December, 16 December, 1 January, 16 January with 15 days' interval. Forty-day-old seedlings were transplanted in Boro season and 20×20 cm spacing was maintained. The unit plot size was 4m×3m. These experiments were laid down in split-plot design with three replications where planting date in main plot and varieties in subplot. The short duration varieties were BRRI dhan88, BRRI dhan96 and BRRI dhan101 and long duration varieties were BRRI dhan89, BRRI dhan92 and BRRI dhan102. Standard management practices were followed for growing the crops.

During Boro 2023-24 for short duration rice varieties, in 10 January transplanting, BRRI

ghan101 produced higher grain yield with growth duration of 150 days (Table 23). After 10 January transplanting grain yield was decreasing in rest of the planting dates. BRRI dhan88 produced higher grain yield from 25 January transplanting to 25 February. BRRI dhan96 obtained lower grain yield from 10 December to 25 January transplanting but in 10 February transplanting to 25 February the lowest grain yield was found in BRRI dhan101 with growth duration of 140 to 142 days (Table 23).

For long duration rice varieties in Boro season, in 10 January transplanting, BRRI dhan89 produced higher grain yield with growth duration of 157 days (Table 24). After 10 January transplanting grain yield was decreasing in rest of the planting dates. BRRI dhan92 produced higher grain yield from 25 January transplanting to 10 February. BRRI dhan102 obtained lower grain yield in all the planting dates (Table 24).

### **Experiment 3: Development of weed control techniques in Boro-Fallow-Fallow cropping pattern**

The experiment was conducted at the research field of BRRI RS, Bhanga, Faridpur in Boro season 2023-24 with the objectives to develop cost effective and eco-friendly weed control practices for sustainable weed management in Boro-Fallow-Fallow cropping systems and evaluate the weed control techniques for sustainable weed management. The experiment was laid out in RCB design replicated thrice with seven treatments. In this experiment, BRRI dhan89 was used as plant material. Forty-day-old seedlings were transplanted with 20 cm×20 cm spacing. The treatments were T1= Farmers' practice (15 DAT, 30 DAT and 45 DAT), T2= BRRI Rice weeder (20 DAT, and 45 DAT) + Hand weeding (30 DAT), T3= Pre-emergence herbicide (5 DAT) + Hand weeding (30 DAT), T4= Post emergence herbicide-1 (14 DAT) + Hand weeding (45 DAT), T5= Pre-emergence herbicide (5 DAT) + Post emergence herbicide (14 DAT) + Hand weeding (40 DAT), T6= Pre-emergence herbicide (5 DAT) + Post emergence herbicide (30 DAT) and T6= Control (no weeding). Pre-emergence herbicide applied Bensulfuron-methyl (4%) + Acetochlor (14%) @ 100 g/33 decimals (1.12 g/plot) and Post-emergence herbicide Bensulfuron-methyl (12% w/w) +

Bispyribac-sodium (18% w/w) @ 19.08 g/33 decimals (0.213 g/plot).

The maximum plant height was found in pre-emergence herbicide followed by hand weeding which was the significant difference among the treatments and the lowest was recorded in control plot. The highest grain yield was found in pre-emergence herbicide followed by hand weeding and lowest in control plot, which was the significant difference among the treatments (Table 25).

### **Experiment 4: Effect of Trichocompost on nutrient management in rice**

The experiment was conducted at the research field of BRRI RS, Bhanga, Faridpur in Boro season 2023-24 with the objectives of efficacy of Trichocompost for nutrient management in rice. The experiment was laid out in RCB design replicated thrice with four treatments. In this experiment, BRRI dhan89 was used as plant material. Forty-day-old seedlings were transplanted with spacing of 20cm×20cm. The treatments were T1= Trichocompost application rate @ 1.5 t/ha, T2= Trichocompost application rate @ 1.5 t/ha + N and TSP full dose, T3= Trichocompost application rate @ 1.5 t/ha + N and TSP full dose + MOP ½ dose and T4= Control (Fertilizers @ recommended dose). Fertilizers were applied @ 296-98-165-110-11 kg ha<sup>-1</sup> urea, DAP, MOP, Gypsum and ZnSO<sub>4</sub> respectively and urea was applied in 3 splits at 15, 30 and 45 DAT. Standard management practices were followed for whole growing the crops.

During Boro season, the maximum plant height was found in BRRI fertilizer applied plot and the lowest was recorded in trichocompost @ 1.5 t/ha + N and TSP full dose + MOP ½ treated plot. The highest grain yield was found in trichocompost @ 1.5 t/ha + N and TSP full dose + MOP ½ treated plot followed by T2, T4 and T1 treated plots respectively but there was no significant difference between the treatments (Table 26).

### **Experiment 5: Effect of herbicide on Azolla infestation in Faridpur region**

The experiment was conducted at the research field of BRRI RS, Bhanga, Faridpur in Boro season 2023-24 with the objectives to reduce the

abundance of Azolla. The experiment was laid out in RCB design replicated thrice with six treatments. Forty-day-old seedlings of BRRI dhan89 were transplanted at 20 cm × 20 cm spacing. The treatments were T1: Remove water from the plot (Farmers' practice), T2: Granite 240 SC (Penoxsulam)@ 93 ml ha<sup>-1</sup>, T3: Nomini gold 10 SC (Bispyribac sodium) @ 150 ml ha<sup>-1</sup>, T4: Nazat 72 SL (2,4-D Amine)@ 2L ha<sup>-1</sup>, T5: Incorporation of Azolla after full mat formation in the field; and T6: Control. All the fertilizers except urea were applied during final land preparation. Irrigation, weeding, disease and insect control were done as and when necessary.

During Boro season, the maximum plant height was found in application of Bispyribac sodium herbicide treated plot and the lowest was recorded in remove water from the plot. The highest grain yield 6.30 t ha<sup>-1</sup> was found in T5 treatment followed by T4, T6 and T2 treated plots, respectively (Table 27).

## SOCIO-ECONOMICS AND POLICY

### **Stability analysis of BRRI released Aman and Boro varieties during T. Aman and Boro 2023-24**

**Stability analysis (Aman 2023).** Stability analysis of 48 BRRI released modern rice varieties were conducted at BRRI RS, Bhanga farm during Aman 2023. For short duration Aman varieties, the highest grain yield was found in BRRI dhan95 (5.44 t/ha) followed by BRRI dhan73 (5.07 t/ha), BRRI hybrid dhan6 (4.87 t/ha) and BRRI dhan75 (4.71 t/ha). BRRI dhan62 produced the lowest yield (3.12 t/ha) amongst the short duration T. Aman rice varieties. In medium duration Aman varieties based on yield BRRI dhan72 produced the highest grain yield 5.19 t/ha followed by BRRI dhan103 (5.02 t/ha), BRRI dhan70 (4.51 t/ha) and BRRI dhan78 (4.46 t/ha). In long duration T. Aman varieties BRRI dhan22 yielded higher (3.60 t/ha) followed by BR10 (3.59 t/ha), BRRI dhan46 (3.58 t/ha) and BRRI dhan41 (3.49 t/ha) whereas BRRI dhan91 produced the lowest grain yield (2.73 t/ha).

**Stability analysis (Boro 2023-24).** Stability analysis of 52 BRRI released modern rice

varieties were conducted at BRRI RS, Bhanga farm during Boro 2023-24. Among the short duration Boro varieties, the highest yield was found in BRRI hybrid dhan8 (9.33 t/ha) followed by BRRI hybrid dhan5 (9.03 t/ha), BRRI hybrid dhan3 (8.68 t/ha), BRRI hybrid dhan2 (7.72 t/ha) and BRRI dhan101 (7.28 t/ha) (Table 28). In long duration Boro varieties, BRRI dhan92 produced the highest (8.57 t/ha) yield followed by BRRI dhan99 (8.47 t/ha) and BRRI dhan89 (7.94 t/ha), respectively (Table 29)

## TECHNOLOGY DISSEMINATION.

Demonstrations of modern rice varieties during Aus 2023, T. Aman 2023 and Boro 2023-24 were conducted at Faridpur, Madaripur, Shariatpur and Rajbari districts with the financial assistance of GoB, PARTNER and LSTD project.

In Aus 2023, a total of 50 demonstrations were established under the supervision of BRRI RS, Bhanga. Newly released high yielding varieties BRRI dhan83 and BRRI dhan98 were used. Yield of BRRI dhan83 varied from 4.10-4.65 t/ha with the average of 4.11 t/ha. Yield of BRRI dhan98 varied from 4.14 to 6.06 t/ha with the average of 5.05 t/ha (Table 30). Similarly, in T. Aman 2023 in total 120 demonstrations were carried out using BRRI dhan75, BRRI dhan87 and BRRI dhan103. Yield of BRRI dhan75 varied from 4.07-5.72 t/ha with the average of 4.90 t/ha. Yield of BRRI dhan87 varied from 4.78-5.94 t/ha with the average of 5.32 t/ha. Yield of BRRI dhan103 varied from 4.79 to 6.54 t/ha with the average of 5.89 t/ha (Table 30). In Boro 2023-24 six varieties such as BRRI dhan58, BRRI dhan67, BRRI dhan88, BRRI dhan89, BRRI dhan92 and BRRI dhan96 were included in 500 demonstrations at nine upazilas of four districts namely Faridpur, Shariatpur, Madaripur and Rajbari under BRRI RS, Bhanga. In total 500 crop cuts were done in different upazilas. Among the demonstrated varieties the grain yield was found 7.12, 6.86, 7.16, 7.90, 8.08 and 7.30 t/ha in BRRI dhan58, BRRI dhan67, BRRI dhan88, BRRI dhan89, BRRI dhan92 and BRRI dhan96 respectively (Table 30). The trial farmers stored

their seeds according to their demands for growing in the next Boro season.

Among the trial varieties under PARTNER project, BRRI hybrid dhan8 produced the highest average grain yield (9.58 t/ha) with 149 days growth duration followed by BRRI dhan102 (7.74 t/ha) and BRRI dhan104 (7.59 t/ha). The lowest average grain yield was found in BRRI dhan101 (7.39 t/ha) with 147 days GD (Table 31). Under LSTD project demonstration trials, BRRI dhan92 produced the highest average grain yield (8.48 t/ha) with 159 days growth duration followed by BRRI dhan89 (8.20 t/ha) and BRRI dhan99 (7.80 t/ha). BRRI dhan88 produced the lowest average

grain yield (7.38 t/ha) with 144 days of growth duration (Table 31).

Nine hundred and thirty farmers along with ninety SAAOs of greater Faridpur region were trained on modern rice production technologies through 34 training programmes in BRRI RS, Bhanga with the cooperation of DAE and the financial assistance of GOB and PARTNER project. In total 37 field days were conducted of which 30, 2, 1 and 4 was funded by GOB, PARTNER, LSTD and Hybrid rice project respectively (Table 32). Through the field days farmers were able to get information about newly released rice varieties.

**Table 1. List of crosses made during T. Aman 2023-24.**

| Cross                       | F <sub>1</sub> seed | Objective                                              |
|-----------------------------|---------------------|--------------------------------------------------------|
| BRRI dhan87 / BR9390-6-2-1B | 110                 | Stem elongation, high yield and photosensitivity       |
| BRRI dhan79 / BR9390-6-2-1B | 50                  | Stem elongation, high yield and photosensitivity       |
| BR23 / China Fatema         | 66                  | High yield and photosensitivity                        |
| BRRI dhan54 / Lal Aman      | 80                  | Water stagnation and anoxia tolerance, High yield      |
| BRRI dhan39 / Shishumoti    | 61                  | Anoxia tolerance, High yield                           |
| BRRI dhan75 / Shishumoti    | 23                  | Anoxia tolerance, High yield                           |
| BRRI dhan79 / Shishumoti    | 100                 | Anoxia tolerance, High yield                           |
| BRRI dhan87 / Shishumoti    | 15                  | Anoxia tolerance, High yield                           |
| China Fatema/ Lal Aman      | 105                 | Anoxia tolerance, High yield                           |
| BRRI dhan98/ Parangi        | 50                  | High yielding short duration Aus variety for char land |
| BRRI dhan83/ Parangi        | 84                  | High yielding short duration Aus variety for char land |
| BRRI dhan98/ Kalo Shaitta   | 30                  | High yielding short duration Aus variety for char land |
| BRRI dhan103/Binadhan-25    | 50                  | High yielding T. Aman with very slender grain type     |
| BRRI dhan87/ BRRI dhan92    | 60                  | High yielding T. Aman                                  |
| BRRI dhan87/ China Fatema   | 51                  | High yielding T. Aman                                  |
| BRRI dhan87/ Binadhan-25    | 62                  | High yielding T. Aman                                  |
| China Fatema/ Binadhan-25   | 86                  | High yielding T. Aman                                  |
| BRRI dhan103/ China Fatema  | 104                 | High yielding T. Aman                                  |

**Table 2. List of Crosses made during Boro 2023-24.**

| Cross                                   | F <sub>1</sub> seed | Objective               |
|-----------------------------------------|---------------------|-------------------------|
| BR (Path)13800-BC3-8-1/BRRI dhan92      | 62                  | High yielding Boro rice |
| BR (Path)13800-BC3-8-6/BRH12-1-7B-P1    | 41                  | High yielding Boro rice |
| BR11867-5R-154/BR(Path)13800-BC3-224-28 | 130                 | High yielding Boro rice |
| NGR 522-2/BRRI dhan89                   | 14                  | High yielding Boro rice |
| BR (Path)13800-BC3-8-6/BRRI dhan92      | 99                  | High yielding Boro rice |
| BRRI dhan92/BR11867-5R-154              | 60                  | High yielding Boro rice |
| BRRI dhan89/BR (Path)13800-BC3-8-1      | 53                  | High yielding Boro rice |
| China Fatema/BRRI dhan89                | 100                 | High yielding Boro rice |

| Cross                                 | F <sub>1</sub> seed | Objective               |
|---------------------------------------|---------------------|-------------------------|
| BR(Path)13800-BC3-8-6/China Fatema    | 31                  | High yielding Boro rice |
| BRRRI dhan92/NGR 522-2                | 105                 | High yielding Boro rice |
| BRRRI dhan29/China Fatema             | 27                  | High yielding Boro rice |
| BRRRI dhan29/NGR 968-1                | 31                  | High yielding Boro rice |
| BRRRI dhan92/ BR(Path)13800-BC3-8-1   | 99                  | High yielding Boro rice |
| BR(Path)13800-BC3-8-6/Binadhan-25     | 90                  | High yielding Boro rice |
| BRRRI dhan92/Binadhan-25              | 61                  | High yielding Boro rice |
| BR(Path)13800-BC3-224-28/BRRRI dhan89 | 75                  | High yielding Boro rice |
| BRH12-1-7B-P1/ BRRRI dhan89           | 18                  | High yielding Boro rice |

**Table 3. Performance of proposed variety trial at BRRRI RS, Bhanga during T. Aman 2023-24.**

| PVT_Set | Location     | Code no. | Growth duration (day) | Yield (t/ha) | Yield advantage (%) |
|---------|--------------|----------|-----------------------|--------------|---------------------|
| Set-1   | BRRRI_Bhanga | I-061    | 126                   | 5.77         | 14.94               |
|         |              | I-062    | 133                   | 5.02         |                     |
| Set-2   | BRRRI_Bhanga | I-065    | 126                   | 4.45         | 19.55               |
|         |              | I-066    | 135                   | 3.58         |                     |
| Set-3   | BRRRI_Bhanga | I-067    | 121                   | 5.94         | 10.6                |
|         |              | I-068    | 108                   | 5.37         |                     |

**Table 4. Performance of proposed variety trial at BRRRI RS, Bhanga during Boro 2023-24.**

| PVT_Set | Location     | Code no. | GD (day) | Yield (t/ha) | Yield advantage (%) |
|---------|--------------|----------|----------|--------------|---------------------|
| Set-I   | BRRRI_Bhanga | I-0075   | 152      | 5.8          | 1.76                |
|         |              | I-0076   | 154      | 5.7          |                     |
| Set-II  | BRRRI_Bhanga | I-0077   | 153      | 6.9          | -                   |
|         |              | I-0078   | 153      | 6.7          |                     |
|         |              | I-0079   | 152      | 7            |                     |
| Set-III | BRRRI_Bhanga | I-0080   | 154      | 7.4          | 3.64                |
|         |              | I-0081   | 154      | 7.2          |                     |
| Set-IV  | BRRRI_Bhanga | I-0082   | 147      | 7.4          | 7.25                |
|         |              | I-0083   | 149      | 7            |                     |
| Set-V   | BRRRI_Bhanga | I-0084   | 165      | 7.35         | -                   |
|         |              | I-0085   | 165      | 7.3          |                     |
|         |              | I-0086   | 165      | 7.1          |                     |
| Set-VI  | BRRRI_Bhanga | I-0087   | 154      | 6.9          | -                   |
|         |              | I-0088   | 154      | 7.4          |                     |
|         |              | I-0089   | 154      | 7.1          |                     |
| Set-VII | BRRRI_Bhanga | I-0090   | 153      | 7.7          | -                   |
|         |              | I-0091   | 154      | 6.9          |                     |
|         |              | I-0092   | 153      | 7.7          |                     |

**Table 5. Grain yield and agronomic characters of ALART DWR at Talma, Nagarkanda, Bhanga, T. Aman 2023.**

| Designation     | PH (cm) | Panicle/sqm | GD (day) | Yield (t/ha) |
|-----------------|---------|-------------|----------|--------------|
| BR10230-7-19-2B | 179     | 265         | 151      | 1.20         |
| BR9890-6-2-1B   | 180     | 262         | 153      | 1.36         |
| Fulkori (ck)    | 196     | 238         | 153      | 1.27         |
| Laxmidigha      | 190     | 283         | 165      | 1.88         |

**Table 6. Grain yield and ancillary characters of ALART (FBR\_SD) at Purba Hashamdiya under the supervision of BRRI RS, Bhanga, Faridpur, Boro 2023-24.**

| Designation      | PH (cm) | GD (day) | GY (t/ha) |
|------------------|---------|----------|-----------|
| BR11903-5R-56    | 103.8   | 151      | 9.15      |
| IR18A2119        | 98.4    | 151      | 8.53      |
| BRRI dhan88 (ck) | 95.4    | 149      | 8.43      |
| BRRI dhan96 (ck) | 90.1    | 153      | 8.98      |
| Mean             | 96.92   | 151      | 8.77      |
| CV (%)           | 4.90    | -        | 3.38      |
| LSD (0.05)       | NS      | NS       | NS        |

**Table 7. Grain yield and ancillary characters of ALART (PQR) at Purba Hashamdiya under the supervision of BRRI RS, Bhanga, Faridpur, Boro 2023-24.**

| Designation          | PH (Cm) | GD (day) | Yield t/ha |
|----------------------|---------|----------|------------|
| BR10645-6-4-8-1-2    | 108.6   | 156      | 9.68       |
| BR10646-3-2-2-4-3    | 117.1   | 156      | 7.83       |
| BR10648-12-1-3-4-1   | 114.7   | 153      | 8.04       |
| Zira Nachol (ck)     | 106.1   | 153      | 8.57       |
| Katari Shibganj (ck) | 111.2   | 157      | 7.98       |
| BRRI dhan104 (ck)    | 103.5   | 157      | 8.24       |
| BRRI dhan107 (ck)    | 111.5   | 157      | 7.72       |
| Binadhan-25 (ck)     | 146.5   | 158      | 6.37       |
| Mean                 | 114.9   | 156      | 8.05       |
| CV (%)               | 0.57    | 0.13     | 6.18       |
| HSD (0.05)           | 1.88    | 0.59     | 1.43       |

**Table 8. Grain yield and ancillary characters of on farm cum ALART (STR) at Purba Hasamdiya under the supervision of BRRI RS, Bhanga, Faridpur, Boro 2023-24.**

| Genotype       | PH (cm) | GD (day) | Yield (t/ha) |
|----------------|---------|----------|--------------|
| BR13106-4R-184 | 108.67  | 160      | 8.40         |
| BR13111-4R-63  | 105.33  | 155      | 7.87         |
| BR13113-4R-116 | 94.00   | 161      | 8.57         |
| BR13113-4R-63  | 102.00  | 159      | 8.77         |
| BR13122-4R-136 | 112.33  | 163      | 8.50         |

| Genotype             | PH (cm) | GD (day) | Yield (t/ha) |
|----------------------|---------|----------|--------------|
| BRRI dhan28 (Std ck) | 96.67   | 157      | 7.90         |
| BRRI dhan88 (Std ck) | 112.67  | 158      | 7.27         |
| Mean                 | 104.50  | 159      | 8.18         |
| CV (%)               | 1.75    | 0.14     | 4.44         |
| LSD (0.05)           | 2.92    | 0.35     | 0.58         |
| Heritability         | 0.98    | 1.00     | 0.84         |

**Table 9. Grain yield and ancillary characters of ALART (FBR\_Bio) at Purba Hasamdiya under the supervision of BRRI RS, Bhanga, Faridpur, Boro 2023-24.**

| Designation           | PH (cm) | GD (day) | GY (t/ha) |
|-----------------------|---------|----------|-----------|
| BR(Bio)13028-AC24-1-2 | 123.6   | 149      | 7.20      |
| BR(Bio)13028-AC24-1-3 | 101.3   | 151      | 6.60      |
| BR(Bio)13028-AC24-1-4 | 104.3   | 147      | 4.95      |
| BRRI dhan86 (ck)      | 94.6    | 146      | 5.26      |
| BRRI dhan96 (ck)      | 96.2    | 151      | 7.67      |
| Mean                  | 103.9   | 149      | 6.34      |
| CV (%)                | 1.15    | 0.43     | 2.50      |
| HSD (0.05)            | 2.88    | 1.78     | 0.45      |

**Table 10. Grain yield and ancillary characters of ALART (FBR\_LD) at Purba Hasamdiya under the supervision of BRRI RS, Bhanga, Faridpur, Boro 2023-24.**

| Designation         | PH (cm) | GD (day) | GY (t/ha) |
|---------------------|---------|----------|-----------|
| V1=BR11318-5R-84    | 116.6   | 167      | 8.52      |
| V2=BRRI dhan92 (ck) | 121.8   | 162      | 8.44      |
| Mean                | 119.20  | 165      | 8.48      |
| CV (%)              | 0.98    | 0.43     | 0.29      |
| LSD (0.05)          | 4.8     | 2.48     | 0.09      |

**Table 11. Grain yield and ancillary characters of ALART SHR\_1 (Zira type), Boro 2023-24, Bhanga, Faridpur.**

| Designation      | PH (cm) | Pan/m2 | GD (day) | Yield (t/ha) |
|------------------|---------|--------|----------|--------------|
| BRH15-24-7B      | 96      | 384    | 149      | 8.21         |
| BR9392-1-7-5B    | 94      | 373    | 150      | 7.69         |
| BR17-23-8-2-7B   | 98      | 354    | 149      | 8.18         |
| BRRI dhan88 (ck) | 97      | 324    | 149      | 8.65         |
| Mean             | 96.30   | 358.83 | 149.25   | 8.18         |
| LSD (0.05)       | NS      | 22.89  | NS       | NS           |
| CV (%)           | 2.22    | 3.19   | -        | 6.3          |

**Table 12. Grain yield and ancillary characters of ALART SHR\_2 (Katari type), Boro 2023-24, Bhanga, Faridpur.**

| Designation      | PH (cm) | Pan/m <sup>2</sup> | GD (day) | Yield (t/ha) |
|------------------|---------|--------------------|----------|--------------|
| BRH11-7-17-10B   | 100     | 399                | 151      | 7.99         |
| BRH9-3-2B        | 101     | 353                | 151      | 7.87         |
| BRH13-9-5-2B     | 101     | 340                | 151      | 7.94         |
| BRRI dhan81 (ck) | 101     | 332                | 149      | 8.05         |
| Mean             | 100.65  | 355.92             | 150.50   | 7.96         |
| LSD (0.05)       | NS      | NS                 | NS       | NS           |
| CV (%)           | 1.76    | 7.29               | -        | 6.06         |

**Table 13. Grain yield of AYT (NUE), Boro 2023-24, BRRI Bhanga, Faridpur.**

| Designation      | 0% N<br>fertilizer | 25% N<br>fertilizer | 50% N<br>fertilizer | 75% N<br>fertilizer | 100% N<br>fertilizer |
|------------------|--------------------|---------------------|---------------------|---------------------|----------------------|
| BR28NILqRL6.1-01 | 6.53               | 6.66                | 7.15                | 7.51                | 7.89                 |
| BR28Ref-01       | 6.85               | 6.95                | 7.28                | 7.58                | 8.22                 |
| BR29NILqRL6.1-03 | 7.27               | 7.02                | 7.91                | 8.31                | 8.39                 |
| BR29Ref-01       | 6.85               | 7.04                | 7.42                | 8.44                | 8.90                 |
| BRRI dhan88      | 5.36               | 6.04                | 6.36                | 6.96                | 7.58                 |
| CV (%)           |                    |                     | 2.52                |                     |                      |
| HSD (0.05)       |                    |                     | 0.67                |                     |                      |

Means with the same letter are not significantly different.

**Table 14. Seedling survivability (%) and seedling height (cm) of tested 48 germplasm.**

| Designation | % Survivable at 21 DAS |      |
|-------------|------------------------|------|
|             | 2022                   | 2023 |
| IR18R1103   | 27.8                   | 25   |
| IR18R1066   | 27.8                   | 13.9 |
| IR18R1117   | 13.9                   | 22.2 |
| IR18R1137   | 27.8                   | 30.6 |
| IR18R1145   | 19.4                   | 19.4 |
| IR18R1148   | 13.9                   | 8.3  |
| IR18R1153   | 38.9                   | 36.1 |
| IR18R1154   | 33.3                   | 27.8 |
| IR18R1156   | 33.3                   | 25   |
| IR18R1160   | 2.8                    | 8.3  |
| IR18R1162   | 8.3                    | 11.1 |
| IR18R1040   | 0                      | 5.6  |
| IR18R1068   | 19.4                   | 22.2 |
| IR18R1073   | 55.6                   | 47.2 |
| IR18R1119   | 16.7                   | 19.4 |
| IR18R1121   | 11.1                   | 13.9 |
| IR18R1123   | 30.6                   | 33.3 |
| IR18R1181   | 19.4                   | 27.8 |
| IR18R1164   | 5.6                    | 16.7 |



| Designation           | % Survivable at 21 DAS |      |
|-----------------------|------------------------|------|
|                       | 2022                   | 2023 |
| IR18R1089             | 41.7                   | 38.9 |
| IR18R1111             | 27.8                   | 16.7 |
| IR19L1007             | 16.7                   | 16.7 |
| BRRI dhan81           | 5.6                    | 19.4 |
| BRRI dhan83           | -                      | 33.3 |
| BRRI dhan39           | -                      | 27.8 |
| BRRI dhan79           | -                      | 30.6 |
| BRRI dhan87           | -                      | 25   |
| BRRI dhan98           | -                      | 41.7 |
| Ciherang Sub1-AG2     | 13.9                   | 19.4 |
| Ciherang Sub1-AG1-AG2 | 13.9                   | 16.7 |
| BR8210-10-3-1-2       | 22.2                   | 22.2 |
| Ciherang Sub1         | 27.8                   | 16.7 |
| KHO                   | 44.4                   | 38.9 |
| Hatisail              | 44.4                   | 52.8 |
| Indrasail             | 58.3                   | 61.1 |
| Khirari               | 58.3                   | 66.7 |
| Joli Aman             | 25                     | 36.1 |
| Lal Aman              | 69.4                   | 63.9 |
| Shishumati            | 75                     | 72.2 |
| Nizersail             | 52.8                   | 61.1 |
| Ratasail              | 36.1                   | 52.8 |
| Halid Jaran           | 0                      | 5.6  |
| Modhusail             | 27.8                   | 30.6 |
| Dharial               | 27.8                   | 38.9 |
| Chaita Boro           | 13.9                   | 19.4 |
| Banajira              | 13.9                   | 11.1 |

**Table 15. Individual crops yield and REY of respective cropping patterns under Wheat-Jute-T. Aman cropping pattern, Bhanga, Faridpur, 2023-24.**

| Treatment       | Yield (t/ha) |      |         | REY                 |
|-----------------|--------------|------|---------|---------------------|
|                 | Wheat        | Jute | T. Aman |                     |
| CP <sub>1</sub> | 3.44         | 3.25 | 5.62    | 17.73 <sup>ab</sup> |
| CP <sub>2</sub> | 3.40         | 3.29 | 5.74    | 17.92 <sup>ab</sup> |
| CP <sub>3</sub> | 3.50         | 3.28 | 5.86    | 18.10 <sup>a</sup>  |
| CP <sub>4</sub> | 3.46         | 3.45 | 5.90    | 18.57 <sup>a</sup>  |
| CP <sub>5</sub> | 3.44         | 3.29 | 5.99    | 17.19 <sup>bc</sup> |
| CP <sub>6</sub> | 3.41         | 3.27 | 4.49    | 16.62 <sup>c</sup>  |
| CV (%)          | 1.73         |      |         |                     |

Means with the same letter are not significantly different.

**Table 16. Cost-return analysis of different crops combinations under Wheat-Jute-T. Aman cropping system, Bhanga, Faridpur, 2023-24.**

| Treatment       | GR (000 Tk) | TVC (000 Tk) | GM (000 Tk) | % GM increase |
|-----------------|-------------|--------------|-------------|---------------|
| CP <sub>1</sub> | 531.90      | 288.50       | 243.40      | 15.90         |
| CP <sub>2</sub> | 537.50      | 288.50       | 249.00      | 18.57         |
| CP <sub>3</sub> | 542.93      | 288.50       | 254.43      | 21.16         |
| CP <sub>4</sub> | 556.97      | 288.50       | 268.47      | 27.84         |
| CP <sub>5</sub> | 515.78      | 288.50       | 227.28      | 8.23          |
| CP <sub>6</sub> | 498.50      | 288.50       | 210.00      | -             |

Market price: Wheat: 30 Tk/Kg, Jute: 80 Tk/Kg and Rice: 30 Tk/Kg.

**Table 17. Individual crops yield and REY of respective cropping patterns under Lentil+M. Melon-Jute-T. Aman cropping pattern, Bhanga, Faridpur, 2023-24.**

| Treatment       | Yield (t/ha) |          |      |         | REY                |
|-----------------|--------------|----------|------|---------|--------------------|
|                 | Lentil       | M. Melon | Jute | T. Aman |                    |
| CP <sub>1</sub> | 2.06         | 10.90    | 3.24 | 5.47    | 25.74 <sup>a</sup> |
| CP <sub>2</sub> | 2.14         | 11.00    | 3.29 | 5.52    | 26.21 <sup>a</sup> |
| CP <sub>3</sub> | 1.98         | 11.23    | 3.26 | 5.11    | 25.36 <sup>a</sup> |
| CP <sub>4</sub> | 1.44         | 0.00     | 3.41 | 4.45    | 17.86 <sup>b</sup> |
| CV (%)          | 2.72         |          |      |         |                    |

Means with the same letter are not significantly different.

**Table 18. Cost-return analysis of different crops combinations under Lentil+M. Melon-Jute-T. Aman cropping system, Bhanga, Faridpur, 2023-24.**

| Treatment       | GR (000 Tk) | TVC (000 Tk) | GM (000 Tk) | % GM increase | MBCR |
|-----------------|-------------|--------------|-------------|---------------|------|
| CP <sub>1</sub> | 772.20      | 368.03       | 404.17      | 64.33         | 3.02 |
| CP <sub>2</sub> | 786.40      | 368.03       | 418.37      | 70.11         | 3.21 |
| CP <sub>3</sub> | 760.70      | 368.03       | 392.67      | 59.66         | 2.88 |
| CP <sub>4</sub> | 535.80      | 289.86       | 245.94      | -             | -    |

Market price: Lentil: 90 Tk/Kg, M. Melon: 15 Tk/Kg, Jute: 80 Tk/Kg and Rice: 30 Tk/Kg

**Table 19. Individual crops yield of respective cropping patterns under Boro-DW Aman cropping pattern, Bhanga, Faridpur, 2023-24.**

| Treatment          | Boro | DW Aman | Total rice yield | % Increase |
|--------------------|------|---------|------------------|------------|
| Boro-T. DW Aman    | 8.37 | 1.86    | 10.23            | 24.45      |
| Boro-DS DW Aman    | 8.10 | 1.77    | 9.87             | 20.07      |
| Boro-Fallow-Fallow | 8.22 | 0       | 8.22             | -          |

**Table 20. Cost-return of different cropping patterns under Boro-DW Aman cropping pattern, Bhanga, Faridpur, 2023-24.**

| Treatment          | GR (000 Tk) | TVC (000 Tk) | GM (000 Tk) | % GM Increase | MBCR |
|--------------------|-------------|--------------|-------------|---------------|------|
| Boro-T. DW Aman    | 334.80      | 172.41       | 162.39      | 25.37         | 1.59 |
| Boro-DS DW Aman    | 322.65      | 162.10       | 160.55      | 23.95         | 1.69 |
| Boro-Fallow-Fallow | 246.60      | 117.07       | 129.53      | -             | -    |

**Table 21. Grain yield and growth duration of the evaluated rice varieties, Shibchar, Madaripur, Aus 2023.**

| Variety     | Grain yield (t/ha) |             |             | Growth duration (day) |             |             |
|-------------|--------------------|-------------|-------------|-----------------------|-------------|-------------|
|             | 5-Apr (T1)         | 15-Apr (T2) | 25-Apr (T3) | 5-Apr (T1)            | 15-Apr (T2) | 25-Apr (T3) |
| BRRi dhan82 | 3.21               | 2.90        | 2.33        | 105                   | 106         | 108         |
| BRRi dhan83 | 3.62               | 3.36        | 3.25        | 104                   | 105         | 107         |
| BBRI dhan98 | 3.28               | 3.11        | 2.65        | 110                   | 111         | 110         |
| Porangi     | 2.10               | 1.75        | 1.60        | 80                    | 81          | 83          |

**Table 22. Mean performances for yield related traits of four rice varieties evaluated at Shibchar, Madaripur, Aus 2023.**

| Variety      | Date of Seeding | PH (cm) | Panicle/ m <sup>2</sup> | Grains/ panicle | Sterility (%) | 1000 gw (gm) | GY (t/ha) |
|--------------|-----------------|---------|-------------------------|-----------------|---------------|--------------|-----------|
| BRRi dhan82  | 5 April         | 95.3    | 257                     | 60              | 27.10         | 23.03        | 3.21      |
|              | 15 April        | 97.3    | 257                     | 65              | 24.15         | 22.38        | 2.90      |
|              | 25 April        | 97.4    | 215                     | 50              | 24.61         | 22.46        | 2.33      |
| BRRi dhan83  | 5 April         | 99      | 273                     | 75              | 23.26         | 22.09        | 3.62      |
|              | 15 April        | 99.2    | 267                     | 78              | 21.84         | 22.54        | 3.36      |
|              | 25 April        | 102.6   | 238                     | 65              | 21.88         | 22.63        | 3.25      |
| BRRi dhan98  | 5 April         | 97.0    | 263                     | 65              | 24.77         | 22.40        | 3.28      |
|              | 15 April        | 96.3    | 252                     | 70              | 26.15         | 21.38        | 3.11      |
|              | 25 April        | 95.1    | 218                     | 56              | 20.68         | 22.84        | 2.65      |
| Porangi (ck) | 5 April         | 97.2    | 240                     | 57              | 12.67         | 22.39        | 2.10      |
|              | 15 April        | 97.9    | 247                     | 55              | 15.65         | 22.69        | 1.75      |
|              | 25 April        | 102.3   | 207                     | 45              | 16.26         | 23.47        | 1.60      |
|              | Mean            | 98.1    | 244                     | 62              | 21.58         | 22.52        | 2.76      |
|              | CV (%)          | 0.7     | 4.08                    | 6.38            | 7.99          | 2.93         | 2.90      |
|              | HSD (0.05)      | 2.01    | 29.59                   | 11.69           | 4.99          | NS           | 0.24      |

**Table 23. Effect of planting time of short duration varieties on grain yield and growth duration, Boro 2023-24, BRRi RS, Bhanga.**

| Variety      | Date of transplanting   |                         |                         |                         |                         |                         |                         |                         |                         |                         |                         |                         |
|--------------|-------------------------|-------------------------|-------------------------|-------------------------|-------------------------|-------------------------|-------------------------|-------------------------|-------------------------|-------------------------|-------------------------|-------------------------|
|              | GY (t/ha)               |                         |                         |                         |                         |                         | Growth duration (day)   |                         |                         |                         |                         |                         |
|              | 10 <sup>th</sup><br>Dec | 25 <sup>th</sup><br>Dec | 10 <sup>th</sup><br>Jan | 25 <sup>th</sup><br>Jan | 10 <sup>th</sup><br>Feb | 25 <sup>th</sup><br>Feb | 10 <sup>th</sup><br>Dec | 25 <sup>th</sup><br>Dec | 10 <sup>th</sup><br>Jan | 25 <sup>th</sup><br>Jan | 10 <sup>th</sup><br>Feb | 25 <sup>th</sup><br>Feb |
| BRRi dhan88  | 4.85                    | 6.58                    | 7.50                    | 6.61                    | 5.95                    | 5.58                    | 156                     | 154                     | 146                     | 140                     | 136                     | 138                     |
| BRRi dhan96  | 4.32                    | 5.62                    | 7.43                    | 5.22                    | 5.11                    | 3.94                    | 154                     | 155                     | 145                     | 142                     | 137                     | 140                     |
| BRRi dhan101 | 5.49                    | 6.84                    | 7.93                    | 6.2                     | 4.99                    | 2.73                    | 160                     | 158                     | 150                     | 146                     | 140                     | 142                     |
| CV (%)       |                         |                         | 3.89                    |                         |                         |                         |                         |                         | 0.34                    |                         |                         |                         |
| HSD (0.05)   |                         |                         | 0.49                    |                         |                         |                         |                         |                         | 1.17                    |                         |                         |                         |

**Table 24. Effect of planting time of long duration varieties on grain yield and growth duration, Boro 2023-24, BRRI RS, Bhanga.**

| Variety      | Date of transplanting   |                         |                         |                         |                         |                         |                         |                         |                         |                         |                         |                         |
|--------------|-------------------------|-------------------------|-------------------------|-------------------------|-------------------------|-------------------------|-------------------------|-------------------------|-------------------------|-------------------------|-------------------------|-------------------------|
|              | GY (t/ha)               |                         |                         |                         |                         |                         | Growth duration (day)   |                         |                         |                         |                         |                         |
|              | 10 <sup>th</sup><br>Dec | 25 <sup>th</sup><br>Dec | 10 <sup>th</sup><br>Jan | 25 <sup>th</sup><br>Jan | 10 <sup>th</sup><br>Feb | 25 <sup>th</sup><br>Feb | 10 <sup>th</sup><br>Dec | 25 <sup>th</sup><br>Dec | 10 <sup>th</sup><br>Jan | 25 <sup>th</sup><br>Jan | 10 <sup>th</sup><br>Feb | 25 <sup>th</sup><br>Feb |
| BRRI dhan89  | 7.34                    | 7.66                    | 8.53                    | 6.77                    | 5.33                    | 3.51                    | 160                     | 158                     | 157                     | 153                     | 148                     | 149                     |
| BRRI dhan92  | 7.78                    | 7.64                    | 8.43                    | 7.19                    | 5.84                    | 2.88                    | 165                     | 163                     | 160                     | 157                     | 153                     | 152                     |
| BRRI dhan102 | 7.23                    | 7.44                    | 7.82                    | 6.15                    | 4.24                    | 2.25                    | 162                     | 160                     | 158                     | 152                     | 150                     | 150                     |
| CV (%)       |                         |                         |                         | 3.28                    |                         |                         |                         |                         |                         | 0.42                    |                         |                         |
| HSD (0.05)   |                         |                         |                         | 0.47                    |                         |                         |                         |                         |                         | 1.11                    |                         |                         |

**Table 25. Effects of herbicide application on growth parameter and yield of BRRI dhan89.**

| Treatment  | PH (cm) | PL (cm) | GY (t ha <sup>-1</sup> ) |
|------------|---------|---------|--------------------------|
| T1         | 116.6   | 26.0    | 6.66                     |
| T2         | 118     | 26.47   | 6.62                     |
| T3         | 118.3   | 26.4    | 6.99                     |
| T4         | 116     | 28.0    | 6.47                     |
| T5         | 115.2   | 27.13   | 6.60                     |
| T6         | 118.8   | 24.73   | 6.28                     |
| T7         | 113     | 24.37   | 4.99                     |
| Mean       | 116.6   | 26.16   | 6.37                     |
| HSD (0.05) | 1.64    | 1.53    | 0.59                     |
| CV (%)     | 0.49    | 2.05    | 3.27                     |

T1= Farmer practice (15 DAT, 30 DAT and 45 DAT), T2= BRRI Rice weeder (20 DAT, and 45 DAT) + Hand weeding (30 DAT), T3= Pre-emergence herbicide (5 DAT) + Hand weeding (30 DAT), T4= Post emergence herbicide-1 (14 DAT) + Hand weeding (45 DAT), T5= Pre-emergence herbicide (5 DAT) + Post emergence herbicide (14 DAT) + Hand weeding (40 DAT), T6= Pre-emergence herbicide (5 DAT) + Post emergence herbicide (30 DAT) and T7= Control (no weeding)

**Table 26. Effects of trichocompost on growth parameter and yield of rice field, Boro, 2023-24, BRRI RS, farm, Bhanga.**

| Treatment  | PH (cm) | Panicle no. m <sup>-2</sup> | GY (t ha <sup>-1</sup> ) |
|------------|---------|-----------------------------|--------------------------|
| T1         | 110.6   | 358                         | 8.36                     |
| T2         | 110.8   | 335                         | 8.57                     |
| T3         | 109.4   | 337                         | 8.75                     |
| T4         | 111.7   | 355                         | 8.37                     |
| Mean       | 110.7   | 346                         | 8.51                     |
| HSD (0.05) | 1.44    | 22.96                       | NS                       |
| CV (%)     | 0.46    | 2.35                        | 2.04                     |

T1= Trichocompost application rate @ 1.5 t/ha, T2= Trichocompost application rate @ 1.5 t/ha + N and TSP full dose, T3= Trichocompost application rate @ 1.5 t/ha + N and TSP full dose + MOP ½ dose and T4= Control (Fertilizers @ recommended dose).

**Table 27. Effect of herbicide on Azolla infestation in rice field, Boro 2023-24, BRRI RS farm, Bhanga.**

| Treatment  | PH (cm) | PL (cm) | GY (t ha <sup>-1</sup> ) |
|------------|---------|---------|--------------------------|
| T1         | 110.2   | 24.33   | 5.96                     |
| T2         | 110.3   | 24.67   | 6.00                     |
| T3         | 116.3   | 25.27   | 5.94                     |
| T4         | 113.8   | 23.87   | 6.11                     |
| T5         | 110.8   | 24.0    | 6.30                     |
| T6         | 114.4   | 23.13   | 6.05                     |
| Mean       | 112.63  | 24.21   | 6.14                     |
| HSD (0.05) | 1.43    | 0.8     | NS                       |
| CV (%)     | 0.45    | 1.16    | 6.06                     |

T1= Remove water from the plot (Farmers' practice), T2= Granite 240 SC (Penoxsulam), T3= Nomini gold 10 SC (Bispyribac sodium), T4= Nazat 72 SL (2,4-D Amine), T5= Incorporation of Azolla after full mat formation in the field; and T6= Control.

**Table 28. Grain yield and agronomic characters of BRRI released short duration Boro varieties under stability analysis in Boro, 2023-24 at BRRI RS, Bhanga, Faridpur.**

| Variety             | GD (day) | Yield (t/ha) |
|---------------------|----------|--------------|
| BR1                 | 150      | 5.27         |
| BR6                 | 153      | 4.96         |
| BR26                | 142      | 6.00         |
| BRRI dhan27         | 157      | 5.16         |
| BRRI dhan28         | 141      | 5.99         |
| BRRI dhan36         | 142      | 5.25         |
| BRRI dhan45         | 141      | 5.82         |
| BRRI dhan55         | 149      | 5.93         |
| BRRI dhan61         | 152      | 5.72         |
| BRRI dhan63         | 146      | 6.66         |
| BRRI dhan67         | 145      | 6.02         |
| BRRI dhan68         | 150      | 6.26         |
| BRRI dhan74         | 147      | 6.88         |
| BRRI dhan81         | 142      | 6.48         |
| BRRI dhan84         | 142      | 6.47         |
| BRRI dhan86         | 142      | 5.67         |
| BRRI dhan88         | 143      | 6.25         |
| BRRI dhan96         | 144      | 6.32         |
| Bangabandhu dhan100 | 147      | 7.23         |
| BRRI dhan101        | 145      | 7.28         |
| BRRI dhan104        | 148      | 7.16         |
| BRRI dhan105        | 147      | 7.25         |
| BRRI hybrid dhan2   | 147      | 7.72         |
| BRRI hybrid dhan3   | 145      | 8.68         |
| BRRI hybrid dhan5   | 146      | 9.03         |
| BRRI hybrid dhan8   | 147      | 9.33         |
| Mean                | 146.17   | 6.57         |
| LSD (0.05)          | 3.83     | 0.92         |
| CV (%)              | 0.82     | 4.38         |

**Table 29. Grain yield and agronomic characters of BRRI released long duration Boro varieties under stability analysis in Boro, 2023-24 at BRRI RS, Bhanga, Faridpur.**

| Variety      | GD (day) | Yield (t/ha) |
|--------------|----------|--------------|
| BR2          | 159      | 5.99         |
| BR3          | 169      | 6.26         |
| BR7          | 148      | 5.46         |
| BR8          | 162      | 5.14         |
| BR9          | 159      | 6.15         |
| BR12         | 168      | 6.36         |
| BR14         | 156      | 6.24         |
| BR15         | 164      | 6.06         |
| BR16         | 160      | 6.42         |
| BR17         | 157      | 4.86         |
| BR18         | 169      | 6.31         |
| BR19         | 169      | 6.35         |
| BRRI dhan29  | 161      | 7.92         |
| BRRI dhan35  | 155      | 6.29         |
| BRRI dhan47  | 148      | 6.35         |
| BRRI dhan50  | 156      | 6.08         |
| BRRI dhan58  | 151      | 7.32         |
| BRRI dhan59  | 147      | 6.60         |
| BRRI dhan60  | 146      | 6.42         |
| BRRI dhan64  | 154      | 5.83         |
| BRRI dhan69  | 153      | 6.84         |
| BRRI dhan89  | 157      | 7.94         |
| BRRI dhan92  | 163      | 8.57         |
| BRRI dhan97  | 152      | 6.79         |
| BRRI dhan99  | 155      | 8.47         |
| BRRI dhan102 | 148      | 7.32         |
| Mean         | 157.15   | 6.55         |
| LSD          | 3.94     | 0.94         |
| CV (%)       | 0.79     | 4.51         |

**Table 30. Performance of BRRI released high yielding Aus, Aman and Boro rice varieties in Faridpur region under BRRI RS, Bhanga, Aus, Aman and Boro 2023-24.**

| Season       | Variety      | No. of trial | Avg. GD (day) | Avg. yield (t/ha) |
|--------------|--------------|--------------|---------------|-------------------|
| Aus 2023     | BRRI dhan83  | 12           | 105 (100-108) | 4.41 (4.10-4.65)  |
|              | BRRI dhan98  | 38           | 111 (108-115) | 5.05 (4.14-6.06)  |
| Aman 2023    | BRRI dhan75  | 50           | 115 (109-119) | 4.90 (4.07-5.72)  |
|              | BRRI dhan87  | 50           | 127 (124-130) | 5.32 (4.78-5.94)  |
|              | BRRI dhan103 | 20           | 129 (126-133) | 5.89 (4.79-6.54)  |
| Boro 2023-24 | BRRI dhan58  | 53           | 150 (143-155) | 7.12 (6.56-8.21)  |
|              | BRRI dhan67  | 32           | 148 (141-154) | 6.86 (5.73-7.63)  |
|              | BRRI dhan88  | 68           | 143 (138-161) | 7.16 (6.25-8.51)  |
|              | BRRI dhan89  | 147          | 156 (149-162) | 7.90 (7.01-9.21)  |
|              | BRRI dhan92  | 147          | 159 (134-164) | 8.08 (6.72-9.44)  |
|              | BRRI dhan96  | 53           | 144 (139-148) | 7.30 (5.81-8.35)  |

**Table 31. Yield of the demonstration trials of BRRI varieties under PARTNER and LSTD project in relation to growth duration, BRRI RS Bhanga, Boro 2023-24.**

| Variety           | No. of trial | Avg. GD (day) | Avg. yield (t/ha) |
|-------------------|--------------|---------------|-------------------|
| PARTNER           |              |               |                   |
| Bangabandhu100    | 135          | 150           | 7.48              |
| BRRI dhan101      | 32           | 147           | 7.39              |
| BRRI dhan102      | 120          | 151           | 7.74              |
| BRRI dhan104      | 26           | 150           | 7.59              |
| BRRI dhan105      | 06           | 149           | 7.45              |
| BRRI hybrid dhan8 | 31           | 149           | 9.58              |
| LSTD              |              |               |                   |
| BRRI dhan88       | 10           | 144           | 7.38              |
| BRRI dhan89       | 5            | 157           | 8.20              |
| BRRI dhan92       | 5            | 159           | 8.48              |
| BRRI dhan99       | 5            | 157           | 7.80              |

**Table 32. Farmers' training conducted by BRRI RS, Bhanga during 2023-24.**

| Funding source | No. of training | Participating farmer | Participating SAAO/SA | No. of field day |
|----------------|-----------------|----------------------|-----------------------|------------------|
| GOB            | 30              | 810                  | 90                    | 30               |
| PARTNER        | 4               | 120                  | -                     | 2                |
| LSTD           | -               | -                    | -                     | 1                |
| Hybrid Project | -               | -                    | -                     | 4                |
| Total          | 34              | 930                  | 90                    | 37               |

## **BRRI RS, Cumilla**

|            |                                            |
|------------|--------------------------------------------|
| <b>350</b> | <b>Summary</b>                             |
| <b>351</b> | <b>Varietal development programme area</b> |
| <b>356</b> | <b>Pest management programme area</b>      |
| <b>357</b> | <b>Crop soil water management</b>          |
| <b>360</b> | <b>Socio-economic programme area</b>       |
| <b>360</b> | <b>Technology transfer programme area</b>  |
| <b>361</b> | <b>BRRI RS, Cumilla karmasuchi</b>         |



## SUMMARY

In OYT#1, sixty-six entries, in AYT#3, six entries, in RYT#1, two entries and in RYT#2 five entries were performed better and produced higher yield than the check varieties in T. Aus 2023 season. In RYT (DWR), one entry performed better than the check varieties during B. Aman 2023 season. In T. Aman 2023 season, 30 crosses were made. Three crosses were confirmed in T. Aman 2023 season. In total 4000, 7000, 10000, 19500 and 9000 plants were advanced in F<sub>2</sub> F<sub>3</sub>, F<sub>4</sub>, F<sub>5</sub> and F<sub>6</sub> generations respectively through FRGA method and in LST total 250 plants were selected from 14 crosses. In total 11, three and two entries were selected in OYT (Cum), PYT (Cum) and SYT (Cum) trial respectively. Similarly, three, three, three, five, five, three, four, three, two, two, six, four, three, six and one entries performed better than the check varieties in RYT (Tall), RYT (Zira), RYT (Katari), RYT#1 (STR), RYT#2 (STR), RYT#1 (RLR), RYT#2 (RLR), RYT (ZER), RYT#1 (BB), RYT#2 (Blast), RYT#3 (FS), RYT#1 (AER), RYT#2 (AER), RYT (PS) and RYT (Biotech.) trial respectively. Under TRB-BRRI project, 44, 31, 12, 12, 11, 18, four, 40, 12 and five entries performed better than the check varieties in OYT#1 (RLR), OYT#2 (RLR), OYT#3 (RLR), AYT#1 (RLR), AYT#1 (RLR), OYT (DRR), AYT (DRR), OYT (IRR-BPH), PYT (IRR-BPH) and AYT (IRR-BPH) trial respectively. In HTH trial, BRRI dhan75 produced the highest yield among the short duration varieties. Under AGGRiNet project, 16 and eight entries performed better than the check varieties in AGGRiNet (stage-1) and AGGRiNet (stage-2) trial respectively during T. Aman 2023 season. In Boro 2023-24 season, 24 crosses were made. Four crosses were confirmed in Boro 2023-24 seasons. Total 10500, 8000, 6500, 1000 and 7000 plants were advanced in F<sub>2</sub> F<sub>3</sub>, F<sub>4</sub>, F<sub>5</sub> and F<sub>6</sub> generation through FRGA method. In LST, total 250 plants were selected from 25 crosses. In total 23, six, five and four entries were performed better than the check varieties in OYT (Cum), PYT#1 (Cum), PYT#2 (Cum) and AYT (Cum) trial respectively. In ALART (STR-SD), four entries produced the highest yield than the check varieties. Five, three,

four, two, six, two, seven, one, four, three, three, two, three, one, two, two, five, two and one entries showed better performance than the standard check varieties in RYT#1 (SD), RYT#2 (MD), RYT#3 (SMD), RYT (ELS), RYT (Barishal), RYT (BB and Blast-MK), RYT#1 (STR), RYT (Bio), RYT#2 (Blast), RYT#3 (Blast), RYT#4 (Blast), RYT#5 (Blast), RYT (BB and Blast-MAL), RYT (ZER), RYT#1 (PQR), RYT#2 (PQR), RYT#3 (PQR), G X E (Basmati) and RYT (Fine grain) trial respectively during Boro 2023-24 season. On the other hand, 35, 69, 15, 11, 25, eight and 19 entries performed better than the check varieties in OYT (DRR-BB), OYT (IRR), PYT (IRR), AYT (IRR), AYT#1 (FBR), AYT#2 (FBR) and AYT#3 (FBR) trial respectively during Boro 2023-24 season. Under AGGRi project, in AGGRiNet trial, total 15 entries performed better than the check varieties during Boro 2023-24 season.

Digital disease survey was conducted from 404 spots (T. Aman) of six Upazilas; and 643 spots (Boro) of eight Upazilas in Cumilla district using ODK mobile Apps. The major rice diseases of neck blast, sheath blight, bacterial blight, false smut, sheath rot and brown spot were observed in Aman and Boro seasons. Rice yield loss was saved 56-90 % (T. Aman) and 79-83% (Boro) by managing neck blast disease. Disease was not found in the BRRI Technology-followed-rice field in Burichang. Eleven (for sheath blight) and 11 (for blast) fungicides were found better for disease control. Twenty-two tungro resistance advanced lines were found resistant to moderately resistant reaction on Tungro disease. Blast disease occurrence became low when rice transplanted from February during Boro season.

In T. Aman, BRRI dhan103 produced higher grain yield (6.2 t/ha) upto 5 August planting. In Boro season, grain yield and growth duration of short duration varieties showed less difference irrespective of sowing dates. On the other hand, long duration variety BRRI hybrid dhan8 produced significantly higher yield (8.68 t/ha) up to 25 December transplantation. In, T. Aman the highest number of grains/panicles was observed in basal with additional application of potassium in 45 DAT

(T5), grain yield was also significantly higher (5.69 t/ha). In Boro season, basal application of potassium produced the highest number of grain yield. Lower seeding density with seedbed nutrient management produced higher seedling strength of BRRI dhan76. Three split urea produced maximum yield (6.33 t/ha). Two-third N splitting with additional 20 kg/ha MOP produced better in older seedling than three splitting. Nitrogen was the most yield limiting factor for T. Aman and Boro seasons. In T. Aman 2023 season, 20 kg/ha rate of P produced the highest grain yield (6.03 t/ha) and 30 kg/ha rate of P produced highest grain yield (6.64 t/ha) during Boro 2023-24 season. BRRI Hybrid dhan7 (Aus), BRRI dhan72, 87 (Aman) and BRRI hybrid dhan8 (9.94 t/ha) (Boro) produced the highest yield.

A total of 810 farmers and 90 SAAOs were trained up. In total 32.804 tons of TLS, 17.8 tons of certified and 31.824 tons of breeder seeds were produced during 2023-24.

## RESULTS

### VARIETY DEVELOPMENT PROGRAMME AREA

In OYT#1, sixty-six entries performed better and produce higher yield than the check varieties in T. Aus 2023 season. In AYT#3, six entries performed better and produced higher yield than the check varieties in T. Aus season. In RYT#1, two entries performed better and produced higher yield than the check varieties and in RYT#2, five entries performed better and produced higher yield than check varieties.

**Table 1. Yield and agronomic performances of breeding materials in regional yield trial#1 (RYT#1), T. Aus 2023.**

| Designation       | GD (day) | PH (cm) | Yield (t/ha) |
|-------------------|----------|---------|--------------|
| BR11898-5R-241    | 117      | 118     | 4.52         |
| BR12087-5R-25     | 107      | 116     | 4.31         |
| BR12087-5R-31     | 108      | 105     | 5.10         |
| BR12087-5R-132    | 106      | 108     | 4.68         |
| BR12090-5R-233/91 | 107      | 106     | 5.18         |
| BR12091-4R-9**    | 107      | 111     | 5.40         |
| BR12091-4R-97     | 105      | 102     | 4.89         |
| BR12091-4R-169    | 108      | 101     | 5.19         |
| BR12101-5R-76     | 108      | 101     | 4.90         |
| BR12102-4R-58**   | 108      | 112     | 5.45         |
| BR11863-5R-82     | 109      | 106     | 5.12         |
| BR11864-5R-31     | 112      | 95      | 5.00         |
| BRRI dhan48 (ck)  | 108      | 111     | 4.78         |
| BRRI dhan98 (ck)  | 108      | 107     | 5.25         |
| LSD (0.05)        | 0.94     | 1.31    | 0.49         |
| Heritability      | 0.99     | 0.99    | 0.72         |

\*\*Performed better DS: 25 Apr 2023 DT: 17 May 2023

In RYT (DWR), one entry performed better than the check varieties during B. Aman 2023 season. The heritability obtained from yield was 86% indicating high level of precision of this experiment.

**Table 2. Yield and agronomic performances of breeding materials in Regional Yield Trial-Deep Water Rice (RYT-DWR), B. Aman 2023.**

| Designation           | GD (day) | PH (cm) | Y (t/ha) |
|-----------------------|----------|---------|----------|
| BR7730-1-1-2B**       | 160      | 153     | 2.50     |
| BR7918-1-2-3B         | 155      | 157     | 2.10     |
| BR7919-1-2-3B         | 166      | 153     | 1.79     |
| BRRI dhan91 (ck)      | 160      | 156     | 2.22     |
| Mura Bajal (Local ck) | 168      | 162     | 2.10     |
| LSD (0.05)            | 1.12     | 3.43    | 0.27     |
| Heritability          | 0.99     | 0.89    | 0.86     |

\*\*Performed better DS: 29 May 2023 Location: Kochua, Chandpur

In T. Aman 2023 season, thirty crosses were made. A total of three crosses were confirmed in T. Aman 2023 season. In total 4000, 7000, 10000, 19500 and 9000 plants were advanced from F<sub>2</sub> F<sub>3</sub>, F<sub>4</sub>, F<sub>5</sub> and F<sub>6</sub> generation through FRGA method and in LST, 250 plants were selected from 14 crosses. In total 11, three and two entries were selected in OYT (Cum), PYT (Cum) and SYT (Cum) trial respectively.

**Table 3. Yield and agronomic performances of selected entries in Secondary Yield Trial (SYT)-Cum, T. Aman 2023.**

| Designation      | GD (day) | PH (cm) | ET/hill | Y (t/ha) |
|------------------|----------|---------|---------|----------|
| BRC368-2-2-3-2-4 | 124      | 105     | 14      | 6.11     |
| IR1-DQ125-L2-D2  | 117      | 103     | 13      | 5.91     |
| BRRI dhan49 (ck) | 133      | 109     | 13      | 5.73     |
| BRRI dhan75 (ck) | 118      | 111     | 13      | 5.56     |
| BRRI dhan87 (ck) | 125      | 114     | 14      | 5.87     |
| LSD (0.05)       | 0.94     | 0.61    | 0.53    | 0.33     |
| Heritability     | 1.00     | 1.00    | 0.98    | 0.80     |

DS: 11 Jul 23 DT: 07 Aug 23

Three, three, three, five, five, three, four, three, two, two, six, four, three, six and one entries performed better than the check varieties in RYT (Tall), RYT (Zira), RYT (Katari), RYT#1 (STR), RYT#2 (STR), RYT#1 (RLR), RYT#2 (RLR), RYT (ZER), RYT#1 (BB), RYT#2 (Blast), RYT#3 (FS), RYT#1 (AER), RYT#2 (AER), RYT (PS) and RYT (Biotech.) trial respectively. Under TRB-BRRI project, 44, 31, 12, 12, 11, 18, four, 40, 12 and five entries performed better than the check varieties in OYT#1 (RLR), OYT#2 (RLR), OYT#3 (RLR), AYT#1 (RLR), AYT#1 (RLR), OYT (DRR), AYT (DRR), OYT (IRR-BPH), PYT (IRR-BPH) and AYT (IRR-BPH) trial respectively. In Head to Head (HTH) trial, BRRI dhan75 produced the highest yield among the short duration varieties.

**Table 4. Yield and average performances of varieties in Head to Head trial (HTH), T. Aman 2023.**

| Variety     | GD (day)* | Y (t/ha)* |
|-------------|-----------|-----------|
| Binadhan-7  | 119       | 3.98      |
| Binadhan-16 | 105       | 4.20      |
| Binadhan-17 | 119       | 4.58      |
| Binadhan-22 | 134       | 4.61      |
| BRRI dhan39 | 123       | 3.83      |
| BRRI dhan71 | 114       | 4.98      |
| BRRI dhan75 | 115       | 5.01      |

\*Average of five locations in Cumilla region

Under AGGRiNet project, 16 and eight entries performed better than the check varieties in AGGRiNet (stage-1) and AGGRiNet (stage-2) trial respectively during T. Aman 2023 season. The heritability obtained from yield was 85% in AGGRiNet (Stage-1) trial indicating high level of precision of this experiment.

**Table 5. Performance of best entries in AGGRiNet (Stage-1), T. Aman 2023.**

| Designation            | GD (day) | PH (cm) | Yield (t/ha) |
|------------------------|----------|---------|--------------|
| IR22MD1344             | 123      | 122     | 6.59         |
| IR22MD1158             | 124      | 115     | 6.57         |
| IR 121020 H            | 121      | 107     | 6.36         |
| IR22MD2048             | 121      | 105     | 6.33         |
| IR22MD1460             | 121      | 110     | 6.25         |
| IR22MD2404             | 123      | 102     | 6.23         |
| IR22MD1538             | 120      | 106     | 6.22         |
| IR22MD3972             | 123      | 104     | 6.2          |
| IR22MD3384             | 126      | 112     | 6.02         |
| IR22MD1746             | 125      | 114     | 6.01         |
| IR22MD3330             | 116      | 110     | 5.98         |
| IR21X1014              | 122      | 106     | 5.98         |
| IR22MD2502             | 123      | 105     | 5.88         |
| IR 116298 H            | 121      | 108     | 5.86         |
| IR22MD3192             | 123      | 110     | 5.85         |
| IR22MD1245             | 121      | 112     | 5.85         |
| BRRI dhan49 (ck)       | 133      | 106     | 5.52         |
| BRRI dhan87 (ck)       | 124      | 118     | 5.83         |
| BRRI dhan94 (ck)       | 135      | 112     | 5.68         |
| Binadhan-17 (ck)       | 119      | 101     | 5.17         |
| BRRI hybrid dhan6 (ck) | 118      | 110     | 5.73         |
| Dhanigold (ck)         | 124      | 114     | 5.17         |
| LSD (0.05)             | 1.27     | 2.67    | 0.78         |
| Heritability           | 0.99     | 0.96    | 0.85         |

DS: 15 Jul 2023 DT: 05 Aug 2023

In Boro 2023-24 season, 24 crosses were made. Four crosses were confirmed. In total 10500, 8000, 6500, 1000 and 7000 plants were advanced from F<sub>2</sub> F<sub>3</sub>, F<sub>4</sub>, F<sub>5</sub> and F<sub>6</sub> generation through FRGA method. In LST, 250 plants were selected from 25 crosses. In total 23, six, five and four entries performed

better than the check varieties in OYT (Cum), PYT#1 (Cum), PYT#2 (Cum) and AYT (Cum) trial respectively in Boro 2023-24 season. The heritability obtained from yield in AYT (Cum) was 89% indicating high level of precision of this experiment.

**Table 6. Performance of entries in Advanced Yield Trial (AYT)-Cum, Boro 2023-24.**

| Designation        | GD (day) | PH (cm) | ET/Hill | Yield (t/ha) |
|--------------------|----------|---------|---------|--------------|
| BRC529-15-2-1-3    | 145      | 127     | 15      | 5.44         |
| BRC533-17-1-2-1A   | 141      | 100     | 14      | 4.54         |
| BRC533-17-1-2-1B   | 145      | 105     | 19      | 5.15         |
| BRC535-11-1-2-1A   | 150      | 104     | 17      | 5.29         |
| BRC535-11-1-3-2    | 141      | 102     | 14      | 4.36         |
| BRC538-12-1-1-2C   | 149      | 118     | 16      | 5.47         |
| BRC557-13-1-1-2    | 155      | 106     | 17      | 5.34         |
| BRC472-19-1-1-B1** | 154      | 108     | 18      | 5.66         |
| BRC491-5-2-1-B1    | 151      | 105     | 20      | 4.15         |
| BRC491-5-2-1-B2    | 154      | 109     | 15      | 4.09         |
| BRC491-5-2-1-B3**  | 140      | 102     | 19      | 6.17         |
| BRC546-5-1-5**     | 147      | 120     | 15      | 5.87         |
| BRC480-2-1-1-2**   | 145      | 111     | 17      | 5.53         |
| BRC548-22-1-6      | 150      | 130     | 18      | 4.86         |
| BRRI dhan58 (ck)   | 149      | 103     | 12      | 4.45         |
| BRRI dhan81 (ck)   | 143      | 102     | 16      | 5.06         |
| BRRI dhan88 (ck)   | 145      | 91      | 18      | 5.22         |
| BRRI dhan89 (ck)   | 155      | 108     | 19      | 5.35         |
| LSD (0.05)         | 1.25     | 4.17    | 4.02    | 0.53         |
| Heritability       | 0.99     | 0.98    | 0.59    | 0.89         |

\*\*Performed better DS: 9

Dec 2023

DT: 25 Jan 2024

In ALART (STR-SD), four entries produced highest yield than the check varieties. Also two, one, one and one entry performed better than the

check varieties in ALART (FBR-SD), ALART (FBR-LD), ALART (FBR-Bio) and ALART (PQR) trial respectively during Boro 2023-24 season.

**Table 7. Performance of entries in ALART (STR-SD), Boro 2023-24.**

| Designation           | GD (day) | PH (cm) | Y (t/ha) |
|-----------------------|----------|---------|----------|
| BR13113-4R-63         | 142      | 100     | 7.67     |
| BR13111-4R-63**       | 145      | 98      | 8.20     |
| BR13106-4R-184**      | 143      | 83      | 8.12     |
| BR13122-4R-136**      | 147      | 104     | 8.44     |
| BR13113-4R-116**      | 142      | 100     | 8.47     |
| BRRI dhan67 (ck)      | 142      | 104     | 6.96     |
| BRRI dhan88 (Std. ck) | 140      | 98      | 7.69     |
| BRRI dhan28 (ck)      | 141      | 101     | 7.61     |

\*\*Performed better

DS: 26 Nov 2023

DT: 1 Jan 2024

Five, three, four, two, six, two, seven, one, four, three, three, two, three, one, two, two, five, two and one entries showed better performance than the standard check varieties in RYT#1 (SD), RYT#2 (MD), RYT#3 (SMD), RYT (ELS), RYT (Barishal), RYT (BB and Blast-MK), RYT#1 (STR), RYT (Bio), RYT#2 (Blast), RYT#3 (Blast),

RYT#4 (Blast), RYT#5 (Blast), RYT (BB and Blast-MAL), RYT (ZER), RYT#1 (P QR), RYT#2 (PQR), RYT#3 (PQR), G X E (Basmati) and RYT (Fine grain) trial respectively during Boro 2023-24 season. The heritability obtained from yield in RYT#1 (SD) was 72% indicating high level of precision of this experiment.

**Table 8. Performance of entries in regional yield trial#1 (RYT#1-SD), Boro 2023-24.**

| Designation      | GD (day) | PH (cm) | ET/Hill | Yield (t/ha) |
|------------------|----------|---------|---------|--------------|
| BR12574-5R-168   | 144      | 108     | 12      | 6.46         |
| BR12574-5R-52**  | 144      | 107     | 13      | 6.64         |
| BR12520-5R-67**  | 141      | 91      | 11      | 6.89         |
| BR12667-4R-86    | 144      | 89      | 12      | 5.85         |
| BR12671-4R-95**  | 150      | 114     | 9       | 7.10         |
| BR12676-4R-392   | 144      | 81      | 12      | 6.02         |
| BR12682-4R-50**  | 150      | 107     | 14      | 7.13         |
| BR12208-4R-278** | 147      | 82      | 12      | 6.75         |
| BRRI dhan88 (Ck) | 143      | 85      | 16      | 6.39         |
| BRRI dhan96 (Ck) | 139      | 81      | 12      | 6.49         |
| LSD (0.5)        | 1.02     | 5.21    | 2.53    | 0.61         |
| Heritability     | 0.99     | 0.98    | 0.77    | 0.72         |

\*\*Performed better

DS: 24 Nov 2023

DT: 9 Jan 2024

On the other hand, 35, 69, 15, 11, 25, eight and 19 entries performed better than the check varieties in OYT (DRR-BB), OYT (IRR), PYT (IRR), AYT (IRR), AYT#1 (FBR), AYT#2 (FBR) and AYT#3 (FBR) trial respectively during Boro 2023-24

season. Under AGGRi project, in AGGRiNet trial, total 15 entries performed better than the check varieties in Boro 2023-24 season. The heritability obtained from yield was 53% indicating acceptable level of precision of this experiment.

**Table 9. Performance of best entries in AGGRiNet, Boro 2023-24.**

| Designation | GD (day) | PH (cm) | Yield (t/ha) |
|-------------|----------|---------|--------------|
| IR22MD2348  | 132      | 103     | 6.58         |
| IR22MD4030  | 128      | 119     | 7.41         |
| IR22MD2665  | 129      | 104     | 6.60         |
| IR22MD1506  | 132      | 103     | 6.60         |
| IR22MD1644  | 133      | 103     | 6.75         |
| IR22MD2048  | 130      | 107     | 7.23         |
| IR22MD1344  | 131      | 112     | 6.74         |
| IR22MD2489  | 131      | 102     | 6.87         |
| IR22MD3710  | 129      | 107     | 6.67         |
| IR22MD1797  | 131      | 101     | 6.74         |
| IR22MD3442  | 130      | 103     | 7.42         |

| Designation       | GD (day) | PH (cm) | Yield (t/ha) |
|-------------------|----------|---------|--------------|
| IR22MD3444        | 129      | 94      | 6.58         |
| IR22MD3091        | 129      | 108     | 6.89         |
| IR22MD3943        | 131      | 103     | 6.58         |
| IR16A3891         | 127      | 91      | 6.59         |
| BRRI dhan67 (ck)  | 132      | 102     | 5.93         |
| BRRI dhan88 (ck)  | 133      | 92      | 5.44         |
| BRRI dhan89 (ck)  | 143      | 106     | 6.56         |
| BRRI dhan92 (ck)  | 143      | 108     | 6.50         |
| BRRI dhan102 (ck) | 138      | 104     | 5.64         |
| BRAC DHAN 2 (ck)  | 131      | 103     | 5.44         |
| Binadhan-10 (ck)  | 126      | 104     | 5.61         |
| Binadhan-25 (ck)  | 134      | 121     | 5.75         |
| LSD (0.05)        | 1.71     | 4.32    | 1.18         |
| Heritability      | 0.95     | 0.92    | 0.53         |

DS: 21                      December 2023                      DT: 22 January 2024

Investigators: A K M Shalahuddin, H Rashid, MR Islam and KM Iftekharuddaula

## PEST MANAGEMENT PROGRAM AREA

**Survey and monitoring of rice diseases in selected areas during 2023-24.** Digital disease survey was conducted from 404 spots of six upazilas; Adarsha Sadar (56), Barura (79), Burichang (148), Chandina (73), Daudkandi (13), Debidwar (35) during T. Aman 2023 season and 643 spots of eight Upazilas; Adarsha Sadar (144), Sadar Dakshin (58), Burichang (99), Chandina (108), Debidwar (30), Laksham (24), Nangalkot (131), Chauddagam (49). during Boro 2022-23 season in Cumilla district using ODK mobile Apps to know the present status of different rice diseases under various climatic environments. Disease incidence and disease severity data of major rice diseases were recorded following SES, IRRI 2013. During T. Aman 2023, neck blast disease was found predominant in the aromatic rice varieties of BRRI dhan34 (Avg DI 25%, and DS 9), Khasa (%DI 62, DS 9) Kalijira (Avg. 3% DI, DS 5). The disease incidence of sheath blight, bacterial blight, false smut, sheath rot and brown spot were 10-80 (DS1-9), 5-50 (DS 3-5), 1-20 (DS 1-3), 1-30 (DS 5-

9) and 5-60 (DS 1-3) respectively. During Boro 2022-23 season, major rice diseases leaf blast, neck blast, bacterial blight, sheath blight, sheath rot and brown spot diseases were recorded as 5-100 % DI (DS 3-9), 0.1-100 % DI (DS 3-9), 5-40 % DI (DS 3-5), 10-80 % DI (DS 3-7), 1-20 % DI (DS 1-9) and 5-60 % DI (DS 1-7) respectively.

Investigators: M M Rashid, M Hossain, M A I Khan, T H Ansari, M R Islam

**Validation of rice neck blast disease management technology under farmer's field condition:** Rice blast disease management technology (5 kg MOP/bigha additionally apply during last top dress of urea, spray fungicide Trooper or Tricyclazole group fungicides @ 0.8 g/L water for two times as preventive 1<sup>st</sup> at split booting stage and 2<sup>nd</sup> at flowering stage in the evening) was validated to build up farmers' awareness on rice blast disease management and minimize yield loss in BRRI RS, Cumilla, Burichang, Sadar Dakshin, Laksam, Adarsha Sadar and Kasba during T. Aman 2023 (BRRI dhan34) and Boro 2023-24 (BRRI dhan81). Disease incidence of neck blast was found 60-96 % (DS 9) in BRRI dhan34 at farmers practice and 0.4-7% DI (DS 1-3) to BRRI practice and rice yield loss was saved 56-90 % by managing neck blast

disease following BRRI developed blast disease management technology in all the areas during T. Aman 2023 season. During Boro 2023-24 season, three field demonstrations were conducted in the farmers field condition and BRRI RS farm using highly susceptible BRRI dhan81 variety in Adarsha Sadar, Burichang, Sadar Dakshin upazila of Cumilla. Farmer's yield was saved 79-83 % by protecting neck blast disease using rice blast management technology.

Investigators: M M Rashid, M A I Khan, M A Monsur, M S Mia, M R Islam, T H Ansari

**Validation of rice tungro disease management technology in Cumilla region.** The Tungro management technology is seedbed along with surroundings should be free from GLH by five days interval hand sweeping along with light trapping Or, Seedbed along with surroundings should be free from GLH by insecticide spray. First spray at 10, 10-15, 15-20 days after seeding during Aus, Aman and Boro seaseon respectively, and 2<sup>nd</sup> spray at 3-5 days before transplanting for each season. To validate the technology 200 seedbeds of 200 farmers were selected in Nangalkot, Burichang, Debidwar during T. Aman 2023 season. Disease was not found in the BRRI Technology-followed-rice field in Burichang. In Nangalkot and Debidwar, tungro disease was found as 10-20 % DI with DS 5-7 in the farmers practice (no spray in the seedbed).

Investigators: M M Rashid, M S Mia, M R Islam, M A I Khan, T H Ansari

**Evaluation of new chemicals against sheath blight and blast diseases of rice.** During T. Aman 2023, 11 out of 36 new fungicides for sheath blight and 11 out of 20 new fungicides for blast performed better and reduced rice diseases above 80%.

Investigators: M M Rashid, M A Monsur, M R Bhuiyan, M Hossain, M A I Khan, T H Ansari, M R Islam

**MLT of Tungro Resistant Lines, in tungro hot-spot area in Cumilla during T. Aman 2023 season.** A total of 22 tungro resistance advanced lines derived from the crosses of TW-16, Matatga-1, IR69705-1-1-1-3-2 and BRRI dhan48, BRRI dhan71 were evaluated in tungro hotspot area along with eight checks to find out the performance of

tungro resistant lines in natural field condition at Kabilpur, Debidwar, Cumilla during T. Aman 2023. Among the tested lines, all lines showed resistant to moderately resistant reaction on Tungro disease.

Investigators: M M Rashid, S A I Nihad, M S Mia, T H Ansari, M R Islam

**Multi-location trial (MLT) of blast resistant materials in hot-spot area in Cumilla Boro 2023-24.** This trial is composed of four advanced breeding lines (V1=HCL 227, V2=HAN 165, V3=HCP 245, V4=HGK 236) and two checks (BRRI dhan63, BRRI dhan 64). Two blast resistant lines V3=HCP 245, V4=HGK 236 showed resistance against blast disease of rice.

Investigators: M A I Khan, M M Rashid, T H Ansari, M R Islam

**Development and Validation of Early Warning System for Rice Blast during Boro 2023-24.** Four rice varieties, three susceptible (BRRI dhan28, BRRI dhan63 and BRRI dhan81) and one field resistant (BRRI dhan74) were used in this study at natural field condition to find out the critical time of blast disease initiation at Kabilpur, Debidwar, Cumilla during Boro 2023-24 season. Neck blast disease was severe in BRRI dhan81 followed by BRRI dhan28, BRRI dhan63 when rice transplanted upto January and very less neck blast disease was observed when rice transplanted from February.

Investigators: M A I Khan, M M Rashid, T H Ansari, M R Islam

## CROP-SOIL-WATER MANAGEMENT

**Effect of planting time on the agronomic output of newly developed BRRI varieties in different eco-systems.** This study was taken to determine the effect of variable planting time on the growth and yield of newly released varieties and to identify the suitable planting time and variety for Cumilla area. During T. Aman 2023, the treatments were A. Time of planting, eg. T1: 5 July, T2: 20 July, T3: 5 August, T4: 20 August, T5: 5 September and T6: 20 September; and B. Varieties: V1: BRRI dhan75, V2: BRRI dhan87, V3: BRRI dhan90, V4: BRRI dhan95 and V5: BRRI dhan49 (ck). In Boro 2023-24, the tested six varieties were BRRI dhan88, BRRI dhan89, BRRI dhan92, BRRI dhan96, BRRI dhan101, BRRI dhan102. All the entries were



transplanted on five transplanting times such as: 10 December, 25 December, 10 January, 25 January, 10 February and 25 February 2023-24 in the BRRI RS, Cumilla research field. The experiment was laid down in the split plot design with three replications where planting dates were in the main plot and varieties were in the sub-plot. Fertilizer were applied N-P-K-S @ 76-20-42-9 kg/ha in T. Aman 2023 and N-P-K-S-Zn @ 145-31-77-13-1.5 kg/ha in Boro 2023-24 respectively.

In T. Aman 2023, the result indicated that from 5 August to 20 August of transplanting, BRRI dhan103 produced similar grain yield and growth duration. After 20 August grain yield decreasing but growth duration increases gradually. Growth duration of BRRI dhan95 was higher with decreasing grain yield from 20 July to 5 September transplanting. BRRI dhan103 showed the highest grain yield (6.2 t/ha) in 5 August transplanting but the lowest was found in 5 September.

In Boro 2023-24, BRRI dhan89, BRRI dhan92 and BRRI dhan102 produced higher grain yield within 155-158 days in first two planting times. BRRI dhan88, BRRI dhan96 and BRRI dhan101 showed expected higher yield with varying range of planting time. It was observed that the best planting time for long duration varieties (>140 days) was last week of December to first week of January.

Investigators: T Ferdous, M S Islam and M R Islam

**Effect of potassium fertilizer management at different growth stages of BRRI dhan87.** An experiment was conducted at the research field, BRRI RS, Cumilla, during July 2023 to December 2023 to study the growth performance of BRRI dhan87 in response to growth stage based additional potassium fertilization. The treatments were T1 = K0 (No Potassium), T2 = K Basal (RD), T3 = T2 + K20 15 DAT (20 kg K/ha), T4 = T2 + K20 30 DAT, T5 = T2 + K20 45 DAT. The experiment was laid out in a randomized complete block design with three replications. The results revealed that potassium fertilization exerted significant influence on growth performance of BRRI dhan87. Basal application with additional potassium @20 kg/ha produced the tallest plant (125.67cm), the highest number of tillers/hill and grain yield 5.69 t/ha. Therefore, application of T5

appeared as the promising practice in BRRI dhan87 cultivation in terms of growth performance.

**Effect of potassium fertilizer management at different growth stages of BRRI dhan88.** During Boro season 2023-24, the treatments were T1 = K0 (No Potassium), T2 = K Basal (RD) Recommended dose as basal, T3 = T2+K2015 DAT 20 kg k/ha at tillering stage (TS), T4 = T2+K20 30 DAT at maximum tillering Stage (MTS), T5 = T2+K20 50 DAT at panicle Initiation Stage (PIS), T6 = T2+K2015 DAT + K20 30 DAT, T7= T2+K2015 DAT + K20 50 DAT, T8 = T2+K2015 DAT + K20 30 DAT+ K20 50 DAT, T9 = T2 + K20 30 DAT+ K20 50 DAT, T10 = Two-third of T2 as basal + One-third at PIS. An increased application of potassium from 0 to 137 kg/ha increased tiller/m<sup>2</sup>, number of panicle/m<sup>2</sup> and increased grain yield over the control T1. The highest number of grains/panicles was observed in T4 where potassium was applied basally as well as additional application in maximum tillering, grain yield was also significantly higher (6.8 t/ha) in this treatment. Potassium application significantly increased the number of filled grains/panicle, 1000-grain weight, grain yield and harvest index. Basal application along with two additional application of potassium showed superiority over split application of 1, 2 and 4 additional applications. Grain yield of T4, T8 did not significantly vary from T2 (K Basal). Therefore, application of T2 can be economically justified.

Investigators: T Ferdous, B Saha, M M Rashid and M R Islam

**Effect of nursery management on the performance of rice variety grown under water stagnant condition.** The productivity of rice in most sub-tropical areas of Asia is low because of the predominance of several abiotic and biotic stresses, use of traditional landraces or old varieties and suboptimal management practices. A combination of high-yielding, stress-tolerant rice varieties and good management practices is necessary to enhance the productivity of these areas. Nursery management practices that suit the new stress-tolerant varieties recently becoming available need to be developed to increase the productivity of rice. In T. Aman 2023 season, on-station trials on nursery management were

conducted using improved rice variety BRRI dhan76 to study the effect of seed density, nutrient management in the nursery. Lower seed density and application of balanced nutrients produced healthy and taller seedlings with high seedling strength (g/cm) in the nursery and with subsequent increase in grain yield after transplanting in the main field. Combining inorganic and organic fertilizers in the seedbed (N1: Urea-TSP-Mop@ 7-0-0 g/m<sup>2</sup> + 500g/m<sup>2</sup> FYM, N2: Urea-TSP-Mop@ 11-15-3 g/m<sup>2</sup> + 500g/m<sup>2</sup> FYM, N3: Urea-TSP-Mop@ 7-15-3 g/m<sup>2</sup> + 500g/m<sup>2</sup> FYM, N4: Urea-TSP-Mop@ 0-15-3 g/m<sup>2</sup> + 500g/m<sup>2</sup> FYM) enhanced shoot length, dry weight, seedling strength. These cost-effective nursery management approaches have great potential for enhancing yield in stress-prone rainfed coastal areas and will help sustain rice yield while ensuring sustainability of the cropping system. Investigators: T Ferdous, B Saha, M M Rashid and M R Islam

#### **Effect of Seedling age and nutrient management in BRRI dhan87**

In T. Aman 2023 season, a field experiment was conducted at the research field at BRRI RS Cumilla from July 2023 to December 2023 to find out the effect of seedling age and different nitrogen (N) and potassium (K) levels on the yield performance of transplant Aman rice (BRRI dhan87). The experiment comprised four ages of seedlings viz 20, 30, 40-day-old and six treatments T1=Full dose of urea at two equal splits, ½ at 15 DAT + ½ at 30 DAT, T2=Full dose of urea at two equal splits+20 kg/ha K, ½ at 15 DAT + ½ at 30 DAT, T3=Full dose of urea at two equal splits, 2/3 at 15 DAT + 1/3 at 45 DAT, T4=Full dose of urea at two equal splits +20 kg/ha K, 2/3 at 15 DAT + 1/3 at 45 DAT, T5=Full dose of urea at three equal splits, 1/3 at 15 DAT + 1/3 at 30 DAT+ 1/3 at 45 DAT, T6=Full dose of urea at three equal splits +20 kg/ha K, 1/3 at 15 DAT + 1/3 at 30 DAT+ 1/3 at 45 DAT, following randomized complete block design (RCBD) with three replications. The effect of age of seedling, treatments and their interactions were significant on growth, yield and yield contributing characters of transplant Aman rice. The treatment T6 produced yield (6.5 t/ha) from 20 days old seedling, 30 days old seedling. Forty days old seedling gave lower yield from all the six

treatments. T3, T4 performed better than other treatments in 40 days.

Investigators: T Ferdous, B Saha, MM Rashid and MR Islam

**Long-term missing element trial at BRRI RS, Cumilla 2023-24.** The experiment was conducted to assess long-term yield trend of rice under different nutrients managements. For this trial, seven fertilizer treatments viz T<sub>1</sub>= N-P-K-S-Zn (all), T<sub>2</sub> = N omission (-N), T<sub>3</sub> = P omission (-P), T<sub>4</sub> = K omission (-K), T<sub>5</sub> = S omission (-S), T<sub>6</sub> = Zn omission (-Zn) and T<sub>7</sub> = N-P-K-S-Zn (all missing) were imposed following RCBD design with three replications both in T. Aman 23 and Boro 2023-24 season. Fertilizer doses were NPKSZn @ 110-15-42-9-1.5 kg/ha in T. Aman and NPKSZn @ 145-31-77-13-1.5 kg/ha in Boro season respectively. During T. Aman 2023, BRRI dhan87 produced the highest grain yield (6.45 t/ha) and straw yield (7.01 t/ha) with NPKZnS fertilizers and the lowest grain yield (3.41 t/ha) and straw yield (3.80 t/ha) with all missing element fertilizers. The N and K omission from complete fertilizer significantly reduced the grain yield. The highest grain yield and straw yield reduction was found in N omission plot, which was 3.84 t/ha and 4.78 t/ha respectively indicating that a soil test-based dose of fertilizer is enough for this variety. In Boro 2023-24, BRRI dhan88 produced the highest grain yield (6.75 t/ha) and straw yield (7.49 t/ha) with NPKZnS fertilizers and the lowest grain yield (3.21 t/ha) and straw yield (3.44 t/ha) with all missing element fertilizers. Omission of N from complete treatment had a significant effect on grain yield (3.74 t/ha) and straw yield (3.87 t/ha) among the treatments. The omission of P, K, S and Zn produced statistically similar grain and straw yield like complete fertilizer treatment.

Investigators: A K M Shalahuddin, T. Ferdous, B Saha, M M Rashid and M R Islam

**Effects of P rates on the yield of BRRI released new variety in BRRI RS farm, Cumilla:** The experiment was conducted to update the P rates of BRRI released new varieties in BRRI RS Farm, Cumilla. Six doses of P (0, 5, 10, 15, 20 and 25 kg/ha) were tested with BRRI dhan87 in T. Aman 2023 and BRRI dhan88 in Boro 2023-24 season. In T. Aman season, 20 kg/ha rate of P produced the highest grain yield (6.03 t ha<sup>-1</sup>) and 30 kg/ha rate of

produced the highest grain yield (6.64 t ha<sup>-1</sup>) during Boro 2023-24 season. Grain yield was increased with the increasing rate of phosphorus up to a level and then produced the statistically similar grain yield.

Investigators: B Saha T. Ferdous, M M Rashid, M R Islam

#### SOCIO-ECONOMIC PROGRAMME AREA

**Stability Analysis of BRRI developed rice varieties during 2023-24.** Fourteen (Aus 2023), 48 (T. Aman 2023) and 52 (Boro 2023-24) varieties were evaluated to determine the stability index of BRRI developed rice varieties at BRRI RS, Cumilla. During Aus 2023 season, BRRI hybrid dhan7 (6.87 t/ha) produced highest yield followed by BRRI dhan98 (5.6 t/ha), BRRI dhan48 (5.5 t/ha), BRRI dhan106 (4.67 t/ha) and BRRI dhan85 (4.53 t/ha). Growth duration of these varieties ranged from 109-114 days. During T. Aman 2023, BRRI dhan72 (7.41 t/ha) produced the highest yield followed by BRRI dhan87 (7.05 t/ha), BR11 (6.60 t/ha), BR3 (6.49t/ha), BRRI dhan95 (6.39 t/ha), and BRRI dhan95 (6.36 t/ha). Growth duration of these varieties ranged from 105-161 days. During Boro 2023-24, BRRI hybrid dhan8 (9.94 t/ha) produced the highest yield followed by BRRI hybrid dhan2 (9.67 t/ha), BRRI hybrid dhan3 (9.07 t/ha), BRRI dhan101 (8.43 t/ha), BRRI dhan105 (8.39 t/ha), BRRI dhan55 (8.26 t/ha) and BRRI dhan74 (8.22 t/ha). Growth duration of these varieties ranged from 135-166 days.

Investigators: M T Husna, A K M Shalahuddin and M R Islam

#### TECHNOLOGY TRANSFER PROGRAMME AREA

**Varietal dissemination through field demonstration (GoB).** In T. Aman 2023 season, 150 field demonstrations were conducted in different Upazilas of Cumilla region. The yield range of BRRI dhan75, BRRI dhan87, BRRI dhan93 and BRRI dhan103 were 3.54-5.36, 4.46-6.2, 4.74-6.27, 4.94-6.73 t/ha respectively. Farmers' acceptance of BRRI dhan93 and BRRI dhan103 was found very high respectively those specific areas for its grain size, panicle length and high yield. The highest grain yield observed in BRRI dhan103 (6.73 t/ha) followed by BRRI dhan93

(6.27 t/ha). Moreover BRRI dhan93 performed better in Brahmanbaria.

In Boro 2023-24 season, 300 field demonstrations (1 bigha each) of newly released BRRI dhan88, BRRI dhan89, BRRI dhan92, BRRI dhan96, Bangabandhu dhan100, BRRI dhan101 and BRRI hybrid dhan8 were conducted in 34 Upazilas of Cumilla, Brammanbaria and Chandpur district. The yield range BRRI dhan88, BRRI dhan89, BRRI dhan92, BRRI dhan96, Bangabandhu dhan100, BRRI dhan101 and BRRI hybrid dhan8 were 4.82-7.02, 4.57-8.48, 4.6-7.78, 5.29-7.05, 5.9-7.33, 5.5-6.6 and 6.4-8.9 t/ha respectively. The highest grain yield observed in BRRI hybrid dhan8 (8.9 t/ha) followed by BRRI dhan89 (8.48 t/ha). On the other hand, short duration variety, BRRI dhan96 performed well all over Cumilla region.

Investigators: T Ferdous, B Saha, M M Rashid and M R Islam

**Farmer's training, field day and fair:** Thirty farmers' training programmes were conducted in different locations of Cumilla region. A total of 810 farmers and 90 SAAOs were trained up. Five field days were conducted in the field demonstration areas at Cumilla region. About 500 farmers as well as extension personnel attended in the field days. Most of the farmers got interested to cultivate new rice varieties in their areas specially BRRI dhan87, BRRI dhan95, BRRI dhan88, BRRI dhan89, BRRI dhan92, BRRI dhan96, Bangabandhu dhan100, BRRI dhan101, BRRI dhan102, BRRI dhan103, BRRI dhan104 and BRRI dhan105. BRRI RS Cumilla also participated in development fair held at DD, DAE Office, Cumilla.

Investigators: T. Ferdous, B Saha, AKM Shalahuddin, M M Rashid and M R Islam

**Seed Production:** During Aus 2023 season, total 11.265 tons TLS seed of BRRI dhan48, 85, 98 was produced. During T. Aman 2023 season, 7.824 tons Breeder seed (BR22, BRRI dhan49, 82, 94, 95) seed and 7.649 tons TLS seeds (BR22, 23, BRRI dhan34, BRRI dhan46, BRRI dhan49, BRRI dhan71, BRRI dhan75, BRRI dhan76, BRRI dhan87, BRRI dhan90, BRRI dhan94, BRRI dhan95 and BRRI dhan103) were produced. During Boro 2023-24, 24.0 ton Breeder seed (BRRI dhan29, BRRI dhan58, BRRI dhan88, BRRI

ghan89, BRRI dhan96, BRRI dhan102), 17.8 ton certified seed and 13.89 ton TLS seeds (BRRI dhan28, BRRI dhan29, BRRI dhan74, BRRI dhan81, BRRI dhan86, BRRI dhan88, BRRI dhan89, BRRI dhan92, BRRI dhan96, BRRI dhan101, BRRI dhan102, BRRI dhan104, BRRI dhan105, BRRI dhan107, BRRI dhan108) were produced in BRRI RS, Cumilla farm.

Investigators: A K M Shalahuddin, T Ferdous, B Saha, M M Rashid and M R Islam

#### BRRI CUMILLA KARMASUCHI

**Varietal dissemination through field demonstration (Karmasuchi).** Thirty field demonstrations were conducted using BRRI dhan98 and yield range was 5.92-6.21 t/ha during Aus 2023 season. During T. Aman 2023 season, in total 35 field demonstrations with six varieties BRRI dhan34, BRRI dhan70, BRRI dhan87, BRRI dhan93, BRRI dhan95 and BRRI dhan103 were conducted in different upazilas of Cumilla region and the yield range were 3.1-3.68, 4.25, 5.22-6.2, 4.6-6.58, 4.35-6.5, 4.6-6.68 t/ha respectively. During Boro 2023-24 season, in total 45 demonstration were conducted using BRRI dhan81, BRRI dhan88, BRRI dhan92, BRRI dhan96, BRRI dhan104 and BRRI hybrid dhan8 and yield range were 6.18-6.39, 6.68-6.8, 5.3-7.6, 7.3-7.85, 5.3-6.5, 7.3-9.1 t/ha respectively.

#### **Training, field day, seminar (Karmasuchi).**

Twenty farmers' trainings and six officers trainings were conducted in different locations of Cumilla region. A total of 600 farmers and 180 Sub Assistant Agricultural Officers/Dealers, Research/Scientific Assistant were trained up. Two field days were conducted in the block demonstration areas at Cumilla region. About 200 farmers as well as extension personnel attended the field days. Most of the farmers got interested to cultivate new rice varieties in their areas. One closing workshop was conducted with Research-Extension-Other Organization.

Investigators: M M Rashid, B Saha, T Ferdous, A Islam and M R Islam

**Seed production (Karmasuchi).** During Aus 2023 season, in total 3.17 tons TLS seed of BRRI dhan48, BRRI dhan85 and BRRI dhan98 was produced. During T. Aman 2023 season, 1.0 tons of BRRI dhan102 was produced.

Investigators: M R Islam, M M Rashid, A K M Shalahuddin, T Ferdous, B Saha and T Husna



## **BRRI RS, Habiganj**

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## SUMMARY

In the B. Aman 2023 season, one RYT focused on the deep-water ecosystem, while three RYT were conducted during T. Aman 2023. A total of 12 crosses were made for the improvement of local popular cultivars during the Boro 2023-24 season. Additionally, two OYTs, fifteen RYTs, and one IIRON (Set#38) trial were carried out during Boro 2023-24. Nine BRRI varieties were evaluated to identify suitable planting time and variety for Haor areas. BRRI dhan96 had less spikelet sterility and higher grain yield than BRRI dhan28. Medium (BRRI dhan102) to long duration varieties (BRRI dhan92) escaped cold stress at reproductive phase in early planting due to its longer growth duration. BRRI dhan89, BRRI dhan107 and BRRI dhan108 showed as moderate lodging tolerant variety. BRRI dhan92, BRRI dhan102 and BRRI dhan104 were found lodging susceptible variety but less than BRRI dhan28. However, Bangabandhu dhan100, BRRI dhan101 and BRRI dhan105 were found lodging susceptible like BRRI dhan28. PHS tolerance of 30 BRRI developed modern Boro varieties were evaluated. BRRI dhan104 was the most susceptible to pre-harvest sprouting, with 71% germinated seed in the panicle at 80% maturity stage followed by BRRI dhan96 (70%), BRRI dhan50 (68%), BRRI dhan86 (66%), BRRI dhan74 (59%) and BRRI dhan101 (44%). In B. Aman 2023 season, advanced line BR9390-6-2-1B had significantly higher grain yield than the check varieties Fulkori and Dudhlaki with 185 days growth duration. In Boro 2023-24, all the tested PQR lines had significantly lower yield than BRRI dhan107, but statistically similar yield to BRRI dhan104. The tested BB and Blast resistant entries BR (path)13800-BC3-134-8 (9.0 t/ha) and BR (path)13800-BC3-134-25 (9.3 t/ha) had significantly higher grain yield than the check varieties BRRI dhan89 and BRRI dhan92. All the three tested BB resistant entries produced statistically similar yield to BRRI dhan92 but higher than BRRI dhan89. Plant height, grain yield and growth duration of the tested FBR#LD entry BR11318-5R-84 was statistically similar to check variety BRRI dhan92. Grain yield of the tested FBR#SD entry IR18A2119 (8.1 t ha<sup>-1</sup>) was significantly higher than the check varieties BRRI

dhan88 and BRRI dhan96. Grain yield of the CTR line BR11894-R-R-R-169 (8.55 t ha<sup>-1</sup>) was significantly higher than the check varieties BRRI dhan28 and BRRI dhan67. We established 1100 varietal demonstrations in farmers field using BRRI developed latest varieties, conducted 28 farmer's training and 16 field day. We produced 21,100 kg breeder seed during Boro 2023-24, 780 kg, 5,670 kg and 14,205 kg TLS in Aus 2023, T. Aman 2023 and Boro 2023-24 season, respectively.

## VARIETAL DEVELOPMENT

### Advanced yield trial (AYT), B. Aman 2023

M A Syed, M R Islam and M M Rashid

Two AYT, one with nine promising local and another with nine advanced deep-water rice genotypes were tested to identify the promising deep-water rice genotypes with higher yield potential and wider adaptability under deep water eco-system during B. Aman 2023. Wet direct seeding was done in a unit plot size 5.0 m × 24 rows with 25 cm row spacing in RCB design with three replications. Appropriate crop management practices were done as and when necessary.

**AYT#Local genotype.** All the genotypes produced almost similar grain yield ranging from 1.61 to 2.23 t/ha with the standard check (2.05 t/ha).

**AYT#Advanced genotype.** Grain yield ranges from 1.65 to 2.59 t/ha. The two genotypes BR7737-1-2-2B (2.57 t/ha), and BR7920-1-2-3B (2.59 t/ha) produced a similar grain yield with the check Hbj. Aman-IV (2.56 t/ha) but produced a higher grain yield than the checks Hbj. Aman-I (1.87 t/ha) and BRRI dhan91 (2.04 t/ha).

### Hybridization, T. Aman 2023

Hybridization was done to develop photosensitive varieties suitable for low-lying areas in Haor ecosystem. Parents were grown in three sets at seven-day intervals to synchronize flowering times for achieving desired cross combinations. Thirty-day-old seedlings were transplanted in a 5.4 m x 4 rows plot with a spacing of 20 x 20 cm. Appropriate crop management practices were done as and when necessary.

Two crosses were made using photosensitive advanced line IR16F1097-P1 with two high-yielding varieties BRRI dhan79 and BRRI dhan87. A total of 141 F<sub>1</sub> seeds were harvested during T. Aman 2023.

#### **Regional yield trial for tall materials, T. Aman 2023**

M A Syed, M M Rashid and A S M Masuduzzaman

Five genotypes along with two check varieties BRRI dhan76 and BRRI dhan91 were tested for high-yielding tall lines in representative shallow deep-water areas (50-90 cm water supply)/ tidal non-saline under early transplanted conditions at BRRI RS, Habiganj during T. Aman 2023. Appropriate crop management practices were done as and when necessary. Data were recorded on the dates of flowering and maturity, plant height (cm), panicle/hill, and grain yield (t/ha).

Among these entries, two genotypes BR10247-14-18-7-3 (3.60 t/ha) and BR9892-8-2-2B (4.00 t/ha) produced a higher grain yield than the checks BRRI dhan91 (2.02 t/ha) and BRRI dhan76 (3.13 t/ha).

#### **Regional Yield Trial (RYT) for False smut resistant advanced lines, T. Aman 2023**

M A Syed, M M Rashid, M M Khatun, and M A Latif

Nine genotypes along with two checks (BRRI dhan49, BRRI dhan87) was evaluated for specific and general adaptability of false smut resistant advanced breeding lines along with disease parameters compared with standard checks in on-station condition at the BRRI RS, Habiganj during T. Aman 2023. Appropriate crop management practices were done as and when necessary. Data were recorded on the dates of flowering and maturity, plant height (cm), and grain yield (t/ha). None of the evaluated entries performed better than the check varieties.

#### **Improvement of local popular cultivars, Boro 2023-24**

M A Syed and M M Rashid

BRRI RS, Habiganj has conducted research for the improvement of local popular cultivars through

development of high-yielding varieties with cold tolerance, acceptable grain and nutritional quality during Boro 2023-24 season. Ten crosses were made using indigenous cultivars (Pashushail, Tepiboro and Rataboro) and high-yielding varieties/ elite lines with two cold tolerant lines BR11894-R-R-R-R-169 and IR18A2171. A total of 835 F<sub>1</sub> seeds were harvested during Boro 2023-24.

#### **Observational Yield Trial (OYT#1-BPH), Boro 2023-24**

M A Syed, M A Nayeem, M R A Sarkar and M M Rashid

An OYT was conducted during Boro 2023-24 season at BRRI RS, Habiganj to identify BPH resistance line with higher grain yield, acceptable grain and nutritional quality. Sixty-six entries along with six checks BRRI dhan28, BRRI dhan67, BRRI dhan88, BRRI dhan89, BRRI dhan92, and BRRI dhan96 were evaluated. Appropriate crop management practices were done as and when necessary. Data were recorded on the dates of flowering and maturity, plant height (cm), and grain yield (t/ha).

There is no BPH infestation in the field. Six genotypes namely BR12679-4R-155 (7.97 t/ha and 156 days), BR12676-4R-63 (8.05 t/ha and 154 days), BR11997-4R-9 (8.66 t/ha and 156 days), BR12682-4R-46 (8.95 t/ha and 156 days), BR12679-4R-173 (9.09 t/ha and 155 days), and BR12679-4R-168 (9.14 t/ha and 158 days) produced significantly higher grain yield than all the checks (5.44 t/ha - 7.12 t/ha). Two genotypes BR12676-4R-221 (7.74 t/ha and 155 days) and BR12676-4R-290 (7.78 t/ha and 157 days) had a higher grain yield than the checks BRRI dhan28 (5.44 t/ha and 149 days), BRRI dhan88 (6.43 t/ha and 153 days), BRRI dhan96 (6.85 t/ha and 152 days), and BRRI dhan67 (6.98 t/ha and 161 days). Furthermore, four genotypes namely BR12676-4R-316 (7.61 t/ha and 157 days), BR12279-4R-11 (7.62 t/ha and 153 days), BR12669-4R-161 (7.71 t/ha and 152 days), and IR107736-7-1-2-1 (7.71 t/ha and 164 days) produced a higher grain yield than the three checks BRRI dhan28 (5.44 t/ha and 149 days), BRRI dhan88 (6.43 t/ha and 153 days), BRRI dhan96 (6.85 t/ha and 152 days).



### **Advanced yield trial (AYT#Hbj), Boro 2023-24**

M A Syed, M M Rashid

An AYT was carried out during Boro 2023-24 season at BRRI RS, Habiganj to select the best performing advanced breeding lines with higher grain yield, acceptable grain and nutritional quality, as well as resistance to insect pests and diseases in field conditions. Thirty-nine genotypes along with the five checks BRRI dhan67, BRRI dhan88, BRRI dhan89, BRRI dhan92, and BRRI dhan108 were evaluated at BRRI RS, Habiganj during Boro 2023-24. Appropriate crop management practices were done as and when necessary. Data were recorded on the date of flowering and maturity, plant height (cm), and grain yield (t/ha).

Seven genotypes NGR 336-2 (6.77 t/ha and 145 days), NGR 957-1 (7.02 t/ha and 152 days), NGR 1240-1 (7.03 t/ha and 151 days), NGR 329-2 (7.26 t/ha and 147 days), NGR 853-2 (7.30 t/ha and 145 days), NGR 1019-1 (7.47 t/ha and 146 days), and NGR 240-1 (7.50 t/ha and 151 days) produced significantly higher grain yield than all the checks (5.79 t/ha – 6.22 t/ha). Furthermore, the genotype NGR 269-2 (6.69 t/ha and 150 days) produced a higher grain yield than all the checks except BRRI dhan92 (6.22 t/ha and 154 days). Two genotypes NGR 933-1 (6.41 t/ha and 151 days) and SV0206 (6.51 t/ha and 148 days) produced a higher grain yield than the checks BRRI dhan67 (5.79 t/ha and 144 days) and BRRI dhan88 (5.82 t/ha and 142 days) but produced a similar grain yield with the other checks (6.06 t/ha to 6.22 t/ha).

### **Regional yield trial (RYT) for favourable Boro rice (FBR), Boro 2023-24**

M A Syed, S Sultana, M A I Khan, M M Rashid and P S Biswas

Six RYT# FBR were conducted to understand general and regional adaptability and select the best-performing breeding lines with the highest genetic merits. Appropriate crop management practices were done as and when necessary. Data were recorded on the dates of flowering and maturity, plant height (cm), and grain yield (t/ha).

**RYT#FBR-SD.** Eight entries along with two checks BRRI dhan88 and BRRI dhan96 were evaluated. Two genotypes, namely BR12574-5R-168 (6.38 t/ha and 152 days) and BR12676-4R-392 (6.39 t/ha and 153 days), produced a higher grain

yield but took 10 days longer growth duration than the check BRRI dhan96 (6.05 t/ha and 143 days) though produced similar grain yield with the check BRRI dhan88 (6.11 t/ha and 149 days). The genotype BR12682-4R-50 (6.20 t/ha and 153 days) produced a similar grain yield with the checks BRRI dhan96 (6.05 t/ha and 143 days) and BRRI dhan88 (6.11 t/ha and 149 days).

**RYT#FBR-MD.** Nine entries along with three checks BRRI dhan58, BRRI dhan89, and BRRI dhan102 were evaluated. Three genotypes, namely BR12517-5R-57 (7.40 t/ha and 153 days), BR12514-5R-27 (7.51 t/ha and 152 days), and BR12508-5R-5 (7.91 t/ha and 152 days), produced significantly higher grain yield than all the checks (6.42 t/ha - 6.83 t/ha). Two genotypes BR12520-5R-11 (7.15 t/ha and 155 days) and BR11894-5R-260 (7.22 t/ha and 153 days) produced a higher grain yield than the checks BRRI dhan102 (6.42 t/ha and 160 days) and BRRI dhan58 (6.70 t/ha and 155 days) but produced a similar grain yield with the check BRRI dhan89 (6.83 t/ha and 159 days). The genotype BR12514-5R-97 (6.94 t/ha and 153 days) produced a higher grain yield than the check BRRI dhan102 (6.42 t/ha and 160 days) but produced a similar grain yield with the checks BRRI dhan58 (6.70 t/ha and 155 days) and BRRI dhan89 (6.83 t/ha and 159 days).

**RYT#FBR-SMD.** Ten entries along with the four checks BRRI dhan58, BRRI dhan88, BRRI dhan89, and BRRI dhan102 were evaluated. Two genotypes, namely IR18A2427 (7.33 t/ha and 148 days) and IR17A2922 (7.01 t/ha and 150 days) produced significantly higher grain yield than all the checks (6.19 t/ha – 6.52 t/ha). Two genotypes BR11894-R-R-R-R-105 (6.83 t/ha and 155 days) and BR13027-BC1-3R-77 (6.88 t/ha and 151 days) produced a higher grain yield but took 5-9 days longer than the check BRRI dhan88 (6.40 t/ha and 146 days).

**RYT#FBR-ELS:** Four entries along with the two checks BRRI dhan63 and BRRI dhan104 were evaluated. Two genotypes, namely BR9945-5R-21 (6.73 t/ha and 156 days) and BR7528-2R-19-16-RIL-59 (6.82 t/ha and 158 days) produced significantly higher grain yield than the checks BRRI dhan63 (6.25 t/ha and 156 days) and BRRI

dhan89 (6.41 t/ha and 161days). The genotype BR7528-2R-19-16-RIL-55 (6.58 t/ha and 159 days) produced the higher grain yield but took three days longer duration than the check BRRI dhan63 (6.25 t/ha and 156 days).

**RYT#FBR-Barishal.** Ten entries along with the two checks BRRI dhan74 and BRRI dhan102 were evaluated. None of the evaluated entries performed better than the check BRRI dhan102. Three genotypes NGR745-2 (7.25 t/ha and 160 days), NGR994-1 (7.26 t/ha and 163 days), and NGR350-2 (7.29 t/ha and 156 days) produced higher grain yield than the check BRRI dhan74 (6.76 t/ha and 155 days) but similar grain yield with the check BRRI dhan102 (7.12 t/ha and 163 days). The genotype NGR745-3 (7.03 t/ha and 162 days) produced a similar grain yield but took seven days longer duration than the check BRRI dhan74 (6.76 t/ha and 155 days).

**RYT#FBR-Biotech.** Six entries along with the two checks BRRI dhan86 and BRRI dhan96 were evaluated. None of the evaluated entries performed better than the check BRRI dhan96 regarding yield and growth duration.

### **Regional yield trial (RYT-Tall) for haor areas, Boro 2023-24**

M A Syed, M M Rashid, and A S M Masuduzzaman

An experiment on RYT-Tall for haor areas was conducted at BRRI RS, Habiganj during Boro 2023-24 for evaluation of high-yielding, tall and lodging tolerant lines in representative low-lying haor areas as better substitutes for BR18. A total of five entries along with check BRRI dhan102 were assessed. Appropriate crop management practices were done as and when necessary. Data were recorded on the date of flowering and maturity, plant height (cm), panicle/hill, and grain yield (t/ha).

None of the evaluated entries performed better than the check BRRI dhan102. Notably, the genotype BR9396-6-2-2B (6.41 t/ha and 139 days) produced a similar grain yield but with 16 days earlier growth duration than the check BRRI dhan102 (6.27 t/ha and 155 days).

### **Regional yield trial (RYT) for disease-resistant rice (DRR), Boro 2023-24**

M A Syed, M Khatun, M M Rashid, T H Ansari, and M A Latif

Six RYT for DRR were conducted at BRRI RS Habiganj during Boro 2023-24 to evaluate the specific and general adaptability of the advanced breeding lines compared to standard checks under on-station conditions. Appropriate crop management practices were done as and when necessary. Data were recorded on the date of flowering and maturity, plant height (cm), panicle/hill, and grain yield (t/ha).

**RYT#DRR-1.** Fourteen entries along with the three checks BRRI dhan88, BRRI dhan89, and BRRI dhan101 were evaluated. None of the evaluated entries performed better than the check BRRI dhan89 regarding yield and growth duration. The genotype BR13790-5R-216 (7.13 t/ha and 156 days) produced a higher grain yield but took eight days longer than the checks BRRI dhan101 (6.24 t/ha and 148 days) and BRRI dhan88 (6.40 t/ha and 148 days). Two genotypes BR12437-4R-164 (6.76 t/ha and 148 days) and BR12125-6R-79 (6.76 t/ha and 148 days) produced higher grain yield than the resistant check BRRI dhan101 (6.24 t/ha and 148 days).

**RYT#DRR-2.** Six entries along with the two checks BRRI dhan88 and BRRI dhan28 were evaluated. The genotype BR (Path)13802-BC3-10-11-12 (6.77 t/ha and 145 days) produced significantly higher grain yield than the checks BRRI dhan28 (6.02 t/ha and 143 days) and BRRI dhan88 (6.16 t/ha and 144 days).

**RYT# Blast-SD:** Four entries along with two checks BRRI dhan28 and BRRI dhan88 were evaluated. The genotype BR (Path)15641-3HR-45 (6.66 t/ha and 144 days) produced the highest grain yield and 2-3 days earlier growth duration than the checks BRRI dhan28 (6.20 t/ha and 146 days) and BRRI dhan88 (6.25 t/ha and 147 days). The genotype BR (Path)15641-3HR-15 (6.52 t/ha and 147 days) produced a higher grain yield than the check BRRI dhan28 (6.20 t/ha and 146 days) but produced a similar grain yield and growth duration with the check BRRI dhan88 (6.25 t/ha and 147 days).

**RYT# Blast-PQR-SD.** Entries along with two checks BRRI dhan50 and BRRI dhan63 were evaluated. Two genotypes BR(Path)15857-BC3-4HR-2 (6.00 t/ha and 150 days) and BR (Path)15857-4HR-19 (6.28 t/ha and 147 days) produced significantly higher grain yield than the checks BRRI dhan50 (5.47 t/ha and 150 days) and BRRI dhan63 (5.67 t/ha and 147 days).

**RYT# Blast-MD.** Four entries along with two checks BRRI dhan58 and BRRI dhan89 were evaluated. None of the evaluated entries performed better than the check BRRI dhan89. The genotype Rod Miniket-1 (6.83 t/ha and 151 days) produced a similar grain yield with the checks BRRI dhan58 (6.31 t/ha and 154 days) and BRRI dhan89 (6.82 t/ha and 157 days). Notably, two genotypes BR (Path)15854-BC1-3HR-21 (6.46 t/ha and 147 days) and BR (Path)15641-4HR-31 (6.72 t/ha and 146 days) produced a similar grain yield with the check BRRI dhan58 (6.31 t/ha and 154 days).

**RYT# Blast-LD.** Five entries along with the check BRRI dhan29 was evaluated. The genotype BR(Path)15855-BC2-3HR-23 (7.36 t/ha and 166 days) produced the highest grain yield but took three days longer growth duration than the check BRRI dhan29 (6.49 t/ha and 163 days). Whereas the genotype BR(Path)15855-BC2-3HR-8 (6.97 t/ha and 155 days) produced the second highest grain yield with eight days earlier growth duration than the check BRRI dhan29 (6.49 t/ha and 163 days).

## CROP SOIL WATER MANAGEMENT

### Effect of planting time on Boro rice varieties at haor region of Bangladesh

M M Rashid, M Khatun, M S Alam, A Nayem, M A Syed

Nine BRRI varieties (BRRI dhan88, BRRI dhan89, BRRI dhan92, BRRI dhan96, Bangabandhu dhan100, BRRI dhan101, BRRI dhan102, BRRI dhan104 and BRRI dhan105) were evaluated in natural field condition at BRRI RS farm, Habiganj to identify the suitable planting time and variety for Haor areas. There were five sets of seeding starting from 25 October at 10 days interval. Growth duration increased significantly in all varieties at

early planting than the late planting one. Plant height of all rice varieties was reduced significantly in earlier two sets than the other sets of planting. Irrespective of rice varieties, 4<sup>th</sup> set (25 November sowing) had longest plant height. Irrespective of rice varieties poor panicle exertion and spikelet degeneration were recorded in first set of planting. BRRI dhan88 had spikelet degeneration up to 3<sup>rd</sup> set (sowing on 15 November), while it was up to 2<sup>nd</sup> set (5 November) for BRRI dhan96, BRRI dhan101, BRRI dhan104, and BRRI dhan105. Irrespective of planting time long duration varieties (BRRI dhan102, BRRI dhan92 and BRRI dhan89) had higher grain yield than the short duration varieties. Among the short duration varieties BRRI dhan88 had significantly higher spikelet sterility than BRRI dhan96 in first three sets of planting which indicating its reproductive stage cold susceptibility. In respect to grain yield and sterility BRRI dhan101 was more or less similar to BRRI dhan96 but BRRI dhan104 was comparable to BRRI dhan88. BRRI dhan105 and Bangabandhu dhan100 had less spikelet sterility and higher grain yield than BRRI dhan88.

### Evaluation of BRRI developed Boro rice varieties for cold tolerance

M M Rashid, M Khatun, M S Alam, A Nayem, M A Syed

An experiment was conducted at BRRI RS farm, Habiganj to observe reproductive phase cold tolerance at natural cold condition. Eight BRRI developed Boro rice varieties (BRRI dhan89, BRRI dhan92, BRRI dhan96, Bangabandhu dhan100, BRRI dhan101, BRRI dhan102, BRRI dhan104 and BRRI dhan105) along with check varieties BRRI dhan67 (moderately tolerant) and BRRI dhan88 (susceptible). Sprouted seeds of the genotypes were shown in the puddle seedbed on 15 October (cold stress) and 15 November 2023 as non-stress control. Forty-day-old seedlings were transplanted. Data on visual cold tolerance score at reproductive phase of rice, plant height, days to first heading, 50% flowering, degeneration of spikelets, panicle emergence, last internode length, last flag leaf sheath length, spikelet fertility, growth duration, grain yield and yield components were recorded.

In early planting, all rice genotypes experienced cold stress at reproductive phase. Cold stress caused longer growth duration, shorter last internode length as well as plant height, poor panicle exertion and higher percentage of sterility over control treatment in all rice genotypes. Considering sensitivity level (gap between stress versus non-stress) of different growth and development parameter of different rice varieties under cold stress condition none of the rice varieties were better or similar to BRRI dhan67 a moderately cold tolerant variety at reproductive phase except BRRI dhan102, which was comparable to BRRI dhan67. However, long duration BRRI dhan92 and BRRI dhan89 escape cold stress at reproductive phase due to their longer growth duration.

### **Evaluation of rice genotypes for lodging tolerance**

M M Rashid, M Khatun, M S Alam, A Nayem, M A Syed

An experiment was conducted at BRRI RS farm, Habiganj to observe the lodging tolerance of rice genotypes. Eight BRRI developed Boro rice varieties (BRRI dhan89, BRRI dhan92, BRRI dhan96, Bangabandhu dhan100, BRRI dhan101, BRRI dhan102, BRRI dhan104, BRRI dhan105, BRRI dhan107 and BRRI dhan108) along with BRRI dhan29 (tolerant) and BRRI dhan28 (susceptible) as check varieties. Data on visible internode length (basal to 5<sup>th</sup> internode), culm length (L), total fresh weight of plant above ground, bending moment (M), wrapping score and visual lodging rate were recorded. None of rice varieties found lodging tolerant like BRRI dhan29. On the other hand, BRRI dhan89, BRRI dhan107 and BRRI dhan108 showed moderately lodging tolerance. BRRI dhan92, BRRI dhan102 and BRRI dhan104 were found lodging susceptible variety but less than BRRI dhan28. However, Bangabandhu dhan100, BRRI dhan101 and BRRI dhan105 were found lodging susceptible like BRRI dhan28.

### **Screening for preharvest sprouting of Boro rice**

M M Rashid, M Khatun, M S Alam, A Nayem, M A Syed

Seeds become spout in the field if mature panicles of susceptible rice variety get contact with water. An experiment was conducted to evaluate pre-harvest sprouting (PHS) tolerance of 30 BRRI developed modern Boro varieties in the field condition during Boro 2023-24 at BRRI farm Habiganj. The plants were tagged at the time of 50% flowering (anthesis). Thirty days after anthesis (DAA), panicles were immersed in a plastic pot filled with water (IL) by bending without causing much damage to the plant. Germination of the seeds of those panicles were counted seven days after immersed into water. On the basis of germination percentage, BRRI dhan104 was the most susceptible to pre-harvest sprouting, with 71% germinated seed in the panicle at 80% maturity stage. BRRI dhan96 (70%), BRRI dhan50 (68%), BRRI dhan86 (66%), BRRI dhan74 (59%), BRRI dhan101 (44%) BRRI dhan67 (38%), BRRI dhan84 (34%), BRRI dhan60 (30%), BRRI dhan88 (28%), BRRI dhan102 (25%), BRRI dhan63 (24%) BRRI dhan59 (22%) and were also identified as susceptible to PHP. BRRI dha35, BRRI dha55, BRRI dhan92 and BRRI dhan97 showed tolerant to PHP.

## **TECHNOLOGY TRANSFER**

### **Advanced line adaptive research trial (ALART)**

#### **ALART deep water rice (DWR), B. Aman 2023**

M Khatun, M S Alam, A Nayem, M A Syed, M M Rashid

Two DWR lines, namely BR10230-7-19-2B and BR9390-6-2-1B along with two standard check varieties, Fulkori (ck) and Dudhlaki (ck), were evaluated in this experiment at the farmer's field of Baniachong upazila in Habiganj during B. Aman 2023.

Growth duration of the tested genotype BR9390-6-2-1B was statistically similar to check varieties, while BR10230-7-19-2B had the shortest growth duration (170 days). Breeding line BR9390-6-2-1B had significantly higher grain yield (3.72 t/ha) than both the check varieties with 185 days growth duration. Other tested entries BR10230-7-19-2B had significantly higher grain yield (1.06 t/ha) than the check variety Fulkori (0.72 t/ha) but lower than Dudhlaki (1.47 t/ha).

**ALART premium quality rice (PQR), Boro 2023-24**

M Khatun, M S Alam, A Nayem, M A Syed, M M Rashid

Three PQR lines, namely BR10645-6-4-8-1-2, BR10646-3-2-2-4-3 and BR10648-12-1-3-4-1 along with five standard check varieties, Zira (Nachol), Katari (Shibganj), BRRI dhan104, BRRI dhan107 and BINA dhan25 were evaluated in this experiment at the farmer's field of Baniachong upazila in Habiganj during Boro 2023-24.

The tested entry BR10646-3-2-2-4-3 had significantly higher plant height (113.8 cm) than all other rice genotypes except the check variety BINA dhan25 (132.2 cm). Plant height of other genotypes ranged from 97.8 to 103.8 cm. Growth duration did not differ among different rice genotypes. Grain yield and growth duration of tested entries ranged from 5.8 to 6.4 t/ha and 159 to 163 days respectively. All the tested entries had significantly lower yield than BRRI dhan107 (7.6 t/ha), but statistically similar yield to BRRI dhan104 (6.3 t/ha) and Katari (Shibganj) (5.8 t/ha). Zira, Nachol had the lowest yield 3.9 t/ha followed by BINA dhan25 (4.53 t/ha).

**ALART bacterial blight (BB) and blast, Boro 2023-24**

M Khatun, M S Alam, A Nayem, M A Syed, M M Rashid

Three BB and blast resistant rice lines, namely BR (path)13800-BC3-134-8, BR (path)13800-BC3-134-25 and BR (path)13800-BC3-224-44 along with two standard check varieties, BRRI dhan89 and BRRI dhan92 were evaluated in this experiment at the farmer's field of Baniachong upazila in Habiganj during Boro 2023-24.

Plant height of the tested entries BR(path)13800-BC3-134-8 and BR (path)13800-BC3-134-25 was significantly shortest than check varieties (Table 1). Growth duration of the tested entries were statistically similar to check varieties. The tested entries BR (path) 13800-BC3-134-8 (9.0 t/ha) and BR (path)13800-BC3-134-25 (9.3 t/ha) had significantly higher grain yield than both the check varieties. Another entries BR (path) 13800-BC3-224-44 produced statistically similar yield to BRRI dhan92. BRRI dhan 89 had the lowest grain yield due to blast infestation.

**Table 1: Plant height, growth duration and grain yield of ALART BB and Blast, Boro 2023-24.**

| Genotype                     | PH (cm) | GD  | GY (tha <sup>-1</sup> ) |
|------------------------------|---------|-----|-------------------------|
| V1= BR(path)13800-BC3-134-8  | 103.4   | 161 | 9.0                     |
| V2= BR(path)13800-BC3-134-25 | 104.8   | 162 | 9.3                     |
| V3= BR(path)13800-BC3-224-44 | 115.3   | 161 | 7.5                     |
| V4= BRRI dhan89 (ck)         | 117.3   | 163 | 6.8                     |
| V5= BRRI dhan92 (ck)         | 118.1   | 163 | 7.9                     |
| CV                           | 1.6     | 3.2 | 4.6                     |
| LSD                          | 3.3     | 9.8 | 0.7                     |

**ALART bacterial blight (BB), Boro 2023-24**

M Khatun, M S Alam, A Nayem, M A Syed, M M Rashid

Three BB resistant rice lines, namely BR (path)13800-BC3-8-1, BR (path)13800-BC3-8-9 and BR (path)13800-BC3-224-28 along with two standard check varieties, BRRI dhan89 and BRRI dhan92, were evaluated in this experiment at the farmer's field of Baniachong upazila in Habiganj during Boro 2023-24.

The tested entry BR (path) 13800-BC3-8-1 and BR (path) 13800-BC3-8-9 had significantly shorter plant height than both the check varieties (Table 2). All the three tested entries produced statistically similar yield (8.0 to 8.6 t ha<sup>-1</sup>) to BRRI dhan92 (7.8 t ha<sup>-1</sup>) but higher than BRRI dhan89 (6.7 t ha<sup>-1</sup>). Growth duration did not differ among different genotypes except BR (path) 13800-BC3-224-28 which had the heigher growth duration.

**Table 2. Plant height, growth duration and grain yield of ALART BB, Boro 2023-24.**

| Genotype                                  | PH (cm) | GD   | GY (tha <sup>-1</sup> ) |
|-------------------------------------------|---------|------|-------------------------|
| V <sub>1</sub> =BR (path)13800-BC3-8-1    | 106.2   | 162  | 8.0                     |
| V <sub>2</sub> =BR (path)13800-BC3-8-9    | 107.8   | 160  | 8.6                     |
| V <sub>3</sub> =BR (path)13800-BC3-224-28 | 108.9   | 164  | 8.0                     |
| V <sub>4</sub> =BRRI dhan89 (ck)          | 113.5   | 159  | 6.7                     |
| V <sub>5</sub> =BRRI dhan92 (ck)          | 115.6   | 159  | 7.8                     |
| CV                                        | 1.76    | 3.53 | 6.91                    |
| LSD                                       | 3.66    | 3.07 | 1.02                    |

### **ALART favorable Boro rice long duration (FBR#LD), Boro 2023-24**

M Khatun, M S Alam, A Nayem, M A Syed, M M Rashid

One FBR#LD line, namely BR11318-5R-84 along with one standard check variety BRRI dhan92 were evaluated in this experiment at the farmer's field of Baniachong upazila in Habiganj during Boro 2023-24.

Plant height, grain yield and growth duration of the tested entry BR11318-5R-84 (116.2 cm, 163 days and 8.0 t/ha) was statistically similar to the check variety BRRI dhan92 (111.7 cm, 162 days and 7.6 t/ha).

### **ALART favourable Boro rice short duration (FBR#SD), Boro 2023-24**

M Khatun, M S Alam, A Nayem, M A Syed, M M Rashid

Two FBR#SD lines, namely BR11903-5R-56, and IR18A2119 along with two standard check varieties, BRRI dhan88 and BRRI dhan96 were evaluated in this experiment at the farmer's field of Baniachong upazila in Habiganj during Boro 2023-24.

Plant height of IR18A2119 (98.9 cm) was statistically similar to the check varieties (95.3 to 98.3 cm). However, BR11903-5R-56 had the longest plant height (115.6 cm). Growth duration of IR18A2119 (147 days) was statistically similar to the check variety BRRI dhan88 (146 days). It was comparable between BR11903-5R-56 (144 days) and BRRI dhan96 (143 days). Grain yield of the tested entry IR18A2119 (8.1 t ha<sup>-1</sup>) was significantly higher than both the check varieties (6.3 to 6.7 t/ha). BR11903-5R-56 (6.6 t ha<sup>-1</sup>) had statistically similar yield to check varieties.

### **ALART cold tolerant rice (CTR), Boro 2023-24**

M Khatun, M S Alam, A Nayem, M A Syed, M M Rashid

Two CTR lines, namely TP16199 and BR11894-R-R-R-169 along with two standard check varieties, BRRI dhan28 and BRRI dhan76 were evaluated at the farmer's field of five locations in Habiganj (Ajmeriganj, Baniachong and Nabiganj) and Sunamganj (Shantiganj and Taherpur) district during Boro 2023-24.

Plant height of BR11894-R-R-R-169 (117.5 cm) was statistically similar to the check variety BRRI dhan67 (116.9 cm) but longer than BRRI dhan28 (102.1 cm). On the other hand, TP16199 had the longest plant height (122.8 cm). Growth duration of both the tested lines was statistically similar to the check variety BRRI dhan67. Grain yield of the advanced line BR11894-R-R-R-169 (8.55 t ha<sup>-1</sup>) was significantly higher than both the check varieties (6.6 to 7.6 t/ha). TP16199 (7.24 t ha<sup>-1</sup>) had statistically similar yield to the check varieties.

### **DEMONSTRATION**

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In Aus 2023, 100 demonstrations of BRRI dhan48, BRRI dhan98 and BRRI Hybrid dhan7 were conducted in Sylhet region. Average yield of BRRI dhan48, BRRI dhan98 and BRRI hybrid dhan7 were 4.1 t/ha, 4.3 t/ha and 4.9 t/ha, respectively. Farmers were motivated to cultivate all the three varieties. In T. Aman 2023, 100 demonstrations of BRRI dhan75, BRRI dhan79, BRRI dhan87, BRRI dhan90, BRRI dhan93, BRRI dhan94, BRRI dhan95, BRRI dhan103, BRRI hybrid dhan4 and BRRI hybrid dhan6 were conducted at Sylhet region. Average yield of BRRI dhan75, BRRI dhan79, BRRI dhan87, BRRI dhan90, BRRI dhan93, BRRI dhan94, BRRI dhan95, BRRI

ghan103, BRRI hybrid dhan4 and BRRI hybrid dhan6 were 4.0 t/ha, 4.9 t/ha, 5.0 t/ha, 4.2 t/ha, 5.3 t/ha, 5.3 t/ha, 5.4 t/ha, 5.7 t/ha, 5.7 t/ha and 5.8 t/ha, respectively. Most of the farmers were motivated to cultivate BRRI dhan79, BRRI dhan95, BRRI dhan103, BRRI hybrid dhan4 and BRRI Hybrid dhan6. BRRI dhan87, BRRI dhan93 and BRRI dhan94 were lodged in some areas. In Boro 2023-24, 900 demonstrations of BRRI dhan88, BRRI dhan89, BRRI dhan92, BRRI dhan96, Bangabandhu dhan100, BRRI dhan101, BRRI dhan102, BRRI dhan104, BRRI dhan105, BRRI hybrid dhan5 and BRRI hybrid dhan8. Average yield of BRRI dhan88, BRRI dhan89, BRRI dhan92, BRRI dhan96, Bangabandhu dhan100, BRRI dhan101, BRRI dhan102, BRRI dhan104, BRRI dhan105, BRRI hybrid dhan5 and BRRI hybrid dhan8 were 5.9 t/ha, 6.8 t/ha, 7.2 t/ha, 6.0 t/ha, 6.1 t/ha, 6.2 t/ha, 7.4 t/ha, 5.8 t/ha, 6.7 t/ha, 7.5 t/ha and 8.0 t/ha, respectively. Most of the farmers have chosen BRRI Hybrid dhan8, BRRI dhan92, BRRI dhan102, and BRRI dhan105 for Boro season due to their higher yield and less blast disease. Some farmers preferred BRRI dhan96 and BRRI dhan88 for their short duration in haor areas.

## FARMERS TRAINING

BRRI RS, Habiganj conducted 28 farmer's training at different locations of Sylhet region during the reporting period. These training programmes were conducted at Habiganj Sadar, Bahuball, Baniachong, Madhobpur, Sylhet Sadar, Daxinsurma, Biswanath, Moulovibazar Sadar, Kamalganj, Sreemangal Rajnagar, Shantiganj. In total 840 persons were trained. Awareness for adopting improved rice cultivation technologies and enhancing the dissemination of BRRI varieties was done through those trainings.

## FARMERS' FIELD DAY

BRRI RS, Habiganj conducted 16 field day programmes in different locations of Sylhet region during the reporting period. More than 1,500 farmers, extension personnel, administrative people, public leaders participated in these field

days. Most of the farmers have preferred BRRI dhan98 over BRRI dhan48 due to its higher yield and slender grain in Aus season. In Aman season, farmers chosen BRRI dhan103 for its higher grain yield and BRRI dhan95 for its non-lodging and higher yield. BRRI dhan92, BRRI dhan96, BRRI dhan102 and BRRI dhan105 have been chosen for Boro season due to their higher yield and less blast disease infestation. Farmers showed their interest to cultivate the demonstrated varieties in the next season.

## SEED PRODUCTION

### Breeder seed production

In Boro 2023-24 season, a total of 21,100 kg (BRRI dhan28 = 4,050 kg, BRRI dhan29 = 5,500 kg, BRRI dhan89 = 4,400 kg, BRRI dhan92 = 1,650 kg, Bangabandhu dhan100 = 2,500 kg, BRRI dhan101 = 500 kg and BRRI dhan102 = 2,500 kg) breeder seed were produced

### TLS seed production

In Aus 2023 season, a total of 780 kg (BRRI dhan48 = 130 kg, BRRI dhan98 = 650 kg), while in T. Aman 2023, a total 5,670 kg (BR22 = 150 kg, BRRI dhan49 = 400 kg, BRRI dhan75 = 220 kg, BRRI dhan79 = 700 kg, BRRI dhan87 = 650 kg, BRRI dhan90 = 600kg, BRRI dhan93 = 450kg, BRRI dhan94 = 700 kg, BRRI dhan95 = 600 kg and BRRI dhan103 = 1200 kg) TLS seed were produced. On the other hand, in Boro 2023-24 season, a total of 15,730 kg (BRRI dhan28 = 114 kg, BRRI dhan29 = 450 kg, BRRI dhan88 = 2,117kg, BRRI dhan89 = 5,968kg, BRRI dhan92 = 1,428kg, BRRI dhan96 = 1,239 kg, Bangabandhu dhan100 = 2,889 kg) TLS seeds were produced.

### Certified seed production

In Boro 2023-24 season, a total of 14,350 kg (BRRI dhan104 = 11480 kg, BRRI dhan107 = 2240 kg and BRRI dhan108 = 630 kg) TLS seed were produced. BRRI released varieties would be disseminated quickly to farmers by using these seeds

# **BRRI RS, Rajshahi**

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## SUMMARY

In late Boro 2023, a total of 46 genotypes were tested with four standard checks. In AYT#1 (HTR), 12 entries produced higher yield compared with the standard checks. In Aus 2023, total 225 genotypes were evaluated in one OYT and 16 genotypes showed significantly higher yield than the standard checks. Three AYT were conducted with 96 genotypes and four checks in T. Aus season. Among them, only nine genotypes showed higher yield than the standard checks. Two regional yield trial (RYT) were conducted with 20 advanced breeding lines and three standard checks. Among the tested entries, BR12087-5R-31, BR12091-4R-9 and BR12091-4R-169 showed significantly higher yield (5.78-6.03 t/ha) than the checks BRRI dhan48 (5.53 t/ha) and BRRI dhan98 (5.61 t/ha) with 107-116 days growth duration in RYT#1 and only two genotypes BR(Path) 13784-BC3-63-6-4-HR6 and BR(Path) 13784-BC3-34-9-10-HR9 produced similar yield and growth duration to the check BRRI dhan48 (5.41 t/ha, 99 days) in RYT#2.

In hybridization programme in T. Aman season, 483 F<sub>1</sub> seeds were produced from five crosses. Six crosses were selected in T. Aman and confirmed as true F<sub>1</sub>s and 39,520 individual progenies were harvested from rapid generation advanced of segregating populations. During Aman 2023, three OYTs with 394 advanced breeding lines were evaluated with seven standard checks where 29 lines produced significantly higher yield compared to the checks. Three AYT were tested with 79 genotypes along with five different checks where 22 lines showed significantly higher yield compared than the checks. A total of 65 breeding lines were evaluated in 12 different RYT at BRRI farm Rajshahi against 13 different standard checks and eight entries (BRH11-7-17-10B, BR17-23-8-2-7B, BRH9-3-14-2B, BRH13-9-5-2B, BR11986-4R-123, BR11869-5R-47, BR(Path)13804-BC3-13 and BR(Path) 13804-BC3-20) were found promising for further advancement.

## VARIETAL DEVELOPMENT

### **Advanced yield trial (AYT), late Boro 2023-24**

AYT#1 (HTR) consists of 32 and AYT#2 (HDNTR) consists of 16 genotypes were evaluated at the experimental field of BRRI RS, Rajshahi where 12

entries produced higher yield (5.27-7.44 t/ha; 97- 122 days) over the checks BRRI dhan28, BRRI dhan98, Bina dhan14 and N22 (4.55-5.77 t/ha; 89-113 days) in AYT#1 (HTR). In AYT#2 (HDNTR), none of the entries gave higher yield against checks.

### **Observational yield trial (OYT), T. Aus 2023-24**

One OYT with 225 advanced genotypes were evaluated. Among them, 16 entries produced significantly higher grain yield (5.85-7.43 t/ha; 95-115 days) compared with four checks BRRI dhan48, BRRI dhan82, BRRI dhan83 and BRRI dhan98 (4.52-5.49 t/ha; 95-104 days). The entry no-BR13165-4R-123 produced the highest yield of 7.43 t/ha.

### **Advanced yield trial (AYT), T. Aus 2023-24**

Three AYT with 96 advanced breeding lines with different checks were evaluated at BRRI RS Rajshahi farm. In AYT#1. Among 36, four entries produce higher yield (6.28-6.52 t/ha; 95-118 days) compared with four checks BRRI dhan48, BRRI dhan82, BRRI dhan98 and N22 (4.72-5.59 t/ha; 92-107days). Entry BR11845-4R-178-1 (6.52 t/ha; 98 days) produced significantly the highest grain among all the entries and checks. In AYT#2, among the 16 entries, three entries produced significantly higher yield (6.10-6.22 t/ha) with GD 108-115 days compared with the checks BRRI dhan48, BRRI dhan98 and N22 (3.69-6.22 t/ha; 108-118 days). IRRI154 entry gave 6.22 t/ha grain against the check BRRI dhan98 (5.72 t/ha). In AYT#3, among the 44, two entries (6.50-6.24 t/ha; 106-107 days) produced higher yield compared with the checks BRRI dhan48 and BRRI dhan98 (5.13-5.73 t/ha; 107-109 days). Entry BR 12590-4 R-131 produced higher yield of 6.50 t/ha against BRRI dhan98 (5.73 t/ha) with similar growth duration.

### **Regional yield trial (RYT), T. Aus 2023-24**

In total 20 advanced breeding lines were evaluated in two RYTs. Out of 12 genotype, BR12087-5R-31, BR12091-4R-9 and BR12091-4R-169 showed significantly higher yield (5.78-6.03 t/ha) than the checks BRRI dhan48 (5.53 t/ha) and BRRI dhan98 (5.61 t/ha) with 107-116 days growth duration in

RYT#1. None of the entry produced higher yield over the checks BRRI dhan82 BRRI dhan98 in RYT#2.

#### **Hybridization, T. Aman 2023-24**

A total of 483 F<sub>1</sub> seeds were produced from five crosses using five parents in T. Aman 2023.

#### **F<sub>1</sub> Confirmation, T. Aman 2023-24**

Out of nine, six crosses were selected and confirmed as true F<sub>1</sub>s comparing with their parents respectively. Seeds of these selected F<sub>1</sub> plants were selfed to produce F<sub>2</sub> seeds.

#### **Rapid generation advance of segregating nurseries, T. Aman 2023-24**

In total 39,520 individual progenies from 42 crosses were harvested from F<sub>2</sub>-F<sub>6</sub> generations through FRGA method.

#### **Observation yield trial (OYT), T. Aman 2023-24**

OYT#1 (DRR-BB), OYT#2 (DTR, GD: 100-130 days) and OYT#3 (DTR, GD: 131-150 days) were evaluated along with standard checks. In OYT#1 (DRR-BB), 98 lines were grown along with standard checks where Six entries produced significantly higher yield (6.55-7.67 t/ha; 108-121 days) compared with four checks BRRI dhan49, BRRI dhan75 and BRRI dhan87 and IRBB60 (4.17-6.04 t/ha; 108-129 days). Among them, entry BR12898-4R-261-1 produced higher yield 7.67 t/ha with 13 days shorter GD (112 days) compared to the highest grain producing check BRRI dhan87 (6.04 t/ha; 125 days). In OYT#2 (DTR, GD: 100-130 days), 136 lines were evaluated with the checks and here 17 entries produced significantly higher yield (6.12-7.26 t/ha; 91-121 days) compared with two checks BRRI dhan71 and BRRI dhan87 (5.17-5.71 t/ha; 111-121 days). BR13058-4R-56 produced highest yield 7.26 t/ha with GD 91 days which was almost one month shorter compared with BRRI dhan87 (5.71 t/ha; 121 days). Due to continuous rainfall from booting to flowering stage so that BRRI dhan87 yielded low. In OYT#3 (DTR, GD: 131-150 days) among 160 lines along with checks, six entries produced significantly higher yield (5.98-6.43 t/ha; 100-107 days) compared with three checks BRRI dhan56, BRRI dhan71 and BRRI

dhan93 (5.19-5.51 t/ha; 112-129 days). BR13058-4R-146 produced higher yield 6.43 t/ha with 29 days shorter GD (100 days) compared with BRRI dhan93 (5.51 t/ha; 129 days).

#### **Advanced yield trial (AYT), T. Aman 2023-24**

Eighty-three genotypes were evaluated in three AYT's with standard checks. In AYT#1 (DRR-BB), 12 lines were tested, among them one line gave statistically significant yield (7.14 t/ha; 105 day) against four checks BRRI dhan49, BRRI dhan75, BRRI dhan87 and IRBB60 (4.82-6.15 t/ha; 108-129 days). In AYT#2 (DTR), 46 lines along with checks were tested and 11 lines gave significantly higher grain (5.72-6.31 t/ha; 107-115 days) compared with three checks BRRI dhan56, BRRI dhan71 and BRRI dhan75 (4.31-5.06 t/ha; 108-118days). Entry BR13023-4R-33 produced higher yield 6.31 t/ha with 10 days shorter GD 107 days compared with the highest yield producing check BRRI dhan71 (5.06 t/ha; 118 days). In AYT#3 (DTR), among the 21 lines, 10 lines produced significantly higher grain (6.26-6.83 t/ha; 109-122 days) compared with three checks BRRI dhan49, BRRI dhan71 and BRRI dhan87 (5.15-5.69 t/ha; 117-121 days). Entry BR12307-5R-226 produced higher yield 6.83 t/ha with 12 days shorter GD of 109 days against BRRI dhan87 (5.69 t/ha; 121 days).

#### **Regional yield trial (RYT), T. Aman 2023-24**

A total of 65 breeding lines were evaluated in 12 different RYT (rainfed lowland rice (RLR), salt tolerant rice (STR), zinc enriched rice (ZER), premium quality rice (PQR) and disease resistance rice (DRR) against 13 different standard checks. In RYT(AER-1), none of the entries over performed than BRRI dhan70 (ck). In RYT(AER-2), only one tested entry, BR12839-4R-137 shown similar yield (5.61 t/h) and growth duration (121 days) to the checks (BRRI dhan49 and BRRI dhan87). In RYT(LA), none of the tested entries produced over yield BRRI dhan87 (5.78 t/ha). None of the tested entries gave over yield in RYT(ZER). In RYT(Jira), among the tested entries, BRH11-7-17-10B and BR17-23-8-2-7B gave significantly higher yield (4.15-4.58 t/ha) with similar GD (107 days) than all the checks (Jirashail and BRRI dhan62). Two tested

entries (BRH9-3-14-2B and BRH13-9-5-2B) produced significantly higher yield (4.25-4.54 t/h) than the check Katari (3.93 t/h) with the growth duration 23 days earlier in RYT(Katari). In RYT (RLR-1), only BR11333-6R-84 produced similar yield (5.35 t/ha) and GD (117 days) as like as the checks BRRI dhan71 (5.21 t/ha) and BRRI dhan75 (5.22 t/ha) among the tested entries. In RYT (RLR-2), only two genotypes showed similar yield and GD with the checks BRRI dhan49 (5.36 t/ha) and BRRI dhan87 (5.37 t/ha). In RYT (STR), only two genotypes showed similar yield and GD with the checks BRRI dhan49 (5.36 t/ha) and BRRI dhan87 (5.37 t/ha). Two tested entries, BR11986-4R-123 and BR11869-5R-47 produced significantly higher yield (5.68 t/h and 5.54 t/h) than the check (IRBB60), although they showed similar yield and growth duration with BRRI dhan75 (5.43 t/h) and BRRI dhan87(5.59 t/h) in RYT(BBR). In RYT(BRR), among the five tested entries, three entries BR (Path) 15640-3-4-4-6, BR (Path) 15640-46-2-5-2 and BR (Path) 15641-10-7-1-1 showed almost similar yield (5.37-5.43 t/h) and growth duration (130-143 days) to the checks (5.45-5.66 t/ha, 116-134 days), although the entry BR (Path) 15641-10-7-1-1 showed 10 days lower growth duration. In RYT(FS), two entries BR (Path)13804-BC3-13 and BR (Path)13804-BC3-20 produced significantly higher yield (5.69 t/h, 5.76 t/h) than the check BRRI dhan49 (5.31 t/h) with seven days earlier growth duration.

### **Hybridization, Boro 2023-24**

A total of 405 F1 seeds were produced from nine crosses using ten parents in Boro 2023-24.

### **Rapid generation advance of segregating nurseries, Boro 2023-24**

In total 34,438 individual progenies from 44 crosses were harvested from F2-F6 generations through FRGA method.

### **Observation Yield Trial (OYT), Boro 2023-24**

In total 680 genotypes were evaluated in four OYT's with eight different checks. In OYT#PQR-1, out of 139, only 14 genotypes shown significantly higher yield (8.07-9.84 t/ha) than the checks BRRI dhan81 (7.14 t/ha) BRRI dhan104 (7.43 t/ha) and BRRI

dhan107 (7.86 t/ha) with the growth duration (139-151 days). In OYT#PQR-2, among the 137 entries, only four genotypes BR12585-4R-43, BR12587-4R-55, BR12587-4R-117 and BR12584-4R-144 produced significantly higher yield (8.51-9.03 t/ha) than the checks BRRI dhan102 (8.12 t/ha), BRRI dhan104 (7.12 t/ha) and BRRI dhan107 (7.50 t/ha) with 142-150 days growth duration. In the tested 20 entries, one (BR12587-4R-261) for BRRI dhan102 (8.40 t/ha), two (BR12583-4R-334 and BR12583-4R-166) for BRRI dhan107 (7.80 t/ha) and five (BR12587-4R-201, BR12585-4R-59, BR12583-4R-146, BR12586-4R-13 and BR12583-4R-246) for BRRI dhan104 (7.38 t/ha) showed similar yield and growth duration (143-151 days) in OYT#PQR-3. In OYT#BB, out of 384, 20 genotypes produced significantly higher yield than the checks BRRI dhan88 (7.68 t/ha), BRRI dhan89 (8.30 t/ha), BRRI dhan92 (7.90 t/ha) and BRRI dhan101 (7.40 t/ha) with 142-154 days growth duration.

### **Advanced yield trial (AYT), Boro 2023-24**

In total 197 genotypes were evaluated in four AYT's with eight different checks. In AYT#PQR-1, out of 84, only four genotypes BR11966-4R-262, BR11966-4R-344, BR11973-4R-224 and BR11966-4R-313 produced significantly higher yield (8.51-9.03 t/ha) than the checks BRRI dhan81 (7.09 t/ha), BRRI dhan102 (8.27 t/ha), BRRI dhan104 (7.29 t/ha) and BRRI dhan107 (7.22 t/ha) with 139 days growth duration. Among 53 genotypes, only nine showed significantly higher yield (8.11-8.86 t/ha) than the checks BRRI dhan104 (7.81 t/ha) and BRRI dhan107 (7.86 t/ha) with the growth duration (135-146 days) in AYT#PQR-2. In AYT#BB (SD), among the 44, eight genotypes shown almost similar yield (7.98-8.50 t/ha) to the best check BRRI dhan101 (8.21 t/ha), only the BR12909-4R-120 produced significantly higher yield (8.50 t/ha) than the check with similar GD and the BR13189-4R-90 produced similar yield (7.98 t/ha) with 8 days earlier GD (146 days). Out of 55 genotypes, 16 showed almost similar yield (8.00-8.51 t/ha) and GD (157-164 days) with the checks BRRI dhan89 (8.37 t/ha) and BRRI dhan92 (8.15 t/ha) in AYT#BB(LD).

### **Regional yield trial (RYT), Boro 2023-24**

Twenty-one RYT<sub>s</sub> (FBR-SD, MD, SMD, LD, ELS, Bio, STR, Barishal; ZER, FG, PQR-SD, MD, LD; Blast-SD, MD, LD, Blast; BB-Blast and BB) were conducted against 17 different standard checks in Boro season in which 126 breeding lines were evaluated. Among the tested entries, the genotype BR12574-5R-168 produced significantly higher yield (7.91 t/ha) than the checks BRRI dhan88 (7.18 t/ha) and BRRI dhan96 (6.32 t/ha) with 150 days in RYT\_FBR(SD). In RYT\_FBR(MD), none of the entries, produced higher yield than the check BRRI dhan89 (8.04t/ha). None of the entries gave higher yield than the check BRRI dhan89 (7.96 t/ha) where only the genotype BR13027-BC1-3R-77 showed significantly higher yield (7.66 t/ha) than the checks BRRI dhan58 (6.59 t/ha), BRRI dhan88 (7.22 t/ha) and BRRI dhan102 (7.43 t/ha) with 150 days growth duration in RYT\_FBR (SMD). In RYT\_ELS, among the tested entries, three genotypes BR7528-2R-19-16-RIL-55, BR7528-2R-19-16-RIL-52 and BR7528-2R-19-16-RIL-59 produced significantly higher yield (6.45-6.86 t/ha) than the check BRRI dhan63 (6.00 t/ha) but showed similar yield to the check BRRI dhan104 (6.75 t/ha) with 151-157 days growth duration. Among the tested entries, four genotypes (BR(Bio)13028-AC1-2-4, BR(Bio)13030-AC13-2-2, BR(Bio)13028-AC1-2-3 and BR (Bio)13028-AC1-2-7) produced significantly higher yield (7.28-7.69 t/ha) than the checks BRRI dhan86 (6.51 t/ha) and BRRI dhan96 (6.79 t/ha) with 148-152 days growth duration in RYT-Bio. In RYT-STR, 10 out of 11 genotypes, gave significantly higher yield (7.55-8.39 t/ha) than the check BRRI dhan88 (7.19 t/ha) with 147-159 days growth duration. In RYT-Barishal, three genotypes (NGR 750-1, NGR 472-2 and NGR 749-2) produced significantly higher yield (7.90-8.09 t/ha) than the checks BRRI dhan74 (6.86 t/ha) and BRRI dhan102 (7.61 t/ha) with 154 days growth duration. All the tested entries shown similar yield (6.89-7.15 t/ha) and growth duration (151 days) with the check BRRI dhan100 (6.98 t/ha) in RYT-FG. The BR10552-1-1-4-6 genotype produced significantly higher yield (8.01 t/ha) in

the tested entries but it showed similar yield and growth duration to the check BRRI dhan89 (7.96 t/ha, 158 days) in RYT\_ZER. Only three genotypes (BR11361-4R-149, BR11359-4R-24 and BR11371-4R-522) produced significantly higher yield (6.65-7.02 t/ha) than the check BRRI dhan81 (6.21 t/ha) with similar growth duration in RYT\_PQR (SD). In RYT\_PQR (MD), none of the entries produced higher yield than the check (BRRI dhan58, BRRI dhan104 and BRRI dhan107). None of the entries gave significantly higher yield than the checks in RYT\_PQR(LD). In RYT\_Blast, the BR (Path)15641-3HR-45 and BR (Path )15641-3HR-15 produced highest yield among the tested entries and shown similar yield (6.95-7.13 t/ha) and growth duration (140-142 days) with the checks (BRRI dhan28 and BRRI dhan88). None of the tested entries showed higher yield than the check BRRI dhan89, but the Rod miniket-1 and BR (Path) 15641-4HR-31 produced significantly higher yield (6.67-7.44 t/ha) than BRRI dhan58 (ck) with similar growth duration (148-155 days) in RYT\_Blast (MD). In RYT\_Blast (LD), out of 5, three genotypes shown similar yield and growth duration (159 days) with the check BRRI dhan29. The genotype-BR (Path)15857-4HR-33 produce significantly higher yield (7.32 t/ha) than the checks BRRI dhan50 (6.15 t/ha) and BRRI dhan63 (6.77 t/ha) with 143 days growth duration in RYT\_Blast (PQR). In RYT\_BB\_Blast, three entries, BR11866-5R-277, BR11867-5R-331 and BR11869-5R-148 produced similar yield (7.78-7.88 t/ha) to the check BRRI dhan89, although BR11869-5R-148 showed eight days earlier growth duration. BR(Path) 13802-BC3-12-10-14 produced significantly higher yield (7.83 t/ha) than BRRI dhan28 and BRRI dhan88 with similar growth duration (142-145 days) in RYT\_BB.

### **RICE FARMING SYSTEMS**

#### **Evaluation of three and four cropped cropping patterns for Rajshahi region**

The trial was conducted at BRRI RS, Rajshahi during 2023-24 in RCB design with three replications to identify the profitable cropping

patterns in Rajshahi region. The cropping patterns were: **CP<sub>1</sub>**: Mustard (BARI Sorisha-14)-Boro (BRRI dhan88)-Aus (BRRI dhan98)-Blackgram (BARI Mas-3); **CP<sub>2</sub>**: Mustard (BARI Sorisha-17)-Boro (BRRI dhan88)-Vegetable (red amaranth, Stem amaranth)-T. Aman (BRRI dhan 87); **CP<sub>3</sub>**: Mustard (BARI Sorisha-17)-Boro (BRRI dhan92)-T. Aman (BRRI dhan 87); **CP<sub>4</sub>**: Boro (BRRI dhan92)-Fallow -T. Aman (BRRI dhan87).

Among the tested cropping pattern, the highest rice equivalent yield (27.57 t ha<sup>-1</sup>) was observed in CP<sub>2</sub> (Mustard-Boro-Vegetable-T. Aman) treatment followed by **CP<sub>1</sub>** (Mustard-Boro-Aus-Blackgram) cropping pattern and the lowest value (14.42 t ha<sup>-1</sup>) was recorded in CP<sub>4</sub> treatment. Therefore, it was observed that systemic yield of the cropping pattern is higher in Rice-Non Rice cropping pattern than the rice-rice cropping pattern. On the other hand, if high valued crops like mustard, blackgram, vegetables etc are cultivated in farmers' practiced Rice-Rice cropping pattern, systemic yield as well as profitability will increase.

#### **Evaluation of zero tillage mustard based cropping patterns in Rajshahi region**

The trial was conducted at BRRI RS, Rajshahi during 2023-24 in RCB design with three replications to identify the extent of resource conservation and to increase the crop productivity. The cropping patterns were CP<sub>1</sub>: Mustard (Conventional tillage BARI Sarina17)- Boro (Bangobandhu dhan100)- T. Aman (BRRI dhan71). CP<sub>2</sub>: Mustard (Zero tillage BARI Sarisa17 Before 7-10 days of harvest of Aman rice) –Boro (Bangobandhu dhan100)- T. Aman (BRRI dhan71). CP<sub>3</sub>: Mustard (Zero tillage BARI Sarina17 After harvesting of Aman rice) –Boro (Bangobandhu dhan100)-T. Aman (BRRI dhan71). CP<sub>4</sub>: Boro (BRRI dhan81)- T. Aman (BRRI dhan71). BRRI and BARI recommended crop and fertilizer management practices were followed for all the treatments.

Among the cropping patterns, the rice equivalent yield (REY) of 1<sup>st</sup> crop (Rabi season) remained higher (2.82 t/ha) in CP<sub>1</sub> followed by CP<sub>3</sub> (2.50

t/ha) and CP<sub>2</sub> (2.41 t/ha). In 2<sup>nd</sup> crop, REY remained higher in CP<sub>2</sub> (6.12 t/ha) followed by CP<sub>1</sub> (6.10 t/ha) and the REY found lower in CP<sub>4</sub> (5.77 t/ha). In T. Aman season (3<sup>rd</sup> crop), the yield difference was insignificant among the treatments where higher REY was found in CP<sub>4</sub> (5.93 t/ha) and that was remained lower in CP<sub>2</sub> (5.70 t/ha). Considering system yield, the higher REY (14.75 t/ha) was found in CP<sub>1</sub> followed by CP<sub>3</sub> (15.42 t/ha). The lower system yield (11.81 t/ha) was found in Rice-Rice cropping system (CP<sub>4</sub>). Out of four, mustard-based cropping patterns like CP<sub>1</sub>, CP<sub>2</sub> and CP<sub>3</sub> produced higher REY than the existing one. On the other hand REY of zero tillage mustard-based cropping pattern like CP<sub>2</sub> and CP<sub>3</sub> reminded lower to CP<sub>1</sub>.

#### **Improvement of productivity in Potato-Boro-T.Aman cropping pattern through variety replacement**

The trial was conducted at farmer's fields of Dhokrakul, Puthia upazila of Rajshahi district during 2023-24 in RCB design with three replications to to validate the profitable cropping pattern in Barind tract. The cropping patterns were CP<sub>1</sub>: Potato (BARI Alu-8)-Boro (BRRI dhan100)-T. Aman (BRRI dhan93), CP<sub>2</sub>: Potato (BARI Alu-25)-Boro (BRRI dhan104) -T.Aman (BRRI dhan103) CP<sub>3</sub>: Potato (BARI Alu-25)-Boro (BRRI dhan104) -T. Aman (BRRI dhan103). BRRI and BARI recommended crop and fertilizer management practices were followed for all the treatments.

In Rabi season, the performance of potato in CP<sub>1</sub>, CP<sub>2</sub> and CP<sub>3</sub> was 24.95, 25.15 and 25.41 (t ha<sup>-1</sup>) respectively. In Boro season, the highest grain yield was obtained from Bangabondhu dhan100 (6.14 t/ha) in CP<sub>1</sub> cropping pattern while the lowest yield was found from the variety BRRI dhan104 (5.98 t/ha). In T. Aman season the highest yield was obtained from BRRI dhan103 under CP<sub>3</sub> followed by BRRI dhan93 in CP<sub>1</sub> (5.03 t/ha). The yield of BRRI dhan90 was notably poor due to false smut disease.

In consideration of the system productivity, the highest REY (51.84 t/ha) was found in CP<sub>3</sub> followed by CP<sub>1</sub> (50.16 t/ha). The lower system yield (49.31 t/ha) was found in Potato (BARI Alu-25)-Boro (BRRI dhan102)- T. Aman (BRRI dhan90) cropping system (CP<sub>2</sub>). Out of three, the cropping patterns with newly released BRRI varieties performed better than the others.

## **SOCIOECONOMICS AND POLICY**

### **Stability analysis of BRRI developed Aus varieties**

Among the 14 varieties trailed in Aus season, BRRI hybrid dhan7 was top ranked (7.04 t/ha) which was significantly different from the others. The second highest yield (5.45 t/ha) was recorded in BRRI dhan48 followed by BRRI dhan98 (5.18 t/ha). The grain yield remained lower in BR21 (3.20 t/ha) decreasingly followed by BRRI dhan42 (3.47 t/ha) and BRRI dhan43(3.42 t/ha).

### **Stability Analysis of BRRI developed T. Aman rice varieties**

Forty-eight Aman rice varieties were evaluated at BRRI RS, Rajshahi farm. Among them, BRRI dhan87 were top ranked in terms of yield (6.40 t/ha) followed by BRRI hybrid dhan4 (6.39 t/ ha) and BRRI hybrid dhan6 (6.25 t/ ha). Next to BRRI dhan87, the rice yields in Aman season remained higher in BRRI dhan103 (5.97 t/ha) and BRRI dhan72 (5.92 t/ha) followed by BRRI dhan10 (5.89 t/ha) and by BRRI dhan11 (5.82 t/ha). BRRI dhan38, BRRI dhan37, BR5, BRRI dhan34 and BR25 were found as low yielding varieties and the yield ranged from 1.32 to 3.02 t/ha.

### **Stability Analysis of BRRI developed Boro rice varieties**

Fifty-two BRRI released rice varieties were evaluated at BRRI RS, Rajshahi farm during Boro season of 2023-24. Considering the yield performance in Boro season, top four rice varieties were BRRI hybrid dhan8 (9.43 t/ha), BRRI hybrid dhan2 (8.63 t/ha), BRRI hybrid dhan3 (8.31 t/ha) and BRRI dhan89 (8.11 t/ha). BR6 (4.66 t/ha) and BRRI dhan27 (4.25 t/ha) were the low yielding among the Boro varieties.

## **TECHNOLOGY TRANSFER**

### **Farmers training and seed distribution**

Farmers' training is an important tool to train up farmers on updated information for rice cultivation. Rajshahi Regional Station arranged 49 training programs on modern rice cultivation, farm mechanization, cropping pattern etc at different upazilas of of Rajshahj region. One thousand fivehundred participants were participated in the training programmes. Seeds of modern rice varieties distributed to the farmers for variety demonstration.

### **Demonstration of BRRI released varieties**

Around 406 field demonstrations were carried out at different locations of Rajshahi region during Boro season of 2023-24 and the yield data were collected from the demonstration plots and the highest yield (7.99 t/ha) was found in BRRI dhan89 followed by BRRI dhan92 (7.78 t/ha) while BRRI dhan90 recorded the lowest grain yield of rice 4.60 t/ha.

### **Truthfully leveled and breeder seed production**

Nucleus seed stock was collected from GRS Division of BRRI. Single seedling was transplanted per hill. For breeder seed production, all official formalities with SCA and BRRI authority were performed through proper channel. Breeder seed was produced in T. Aman and Boro seasons but TLS seed was produced in Aus and T. Aman and Boro seasons. Considering three seasons (Aus, T. Aman and Boro), breeder and TLS seed were produced 28 and 12 tons respectively.

### **Advisory services**

Any serious problem related to rice production at farmers' field was addressed duly in co-operation with the Department of agricultural Extension (DAE), Bangladesh Agricultural Development Corporation (BADC), Barind Multipurpose Development Authority (BMDA), Seed Certification Agency (SCA) and different NGOs. Field visits were done mainly to address different problems on insect and disease attack, seed sterility at flowering time etc.



## **BRRI RS, Rangpur**

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# SUMMARY

For developing region specific suitable modern rice varieties to be used in Rangpur-Dinajpur region, 10 germplasms were collected from farmers' field for maintenance breeding, four single crosses were made and 40 individual plants were bulked from 2F<sub>6</sub> and 1F<sub>7</sub> generations during 2023-2024. In total, 200 individual plants and three fixed genotypes were selected from observational yield trial under the program of breeding for second generation rice. In OYT, BRrang35-RGA-5-5-1-1-1 produced 8.45 t/ha, which was higher than BRRI dhan88 (6.60 t/ha). Under Basmati rice breeding programme, 150 individual plants and three fixed genotypes were selected from OYT. BRrang55-RGA-40-1-1-1 produced the highest yield (7.52 t/ha) over BRRI dhan104 (6.55 t/ha) in OYT. Under the development of hybrid rice parental lines and hybrids, in total 61 testcross F<sub>1</sub>s were made from source nursery by testcross. A total of 45 RYT's and 16 ALARTs' were conducted during this reporting period. In planting time experiment, appreciable better yield in the Rangpur region, BRRI dhan75 should preferably be transplanted on 20 July- 20 August, BRRI dhan87 and BRRI dhan90 on 20 of August and BRRI dhan52, BRRI dhan79 and BRRI dhan93 on 20 July – 5 August. In Boro season, both short and long duration varieties had higher grain yield on 25 December to 25 January planting. BRRI dhan74 giving higher yield

up to 25 February have the potentiality of late Boro variety. In long-term nutrient omission trial, it was observed that the omission of N in T. Aman and omission of N and P in Boro season from complete fertilizer significantly reduced the grain yield of rice at BRRI RS Rangpur farm. Among the major nutrient elements, omission of N appeared as the most yield limiting nutrient followed by P and K omission for rice in both seasons. A total of 2086 varietal demonstrations were conducted in Rangpur-Dinajpur region during this reporting period. Fifteen field days were arranged and 30 farmers training were conducted on modern rice production technology. A total of 10,607 kg, 10,992 kg and 9,748 kg TLS were produced in T. Aus, T. Aman and Boro season respectively. A total of 9,250 kg Breeder seed was produced and sent to the GRS Division, BRRI HQ Gazipur. In this reporting period, 18,826 kg TLS was distributed for dissemination and popularization of latest BRRI varieties in Rangpur-Dinajpur region.

## VARIETY DEVELOPMENT PROGRAMME (VDP)

### Development of rice varieties suitable for T. Aman and Boro season in Rangpur region

In total, 10 germplasm were collected from farmers' field for maintenance breeding (Table 1). Four single crosses were made using five parents (Table 2). In T. Aman, 40 individual plants were selected from 2F<sub>6</sub> and 1F<sub>7</sub> generations (Table 3).

**Table 1. List of rice germplasms collected from different sources during reporting period 2023-2024.**

| Germplasm                 | Location/Division             | Characteristic       |
|---------------------------|-------------------------------|----------------------|
| Rata Boro                 | Plant Breeding Division, BRRI | Premium quality      |
| Tepi Boro                 | Plant Breeding Division, BRRI | Premium quality      |
| Guti Swarna               | Sadar, Nilphamari             | High yield potential |
| Swarna paijam             | Sadar, Nilphamari             | High yield potential |
| Masuri guti               | Sadar, Nilphamari             | Premium quality      |
| Jira                      | Sadar, Nilphamari             | Premium quality      |
| Pusa Basmati-1509         | Sadar, Dinajpur               | Premium quality      |
| Rosulbhog                 | Nageshwari, Kurigram          | Premium quality      |
| Pusa Basmati-1 (BVE/2020) | PBD, BRRI                     | Premium quality      |
| Basmati (Acc. no. 4361)   | GSRD, BRRI                    | Premium quality      |

**Table 2. List of crosses made, breeding for standard rice varieties for Rangpur region Boro 2023-24.**

| Cross combination         | F <sub>1</sub> seed | Characteristic  |
|---------------------------|---------------------|-----------------|
| BRRI dhan29/PB1509        | 37                  | Premium quality |
| BRRI dhan89/PB1509        | 42                  | Premium quality |
| BRrang35-5-5-1-1-1/BP1509 | 45                  | Premium quality |
| PB1509/BR1286-4R-312      | 30                  | Premium quality |

**Table 3. List of selected progenies from F<sub>6</sub> and F<sub>7</sub>, breeding for standard rice varieties for Rangpur region, T. Aman, 2023.**

| BR                        | Cross                          | Selected progeny | Objectives      |
|---------------------------|--------------------------------|------------------|-----------------|
| F <sub>6</sub> Generation |                                |                  |                 |
| BRrang35                  | BRRI dhan90/BRRI dhan70        | 10               | Premium quality |
| BRrang36                  | BRRI dhan87/Miniket (Dinajpur) | 20               | Premium quality |
| F <sub>7</sub> Generation |                                |                  |                 |
| BRrang28                  | BRRI dhan87/Shompa katari      | 10               | Premium quality |
|                           | Total                          | 40               |                 |

**Breeding for second generation rice (SGR)**

In total, 200 individual plants were selected based on the better performance during in flowering, phenotypic acceptability, insect and disease

reaction, earliness and grain yield. Selected plants will be evaluated in the next season. Three fixed genotypes were selected (Table 4).

**Table 4. Agronomic parameters of the selected materials from Observational Yield Trial (OYT), Boro 2023-24.**

| Designation            | PHt. (cm) | Mat. (day) | Yield (t/ha) |
|------------------------|-----------|------------|--------------|
| BRrang35-RGA-5-5-1-1-1 | 101       | 150        | 8.45         |
| BRrang31-2-9-7-1       | 105       | 147        | 8.12         |
| BR8415-5-4-Rang5-8-1-1 | 103       | 150        | 7.84         |
| BRRI dhan88 (ck)       | 105       | 146        | 6.60         |
| BRRI dhan89 (ck)       | 98        | 159        | 7.25         |

DS: 10 Dec 2023; DT: 27 Jan, 2024 and Spacing: 20 cm x 20 cm

**Breeding for Basmati Rice (God of Grains)**

In total 150 individual plants were selected based on the better performance with in flowering, phenotypic acceptability, insect and disease

reaction, earliness and grain yield. Selected plants will be evaluated in the next season. Three fixed genotypes were selected (Table 5) and physico-chemical properties were analysed (Table 6 and 7).

**Table 5. Agronomic parameters of the selected materials from Observational Yield Trial (OYT), Boro 2023-24.**

| Designation           | PHt. (cm) | Mat. (day) | Yield (t/ha) |
|-----------------------|-----------|------------|--------------|
| BRrang55-RGA-40-1-1-1 | 108       | 152        | 7.52         |
| BRrang55-RGA-14-2-1-2 | 95        | 150        | 6.75         |
| BRrang55-RGA-44-5-1-1 | 105       | 148        | 6.50         |
| BRRI dhan104 (ck)     | 95        | 154        | 6.55         |

DS: 10 Dec 2023; DT: 25 Jan 2024 and Spacing: 20 cm x 20 cm

**Table 6. Physical characteristics of selected basmati genotypes from observational yield trial (OYT), Boro 2023-24.**

| AC#   | Designation       | MO (%) | Head rice recovery | Chaki (%) | M GrL (mm) | MGrW (mm) | L/B ratio | Size & Shape | TWG (gm) | Aroma |
|-------|-------------------|--------|--------------------|-----------|------------|-----------|-----------|--------------|----------|-------|
| 18088 | BRrang-RGA-14-2-1 | 70     | 43                 | 48        | 7.7        | 1.7       | 4.5       | ELS          | 21.4     | +     |
| 18091 | BRrang-RGA-20-2-1 | 70     | 46                 | 40        | 7.4        | 1.7       | 4.4       | LS           | 21.3     | ++    |
| 18100 | BRrang-RGA-44-5-1 | 70     | 46                 | 51        | 7.7        | 1.7       | 4.5       | ELS          | 20.3     | ++    |
| 18103 | BRRI dhan50 (Ck)  | 67     | 26                 | 45        | 6.4        | 1.5       | 4.3       | LS           | 17.8     | +     |
| 18104 | BRRI dhan70 (Ck)  | 69     | 57                 | 33        | 6.6        | 2.0       | 3.4       | LS           | 19.7     | ++    |
| 18106 | BRRI dhan104 (Ck) | 67     | 52                 | 49        | 7.4        | 1.8       | 4.1       | LS           | 23.8     | ++    |

**Table 7. Chemical properties of selected basmati genotypes from observational yield trial (OYT), Boro 2023-24.**

| AC#   | Designation       | Alakali spreading value | Amy (%) | Protein (%) | Cooked rice L (mm) | EL  | IR  | Ring formation  |
|-------|-------------------|-------------------------|---------|-------------|--------------------|-----|-----|-----------------|
| 18078 | BRrang-RGA-4-2-4  | 7.0                     | 22.8    | 8.7         | 12.0               | 1.5 | 4.3 | Slightly ring   |
| 18082 | BRrang-RGA-10-2-1 | 7.0                     | 23.0    | 8.7         | 13.2               | 1.6 | 4.3 | Slightly ring   |
| 18088 | BRrang-RGA-14-2-1 | 7.0                     | 24      | 8.2         | 13.7               | 1.8 | 5.0 | Slightly ring   |
| 18091 | BRrang-RGA-20-2-1 | 6.7                     | 23.8    | 8.0         | 12.6               | 1.7 | 4.3 | Slightly ring   |
| 18098 | BRrang-RGA-40-1-1 | 7.0                     | 23.9    | 8.0         | 14.0               | 1.9 | 4.8 | Moderately ring |
| 18100 | BRrang-RGA-44-5-1 | 6.8                     | 24.1    | 7.9         | 13.0               | 1.7 | 4.1 | Moderately ring |
| 18103 | BRRI dhan50 (ck)  | 3.1                     | 26.8    | 8.1         | 9.0                | 1.4 | 3.7 | NA              |
| 18104 | BRRI dhan70 (ck)  | 4.0                     | 21.7    | 7.1         | 10.7               | 1.6 | 4.1 | Slightly ring   |
| 18106 | BRRI dhan104 (ck) | 7.0                     | 27.3    | 8.9         | 11.8               | 1.6 | 3.7 | Slightly ring   |

#### DEVELOPMENT OF HYBRID RICE PARENTAL LINES AND HYBRIDS

**General objective:** To develop maintainer and restorer lines from diverse genetic origin

#### T. Aman, 2023

#### Experiment 1: Constituting of Source Nursery (SN), T. Aman, 2023

A total sixty one (61) testcross F<sub>1</sub>s were made from source nursery by testcross. The testcross F<sub>1</sub>s along with corresponding male parents and standard

checks will be evaluated in testcross nursery during next Boro season, 2023-24.

#### Experiment 2: Testcross nursery (SN), T. Aman, 2023

Out of 139, two (2) testcross F<sub>1</sub>s were found completely sterile and initiated to backcrossing with corresponding male parents for conversion of prospective maintainers into new CMS lines against bacterial blight. But none of hybrids were found heterotic compare to standard checks. Mature backcross (BC<sub>1</sub>F<sub>1</sub>) seeds were properly collected and growing in Boro season, 2023-24.

### **Experiment 1: Constituting of Source Nursery (SN), Boro season, 2023-24**

A total of ninety (90) testcross  $F_1$ s were made from source nursery by testcross. The testcross  $F_1$ s along with corresponding male parents and standard checks will be evaluated in testcross nursery during next T. Aman season, 2024.

### **Experiment 2: Test cross nursery (TCN), Boro season, 2023-24**

Seventy one (71) test crosses ( $F_1$ s) were evaluated in test cross nursery for their pollen fertility status. None of testcrosses ( $F_1$ s) were found heterotic over check varieties.

### **Experiment 3: Back cross nursery (BCN), Boro season, 2023-24**

Two back cross generations ( $BC_1$ ) were advanced to next generations ( $BC_2$ ) for conversion of prospective maintainers into new CMS lines against bacterial blight.

### **Experiment 4: Development of disease resistant (Blast) hybrid rice parental lines by molecular approach, Boro season, 2023-24**

Hybridization was done between two recipient parents BRRI31R-MASP4-4-1, IR75608B-MASP2-1-1 and one donor parent IRR1154Pi9 carrying blast resistance gene *Pi9*. One hundred and thirty one  $F_1$  seeds (naked) were found (Table 6) from two cross combinations. The  $F_1$  populations will be grown in T. Aman season, 2024.

### **Regional Yield Trial (RYT), T. Aus, 2023**

Three RYT was conducted under T. Aus season including two favourable and one Bacterial Blight Resistant against the standard check varieties.

**RYT#1 (Favourable).** Twelve genotypes along with two standard checks-BRRI dhan48 and BRRI dhan98 were evaluated. The highest grain yield was observed in BRRI dhan98 (5.33 t/ha). None of the tested genotypes were found high yielder over the check varieties.

**RYT#2 (Favourable).** Twelve genotypes along with two standard checks-BRRI dhan48 and BRRI dhan98 were evaluated. The highest grain yield was found in BR12096-4R-25-1 (4.32 t/ha) followed by BRRI dhan98 (3.66 t/ha).

**RYT#3 (BB).** Eight genotypes along with three standard checks-BRRI dhan48, BRRI dhan82 and BRRI dhan98 were evaluated. BR (path)13784-

BC3-6-8-9-HR16 (5.24 t/ha) produced highest grain yield followed by BRRI dhan98 (5.13 t/ha).

### **Regional Yield Trial (RYT), T. Aman, 2023**

A total of 19 RYT's were conducted under T. Aman season including two rainfed lowland rice (RLR), one zinc enriched rice (ZER), two salinity tolerant rice (STR), three drought tolerant rice (DTR), one disease resistant rice (DDR-BB), one false smut rice, one low amylose (LA-Biotechnology), one long duration, one premium quality rice (aromatic), one premium quality rice (Non-aromatic), one photosensitive, two katari and two zira type against standard check varieties.

**RYT#1 (RLR-1).** Nine genotypes along with two standard checks-BRRI dhan71 and BRRI dhan75 were evaluated. BRRI dhan71 produced the highest yield (5.20 t/ha) with 115 days among all the tested entries. Therefore, none of the tested genotypes were found high yielder over the check varieties.

**RYT#2 (RLR-2).** Seven genotypes along with two standard checks-BRRI dhan49 and BRRI dhan87 were evaluated. BR10797-6R-24 produced the highest yield (5.72 t/ha) followed by BR11336-6R-10 (5.10 t/ha).

**RYT#3 (ZER).** Four genotypes along with four standard checks-BRRI dhan49, BRRI dhan72, BRRI dhan87 and BRRI dhan93 were tested. BR10854-4-1-1-2-8 produced highest yield (5.74 t/ha) with 135 days over all the checks yield; BRRI dhan72 (5.32 t/ha) and BRRI dhan87 (5.37 t/ha).

**RYT#4 (STR-1).** Twelve genotypes were evaluated against two standard checks-BRRI dhan73 and BRRI dhan87. BR13111-4R-63 produced the highest yield (5.55 t/ha) over all checks yield; BRRI dhan73 (4.86 t/ha) and BRRI dhan87 (4.10 t/ha).

**RYT#5 (STR-2).** Seventeen genotypes were evaluated against three standard checks-BRRI dhan30, BRRI dhan87 and Gainza. BR13121-4R-40 produced the highest yield (4.93 t/ha) followed by BR13105-4R-37 (4.91 t/ha) among the tested genotypes; BRRI dhan30 (4.53 t/ha) and BRRI dhan87 (4.23 t/ha).

**RYT#6 (DTR-1).** Seven genotypes were evaluated against BRRI dhan71. None of the tested genotypes were observed high yielder over the check-varieties.

**RYT#7 (DTR-2, Nilphamari).** Seven genotypes were evaluated against BRRI dhan71. The highest grain yield was observed in IR17L1360 (5.33 t/ha) followed by BR12023-6R-111 (5.17 t/ha).

**RYT#8 (DTR-3, Kurigram).** Seven genotypes were evaluated against BRRI dhan71. The highest grain yield was observed in IR17L1360 (5.54 t/ha) followed by BR12023-6R-111 (5.42 t/ha).

**RYT#9 (LA-Bio).** Three genotypes along with two standard checks-BRRI dhan71 and BRRI dhan87 were evaluated. BR(Bio)10381-AC11-7-1 produced highest yield (6.26 t/ha) with 136 days over all checks yield; BRRI dhan71 (4.86 t/ha) and BRRI dhan87 (5.79 t/ha).

**RYT#10 (DRR-BB).** Six genotypes were tested along with three checks-BRRI dhan75, BRRI dhan87 and IRBB60 (Res Ck.). BR11869-5R-47 gave highest yield (6.04 t/ha) followed by BRRI dhan87 (5.62 t/ha).

**RYT#11 (False smut).** Nine genotypes were tested along with two checks-BRRI dhan49 and BRRI dhan87. BR(path)13804-BC3-4 gave highest yield (5.16 t/ha) with 118 days where as BRRI dhan49 (5.14 t/ha).

**RYT#12 (Long duration).** Four genotypes were tested along with two checks-BRRI dhan76 and BRRI dhan91. BR9892-8-2-2B was observed high yielder (3.27 t/ha) over the check varieties; BRRI dhan76 (1.60 t/ha) and BRRI dhan91 (1.32 t/ha).

**RYT#13 (Premium Quality Rice-Aromatic).** Five genotypes were tested along with two checks-BRRI dhan34 and BRRI dhan70. BR12836-4R-312 was observed high yielder (4.40 t/ha) followed by BR12839-4R-51 (4.16 t/ha).

**RYT#14 (Premium Quality Rice-Non Aromatic).** Seven genotypes were tested along with two checks-BRRI dhan49 and BRRI dhan87. The highest yield was observed in BRRI dhan49 (5.45 t/ha) followed by BR12839-4R-106 (5.23 t/ha).

**RYT#15 (Photosensitive).** Eight genotypes were tested along with two checks-BRRI dhan49 and BRRI dhan87. The highest yield was observed in BR10212-5-5-3 (5.34 t/ha) followed by IR13F652-1-P3 (4.80 t/ha).

**RYT#16 (Katari type, Mithapukur Rangpur).** Three genotypes along with one check Katari were evaluated. BRH9-3-14-2B produced the highest

yield (4.46t/ha) with 108 days over all the tested entries.

**RYT#17 (Zira type, Mithapukur Rangpur).** Five genotypes along with two checks- Zirashail and BRRI dhan62 were evaluated. BRH11-7-17-10B gave highest yield (4.13t/ha) with 108 days over all tested entries.

**RYT#18 (Katari type, BRRI RS Rangpur).** Three genotypes along with one check- Katari were evaluated. BRH9-3-14-2B produced the highest yield (4.78t/ha) with 108 days over all the tested entries.

**RYT#19 (Zira type, Mithapukur Rangpur).** Four genotypes along with two checks- Zirashail and BRRI dhan62 were evaluated. BRH17-23-8-2-7B produced the highest yield (4.49 t/ha) followed by BRH11-7-17-10B (4.29 t/ha).

#### **Regional yield trial (RYT), Boro 2023-2024**

A total of 23 RYT's were conducted during Boro season: one Favourable Boro rice (FBR-SD), one Favourable Boro rice (FBR-MD), one Favourable Boro rice (FBR-SMD), one Favorable Boro rice (FBR-ELS), one Favourable Boro rice (FBR-Barishal), one salinity tolerant rice (STR), one salinity tolerant rice (ALART Cum RYT), one fine grain, one zinc enriched rice (ZER), six premium quality rice (PQR), six disease resistant rice (DRR) and two heat tolerant rice against standard the check varieties.

**RYT#1 (FBR-SD):** Eight genotypes along with two checks-BRRI dhan88 and BRRI dhan96 were evaluated. BR12671-4R-95 produced the highest grain yield (7.27 t/ha) followed by BR12574-5R-52 (7.10t/ha) and BRRI dhan96 (7.09 t/ha).

**RYT#2 (FBR-MD):** Nine genotypes along with three checks-BRRI dhan58, BRRI dhan89 and BRRI dhan102 were evaluated. None of the entries produced higher grain over the standard check varieties.

**RYT#3 (FBR-SMD):** Ten genotypes along with four checks-BRRI dhan58, BRRI dhan88, BRRI dhan89 and BRRI dhan102 were evaluated. BR13027-BC1-3R-77 (6.71 t/ha) performed better over all the tested entries.

**RYT#4 (FBR-ELS):** Four genotypes along with two checks-BRRI dhan63 and BRRI dhan104 were evaluated. BR7528-2R-19-16-RIL-59 (7.40 t/ha)

produced the highest grain yield followed by BR9945-5R-21 (7.36 t/ha).

**RYT#5 (FBR-Barishal).** Ten genotypes along with two checks-BRRI dhan74 and BRRI dhan102 were evaluated. NGR749-2 produced the highest grain yield (8.08 t/ha) followed by NGR745-2 (8.04 t/ha).

**RYT#6 (STR).** Twelve genotypes along with three checks-BRRI dhan28, BRRI dhan67 and BRRI dhan88 were evaluated. BR13113-4R-116 produced the highest grain yield (7.47 t/ha) followed by BR13111-4R-191 (7.38 t/ha).

**RYT#7 (ALART cum RYT-STR).** Five genotypes along with three checks-BRRI dhan28, BRRI dhan67 and BRRI dhan88 were evaluated. BR13111-4R-63 produced the highest grain yield (7.71 t/ha) followed by BR13113-4R-63 (7.49 t/ha).

**RYT#8 (Fine grain).** Four genotypes along with one check-BRRI dhan28, BRRI dhan67 and BRRI dhan88 were evaluated. BR10247-14-18-4 produced the highest grain yield (7.96 t/ha) followed by BRH9-3-12-2B (7.43 t/ha).

**RYT#9 (ZER).** Six genotypes were evaluated along with two checks-BRRI dhan74 and BRRI dhan89. BR10572-2-7-1-4 produced highest grain yield (8.38 t/ha and 166 days) followed by BRRI dhan89 (7.78 t/ha and 166 days).

**RYT#10 (PQR-1, BRRI RS, Rangpur).** Six genotypes were evaluated along with three checks-BRRI dhan81, BRRI dhan104 and BRRI dhan107. BR11361-4R-149 produced the highest yield (7.10 t/ha) followed by BR11359-4R-24 (6.92 t/ha).

**RYT#11 (PQR-2, BRRI RS, Rangpur).** Five genotypes were evaluated along with three checks-BRRI dhan58, BRRI dhan104 and BRRI dhan107. None of the tested genotypes performed better over the standard checks.

**RYT#12 (PQR-3, BRRI RS, Rangpur).** Ten genotypes were evaluated along with three checks-BRRI dhan102, BRRI dhan104 and BRRI dhan107. BR11359-4R-181 produced the highest yield (7.36 t/ha) followed by BR11359-4R-289 (6.89 t/ha).

**RYT#13 (PQR-1, Parbartipur-Dinajpur).** Six genotypes were evaluated along with three checks-BRRI dhan81, BRRI dhan104 and BRRI dhan107. BR11366-4R-133 produced the highest yield (7.16 t/ha) followed by BR11371-4R-522 (7.11 t/ha).

**RYT#14 (PQR-2, Parbartipur-Dinajpur).** Five genotypes were evaluated along with three checks-

BRRI dhan58, BRRI dhan104 and BRRI dhan107. None of the tested genotypes performed better over the standard checks.

**RYT#15 (PQR-3, Parbartipur-Dinajpur).** Ten genotypes were evaluated along with three checks-BRRI dhan102, BRRI dhan104 and BRRI dhan107. BR11359-4R-288 produced the highest yield (7.34 t/ha) followed by BR11359-4R-181 (7.01 t/ha).

**RYT#16 (DRR).** Fourteen genotypes along with three standard checks-BRRI dhan88, BRRI dhan89 and BRRI dhan101 were evaluated. BR11867-5R-331 produced the highest yield (8.43 t/ha) followed by BRRI dhan89 (8.33 t/ha), BR12125-6R-79 (7.99 t/ha) and BR13793-4R-1 (7.96 t/ha).

**RYT#17 (DRR, BB-BLAST).** Six genotypes along with two standard checks-BRRI dhan28 and BRRI dhan88 were evaluated. BR (path) 13802-BC3-12-10-14 produced the highest yield (7.42 t/ha) followed by BR (path) 13802-BC3-10-11-12 (7.04 t/ha) and BRRI dhan28 (7.02 t/ha).

**RYT#18 (DRR, BLAST-LD).** Five genotypes along with one standard checks-BRRI dhan29 were evaluated. None of the tested genotypes performed better than the standard checks.

**RYT#19 (DRR, BLAST-MD).** Four genotypes along with two standard checks-BRRI dhan58 and BRRI dhan89 were evaluated. Rod miniket-1 produced highest yield (8.42 t/ha) followed by BRRI dhan89 (8.32 t/ha) and BRRI dhan58 (7.59 t/ha).

**RYT#20 (DRR, BLAST-premium quality).** Three genotypes along with two standard checks-BRRI dhan50 and BRRI dhan63 were evaluated. None of the tested genotypes performed better over the standard checks.

**RYT#21 (DRR, BLAST).** Four genotypes along with two standard checks-BRRI dhan28 and BRRI dhan88 were evaluated. BR (path) 15641-3HR-15 produced the highest yield (7.73 t/ha) followed by BRRI dhan28 (7.14 t/ha) and BR (path) 15641-3HR-45 (6.92 t/ha).

**RYT#22 (High temperature tolerant rice-1).** Five genotypes along with three standard checks-BINA dhan14, BRRI dhan28 and BRRI dhan98 were evaluated. BR12605-4R-298 produced the highest yield (5.52 t/ha) followed by BR12605-4R-297 (5.29 t/ha) and BRRI dhan98 (5.27 t/ha).

**RYT#23 (High temperature tolerant rice-2).** Five genotypes along with three standard checks-BINA dhan14, BRRI dhan28 and BRRI dhan98 were evaluated. None of the tested genotypes performed better than the standard checks.

#### **Advanced Line Adaptive Research Trial (ALART)**

A total of sixteen ALARTs' were conducted under T. Aman 2023 and Boro 2023-24 seasons. In T. Aman, three ALART's and thirteen ALART's in Boro season were performed to develop rice varieties. In T. Aman 2023, BR9396-6-2-2B (4.39 t/ha) performed better over the standard check-BRRI dhan49 under Superior High Yielding Rice programme. BRH11-7-17-10B (8.71 t/ha) from SHR-2 and BR(Path)13800-BC3-224-44 (8.55 t/ha) from BLAST-BB, BR (Path)13800-BC3-224-28 (8.28 t/ha) from BRR-BB performed better over standard checks during Boro/2023-24.

### **CROP-SOIL-WATER MANAGEMENT**

#### **1. Effect of planting time of newly developed brri varieties in different regional stations**

The experiments were conducted at the BRRI RS Farm, Rangpur both in T. Aman and Boro seasons, 2023-2024 for newly released varieties to improve rice yield through find out the suitable transplanting time under specific agro-climatic conditions.

**T. Aman 2023.** The experiment was conducted at BRRI RS farm, Rangpur aimed to identify a suitable planting window of short duration (BRRI dhan75, BRRI dhan87, BRRI dhan90) and long duration (BRRI dhan52, BRRI dhan79 and BRRI dhan93) varieties. The selected varieties were planted at five different dates at 15 days interval from 5 July to 5 Sep. Twenty-five-day-old seedlings were transplanted following split-plot design, placing planting date in the main plots and varieties in the sub-plots with three replications. Results showed that there was a significant effect of transplanting data on the yield potential of the tested varieties in T. Aman season (Tables 8 and 9). Early transplanting of BRRI dhan75 (5 July to 20 August) produced higher grain yield than the delayed transplanting, but planted on July 5 had lodging at maturity. BRRI dhan87 and BRRI dhan90 transplanted on 20 August produced higher grain yield (Table 8). All the long duration varieties gave higher yield on 20 July to 5 August (Table 9). Early planting had lower yield due to lodging and rainfall at flowering. In conclusion, to achieve appreciable better yield in the Rangpur region, BRRI dhan75 should preferably be transplanted on 20 July- 20 August, BRRI dhan87 and BRRI dhan90 on 20 of August and BRRI dhan52, BRRI dhan79 and BRRI dhan93 on 20 July - 5 August.

**Table 8. Effect of planting time on the growth duration and yield of short duration BRRI varieties in T. Aman 2023 at BRRI RS, Rangpur.**

| Variety     | Date of transplanting |           |          |           |          |           |           |          |           |          |
|-------------|-----------------------|-----------|----------|-----------|----------|-----------|-----------|----------|-----------|----------|
|             | GD (day)              |           |          |           |          | GY (t/ha) |           |          |           |          |
|             | 5<br>Jul              | 20<br>Jul | 5<br>Aug | 20<br>Aug | 5<br>Sep | 5<br>Jul  | 20<br>Jul | 5<br>Aug | 20<br>Aug | 5<br>Sep |
| BRRI dhan75 | 113                   | 108       | 106      | 106       | 124      | 4.11*     | 4.88      | 4.90     | 4.68      | 1.98     |
| BRRI dhan87 | 124                   | 119       | 121      | 131       | 125      | 3.22**    | 3.86***   | 5.13     | 5.37      | 2.75     |
| BRRI dhan90 | 119                   | 116       | 113      | 109       | 126      | 2.99*     | 3.34***   | 3.81     | 3.83      | 1.61     |
| CV (%)      | 0.2                   |           |          |           |          | 10.3      |           |          |           |          |
| CV (%)      | 0.2                   |           |          |           |          | 7.9       |           |          |           |          |
| LSD         | 0.44                  |           |          |           |          | 0.51      |           |          |           |          |

\*Lodging at maturity; \*\*lodging at flowering; \*\*\*Rainfall at flowering

**Table 9. Effect of planting time on the growth duration and yield of long duration BRRI varieties in T. Aman 2023 at BRRI RS, Rangpur.**

| Variety     | Date of transplanting |           |          |           |          |           |           |          |           |          |
|-------------|-----------------------|-----------|----------|-----------|----------|-----------|-----------|----------|-----------|----------|
|             | GD (days)             |           |          |           |          | GY (t/ha) |           |          |           |          |
|             | 5<br>Jul              | 20<br>Jul | 5<br>Aug | 20<br>Aug | 5<br>Sep | 5<br>Jul  | 20<br>Jul | 5<br>Aug | 20<br>Aug | 5<br>Sep |
| BRRI dhan52 | 141                   | 137       | 135      | 129       | 124      | 4.49**    | 5.67*     | 6.11     | 4.64      | 3.94     |
| BRRI dhan79 | 138                   | 132       | 131      | 126       | 125      | 4.17**    | 5.44      | 5.67     | 5.04      | 3.76     |
| BRRI dhan93 | 147                   | 141       | 138      | 133       | 126      | 2.55**    | 4.08*     | 5.42*    | 5.31      | 3.39     |
| CV (%)      | 0.2                   |           |          |           |          | 8.0       |           |          |           |          |
| CV (%)      | 0.3                   |           |          |           |          | 7.4       |           |          |           |          |
| LSD         | 0.567                 |           |          |           |          | 0.583     |           |          |           |          |

\*90-100% lodging; \*\*Lodging and rainfall at flowering

**Boro 2023-24.** In Boro season, short duration varieties BRRI dhan74, BRRI dhan88, BRRI dhan96, BRRI dhan101, BRRI dhan104 and BRRI dhan105 and long duration varieties BRRI dhan89, BRRI dhan92 and BRRI dhan102 were tested to find out the optimum planting date. Forty-days-old seedling was transplanted during 10 December to 25 February at 15 day interval. Single seedlings were transplanted at 20 cm x 20 cm spacing. The

treatments were distributed in a split-plot design, placing planting date in the main plots and varieties in the sub-plots with three replications. Results indicates that both short and long duration variety had higher grain yield on 25 December to 25 January planting (Table 10 and 11). BRRI dhan74 giving higher yield up to 25 February have the potentiality of late Boro variety.

**Table 10. Effect of planting time on the growth duration and grain yield of short duration rice in Boro, 2023-24 season at BRRI RS, Rangpur.**

| Variety      | Date of transplanting |           |           |           |           |           |           |           |           |           |           |           |
|--------------|-----------------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
|              | GD (day)              |           |           |           |           |           | GY (t/ha) |           |           |           |           |           |
|              | 10<br>Dec             | 25<br>Dec | 10<br>Jan | 25<br>Jan | 10<br>Feb | 25<br>Feb | 10<br>Dec | 25<br>Dec | 10<br>Jan | 25<br>Jan | 10<br>Feb | 25<br>Feb |
| BRRI dhan74  | 176                   | 170       | 162       | 150       | 145       | 135       | 5.10      | 7.05      | 7.00      | 6.97      | 6.27      | 6.60      |
| BRRI dhan88  | 174                   | 169       | 160       | 142       | 136       | 129       | 5.80      | 6.57      | 7.89      | 7.22      | 5.46      | 5.87      |
| BRRI dhan96  | 170                   | 168       | 157       | 141       | 133       | 128       | 5.35      | 7.33      | 7.29      | 6.91      | 5.96      | 5.56      |
| BRRI dhan101 | 184                   | 177       | 165       | 155       | 146       | 142       | 6.43      | 7.50      | 7.27      | 7.38      | 6.13      | 6.81      |
| BRRI dhan104 | 180                   | 175       | 165       | 154       | 153       | 142       | 7.23      | 6.94      | 6.93      | 7.02      | 5.57      | 4.65      |
| BRRI dhan105 | 181                   | 175       | 164       | 154       | 149       | 138       | 7.24      | 7.69      | 7.29      | 7.27      | 6.26      | 6.33      |
| CV (%)       | 0.6                   |           |           |           |           |           | 5.1       |           |           |           |           |           |
| CV (%)       | 0.4                   |           |           |           |           |           | 8.0       |           |           |           |           |           |
| LSD          | 0.96                  |           |           |           |           |           | 0.87      |           |           |           |           |           |

**Table 11. Effect of planting time on the growth duration and grain yield of long duration rice in Boro, 2023-24 season at BRRI RS, Rangpur.**

| Variety      | Date of transplanting |           |           |           |           |           |           |           |           |           |           |           |
|--------------|-----------------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
|              | GD (day)              |           |           |           |           |           | GY (t/ha) |           |           |           |           |           |
|              | 10<br>Dec             | 25<br>Dec | 10<br>Jan | 25<br>Jan | 10<br>Feb | 25<br>Feb | 10<br>Dec | 25<br>Dec | 10<br>Jan | 25<br>Jan | 10<br>Feb | 25<br>Feb |
| BRRI dhan89  | 185                   | 179       | 169       | 160       | 156       | 147       | 7.17      | 7.46      | 8.02      | 8.28      | 6.26      | 6.04      |
| BRRI dhan92  | 187                   | 181       | 171       | 162       | 159       | 149       | 7.10      | 6.70      | 7.63      | 7.52      | 5.98      | 4.97      |
| BRRI dhan102 | 187                   | 180       | 171       | 161       | 156       | 147       | 7.65      | 6.80      | 7.76      | 8.36      | 7.34      | 4.72      |



| Variety | Date of transplanting |           |           |           |           |           |           |           |           |           |           |           |
|---------|-----------------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
|         | GD (day)              |           |           |           |           |           | GY (t/ha) |           |           |           |           |           |
|         | 10<br>Dec             | 25<br>Dec | 10<br>Jan | 25<br>Jan | 10<br>Feb | 25<br>Feb | 10<br>Dec | 25<br>Dec | 10<br>Jan | 25<br>Jan | 10<br>Feb | 25<br>Feb |
| CV (%)  |                       |           | 0.5       |           |           |           |           |           | 9.5       |           |           |           |
| CV (%)  |                       |           | 0.8       |           |           |           |           |           | 8.3       |           |           |           |
| LSD     |                       |           | 2.13      |           |           |           |           |           | 0.58      |           |           |           |

## 2. Effect of planting time on false smut disease incidence of rice

The experiment was conducted at BRRI regional station farm, Rangpur aimed to identify a suitable planting time to avoid the incidence of rice false smut (RFSm) disease and to find out the better genotypes against false smut. 9 (nine) selected genotypes and 2 (two) checks were planted at three different dates at 15 days interval from August 05 to September 05. Twenty-five days-old seedlings were transplanted following split-plot design, placing planting date in the main plots and genotypes in the sub-plots with three replications. Single seedling was transplanted with row spacing 20 cm and plant to plant spacing 20 cm and the plot size was 1.0 m<sup>2</sup>. All agronomic practices were performed uniformly for all the treatments except fungicide application.

The infection of RFSm in the experimental field ranged from 0.0 to 56.7% of the hills for different genotypes at different planting time (Table 12). All the genotypes had lower incidence of RFSm than the susceptible check except BR(path)13800-BC3-134-21-1. Only the BR(path)13800-BC3-134-21-1 had higher incidence even at early planting (05 August) due to low relative humidity and higher sunshine hour at flowering. All the genotypes and checks had RFSm incidence at late planting (05 Sep) and the incidence was very low except the check BRRI dhan49 and the genotype BR(path)13800-BC3-134-21-1 because the flowering period ranges from November 01 to November 20 and had the favorable environment for disease incidence.

**Table 12. Effect of planting time on grain yield and false smut incidence of rice in Aman, 2023 at BRRI RS, Rangpur.**

| Variety                     | Date of transplanting |        |       |               |        |       |
|-----------------------------|-----------------------|--------|-------|---------------|--------|-------|
|                             | GY (t/ha)             |        |       | Incidence (%) |        |       |
|                             | 5 Aug                 | 20 Aug | 5 Sep | 5 Aug         | 20 Aug | 5 Sep |
| BR (path)13804-BC3-4        | 5.00                  | 6.59   | 4.79  | 1.3           | 0.0    | 2.0   |
| BR (path)13804-BC3-9        | 4.49                  | 5.97   | 4.37  | 0.0           | 0.0    | 3.0   |
| BR (path)13804-BC3-13       | 4.81                  | 5.47   | 3.34  | 0.0           | 0.7    | 4.0   |
| BR (path)13804-BC3-14       | 5.33                  | 5.57   | 5.07  | 0.3           | 0.3    | 4.0   |
| BR (path)13804-BC3-16       | 5.48                  | 6.22   | 3.45  | 1.3           | 0.7    | 6.7   |
| BR (path)13804-BC3-18       | 5.03                  | 5.54   | 4.23  | 6.7           | 1.0    | 7.3   |
| BR (path)13804-BC3-20       | 5.97                  | 6.31   | 4.91  | 1.0           | 0.0    | 6.0   |
| BR (path)13804-BC3-21       | 4.86                  | 5.34   | 4.56  | 1.7           | 0.3    | 4.0   |
| BR (path)13800-BC3-134-21-1 | 5.37                  | 5.47   | 3.95  | 53.3          | 5.0    | 56.7  |
| BRRI dhan49 (ck)            | 5.19                  | 5.20   | 3.22  | 2.0           | 0.0    | 33.7  |
| BRRI dhan87 (ck)            | 6.35                  | 6.19   | 4.49  | 0.0           | 0.0    | 11.7  |

## 3. Long-term missing element trial at BRRI RS, Rangpur

Long-term nutrient omission trial is an effective tool for identifying the contribution of nutrients in

crop production. In order to find the role of major macro and micronutrients, a long-term field experiment has been running in the BRRI RS, farm, Rangpur since 2014-15 in Rice-Fallow-Rice

cropping pattern. The experiment includes seven treatments [T<sub>1</sub>=Fertilizer control, T<sub>2</sub>= NPKSZn, T<sub>3</sub>= PKSZn (-N), T<sub>4</sub>= NKSZn (-P), T<sub>5</sub>= NPSZn (-K), T<sub>6</sub>= NPKZn (-S), T<sub>7</sub>=NPKS (-Zn)] which were designed in RCB with three replications. Fertilizer nutrients i.e., N-P-K-S-Zn rate was 95-8-40-12-1 kg ha<sup>-1</sup> and 145-10-60-15-2 kg ha<sup>-1</sup> in T. Aman and Boro seasons respectively. HYV rice has been growing in Boro-Fallow-T. Aman cropping pattern. Omission of major nutrients significantly reduced the grain yield. After ninth cropping year, it was

observed that the omission of N in T. Aman and omission of N and P in Boro season from complete fertilizer significantly reduced the grain yield of rice at BRRI RS, Rangpur farm. Among the major nutrient elements, omission of N appeared as the most yield limiting nutrient followed by P and K omission for the rice in the both seasons. Yet the S and Zn omission have less effect on yield reduction at BRRI RS farm Rangpur in both T. Aman and Boro season (Table 13 and 14).

**Table 13. Effect of long-term missing element on the tiller, panicle, grain and straw yield of BRRI dhan87 at BRRI RS farm, Rangpur in T. Aman 2023.**

| Treatment      | Tiller per m <sup>2</sup> | Panicle per m <sup>2</sup> | Grain yield (t ha <sup>-1</sup> ) | Straw yield (t ha <sup>-1</sup> ) | (%) Grain yield decreased due to nutrient omission |
|----------------|---------------------------|----------------------------|-----------------------------------|-----------------------------------|----------------------------------------------------|
| T <sub>1</sub> | 176 b                     | 166 b                      | 3.37 c                            | 3.10 c                            | -                                                  |
| T <sub>2</sub> | 267 a                     | 254 a                      | 5.82 a                            | 6.05 a                            | -                                                  |
| T <sub>3</sub> | 203 b                     | 195 b                      | 3.95 b                            | 4.36 b                            | 32                                                 |
| T <sub>4</sub> | 257 a                     | 240 a                      | 5.59 a                            | 5.94 a                            | 4                                                  |
| T <sub>5</sub> | 261 a                     | 245 a                      | 5.70 a                            | 5.99 a                            | 2                                                  |
| T <sub>6</sub> | 262 a                     | 249 a                      | 5.65 a                            | 6.04 a                            | 3                                                  |
| T <sub>7</sub> | 265 a                     | 252 a                      | 5.74 a                            | 6.10 a                            | 1.5                                                |
| CV (%)         | 6.7                       | 6.71                       | 2.72                              | 3.45                              |                                                    |

**N.B.** T<sub>1</sub>= Control, T<sub>2</sub>= NPKSZn, T<sub>3</sub>= PKSZn (-N), T<sub>4</sub>= NKSZn (-P), T<sub>5</sub>= NPSZn (-K), T<sub>6</sub>= NPKZn (-S), T<sub>7</sub>=NPKS (-Zn)

**Table 14. Effect of long-term missing element on the tiller, panicle, grain and straw yield of BRRI dhan89 at BRRI RS farm, Rangpur in Boro 2023-24.**

| Treatment      | Tiller/m <sup>2</sup> | Panicle/m <sup>2</sup> | Grain yield (t ha <sup>-1</sup> ) | Straw yield (t ha <sup>-1</sup> ) | (%) Grain yield decreased due to nutrient omission |
|----------------|-----------------------|------------------------|-----------------------------------|-----------------------------------|----------------------------------------------------|
| T <sub>1</sub> | 126 b                 | 120 b                  | 3.04 c                            | 2.75 c                            | -                                                  |
| T <sub>2</sub> | 224 a                 | 214 a                  | 6.71 a                            | 6.18 a                            | -                                                  |
| T <sub>3</sub> | 141 b                 | 135 b                  | 3.54 c                            | 3.22 c                            | 47                                                 |
| T <sub>4</sub> | 199 a                 | 189 a                  | 5.10 b                            | 4.65 b                            | 24                                                 |
| T <sub>5</sub> | 206 a                 | 191 a                  | 6.32 a                            | 5.88 a                            | 6                                                  |
| T <sub>6</sub> | 208 a                 | 198 a                  | 6.51 a                            | 6.06 a                            | 3                                                  |
| T <sub>7</sub> | 209 a                 | 199 a                  | 6.53 a                            | 6.10 a                            | 2.5                                                |
| CV (%)         | 5.77                  | 5.91                   | 5.3                               | 3.39                              |                                                    |

**N.B.** T<sub>1</sub>= Control, T<sub>2</sub>= NPKSZn, T<sub>3</sub>= PKSZn (-N), T<sub>4</sub>= NKSZn (-P), T<sub>5</sub>= NPSZn (-K), T<sub>6</sub>= NPKZn (-S), T<sub>7</sub>=NPKS (-Zn)

## SOCIO-ECONOMIC

### **Stability analysis of BRRI varieties at BRRI RS, Rangpur in T. Aus, T. Aman and Boro season during 2023-2024.**

One hundred nine of BRRI developed varieties were evaluated during T. Aus (13), T. Aman (48) and Boro (48) season at the BRRI RS following RCBD with three replications. BRRI dhan83 produced the highest yield (5.44 t/ha) followed by BRRI dhan98 (5.02 t/ha) and BRRI hybrid dhan107 (4.60 t/ha) during T. Aus season. In T. Aman, BRRI dhan33 (5.73 t/ha) produced the highest yield followed by BRRI dhan66 (5.72 t/ha) and BRRI dhan95 (5.53 t/ha) in short duration; BR11 (7.24 t/ha) produced the highest yield followed by BRRI dhan94 (6.52 t/ha) and BRRI dhan31 (6.49t/ha) in medium duration. In long duration, BR10 (4.31 t/ha) gave highest yield followed by BRRI dhan41 (3.72 t/ha). During Boro season, BRRI hybrid dhan3 showed the highest yield (7.98 t/ha) followed by BRRI dhan74 (7.81 t/ha) in short duration group. In long duration group, BRRI dhan29 produced the highest yield (8.15 t/ha) followed by BRRI dhan102 (8.13 t/ha) and BRRI dhan89 (8.10 t/ha).

## TECHNOLOGY TRANSFER DEMONSTRATION

A total of 2,086 (2,086 bighas) variety demonstrations were conducted at different locations of Rangpur-Dinajpur region. In T. Aus season (73 Bighas), BRRI dhan98 and BRRI hybrid dhan7 were used and maximum yield was observed 5.40 t/ha in BRRI dhan98 at Sadar Dinajpur. In T. Aman session (1,145 bighas), BRRI dhan71, BRRI dhan75, BRRI dhan87, BRRI dhan90, BRRI dhan93, BRRI dhan95, BRRI dhan103, BRRI hybrid dhan4 and BRRI hybrid dhan6 were used. Maximum yield was observed 6.8 t/ha in BRRI dhan93 at Ranisankail, Thakurgoan and Sadar, Panchagarh. In Boro season (2,800 bighas), BRRI dhan74, BRRI dhan89, BRRI dhan92, BRRI dhan100, BRRI dhan101, BRRI dhan102, BRRI dhan104, BRRI dhan105 and BRRI hybrid dhan8 were used. Yield range was 5.8 to 9.58 t/ha. Maximum yield was observed 9.58 t/ha in BRRI dhan92 at Boda, Panchagarh and minimum was 5.8 t/ha in BRRI dhan100 in Rajarhat, Kurigram.

## Training and field day

Twenty farmers training on modern rice production technology was conducted at different upazilas of Rangpur-Dinajpur region in collaboration with DAE. A total of 810 farmers and 90 SAAOs were trained through 30 training programmes. A total of 100 women were present in farmers training programmes. It was very much helpful to minimize knowledge gap on modern rice production technologies. Twelve in-house training were arranged at the programme BRRI RS to improve the capability in office management of the office staff. Fifteen field days were arranged at different demonstration sites in collaboration with DAE during 2023-24. A total of 1,500 farmers, local leaders and DAE personnel attended those field day programmes.

### **Seeds and Seedling distribution among the flood affected farmers**

BRRI RS, Rangpur arranged special programmes for the flood affected farmers. Different photosensitive varieties viz BR22, Nizarsail and Gainja were distributed among the flood affected farmers in Sadar-Gaibandha, Sadar-Kurigram, Gangachora-Rangpur, Sadar-Lalmonirhat and Dharmadas- Metro-Rangpur.

### **Promotional activities for the formers enclave's farmer**

BRRI RS, Rangpur conducted 40 demonstration programmes for the dissemination of BRRI developed latest varieties in Dashiarchora, Fulbari, Kurigram (Former enclave).

### **Seed production and dissemination in July 2023-June 2024**

A total of 10,607 kg, 10,992 kg and 9,748 kg TLS were produced in T. Aus, T. Aman and Boro season respectively. A total of 4,000 kg breeder seed (BRRI dhan90 and BRRI dhan93) was produced in T. Aman season and 5,250 kg breeder seed (BRRI dhan89 and BRRI dhan104) was also produced in Boro season. A total of 9,250 kg breeder seed was sent to the GRS Division, BRRI Gazipur. In three seasons, 18,826 kg TLS was distributed among the farmers for dissemination in Rangpur-Dinajpur region.

## **BRRI RS, Satkhira**

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## SUMMARY

### VARIETY DEVELOPMENT

#### **Regional yield trial during T. Aman 2023**

##### **Regional yield trial (RYT-BB) for high yielding rice**

Six entries were evaluated in RYT-Bio for high yielding rice comparing with BRRi dhan75 BRRi dhan87 and IRBB60. BR11869-5R-47 stands out for its high yield performance, making it a promising option for high-yield rice cultivation. BRRi dhan87 and BR12442-4R-49 also demonstrate strong performance, though slightly behind BR11869-5R-47. Varieties like BR12098-4R-117 offer lower yields, despite longer plant height, indicating that yield potential may not always correlate with plant size.

##### **Regional yield trial (RYT-Low Amylose) for high yielding rice**

Three entries were evaluated in RYT-Low amylose for high yielding rice comparing with BRRi dhan71 and BRRi dhan87. BR (Bio)10381-AC11-7-1 is the top-performing variety in terms of yield, making it highly suitable for high-yield cultivation in low amylose rice. BRRi dhan87 and BR(Bio)10381-11-8-1 also performed well, though slightly behind BR(Bio)10381-AC11-7-1. BR(Bio)13031-AC1-2 has the lowest yield, suggesting it may not be as favourable for high yield in this trial.

##### **Regional yield trial (RYT-tall materials) for high yielding rice**

Four entries were evaluated in RYT- Tall materials for high yielding rice comparing with BRRi dhan76 and BRRi dhan91. BRRi dhan76 is the top performer for grain yield among the tall material varieties. BR10247-14-18-7-3 and BR9892-8-2-2B also demonstrate good yields but are outperformed by BRRi dhan76. BRRi dhan91 and BR10238-5-1-9-2B show lower yields despite their tall stature.

##### **Regional yield trial (RYT-Katari type) for high yielding rice**

Three entries were evaluated in RYT-Katari type for high yielding rice comparing Katari.

Overall, Katari and BRH9-3-2B are the standout varieties for high yield, with Katari having the highest yield but a longer growth period. BRH9-3-2B offers a competitive yield with a shorter growth duration.

##### **Regional yield trial (RYT-Photosensitive) for high yielding rice**

Eight entries were evaluated in RYT-Bio for high yielding rice comparing with BR22 and BR23. None of the variety performed better than check.

##### **Regional yield trial (RYT-False smut) for high yielding rice**

Nine entries were evaluated in RYT-False smut for high yielding rice comparing with BRRi dhan49 and BRRi dhan87. BR (path)13804-BC3-14 is the top variety in terms of yield with 5.04 t ha<sup>-1</sup>, followed by BR (path)13804-BC3-18 and BR (path)13804-BC3-21. BRRi dhan87 also performed well with a yield of 4.59 t ha<sup>-1</sup>. BR (path)13804-BC3-134-21-1 and BRRi dhan49 showed the lowest yields, indicating they were less effective for high yield in this trial.

##### **Regional yield trial for zinc enriched rice (RYT-ZER)**

Four entries were evaluated with four check varieties, BRRi dhan49, BRRi dhan72, BRRi dhan87 and BRRi dhan93. BR10855-3-2-5-2-5 performed better than the check- BRRi dhan49 and BRRi dhan93. And no entries performed better over the check.

### **BRRi dhan72 and BRRi dhan87.**

#### **Regional yield trial (RYT) for rainfed Lowland Rice (RYT-RLR#1)**

Nine entries were evaluated in RYT-RLR#1 for high-yielding rice compared with BRRi dhan71 and BRRi dhan75. BR12007-6R-61 and BR12005-6R-14 performed better over the check- BRRi dhan71 and BRRi dhan75.

#### **Regional yield trial (RYT) for rainfed lowland rice (RYT-RLR#2)**

Seven entries were evaluated in RYT-RLR#2 for high-yielding rice compared with BRRi dhan49 and BRRi dhan87. BR12007-6R-61 and BR12005-6R-14 performed better than the check- BRRi dhan71 and BRRi dhan75.

#### **Regional yield trial for development of zira type grain**

Four entries were evaluated with two check varieties, Zirashail and BRRi dhan62. In RYT-Zira type grain, BRH11-7-17-10B and BR17-23-8-2-7B performed statistically better than the two check varieties.

#### **Regional yield trial for development of blast resistance rice (BRR)**

Five entries were evaluated with two check varieties, BRRi dhan87 and BRRi dhan75. BR (Path)15640-46-2-5-2 performed better over the two check varieties but these were identical to each others.

### **Regional Yield Trial During Boro 2023-24**

#### **Regional Yield Trial (RYT-STR) for High Yielding Rice**

Twelve entries were evaluated in RYT-STR for high yielding rice comparing with BRRi dhan 67 BRRi dhan88 and BRRi dhan28. Significant higher grain yield was found in tested line BR13113-4R-116 over BRRi dhan88 (check) than BRRi dhan28

BR13113-4R-63 producing higher yield over BRRi dhan28.

#### **Regional yield trial (RYT-SMD) for high yielding rice**

Ten entries were evaluated in RYT-SMD for high yielding rice comparing with BRRi dhan58, BRRi dhan88, BRRi dhan89 and BRRi dhan102. Significant higher grain yield was found in tested lines over BRRi dhan58 (check), BRRi dhan88 BRRi dhan89 and BRRi dhan102.

#### **Regional yield trial (RYT-ELS) for high yielding rice**

Four entries were evaluated in RYT-ELS for high yielding rice comparing with BRRi dhan63 and BRRi dhan104. Tested line BR7528-2R-19-16-RIL-52 and BR7528-2R-19-16-RIL-55 produced higher yield than BRRi dhan63 (check) and BRRi dhan104.

#### **Regional yield trial (RYT-MD) for high yielding rice**

Nine entries were evaluated in RYT-MD for high yielding rice comparing with BRRi dhan58, BRRi dhan89 and BRRi dhan102. All the Tested line produced higher yield than BRRi dhan58 (check) and BRRi dhan89.

#### **Regional yield trial (RYT-PQR1) for high yielding rice**

Six entries were evaluated in RYT-PQR1 for high yielding rice comparing with BRRi dhan81 BRRi dhan104 and BRRi dhan107. All the Tested lines produced higher yield than BRRi dhan81 (check), BRRi dhan104 and BRRi dhan107.

#### **Regional yield trial (RYT-PQR2) for high yielding rice**

Five entries were evaluated in RYT-PQR2 for high yielding rice comparing with BRRi dhan58 BRRi dhan104 and BRRi dhan107. Tested line BR11359-4R-169 produced higher yield than BRRi dhan58 (check), BRRi dhan104 and BRRi dhan107.

### **Regional yield trial (RYT-PQR3) for high yielding rice**

Ten entries were evaluated in RYT-PQR2 for high yielding rice comparing with BRRI dhan102, BRRI dhan104 and BRRI dhan107. All the Tested lines produced higher yield than BRRI dhan102 (check), BRRI dhan104 and BRRI dhan107.

### **Regional yield trial (RYT-ZER) for high yielding rice**

Six entries were evaluated in RYT-ZER for high yielding rice comparing with BRRI dhan74 BRRI dhan89 and BRRI dhan100. The tested line BR10571-15-6-8-5 produced higher yield than the check variety BRRI dhan89 and Bangabandhu dhan100.

### **Regional yield trial (RYT-TALL) for high yielding rice**

Five entries were evaluated in RYT-TALL for high yielding rice comparing with BRRI dhan102. The tested line BR10571-15-6-8-5 produced higher yield than the check variety BRRI dhan89 and Bangabandhu dhan100.

### **Regional yield trial (RYT-STR CUM ALART) for high yielding rice**

Five entries were evaluated in RYT- RYT-STR CUM ALART for high yielding rice comparing with BRRI dhan88 and BRRI dhan28. The tested line BR13113-4R-63 produced higher yield than the check variety BRRI dhan28 and BRRI dhan88.

### **Regional yield trial for blast and bacterial blight resistance (BB-Blast)**

Six entries were evaluated with two check varieties BRRI dhan28 and BRRI dhan88. The entry, BR (Path)13802-BC3-10-11-12 produced statistically higher yield over BRRI dhan28 and BRRI dhan88.

### **Regional yield trial for development of disease resistant rice for BB and blast**

A regional yield trial for BB and blast resistance rice was evaluated consisting of 14 entries comparing with three check varieties, BRRI dhan88, BRRI dhan89 and BRRI dhan101. The

entry BR11866-5R-277, BR11867-5R-118, BR11867-5R-119 and BR12437-4R-164 performed better producing higher yields over BRRI dhan88 and BRRI dhan89. These entries and check BRRI dhan101 were identical to each other.

### **Regional yield trial for development of disease resistant rice (Short duration)**

Four entries were evaluated with two check varieties, BRRI dhan28 and BRRI dhan88. The tested entry BR (Path)15857-BC3-4HR-6 and BR (Path)15641-3HR-15 showed statistically better yield over the check variety- BRRI dhan88. BR(Path)15857-BC3-4HR-6 was also good. It maybe also alternative to BRRI dhan28 although these are similar to each other.

### **Regional yield trial for development of disease resistant rice (Medium duration)**

Four entries were evaluated with two check varieties, BRRI dhan58 and BRRI dhan89. The tested entry BR (Path)15854-BC1-3HR-21, BR (Path)15641-4HR-31 and Rod miniket-1 showed statistically better yield over the check variety- BRRI dhan58 and BRRI dhan89.

### **Regional yield trial for development of disease resistant rice (Long duration)**

Five entries were evaluated with one check variety- BRRI dhan29. The entry BR (Path)15855-BC3-2HR-5 produced statistically higher yield over the check- BRRI dhan29.

### **Regional yield trial for development of disease resistant rice (Premium quality short duration)**

Four entries were evaluated with two check varieties- BRRI dhan58 and BRRI dhan89. No tested entries performed statistically better yield over the checks. The entry, BR (Path)15857-4H-33 gave higher yield over the check, BRRI dhan50 but they were statistically similar.

### **Regional yield trial (Barishal) for Favourable Boro rice**

A regional yield trial for favourable Boro rice was evaluated consisting of ten entries comparing with

two check varieties, BRRI dhan74 and BRRI dhan102. The entry NGR 350-2 and NGR 994-1 performed better producing statistically higher yields over BRRI dhan74 and BRRI dhan102.

#### **RYT for short duration (RYT-SD)**

Eight entries were evaluated with two check varieties- BRRI dhan88 and BRRI dhan96. The entries, BR12574-5R-168, BR12208-4R-50, BR12574-5R-52 and BR12671-4R-95 produced statistically higher yield over the two checks.

#### **RYT for GXE interaction of Basmati rice (RYT-GXE)**

Twenty entries were evaluated with six check varieties. The entry, Pusha Basmati and BRRI dhan81 produced statistically higher yield among the entries.

#### **RYT for Favourable Boro**

Six entries were evaluated with two check varieties- BRRI dhan86 and BRRI dhan96. The entry, BR (Bio)13028-AC1-2-4 produced statistically higher yield over the two checks.

#### **Advanced line adaptive research trial (ALART)**

##### **RYT (ALART-SHR -1) for High Yielding Rice**

Two entries were evaluated in RYT-SHR-1 for high yielding rice comparing with BRRI dhan49.

BRH13-2-14-2-1B showing the highest yield with a relatively shorter growth duration.

##### **RYT (ALART-Antioxidant) for high yielding rice**

Two entries were evaluated in RYT-Antioxidant for high yielding rice comparing with BRRI dhan34 and BRRI dhan70. BRRI dhan70 (ck) is the top performer with the highest yield of 4.17 t ha<sup>-1</sup>, despite having the tallest plant height. BR12836-4R-312 also performed well, showing a competitive yield of 3.45 t ha<sup>-1</sup>. BRRI dhan34 (ck) showed the lowest yield, suggesting that the advanced lines BR12836-4R-63 and BR12836-4R-312 offer better yield performance in this trial.

#### **Advanced line adaptive research trial (ALART) for superior high yielding rice (SHR-2) Swarna type grain**

In T. Aman 2023, ALART was conducted for superior high yielding (SHR-2) Swarna type grain with the following objectives:

In ALART-SHR-2, the tested entry BRH9392-6-2-1-3-4 and BR9396-6-2-2B showed statistically better yield over the check variety, BRRI dhan94. BRH9392-6-2-1-3-4 was also good. It may also be alternative to BRRI dhan92.

#### **ALART for salt tolerant rice (STR-Satkhira sadar, Shyamnagar, Kaliganj)**

Advanced line adaptive research trial for salt tolerant rice (STR) was evaluated consisting of four entries comparing with the check varieties of BRRI dhan67 and BRRI dhan89. In satkhira sadar, among the tested genotypes of ALART for STR, none of the entries performed better than the check variety of BRRI dhan67 (7.48 t ha<sup>-1</sup> in 155 days) but produced better than the other check BRRI dhan89. In Syamnagar, no entries performed better over the check, BRRI dhan67 but entries- BR11712-4R-44, BR11712-4R-93, BR11717-4R-12 and BR11727-4R-6 performed better over BRRI dhan89. In ALART-STR, 1st three entries performed better than the check- BRRI dhan67 but these were identical to each other.

#### **ALART for FBR-Bio.**

Advanced line adaptive research trial for FBR-Bio was evaluated consisting of three entries comparing with the check varieties of BRRI dhan86 and BRRI dhan96. Among the three tested genotypes of ALART for FBR-Bio, BRRI dhan96 produced the highest grain yield at 6.13 t ha<sup>-1</sup>. BRRI dhan86 follows with yield of 5.90 t ha<sup>-1</sup>. BR (Bio) 13028AC24-1-2 yielded 5.40 t ha<sup>-1</sup>, BR (Bio)13028AC24-1-3 yielded 4.96 t ha<sup>-1</sup>, and BR (Bio) 13028AC24-1-4 yielded the lowest at 4.10 t ha<sup>-1</sup>.



### **ALART for SHR-1 (Zira type)**

Advanced line adaptive research trial for SHR-1 (Zira type) was evaluated consisting of three entries comparing with the check varieties of BRRI dhan88. Among the three tested genotypes of ALART for ZER, none of the line performed better than the check.

### **ALART for SHR-2 (Katari type)**

Advanced line adaptive research trial for SHR-2 (Katari type) was evaluated consisting of three entries comparing with the check variety of BRRI dhan81. Among the three tested genotypes of ALART for Katari type, BRH9-3-2B was the best performer in terms of both height and yield.

### **ALART for bacterial blight (BB)**

Advanced line adaptive research trial for bacterial blight (BB) was evaluated consisting of three entries comparing with the check varieties of BRRI dhan89 and BRRI dhan92.

Among the three tested genotypes of ALART for BB, BRRI dhan89 (ck) was the top performer for grain yield. BR (path)13800-BC3-224-28 offered a competitive yield, but still fell short of BRRI dhan89 (ck). BRRI dhan92 (ck) and BR (path)13800-BC3-8-1 provided lower yields with the latter having the lowest yields among all the varieties.

ALART for Bacterial blight and Blast resistant (BB-BLAST)

Advanced line adaptive research trial for bacterial blight and blast resistant (BB-BLAST) was evaluated consisting of three entries comparing with the check varieties of BRRI dhan29 and BRRI dhan84. R(path)13800-BC3-224-44 was the best performing entry in this trial for grain yield, suggesting it has superior productivity compared to the other tested varieties.

### **CROP-SOIL-WATER MANAGEMENT**

Effect of missing nutrient on rice production in southern coastal areas during T. Aman 2023 and Boro 2023-24

Nutrient deficiency problems are a major constraint on rice production in all over the country. Proper identification and management of these problems are a prerequisite for boosting production and sustaining high yields over long period of time. Field evaluation of the fertility status of soils plays very important role complementary to soil and plant tests. The missing element trial is an effective technique for field evaluation of fertility status of soils to identify limiting elements which can help proper nutrient management for maximization of rice production. In T. Aman 2022, nutrient controlled plot and N omitted plot produced the lowest yield compared to other fertilizer treatments. Control plot (without fertilization) reduced the highest yield level of 35% followed by N omitted plot (30%), where other nutrient omitted plots reduced the yield level of 9-21% compared to complete fertilizer dose. In Boro season, application of NPKS and Zn significantly increased rice yield compared to control and N omitted plot. Omission of NPKS and Zn (control plot) significantly reduced rice yield over the missing of PKS and Zn plot. However, insignificant variation in rice yield was observed between the missing of N solely and control treatment. Control plot (without fertilization) reduced the highest yield level of 64% followed by N omitted plot (57%), where other nutrient omitted plots reduced the yield level of 5-20% compared to complete fertilizer dose.

### **SOCIO-ECONOMIC AND POLICY**

Stability analysis of BRRI varieties at Satkhira

Stability of a crop in various environments across the country is important for its adoption and expansion to the farmers' field. BRRI has already developed 115 rice varieties for different ago-

ecosystem for Aus, Aman and Boro season. This experiment was taken to identify the most suitable and adaptable BRRI rice varieties for specific area.

During T. Aman 2023, among short-duration varieties, BRRI hybrid dhan6 ( $6.27 \text{ t ha}^{-1}$ ) had the best performance based on yield compared to the others. In medium-duration Aman varieties (22) based on yield, BRRI dhan103 produced the highest grain yield ( $5.95 \text{ t ha}^{-1}$ ), which was identical to BRRI dhan72 ( $5.60 \text{ t ha}^{-1}$ ). The growth duration of those varieties ranged from 126-129 days. In long-duration T. Aman varieties (11), BR23 ( $4.86 \text{ t ha}^{-1}$ ) produced the highest yield, which was identical to BRRI dhan10 ( $4.79 \text{ t ha}^{-1}$ ).

During Boro 2023-24, among the short-duration varieties (26), particularly among hybrid varieties, BRRI hybrid dhan8 produced the highest yield ( $8.36 \text{ t ha}^{-1}$ ) compared to BRRI hybrid dhan3 ( $7.72 \text{ t ha}^{-1}$ ). And particularly among inbred varieties, BRRI dhan101 ( $7.00 \text{ t/ha}$ ) and Bangabandhu dhan100 ( $6.75 \text{ t/ha}$ ) showed better performance considering yield compared to the others. Among the long-duration varieties (26), BRRI dhan47 produced the highest yield ( $6.80 \text{ t ha}^{-1}$ ) followed by BRRI dhan99 ( $6.77 \text{ t ha}^{-1}$ ) but they were almost identical to each other. The growth duration of those varieties ranged from 139-146 days.

## OTHER ACTIVITIES

### Breeder Seed Production

Breeder seed production is the mandatory work to produce breeder seed of BRRI released rice varieties to ensure breeder seed to the public and private seed producers. This is the routine work of BRRI regional station. A total of 21.56 tons of breeder seeds were produced during 2023-2024. In T. Aman season, total 8.30 tons of breeder seeds were produced from two varieties. In addition, 21.65 tons of breeder seeds were produced from four varieties during Boro 2022-2023. All the seeds were sent to GRS Division, BRRI, Gazipur.

### Truthfully labeled seed (TLS) Production

During T. Aman 2023 and Boro 2023-24 seasons, in total 21.09 tons of TLS were produced, stored as well as sold and distributed to the farmers, NGOs, DAE as well. In T. Aman season, total 1.15 tons of TLS seeds were produced from two varieties while, in Boro season, total 1.53 tons of TLS seeds were produced from five varieties.

### Field Day, Farmer's Training and Agriculture Fair

Fourteen farmer's trainings on rice production technology, quality seed production and preservation were conducted to train up 410 farmers of Satkhira, Khulna and Jashore districts. A total of 15 field days were arranged during the reporting period. BRRI, Satkhira attended one agricultural fair as well as participated in various workshops, seminars, regional and district agricultural coordination committee meetings, district coordination committee meetings, discussion meetings, farmers' field visits with advisory activities in field level and on-line basis.

### PROJECT: IRRI-NARES Network trials in Bangladesh for salt-stress prone environment Evaluation of genotypes under IRRI-NARES Network trials in 2023-24 Dry Season (Boro)

In Dumuria, Khulna, grain yield ranged from  $3.69 \text{ t ha}^{-1}$  (IR 145388-B-B-41-B) to  $1.17 \text{ t ha}^{-1}$  (IR 145386-5-B-330-B) and growth duration 143 days (IR21LT1588) to 129 days (IR 145386-5-B-75-B), respectively. A total of 25 entries were selected from stage-1 and five entries were selected from stage 2 trial at Dumuria, Khulna marked in bold in the corresponding tables. Result from stage 1 and stage 2 trial in Dumuria, Khulna. Among 120 entries, only 24 genotypes were selected based on salinity tolerance at hotspot condition, grain type and grain yield. In Shyamnagar and Kaliganj, none of the entries were harvested due to complete damage of the plants for extremities of salinity. None of the entries were selected due to complete

damage of that trial. However, only five entries from stage 1 trial was survived in Shyamnagar as listed in the salinity level at Shyamnagar and Kaliganj, respectively during Boro season 2023.

### **Report of AFACI Trial during Boro 2023-24**

Out of 133 tested entries 27 entries were selected in Dumuria, Khulna on the basis of salinity tolerance label and grain types. The performance of all genotypes and check varieties. The selected genotypes showed low yield performance 532 kg/ha-4582 kg/ha due to the moderately high salinity (4.08-5.95 dS m<sup>-1</sup>), high heat and drought stress. In Kaliganj only eight entries were survived in vegetative stage but all the entries were damaged due to high salinity (10.63-22.65 dS m<sup>-1</sup>) in reproductive stage, so no yield could be collected.

### **Reports on i) Development of salinity tolerant rice (STR), Boro 2023-24 and ii) Development of upland rice (DSR Aus) and jhum rice 2024 funded by PARTNER project**

**Salinity tolerant rice (STR).** In Boro Season, 32 crosses were made using 64 elite parents. A total of 37 F<sub>1</sub>s was confirmed as true hybrid through F<sub>1</sub> verification by quality check (QC) genotyping with purity SNP panel. Total 52,535 segregating progenies from 124 crosses (F<sub>2</sub>-F<sub>5</sub> generation) were harvested from FRGA nursery and grown in the subsequent generation. In LST trial, 425 lines out of 4,331 lines were selected on the basis of desirable plant type, grain quality and uniformity at flowering under field condition. Among 472 and 485 entries, 79 and 167 were selected in OYT-1 and OYT-2 from three locations based on their phenotypic acceptance and salinity tolerance ability during Boro 2023-24 for next breeding programme, but this selection will be further finalized based on yield and relevant quantitative data which is currently under processing. Similar data processing activities is going on for other yield trials viz., PYT to ALART. Among 50 entries in PYT-1 and 59 in PYT-2 were evaluated and 21 entries from PYT-1

and 31 entries from entries PYT-2 were selected from three locations based on their phenotypic acceptance and salinity tolerance. In AYT, among 52 and 44 entries 30 and 27 were selected in AYT-1 and AYT-2 from three locations based on their phenotypic acceptance and salinity tolerance. Result from multilocation data for RYT, ALART and on-farm trial is still in progress, but list of genotypes with relevant protocol is attached in the detailed report. All yield trials were conducted in Gazipur, Khulna and Satkhira region during Boro season where salinity level (EC) varied from 3.09 dS/m to 28.5 dS/m in the field.

### **Development of upland rice (DSR Aus) and jhum rice 2024**

- Population improvement (hybridization to LST) and yield trials (OYT to RYT) of upland and jhum rice are in progress.
- AYT of *ghum* rice has conducted in six different locations of three hill districts (Khagrachori, Rangamati and Bandarban)

## **DEVELOPMENT OF SALT-TOLERANT RICE (STR) FOR SOUTHERN COASTAL BANGLADESH**

### **Hybridization**

Thirty-two crosses were made using 64 elite parents in Boro season. These crosses were made to develop desirable F<sub>1</sub>s having salinity tolerance with other useful traits. Parent selection for crossing was done on the basis of the following criteria such as i) phenotypic value that improves breeding value, ii) genetic distance, iii) no sister lines were used for making cross, iv) the most of the OYT and PYT lines used that are well characterized using trait markers for high amylose+high yield+*Saltol*+*Tr(Chalk5)* + Grain size shape + *Pi54;Pi9 (Blast)+BPH17+Xa21+xa13*), previous mega varieties (BR11, BRRI dhan28 and BRRI dhan29) excluded; and vi) specific line(s) used not more than 3 to 5 times in the crossing program. For

line augmentation, 4 BC<sub>2</sub>F<sub>1</sub>, 2 BC<sub>2</sub> F<sub>1</sub> and 2BC<sub>2</sub>F<sub>2</sub> cross are confirmed for desirable traits.

### **Hybridity test for confirming F<sub>1</sub>s**

To confirm of F<sub>1</sub>s as true hybrid and confirmed F<sub>1</sub>s registered into BRRI cross list and database.

A total of 37 F<sub>1</sub>s was confirmed as true hybrid through F<sub>1</sub> verification by visual comparison of all the crosses with respective parents and also quality check (QC) genotyping with purity SNP panel both in Boro season respectively. The F<sub>1</sub> plants with heterozygous alleles at least two or more SNP loci were declared as true F<sub>1</sub>s (hybrids). After confirmation, the F<sub>2</sub> seeds were collected and preserved. These confirmed F<sub>1</sub>s were registered into BRRI cross list with BR number in Boro season.

### **Growing of FRGA population**

During Boro season about 52,535 genotypes were selected from 124 crosses (F<sub>2</sub>-F<sub>5</sub>)

### **Line Stage Trial (LST)**

Among 4331 lines 425 lines were selected in LST trial in BRRI farm, Satkhira during Boro 2023-24 based on their uniformity, phenotypic acceptance and salinity tolerance ability. These selected lines will be evaluated in next season in STR breeding programme as OYT.

### **Observational Yield Trial (OYT)**

Among 472 and 485 entries, 79 and 167 were selected in OYT-1 and OYT-2 from three locations

based on their phenotypic acceptance and salinity tolerance ability during Boro 2023-24 for next breeding programme. Data collection process is ongoing now. List of materials were selected from OYT-1 and OYT-2.

### **Preliminary Yield Trial (PYT)**

Among 50 entries in PYT-1 and 59 in PYT-2 were evaluated and 21 from entries from PYT-1 and 31 entries from PYT-2 were selected from three locations based on their phenotypic acceptance and salinity tolerance capacity during Boro 2023-24 for next breeding programme. Data analysis is ongoing now. List of materials were selected from PYT-1 and PYT-2.

### **Advanced Yield trial (AYT)**

Among 52 and 44 entries 30 and 27 were selected in AYT-1 and AYT-2 from three locations based on their phenotypic acceptance and salinity tolerance capacity during Boro 2023-24 for next breeding programme. Data analysis is in progress. List of materials were selected from AYT-1 and AYT-2.

### **Regional yield trial (RYT-1: Early maturity-STR) Development of salt tolerant rice, Boro 2023-24**

**Specific objective:** To evaluate specific and general adaptability of the advanced breeding lines as compared with standard checks under on-station condition at different AEZ.



## **BRRI RS, Sonagazi**

|            |                                      |
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## SUMMARY

Altogether 40 crosses were made during T. Aman and Boro at BRRI Regional Station (RS), Sonagazi. One F1 cross of BR22/BR23 and seven F1 crosses were confirmed in Aman and Boro season respectively. Twenty-three BC1F1 crosses of Rajashail and Kajolshail were made during T. Aman. For pure line selection of Ranguin (one of the best local Aus varieties in Hilly areas), 18 uniform lines were selected during T. Aus.

### **AYT (Advanced yield trial) Aus 2023.**

Eight lines along with standard checks BRRI dhan27, BRRI dhan98, BRRI dhan106 and Gota IRRI were tested under AYT#4 (Favourable condition) from which, three lines (BR10969 -3R-23, BR11848-4R-104 and BR12096-4R-12-7) were selected for RYT.

**Regional yield trials (RYT).** A total of 243 breeding lines were tested under RYT during the reporting period from which 43 lines were found better than the checks regarding grain yield and yield contributing characters. Breeding lines were supplied from Plant the breeding and Biotechnology divisions.

**RYT Aus 2023.** Thirty-three lines along with the standard checks BRRI dhan48, BRRI dhan82 and BRRI dhan98 were tested under 3 RYTs (Favourable condition and bacterial Blight resistance) from which, two lines from RYT#1-Favourable condition (BR11863-5R-82 and BR11864-5R-31), three lines from RYT#2-BB (BR 11866-5 R-312, BR11867-5R-87 and BR 11867-5 R-442), three lines from RYT#3-BB (BR(Path)13784 C3-63-6-4-HR6, BR(Path)13784 C3-34-9-10-HR9 and BR(Path)13784 C3-5-3-4-HR 15) were selected for advancing trials.

**RYT Aman 2023.** Ninety-eight lines along with standard checks BR22, BR23, BRRI dhan3, BRRI dhan49, BRRI dhan62, BRRI dhan71, BRRI dhan72, BRRI dhan73, BRRI dhan87, BRRI dhan91, BRRI dhan93, Zira and Katari were tested under 14 RYTs (BB, RLR1, RLR2, Photosensitive,

Tall, ZER, FSm,, Antioxident1, Antioxident2, STR1, STR2, Bio, Zira and Katari) from which, three lines from RYT-BB (BR12098-4R-117, BR12442-4R-49 and BR11869-5R-72), three lines from RYT-FSm (BR (Path) 13804 C3-4, BR (Path)13804 C3-14 and BR (Path)13804 C3-16), one line from RYT-ZER (BR10863-8-3-5-3-2), two lines from RYT-Photosensitive (BR10212-5-5-3 and IR13F652-1-P3), one line from RYT-STR1 (BR13118-4R-76), four lines from RYT-STR2 (BR13103-4R-37, BR13105-4R-37, BR13121-4R-40 and BR13115-4R-32), two lines from RYT-RLR1 (BR12005-6R-14 and BR11333-6R-84), three lines from RYT-Tall (BR98892-8-2-2B, BR10247-14-18-7-3 and BR10238-5-1-9-2B), one line from RYT-Katari (BRH9-3-14-2B), one line from RYT-Zira (BRH11-7-17-10B) were selected for advancing trial.

**RYT Boro 2023-24.** One hundred twelve lines along with standard checks BRRI dhan28, BRRI dhan50, BRRI dhan58, BRRI dhan63, BRRI dhan67, BRRI dhan74, BRRI dhan81, BRRI dhan88, BRRI dhan89, BRRI dhan92, BRRI dhan96, Bangabandhu dhan100, BRRI dhan102, BRRI dhan104 and Local checks (Tepi Boro and Rata Boro) were tested under 12 RYTs (BB-Blast, BB, ZER, FBR-Barishal, FBR-SD, FBR-MD, FBR-SMD, FBR-ELS, FBR-Biotechnology, PQR-Basmati, STR and Tall) from which five lines from FBR-SD (BR12574-5R-168, BR12574-5R-52, BR12520-5R-67, BR12671-4R-95 and BR12208-4R-278), three lines from FBR-MD (BR12517-5R-57, BR12514-5R-27 and BR11318-5R-148), one line from FBR-SMD (BR13027-BC1-3R-77), one line from FBR-ELS (BR7528-2R-19-16-RIL-59), two lines from FBR-Barishal (NGR 350-2 and NGR745-2), five lines from STR (BR13113-4R-63, BR13118-4R-76, BR13113-4R-185, BR13106-4R-184 and BR13122-4R-136), three lines from BB (BR11867-5R-118, BR11867-5R-119 and BR12450-4R-24), three lines from BB-Blast (BR (Path) 13802-BC3-11-10-13, BR (Path) 13802-BC3-12-10-14 and BR (Path) 13784-BC3-19-12-8-HR20) were selected for advanced trial.

**AGGRi network trials (ANT) for salt-stress prone environment in Aman 2023.** The entries showed a wide range of variations in grain yield starting from 0.20 to 6.23 t ha<sup>-1</sup> with a mean value of 3.34 t ha<sup>-1</sup> in first replication and 0.30 to 5.39 t ha<sup>-1</sup> with mean value of 2.76 t ha<sup>-1</sup> in second replication. The overall performance across the site of the tested lines varied from 0.20 to 5.75 t ha<sup>-1</sup> with mean value of 3.04 t ha<sup>-1</sup>. Flowering (50%) and growth duration also varied significantly within the sites. The entries varied in flowering from 81-119 days and growth duration from 116 to 144 days. Wider variations in plant height were also observed within the locations. Plant height of the entries varied from 77 to 136 cm. During the experimental period, significant salinity levels were observed. Mean salinity levels were 0.65, 2.16 and 9.56 dS/m at vegetative, flowering and maturity stages, respectively. A total of 13 rice genotypes IR16F1065, IR20LT2435, IR22LT1621, IR22LT1432, IR22LT1257, IR22LT1490, IR22LT1213, IR22LT1627, IR21LT1445, IR21LT1456, IR22LT1511, IR22LT1345 and IR21LT126 were selected based on yield performance (4.33 to 5.75 t ha<sup>-1</sup>), growth duration (118 to 134 days), plant height (99 to 124 cm) and salinity score (1 to 3) under salinity stress for further investigation

**AGGRi network trials (ANT) for salt-stress prone environment in Boro 2023-24.** Based on salinity score, sterility and yield performance, rice genotypes IR 145405-4-B-115-B, IR 145405-4-B-110-B, IR 145396-B-B-369-B, IR 145411-B-B-96-B, IR 145389-B-B-248-B, IR 145398-B-B-28-B, IR 145398-B-B-342-B, IR 145396-B-B-137-B, IR 145396-B-B-154-B, IR 145396-B-B-263-B, IR 145388-B-B-2-B, IRRI 147, BRRI dhan67 and BRRI dhan97 from stage-1 and IR21LT1525, IR21LT1550, IRRI 147, IRRI 239, BRRI dhan67, BRRI dhan88 and Binadhan-10 from Stage-2 were selected for further proceed under salinity stress. Saline water was imposed in experimental field to increasing salinity stress for the crop. Water salinity was measured at three days interval. Inclusion of salt water from river was started on 12 March 2024. Average salinity label was 8.9, 18.77 and 7.13

dS/m at vegetative, flowering and ripening stage respectively. The crops were severely affected by salinity at reproductive phase so that most of the entries, yield tend to zero. Moreover, plants of most of the entries converted to straw color before ripening, however, plants of some entries remained still green. We hope those entries could be used for future research.

**Advanced line adaptive research trial (ALART).** Six and 33 lines along with standard checks were evaluated under three ALARTs and 11 ALARTs during Aman 2023 and Boro 2023-24, respectively in different locations of BRRI RS, Sonagazi, Feni and Noakhali.

**MLT (Multi-locations yield trial) Boro 2023-24.** Twenty-five lines along with standard checks were evaluated under five MLTs during Boro 2023-24.

**Survey of pest incidence.** Survey was carried out at farmers' fields of Feni, Noakhali, Laxmipur, Cox's bazar, Chattogram and Khagrachari districts in Aman 2023 and Boro 2022-24. Sites were selected with the suggestion and collaboration of Upazila Agriculture Officer (UAO) of the Department of Agricultural Extension (DAE). Sub Assistance Agricultural Officers (SAAO) of concerned block helped in site selection who were the front-line workers and very much familiar to the farmers as well as their fields.

Bacterial leaf blight (BLB), bacterial leaf streak (BLS), sheath rot, false smut and Sheath blight infestation were observed in different scores during Aman season. BRRI dhan49 in different locations and other breeding materials of BRRI RS, Sonagazi research field were affected by false smut disease in different locations due to fluctuation of environmental conditions during Aman season. BRRI dhan28, BRRI dhan29, BRRI dhan67, BRRI dhan97, BRRI dhan89, BRRI dhan92 and BRRI dhan84 were affected moderately to high by neck blast during Boro season. The farmers were suggested for taking preventive measures using fungicide.



Rice insect pests and their natural enemies were monitored throughout the reporting period by Pennsylvanian light traps from July 2023 to June 2024 at the experimental field of BRRI RS, Sonagazi, Feni. The abundance of leaf roller, stem borer, rice bug, green leafhopper, grasshopper, mole cricket, field cricket, and stink bug were found in the light trap during the reporting period. Some beneficial insects like lady bird beetle, spider, damselfly, carabid beetle, staphylinid beetle were also found.

**Reduction of insecticide use in rice production during Aman 2023.** BRRI dhan72 and BRRI dhan87 produced significantly higher yield in T2 (Prophylactic insecticide use) treatment as compared to T1 (Refrained from insecticide) treatment. BRRI dhan95 produced significantly similar yield in both the treatments. Higher number of dead heart and white head (caused by yellow stem borer attack) and ETL percentage was found in all three varieties using T1 treatment as compared to T2 treatment. Nevertheless, BRRI dhan87 produced the highest yield ( $5.61 \text{ t ha}^{-1}$ ) using T2 treatment as compared to all treatment-variety combinations. Besides, BRRI dhan87 showed significantly higher number of dead heart (759) and white head (117) which ETL percentage were 19.01 and 4.16 respectively, using T1 treatment as compared to all treatment-variety combinations. All treatment-variety combinations showed below 5% ETL.

**Reduction of insecticide use in rice production during Boro 2023-24.** Bangabandhu dhan100 ( $6.58 \text{ t ha}^{-1}$ ), BRRI dhan96 ( $6.21 \text{ t ha}^{-1}$ ) and BRRI dhan97 ( $5.58 \text{ t ha}^{-1}$ ) produced higher yield in T<sub>3</sub> (application of Bio-insecticide) treatment as compared to the other (T<sub>1</sub>= Refrained from insecticide and perching, T<sub>2</sub>= application of Prophylactic insecticide and T<sub>4</sub>= Refrained from insecticide, using perching) treatments. Significantly higher number of dead heart and white head (caused by yellow stem borer attack) and ETL percentage was found in all the three varieties using T1 treatment as compared to T2, T3

and T4 treatments. Nevertheless, Bangabandhu dhan100 produced the highest yield ( $6.58 \text{ t ha}^{-1}$ ) using T3 treatment as compared to all treatment-variety combinations. Besides, BRRI dhan97 showed significantly higher number of dead heart and white head which ETL percentage using T1 treatment as compared to all treatment-variety combinations. These combinations showed below 5% ETL.

**Determination of suitable seedling age from dibbled field, Aus 2023.** Among the treatments, D<sub>2</sub> (splitting tillers at 25 days after dibbling) produced the highest mean grain yield  $5.14 \text{ t ha}^{-1}$ , which was statistically similar with D<sub>3</sub> (splitting tillers at 30 days after dibbling) ( $4.84 \text{ t ha}^{-1}$ ), D<sub>4</sub> ( $4.81 \text{ t ha}^{-1}$ ), D<sub>1</sub> ( $4.74 \text{ t ha}^{-1}$ ). The lowest mean grain yield obtained in the D<sub>1</sub> = splitting tillers at 20 days after dibbling ( $4.74 \text{ t ha}^{-1}$ ) followed by D<sub>4</sub> = splitting tillers at 35 days after dibbling ( $4.81 \text{ t ha}^{-1}$ ). Yield was not increased significantly in among the different seedling ages. Therefore, it is concluded that early seedling age, 25-day-old seedling would be recommended for transplanting by uprooting plants from dibbled field at saline char land.

**Effect of planting time, Aman 2023.** Yield decreased due to early and delay plantings, lodging and bird damage. Optimum date for short duration in Aman season was found between mid-july to mid-August. The lowest grain yield of tested varieties in short duration was found on BRRI dhan90 ( $1.81 \text{ t/ha}$ ) in the first set transplanted on 5 July 2023. Growth duration of short duration varieties ranges from 114 to 128 days. Among the long duration varieties BRRI dhan52 produced the highest grain yield ( $5.98 \text{ t/ha}$ ) transplanted at 5 August 2023 followed by BRRI dhan93 ( $5.61 \text{ t/ha}$ ) and BRRI dhan79 ( $4.83 \text{ t/ha}$ ). Yield decreased due to early and delay plantings, lodging and bird damage. The lowest grain yield of the tested varieties in long duration was found on BRRI dhan93 ( $2.17 \text{ t/ha}$ ) in the first set transplanted on 5 July 2023. Growth duration of long duration varieties ranges from 134 to 141 days.

#### **Effect of planting time, Boro 2023-24.**

Yield and yield components were significantly affected by both the planting dates and varieties. Across the planting dates, BRRI dhan92 produced the highest grain yield (8.04 t/ha) transplanted at 25 December 2023 followed by BRRI dhan89 (7.68 t/ha). Yield decreased gradually in the deployed plantings due to weather factors. The lowest grain yield of tested varieties was found on BRRI dhan96 (4.85 t/ha) in the last set transplanted on 25 February 2024 followed by BRRI dhan88 (5.20 t/ha).

#### **Effect of nitrogen levels on protein quality of rice at different regions, Aman 2023.**

Yield and yield components data were taken at the maturity stage. Grain yield, plant height, filled and unfilled grain panicles<sup>-1</sup>, 1000-grain weight and growth durations were significantly affected by the different levels of N fertilizer treatments except tiller no. hill<sup>-1</sup> and panicles no. hill<sup>-1</sup>. Every parameter, 100 kg N ha<sup>-1</sup> (T<sub>4</sub>) treatment has been performed the best.

**Multi-location trials (MLT) of promising hybrid, Aman 2023.** Entry AZ 7006 (Ck-2) produced the highest yield (5.35 t/ha) compared to the other entries (5.01-1.98 t/ha) and showed 104 cm plant height and 118 days growth duration. On the other hand, entry Dhanny Gold (Ck-3), BRRI hybrid dhan6 (Ck-, BRRI97A/BRRI42R, IR79156A/BRRI42R produced satisfactory higher yield (5.501- 3.56 t/ha) than the rest of the entries (3.53-1.98 t/ha) and exhibited 113-128 cm plant height having 105-109 days growth duration. Most of the entries were heavily affected by BLB and sheath blight disease and were also infested by stem borer. So, on the basis of yield, growth duration, plant height and other agronomic character, entry BRRI97A/BRRI42R and IR79156A/BRRI42R were selected for advanced trials.

**Multi-location trials (MLT) of promising hybrid, Bror 2023-24.** Entry Tej Gold (Ck-4) produced the highest yield (7.16 t/ha) compared to the other entries. On the other hand,

entry BRRI109A/BRRI42R and BRRI120A/BRRI55R produced satisfactory higher yield 6.50 and 6.40 t/ha respectively than the rest of the entries. Most of the entries were heavily affected by BLB and sheath blight diseases. Rat damages were also seen in some entries. So, on the basis of yield, growth duration, plant height and other agronomic characters, entry BRRI109A/BRRI42R and BRRI120A/BRRI55R were selected for advanced trials.

**Stability analysis, Aus 2023.** Among the varieties, BRRI dhan98 produced the highest mean grain yield (6.263 t ha<sup>-1</sup>) followed by BRRI hybrid dhan7 (5.887 t ha<sup>-1</sup>). BR21, BR24, and BRRI dhan65 BRRI dhan27 produced lower grain yield 3.320, 3.770 and 3.362 t ha<sup>-1</sup> respectively.

**Stability analysis, Aman 2023.** Among the varieties, BRRI hybrid dhan6 ranked the top in terms of yield (6.03 t ha<sup>-1</sup>) followed by BRRI dhan103 (5.75 t/ha). BR5, BRRI dhan91 and BRRI dhan37 were found low yielding varieties having grain yield 2.56, 3.01 and 3.20 t ha<sup>-1</sup> respectively.

**Stability analysis, Boro 2023-24.** Among the varieties, BRRI hybrid dhan8 ranked the top in terms of yield (8.7 t ha<sup>-1</sup>) followed by BRRI hybrid dhan5 (8.12 t ha<sup>-1</sup>). The varieties BRRI dhan28, BRRI dhan81 and BRRI dhan63 were found low yielding having grain yield of 3.80, 4.12 and 4.29 t ha<sup>-1</sup> respectively.

**Demonstration of modern rice varieties.** A total 2740 demonstrations of modern rice varieties were executed in 2740 bigha land during the reporting period under GoB and different projects.

**GOB fund.** A total of 450 demonstrations were executed in 450 bigha land at farmers' field at Chattogram and Rangamati regions during 2023-2024 funded by GOB.

**Karmasuchi fund.** A total of 660 demonstrations were executed in 660 bigha land at farmers' field during the reporting period under BRRI Sonagazi Research and Development Karmasuchi.

**Hybrid project fund.** A total of 130 demonstrations were executed in 130 bigha land at farmer's field during 2023-2024 funded by BRRI Hybrid project.

#### **Farmers Training on Rice Technology 2023-24**

**GOB fund.** Forty farmers trainings on rice technologies were executed and trained up 1200 farmers having 952 male and 248 female farmers.

**Karmasuchi fund.** Sixty-six farmers trainings on rice technologies were conducted and trained up 1,980 farmers having 1,522 male and 458 female farmers.

**PARTNER fund.** Eight farmers trainings on rice technologies were conducted and trained up 240 farmers having 213 male and 27 female farmers.

**LSTD fund.** Two farmers trainings on rice technologies were conducted and trained up 80 farmers having 71 male and nine female farmers.

#### **Field day 2023-24**

**GOB fund.** Nineteen field days were conducted in selected demonstration sites at maturity stage during 2023-2024 financial year. Nearly 1700 progressive farmers, local leaders, extension personnel (DAE and NGO personnel) and public representatives were participated in those occasions.

**Karmasuchi fund.** Twenty-six field days were organized in selected demonstration sites at maturity stage during 2023-24 funded by BRRI RS, Sonagazi Research and development Karmasuchi. Almost 2,600 progressive farmers, local leaders, extension personnel and public representatives were participated in the occasions.

**Hybrid project fund.** Two field days were conducted under the Hybrid rice project. About 210 progressive farmers, local leaders, extension personnel (DAE and NGO personnel) and public representatives participated in those occasions.

#### **Breeder Seed Production**

**GOB fund.** A total of 12.75 ton breeder seeds were produced under GOB fund during the reporting period. All the breeder seeds of different varieties were sent to the Genetic Resources and Seed Division, BRRI HQ, Gazipur.

**Karmasuchi fund.** A total of 19.5 ton breeder seeds were produced under the Karmasuchi fund during the reporting period. All the Breeder seeds of different varieties were sent to the Genetic Resources and Seed Division, BRRI HQ, Gazipur.

#### **Quality Seed (TLS) Production**

**GOB fund.** 20.22 tons TLS of modern rice varieties were produced by BRRI RS, Sonagazi during the reporting period.

**Karmasuchi Fund.** A total of 52.25 ton TLS of modern rice varieties were produced by BRRI RS, Sonagazi during the reporting period.

**F1 seed production of BRRI hybrid dhan5.** In Boro 2023-24 season, F1 seed production of BRRI hybrid dhan5 was conducted at the field of BRRI RS, Sonagazi, Feni. A total of 1,050 kg (0.98 t/ha) seeds of BRRI hybrid dhan5 were obtained.

#### **VARIETY DEVELOPMENT PROGRAMME**

##### **Germplasm collection for Pure line selection:**

Ranguin is a one of the best and popular local Aus variety in hilly areas. Eighteen uniform lines were selected during T. Aus season.

Investigators: M Adil, S Tamanna, B Karmakar

##### **AYT (Advanced yield trial), T. Aus 2023**

Eight lines along with the standard checks BRRI dhan27, BRRI dhan98, BRRI dhan106 and Gota IRRI were tested under AYT#4 (Favourable condition) in BRRI RS, Sonagazi, Feni to find out the yield performance and to advance evaluation of promising breeding lines. Three lines (BR10969 - 3R-23, BR11848-4R-104 and BR12096-4R-12-7) were selected for RYT.

Investigators: M Adil, S Tamanna, B Karmakar

### Regional yield trials (RYT), T. Aus 2023

Thirty-three lines along with the standard checks BRRI dhan48, BRRI dhan82 and BRRI dhan98 were tested under 3 RYT (Favourable condition and bacterial blight resistance) in in BRRI RS, Sonagazi, Feni to test the yield performance and to evaluate the yield potential and adaptability. Two lines from RYT#1-Favourable condition (BR11863-5R-82 and BR11864-5R-31), three lines from RYT#2-BB (BR 11866-5 R-312, BR11867-5R-87 and BR 11867-5 R-442), three lines from RYT#3-BB BR (Path)13784 C3-63-6-4-HR6, BR (Path) 13784 C3-34-9-10-HR9 and BR (Path)13784 C3-5-3-4-HR15) were selected for advance trial.

Investigators: M Adil, S Tamanna, B Karmakar

### Hybridization, T. Aman 2023

In this hybridization programme, five crosses were made to forward breeding using BRRI varieties (Table 1) and 23 BC<sub>1</sub>F<sub>1</sub> crosses of Rajashail and Kajolshail were made (Table 2), expected to introgress genes from diverse genetic background for the improvement of local popular photosensitive variety with higher yield (7.0 t/ha), slender grain, lodging tolerance. In, backcross breeding, crossing was done between F<sub>1</sub> and respective donor parents and to forward breeding crossing was done between elite vs elite parents. Usual method of emasculation and pollination was followed for crossing.

Investigators: M Adil, S Tamanna, B Karmakar

**Table 1. List of crosses made for forward breeding during T. Aman 2023, BRRI RS, Sonagazi.**

| Cross combinations       | Traits                                          | No. of F <sub>1</sub> Seeds |
|--------------------------|-------------------------------------------------|-----------------------------|
| BRRI dhan87/BRRI dhan75  | Lodging tolerant, short duration                | 21                          |
| BRRI dhan103/BRRI dhan75 | Lodging tolerant, short duration                | 19                          |
| BRRI dhan49/BRRI dhan75  | Short duration, slender grain                   | 63                          |
| BRRI dhan75/BRRI dhan34  | Aroma, short grain                              | 90                          |
| BRRI dhan52/BRRI dhan75  | Lodging tolerant, short duration, slender grain | 5                           |

**Table 2. List of crosses made for backcross breeding (BC<sub>1</sub>F<sub>1</sub>) during T. Aman 2023, BRRI RS, Sonagazi.**

| BR No.  | Cross combinations                    | Traits                                                        | No. of F <sub>1</sub> Seeds |
|---------|---------------------------------------|---------------------------------------------------------------|-----------------------------|
| BRSon1  | Rajashail/BRRI dhan103// BRRI dhan103 | Photosensitivity, high yield                                  | 111                         |
| BRSon2  | Rajashail/BRRI dhan87// BRRI dhan87   | Photosensitivity, high yield                                  | 158                         |
| BRSon3  | Rajashail/BRRI dhan52// BRRI dhan52   | Photosensitivity, high yield, submergence                     | 152                         |
| BRSon4  | Rajashail/BRRI dhan49// BRRI dhan49   | Photosensitivity, high yield, lodging tolerant                | 75                          |
| BRSon5  | Rajashail/BR11//BR11                  | Photosensitivity, high yield                                  | 82                          |
| BRSon6  | Rajashail/BRRI dhan54// BRRI dhan54   | Photosensitivity, high yield                                  | 104                         |
| BRSon7  | Rajashail/BRRI dhan71// BRRI dhan71   | Photosensitivity, high yield                                  | 16                          |
| BRSon8  | Rajashail/BRRI dhan75// BRRI dhan75   | Photosensitivity, high yield, slender grain, lodging tolerant | 41                          |
| BRSon9  | Rajashail/BR22// BR22                 | Photosensitivity, high yield                                  | 24                          |
| BRSon10 | Rajashail/BRRI dhan72// BRRI dhan72   | Photosensitivity, high yield                                  | 84                          |
| BRSon11 | Rajashail/BRRI dhan79// BRRI dhan79   | Photosensitivity, high yield                                  | 365                         |
| BRSon12 | Rajashail/BRRI dhan80// BRRI dhan80   | Photosensitivity, high yield, slender grain                   | 96                          |
| BRSon13 | Rajashail/BRRI dhan90// BRRI dhan90   | Photosensitivity, high yield, short grain                     | 25                          |
| BRSon14 | Rajashail/BRRI dhan94//BRRI dhan94    | Photosensitivity, high yield                                  | 144                         |
| BRSon16 | Kajalshail /BRRI dhan46// BRRI dhan46 | Photosensitivity, high yield                                  | 73                          |
| BRSon17 | Kajalshail /BRRI dhan49// BRRI dhan49 | Photosensitivity, high yield, lodging tolerant                | 135                         |

| BR No.  | Cross combinations                    | Traits                                                        | No. of F <sub>1</sub> Seeds |
|---------|---------------------------------------|---------------------------------------------------------------|-----------------------------|
| BRSon18 | Kajalshail /BRRI dhan51// BRRI dhan51 | Photosensitivity, high yield, submergence                     | 319                         |
| BRSon19 | Kajalshail /BRRI dhan52// BRRI dhan52 | Photosensitivity, high yield, submergence                     | 241                         |
| BRSon20 | Kajalshail /BRRI dhan54// BRRI dhan54 | Photosensitivity, high yield                                  | 109                         |
| BRSon21 | Kajalshail /BRRI dhan75// BRRI dhan75 | Photosensitivity, high yield, slender grain, lodging tolerant | 158                         |
| BRSon22 | Kajalshail /BRRI dhan78// BRRI dhan78 | Photosensitivity, high yield, submergence                     | 40                          |

**F1 confirmation, T. Aman 2023.** One F1 cross of BR22/BR23 was confirmed (Table 3).

Investigators: M Adil, S Tamanna, B Karmakar

**Table 3. List of cross confirmed for forward breeding during T. Aman 2023, BRRI RS, Sonagazi.**

| BR      | Parentage | Trait                        |
|---------|-----------|------------------------------|
| BRSon23 | BR22/BR23 | Photosensitivity, high yield |

### Hybridization, Boro 2023-24

In this hybridization program, 35 crosses were made to forward breeding using BRRI varieties/ Breeding lines (Table 4), expected to introgress genes from diverse genetic background for the development of high yielding variety (8.50-9.50 t/ha) with salt tolerant, short duration, slender grain,

lodging tolerant and disease resistant (Blast and BB. Crossing was done between elite vs elite parents. Usual method of emasculation and pollination was followed for crossing.

Investigators: M Adil, S Tamanna, B Karmakar

**Table 4. List of crosses made during Boro 2023-24, BRRI RS, Sonagazi.**

| Parentage                             | Predicted GY (t/ha) | Predicted GD (day) | Trait                                     | No. of F <sub>1</sub> seeds |
|---------------------------------------|---------------------|--------------------|-------------------------------------------|-----------------------------|
| BRRI dhan74/BR11717-4R-12             | 7.35                | 148                | Salinity, high yield                      | 11                          |
| BRRI dhan74/BR10645-6-4-8-1-2         | 6.98                | 149                | PQR, high yield                           | 29                          |
| BRRI dhan74/BR11712-4R-44             | 7.84                | 149                | Salinity, high yield                      | 16                          |
| BRRI dhan67/BR (path)13800-BC3-134-8  | 7.75                | 145                | BB, blast, salinity, High yield           | 3                           |
| BRRI dhan67/BR11727-4R-6              | 7.05                | 144                | Salinity, high yield                      | 8                           |
| BRRI dhan67/BR11712-4R-44             | 7.84                | 145                | Salinity, high yield                      | 13                          |
| BRRI dhan67/BR11712-4R-93             | 7.90                | 145                | Salinity, high yield                      | 21                          |
| BRRI dhan84/BR (path)13800-BC3-134-8  | 7.25                | 145                | BB, blast, high yield                     | 40                          |
| BRRI dhan84/BR11712-4R-93             | 7.40                | 145                | Salinity, slender grain, zinc, high yield | 31                          |
| BRRI dhan89/BR11903-5R-56             | 7.50                | 149                | Short duration, high yield                | 45                          |
| BRRI dhan89/BR (path)13800-BC3-134-25 | 8.20                | 153                | BB, blast, high yield                     | 23                          |
| BRRI dhan89/BR11712-4R-44             | 8.09                | 152                | Salinity, high yield                      | 30                          |
| BRRI dhan89/BR (path)13800-BC3-134-8  | 8.00                | 152                | BB, blast, high yield                     | 13                          |
| BRRI dhan92/BR (path)13800-BC3-134-8  | 8.25                | 153                | BB, blast, high yield                     | 29                          |
| BRRI dhan92/BR (path)13800-BC3-134-25 | 8.45                | 154                | BB, blast, high yield                     | 61                          |
| BRRI dhan92/BR11712-4R-44             | 8.34                | 154                | Short duration, salinity, high yield      | 47                          |

| Parentage                              | Predicted<br>GY (t/ha) | Predicted<br>GD (day) | Trait                                      | No. of F <sub>1</sub><br>seeds |
|----------------------------------------|------------------------|-----------------------|--------------------------------------------|--------------------------------|
| BRR I dhan96/BR (path)13800-BC3-134-8  | 7.75                   | 145                   | Short duratin, BB, blast, high yield       | 13                             |
| BRR I dhan96/BR11712-4R-44             | 7.84                   | 145                   | Short duration, salinity, high yield       | 25                             |
| BRR I dhan96/BPH Line                  | 7.00                   | 143                   | BPH, Short duration, high yield            | 19                             |
| BRR I dhan96/BR11712-4R-93             | 7.90                   | 145                   | Short duration, salinity, high yield       | 39                             |
| BRR I dhan97/BR (path)13800-BC3-134-8  | 7.50                   | 150                   | BB, blast, salinity, high yield            | 24                             |
| BRR I dhan97/BR11712-4R-44             | 7.59                   | 150                   | Salinity, high yield                       | 13                             |
| BRR I dhan97/BR11717-4R-12             | 7.61                   | 150                   | BB, Blast, salinity, high yield            | 12                             |
| BRR I dhan97/BRR I dhan104             | 7.00                   | 147                   | Short duration, salinity, high yield       | 8                              |
| BRR I dhan97/BR11712-4R-93             | 7.65                   | 150                   | Salinity, high yield                       | 23                             |
| BRR I dhan97/BR11727-4R-6              | 7.10                   | 150                   | Salinity, high yield                       | 39                             |
| BRR I dhan97/BR (path)13800-BC3-8-1    | 6.80                   | 149                   | BB, blast, salinity, high yield            | 35                             |
| BRR I dhan97/BR11903-5R-56             | 7.15                   | 149                   | Slender grain, salinity, aroma, high yield | 12                             |
| BRR I dhan99/BR11727-4R-6              | 6.95                   | 150                   | Salinity, high yield                       | 20                             |
| BRR I dhan99/BR (path)13800-BC3-8-1    | 7.76                   | 151                   | BB, blast, salinity, high yield            | 13                             |
| BRR I dhan99/BRR I dhan104             | 7.30                   | 150                   | Slender grain, salinity, aroma, high yield | 13                             |
| BRR I dhan99/BR11712-4R-93             | 7.80                   | 151                   | Salinity, high yield                       | 30                             |
| BRR I dhan99/BR11712-4R-44             | 7.74                   | 151                   | Salinity, Short duration, high yield       | 110                            |
| BRR I dhan99/IR18A2119                 | 7.05                   | 149                   | Salinity, Short duration, high yield       | 79                             |
| BRR I dhan99//BR (path)13800-BC3-134-8 | 7.65                   | 151                   | BB, Blast, salinity, high yield            | 29                             |

**F1 confirmation, Boro 2023-24.** Seven F1 crosses was confirmed (Table 5).

Investigators: M Adil, S Tamanna, B Karmakar

**Table 5. List of cross confirmed for forward breeding during Boro 2023-24, BRR I Rs, Sonagazi.**

| BR no.  | Parentage                   |
|---------|-----------------------------|
| BRSon24 | BRR I dhan99/BR11715-4R-16  |
| BRSon25 | BRR I dhan99/BR11712-4R-79  |
| BRSon26 | RRI dhan99/BR11712-4R-1     |
| BRSon27 | BRR I dhan99/BR12180-5R-7   |
| BRSon28 | BRR I dhan74/BR11716-4R-105 |
| BRSon29 | BRR I dhan74/BR11712-4R-93  |
| BRSon30 | BRR I dhan74/IRRI 154 (Pi9) |

## **Regional yield trials (RYT), Boro 2023-24**

One-hundred twelve lines along with standard checks BRRI dhan28, BRRI dhan50, BRRI dhan58, BRRI dhan63, BRRI dhan67, BRRI dhan74, BRRI dhan81, BRRI dhan88, BRRI dhan89, BRRI dhan92, BRRI dhan96, Bangabandhu dhan100, BRRI dhan102, BRRI dhan104 and Local checks (Tepi Boro and Rata Boro) were tested under 12 RYT's (BB-Blast, BB, ZER, FBR-Barishal, FBR-SD, FBR-MD, FBR-SMD, FBR-ELS, FBR-Biotechnology, PQR-Basmati, STR and Tall) in in BRRI RS, Sonagazi, Feni to test the yield performance and to evaluate the yield potential and adaptability. Five lines from FBR-SD (BR12574-5R-168, BR12574-5R-52, BR12520-5R-67, BR12671-4R-95 and BR12208-4R-278), three lines from FBR-MD (BR12517-5R-57, BR12514-5R-27 and BR11318-5R-148), one line from FBR-SMD (BR13027-BC1-3R-77), one line from FBR-ELS (BR7528-2R-19-16-RIL-59), two lines from FBR-Barishal (NGR 350-2 and NGR745-2), five lines from STR (BR13113-4R-63, BR13118-4R-76, BR13113-4R-185, BR13106-4R-184 and BR13122-4R-136), three lines from BB (BR11867-5R-118, BR11867-5R-119 and BR12450-4R-24), three lines from BB-Blast (BR (Path) 13802-BC3-11-10-13, BR (Path) 13802-BC3-12-10-14 and BR (Path) 13784-BC3-19-12-8-HR20) were selected for advanced trial.

## **Advanced line adaptive research trial (ALART)**

Investigators: M Adil, Md. Asib Biswas, Sania Tamanna, B Karmakar

Six and 33 lines along with standard checks were evaluated under 3 ALARTs and 11 ALARTs during Aman 2023 and Boro 2023-24, respectively in different locations of BRRI RS, Sonagazi, Feni and Noakhali to test the yield performance and to evaluate the yield potential and adaptability of superior breeding lines.

## **PEST MANAGEMENT**

### **Survey and monitoring of rice diseases**

Investigators: Sania Tamanna, M Adil, B Karmakar

Survey was carried out at farmers' fields of Feni, Noakhali, Laxmipur, Cox'sbazar, Chattogram and Khagrachari districts in Aman 2023 and Boro 2022-24. Sites were selected with the suggestion and collaboration of Upazila Agriculture Officer (UAO) of the Department of Agricultural Extension (DAE). Sub Assistance Agricultural Officer (SAAO) of concerned block helped in site selection who were the front-line workers and very much familiar to the farmers as well as their fields. Bacterial leaf blight (BLB), bacterial leaf streak (BLS), Sheath rot, False smut and Sheath blight infestation were observed in different scores during Aman season. BRRI dhan49 in different locations and other breeding materials of BRRI RS, Sonagazi research field were affected by false smut disease in different locations due to fluctuation of environmental conditions during Aman season. BRRI dhan28, BRRI dhan29, BRRI dhan67, BRRI dhan97, BRRI dhan89, BRRI dhan92 and BRRI dhan84 were affected moderately to high by neck blast during Boro season. The farmers were suggested for taking preventive measures using fungicide.

### **Monitoring of insect pests and natural enemies by using light trap**

Investigators: Sania Tamanna, M Adil, B Karmakar

Rice insect pests and their natural enemies were monitored throughout the reporting period by Pennsylvanian light traps from July 2023 to June 2024 at the experimental field of BRRI RS, Sonagazi, Feni. The abundance of leaf roller, stem borer, rice bug, green leafhopper, grasshopper, mole cricket, field cricket, and stink bug were found in the light trap during the reporting period. Some beneficial insects like lady bird beetle, spider, damsel fly, carabid beetle, staphylinid beetle were also found.

### **Reduction of insecticide use in rice production to ensure safe food production in Aman 2023**

Investigators: Sania Tamanna, M Adil, B Karmakar

The experiment was conducted at the experimental field of BRRI RS, Sonagazi during Aman 2023 season to manage insect pests with less or no use of insecticide and to compare insect pests and natural enemy status in insecticide free and insecticide spray field. BRRI varieties i.e., V1=BRRI dhan72, V2=BRRI dhan87 and V3=Bangabandhu dhan95 were transplanted. Unit plot size was one bigha. Two treatments i.e., T<sub>1</sub>=Refrained from insecticide use up to 40 days (to increase natural enemies) and T<sub>2</sub>= Prophylactic insecticide use@15 days interval (3 times) were applied. This experiment was laid out in a CRD with three replications. Twenty-day-old seedlings of each variety were transplanted in one bigha land using 2-3 seedlings with a spacing of 20 cm x 20 cm. BRRI recommended fertilizer doses were used in all the plots. All the intercultural operations were done when required except insecticide. Insect pests and natural enemies in the rice field were monitored fortnightly by sweeping and visual counting of randomly selected 20 hills. Perching @100/ha were also used in T<sub>1</sub> and insecticide used ETL based or not. In T<sub>2</sub>, granular insecticide was used during 1<sup>st</sup> top dressing of urea as a farmers practice without considering insect infestation. Again two times insecticide were also used at 15 days interval in T<sub>2</sub>. BRRI dhan72 and BRRI dhan87 produced significantly higher yield in T<sub>2</sub> (Prophylactic insecticide use) treatment as compared to T<sub>1</sub> (Refrained from insecticide) treatment. BRRI dhan95 produced significantly similar yield in both treatments. Higher number of dead heart and white head (caused by yellow stem borer attack) and ETL percentage was found in all three varieties using T<sub>1</sub> treatment as compared to T<sub>2</sub> the treatment. Nevertheless, BRRI dhan87 produced highest yield (5.61 tha<sup>-1</sup>) using T<sub>2</sub> treatment as compared to all treatment-variety combinations. Besides, BRRI dhan87 showed significantly higher number of dead heart (759) and white head (117) which ETL percentage were 19.01 and 4.16 respectively, using T<sub>1</sub> treatment as compared to all treatment-variety

combinations. All treatment-variety combinations showed 5% ETL.

### **Reduction of insecticide use in rice production to ensure safe food production in Boro 2023-24**

Investigators: Sania Tamanna, M Adil, B Karmakar

The experiment was conducted at the experimental field of BRRI Rs, Sonagazi during Boro 2023-24 designed to manage insect pests with less or no use of insecticide and to compare insect pests and natural enemy status in insecticide-free and insecticide-spray field. BRRI varieties i.e., V1=BRRI dhan96, V2=BRRI dhan97 and V3=Bangabandhu dhan100 were transplanted. Unit plot size was two decimals. Four treatments i.e., (T<sub>1</sub>= Refrained from insecticide and perching, T<sub>2</sub>= application of Prophylactic insecticide, T<sub>3</sub>= application of Bio-insecticide and T<sub>4</sub>= Refrained from insecticide, use perching) treatments were applied. This experiment was laid out in a Strip plot design with three replications. Forty-day-old seedlings of each variety were transplanted in one bighas of land using 2-3 seedlings with a spacing of 20 cm x 20 cm. BRRI recommended fertilizer doses were used in all the plots. All the intercultural operations were done when required except insecticide. Insect pests and natural enemies in the rice field was monitored fortnightly by sweeping and visual counting of randomly selected 20 hills. Perching @100/ha were also used in T<sub>4</sub> and insecticide used ETL based or not. In T<sub>2</sub> and T<sub>4</sub>, granular insecticide and bio-insecticide were used during 1<sup>st</sup> top dressing of urea as a farmers practice without considering insect infestation. Two times insecticide were also used at 15 days interval in T<sub>2</sub> and T<sub>4</sub>. Bangabandhu dhan100 (6.58 tha<sup>-1</sup>), BRRI dhan96 (6.21 tha<sup>-1</sup>) and BRRI dhan97 (5.58 tha<sup>-1</sup>) produced higher yield in T<sub>3</sub> (application of Bio-insecticide) treatment as compared to the other (T<sub>1</sub>= Refrained from insecticide and perching, T<sub>2</sub>= application of prophylactic insecticide and T<sub>4</sub>= refrained from insecticide, use perching) treatments. Significantly Higher number of dead



heart and white head (caused by yellow stem borer attack) and ETL percentage was found in all three varieties using T<sub>1</sub> treatment as compared to T<sub>2</sub>, T<sub>3</sub> and T<sub>4</sub> treatments. Nevertheless, Bangabandhu dhan100 produced the highest yield (6.58 t/ha) using T<sub>3</sub> treatment as compared to all treatment-variety combinations. Besides, BRRI dhan97 showed significantly higher number of dead heart and white head which ETL percentage using T<sub>1</sub> treatment as compared to all treatment-variety combinations. All treatment-variety combinations showed below 5% ETL.

## CROP-SOIL-WATER MANAGEMENT

### **Effect of planting date on the performance of modern rice varieties at southeast of Bangladesh, Aman 2023**

Investigators: M A I Khalid, B Karmakar, M Adil and M S Islam

During Aman 2023 season this experiment was conducted at BRRI RS, Sonagazi farm, aimed to identify a suitable planting window of Boro rice cultivars to maximize grain yield. It was a two factors experiment where five transplanting dates and six varieties BRRI dhan75, BRRI dhan87, BRRI dhan90, (short duration) BRRI dhan52, BRRI dhan79 and BRRI dhan93 (long duration) were included. The seeding started on 10 June 2023 and continued up to 10 August 2023 at 15 days interval and transplanting started on 5 July 2023 and completed on 5 September 2023 at 15 days interval. Twenty-five-day-old seedlings were transplanted for all of the plantings. The spacing was 25 cm x 15 cm. Unit plot size was 3 m x 4 m. This experiment was laid out in Randomized Complete Block Design RCBD with three replications. Fertilizer doses NPKS and Zn @ 83, 15, 38, 10.6 and 1.5 kg ha<sup>-1</sup> (Urea, TSP, MOP, gypsum and zinc sulfate (Monohydrate) @ 180, 75, 75, 60 and 7.5 kg ha<sup>-1</sup>) were applied equally for all the sets. Urea top dressing was done at 15, 30 and

45 days after transplanting (DAT). Unified management practices were followed for all the plantings. Yield and yield components were significantly affected by both the planting dates and varieties. Across the planting dates, in short duration BRRI dhan87 produced the highest grain yield (4.17 t/ha) transplanted on 20 July 2023 followed by BRRI dhan75 (4.02 t/ha) and BRRI dhan90 (2.31 t/ha). Yield decreased due to early and delayed plantings, lodging and bird damage. Optimum date for short duration in Aman season was found between mid-July to mid-August. The lowest grain yield of tested varieties in short duration was found on BRRI dhan90 (1.81 t/ha) in the first set transplanted on 5 July 2023. Growth duration of short duration varieties ranges from 114 to 128 days. Among the long duration varieties BRRI dhan52 produced the highest grain yield (5.98 t/ha) transplanted on 5 August 2023 followed by BRRI dhan93 (5.61 t/ha) and BRRI dhan79 (4.83 t/ha). Yield decreased due to early and delayed plantings, lodging and bird damage. The lowest grain yield of tested varieties in long duration was found on BRRI dhan93 (2.17 t/ha) in the first set transplanted on 5 July 2023. Growth duration of long duration varieties ranges from 134 to 141 days.

### **Effect of planting date on the performance of modern rice varieties at southeast of Bangladesh, Boro 23-24**

Investigators: M A I Khalid, B Karmakar, M Adil and M S Islam

During Boro 2023-24 season this experiment was conducted at BRRI RS, Sonagazi farm, aimed to identify a suitable planting window of Boro rice cultivars to maximize grain yield. It was two factors experiment where six transplanting dates and six varieties BRRI dhan88, BRRI dhan96, BRRI dhan101, BRRI dhan89, BRRI dhan92 and BRRI dhan102 were included in the experiment. The

seeding started on 1 November 2023 and continued up to 16 January 2024 at 15 days interval and transplanting started on 10 December 2023 and completed on 25 February 2024 at 15 days interval. Forty-day-old seedlings were transplanted for all the plantings. The spacing was 20 cm x 20 cm. Unit plot size was 3 m x 4 m. This experiment was laid out in RCBD with three replications. Fertilizer doses NPKS and Zn @ 138, 22.4, 75, 20.4 and 4.0 kg ha<sup>-1</sup> (Urea, TSP, MOP, gypsum and zinc sulfate (Monohydrate) @ 300, 112, 150, 112 and 11 kg ha<sup>-1</sup>) were applied equally for all the sets. Urea top dressing was done at 20, 35 and 50 days after transplanting (DAT). Unified management practices were followed for all the plantings. Yield and yield components were significantly affected by both the planting dates and varieties. Across the planting dates, BRRI dhan92 produced the highest grain yield (8.04 t/ha) transplanted at 25 December 2023 followed by BRRI dhan89 (7.68 t/ha). Yield decreased gradually in the deployed plantings due to weather factors. The lowest grain yield of tested varieties was found on BRRI dhan96 (4.85 t/ha) in the last set transplanted on 25 February 2024 followed by BRRI dhan88 (5.20 t/ha).

#### **Determination of suitable seedling age for transplanting by uprooting plants from dibbled field at saline char land, Aus 2023**

Investigators: Md Asib Biswas, Mamunur Rahman, M Adil, Md Sirajul Islam, Biswajit Karmakar

This experiment was conducted at BRRI RS, Sonagazi farm during Aus 2023 seasons to identify suitable seedling age for splitting tillers of dibbled plot of rice at saline char land. Four treatments in RCBD with three replications were imposed and each treatment was assigned in 5 m x 4 m sized plot. The treatments were D<sub>1</sub> = splitting tillers at 20 days after dibbling, D<sub>2</sub> = splitting tillers at 25 days after dibbling, D<sub>3</sub> = splitting tillers at 30 days after

dibbling, D<sub>4</sub> = and in T. Aman and spacing 20 cm x 20 cm. Fertilizer doses were applied by following BRRI recommended dose. All other intercultural operations were done as and when necessary. Different data were collected at vegetative and reproductive phase. Yield and yield components data were taken at maturity stage. The treatments had significant effects on growth duration of seedling age. Among the treatments, D<sub>2</sub> produced the highest mean grain yield 5.14 t ha<sup>-1</sup>, which was statistically similar to D<sub>3</sub> (4.84 t ha<sup>-1</sup>), D<sub>4</sub> (4.81 t ha<sup>-1</sup>), D<sub>1</sub> (4.74 t ha<sup>-1</sup>). The lowest mean grain yield obtained in the D<sub>1</sub> = splitting tillers at 20 days after dibbling (4.74 t ha<sup>-1</sup>) followed by D<sub>4</sub> = splitting tillers at 35 days after dibbling (4.81 t ha<sup>-1</sup>). Yield was not increased significantly in among the different seedling age. Therefore, it is concluded that early seedling age 25-Day-old seedling would be recommended for transplanting by uprooting plants from dibbled field at saline char land.

#### **Effect of nitrogen levels on protein quality of rice at different regions, Aman 2023**

Investigators: Md Asib Biswas, Mohammad Rezaul Manir, M Adil, Biswajit Karmakar

This experiment was conducted at BRRI RS, Sonagazi farm during T. Aman 2023 seasons to find out the best nitrogen level for protein quality of rice at different regions. Five treatments in RCBD with three replications were imposed and each treatment was assigned in 5 m x 4 m sized plot. The treatments were T<sub>1</sub> = No N, T<sub>2</sub> = 50 kg N ha<sup>-1</sup>, T<sub>3</sub> = 75 kg N ha<sup>-1</sup>, T<sub>4</sub> = 100 kg N ha<sup>-1</sup> and T<sub>5</sub> = 125 kg N ha<sup>-1</sup> in T. Aman and spacing 20 cm x 20 cm. Twenty-five-day-old seedlings were transplanted on selected dates. All other intercultural operations were done as and when necessary. Yield and yield components data were taken at maturity stage. Grain yield, plant height, filled and unfilled grain panicles<sup>-1</sup>, 1000-grain weight and growth durations were significantly affected by the different levels of N fertilizer treatments except tiller no. hill<sup>-1</sup> and

panicles no. hill<sup>-1</sup>. Every parameter, 100 kg N ha<sup>-1</sup> (T<sub>4</sub>) treatment have been performed the best.

### **Multi-location yield trials (MLT) of promising hybrid, T. Aman 2023**

Investigators: Md. Asib Biswas, MJ Hasan, M Adil, Biswajit Karmakar

The experiments were conducted at BRRI RS, Sonagazi, during T. Aman 2023, pointed to assess the yield of promising rice hybrids at different locations for their adaptability. Eleven hybrids with three checks were used as planting materials. Twenty-one-day-old seedlings were transplanted with a spacing of 20 × 15 cm<sup>2</sup> using one seedling/hill. Fertilizers were applied @ with 150:100:70:60:10 kg/ha urea, TSP, MP, gypsum and ZnSO<sub>4</sub> respectively. Intercultural and agronomic practices were made when necessary. Entry AZ 7006 (Ck-2) produced the highest yield (5.35 t/ha) compared to the other entries (5.01-1.98 t/ha) and showed 104 cm plant height and 118 days growth duration. On the other hand, entry Dhanny Gold (Ck-3), BRRI hybrid dhan6 (Ck-, BRRI97A/BRRI42R, IR79156A/BRRI42R produced satisfactory higher yield (5.5.01- 3.56 t/ha) than the rest of the entries (3.53-1.98 t/ha) and exhibited 113-128 cm plant height and 105-109 days growth duration. Most of the entries heavily affected BLB and sheath blight disease and also infested by stem borer. So, on the basis of yield, growth duration, Plant height and other agronomic character, entry BRRI97A/BRRI42R and IR79156A/BRRI42R were selected for advanced trials.

### **Multi-location yield trials (MLT) of promising hybrids, Boro 2023-24**

Investigators: M A I Khalid, M J Hasan, M Adil, Biswajit Karmakar

The experiments were conducted at BRRI RS Sonagazi, during Boro 2023-24, pointed to find out suitable promising hybrids for Boro season. Fifteen hybrids with four checks were used as planting materials. Thirty-five-day-old seedlings were transplanted with a spacing of 20 × 20 cm<sup>2</sup> using one seedling/hill. Fertilizers were applied @ with 36:17:16: 9:1 kg/bigha urea, TSP, MoP, gypsum and zinc sulphate respectively. Intercultural and agronomic practices were made when necessary. Entry Tej Gold (Ck-4) produced the highest yield (7.16 t/ha) compared to other entries. On the other hand, entry BRRI109A/BRRI42R and BRRI120A/BRRI55R produced satisfactory higher yield 6.50 and 6.40 t/ha respectively than the rest of the entries. Most of the entries were heavily affected by BLB and sheath blight diseases. Rat damages were also seen in some entries. So, on the basis of yield, growth duration, plant height and other agronomic character, entry BRRI109A/BRRI42R and BRRI120A/BRRI55R were selected for advanced trials

### **SOCIO-ECONOMIC AND POLICY**

#### **Stability analysis of BRRI developed rice varieties**

Investigators: Sania Tamanna, MAI Khalid, M Adil, B Karmakar

Three experiments on Stability analysis of BRRI developed rice varieties were conducted in Aus 2022, Aman 2022 and Boro 2023 seasons. The experiments were laid out in RCBD with three replications. Standard management practices were followed for all the experiments in all the seasons.

**Stability analysis, Aus 2023.** Among the varieties, BRRI dhan98 produced the highest mean grain yield (6.263 t ha<sup>-1</sup>) followed by BRRI hybrid dhan7 (5.887 t ha<sup>-1</sup>). BR21, BR24, and BRRI dhan65 BRRI dhan27 produced lower grain yield 3.320, 3.770 and 3.362 t ha<sup>-1</sup> respectively.

**Stability analysis, Aman 2023.** Among the varieties, BRRI hybrid dhan6 ranked the top in terms of yield ( $6.03 \text{ t ha}^{-1}$ ) followed by BRRI dhan103 ( $5.75 \text{ t/ha}$ ). BR5, BRRI dhan91 and BRRI dhan37 were found low yielding varieties having grain yield 2.56, 3.01 and  $3.20 \text{ t ha}^{-1}$  respectively.

**Stability analysis, Boro 2023-24.** Among the varieties, BRRI hybrid dhan8 ranked the top in terms of yield ( $8.7 \text{ t ha}^{-1}$ ) followed by BRRI hybrid dhan5 ( $8.12 \text{ t ha}^{-1}$ ). The variety BRRI dhan28, BRRI dhan81 and BRRI dhan63 were found as the low yielding varieties having grain yield 3.80, 4.12 and  $4.29 \text{ t ha}^{-1}$  respectively.

## TECHNOLOGY TRANSFER

### Demonstration of modern rice varieties

Investigators: Sania Tamanna, MAI Khalid, Md. Asib Biswas, MN Ahmed, M Adil, B Karmakar

#### Demonstration of Modern Rice Varieties.

A total 2,740 demonstrations of modern rice varieties were executed in 2,740 bigha land during the reporting period under GOB and different projects.

**GOB fund.** A total of 450 demonstrations were executed in 450 bigha land at farmers' field at Chattogram and Rangamati regions during 2023-24 funded by GOB.

**Karmasuchi fund.** A total of 660 demonstrations were executed in 660 bigha land at farmer's field during the reporting period under BRRI RS, Sonagazi Research and Development Karmasuchi.

**Hybrid Project fund.** A total of 130 demonstrations were executed in 130 bigha land at farmers' field during 2023-2024 funded by BRRI Hybrid project.

### Farmers Training on Rice Technology 2023-24

Investigators: Sania Tamanna, M A I Khalid, Md Asib Biswas, M N Ahmed, M Adil, B Karmaka

**GOB fund.** A total of 40 farmers trainings on rice technologies were executed and trained up 1200 farmers having 952 male and 248 female farmers.

**Karmasuchi fund.** A total of 66 farmers trainings on rice technologies were conducted and trained up 1980 farmers having 1522 male and 458 female farmers.

**PARTNER Fund.** Eight farmers trainings on rice technologies were conducted and trained up 240 farmers having 213 male and 27 female farmers.

**LSTD Fund.** Two farmers trainings on rice technologies were conducted and trained up 80 farmers having 71 male and 9 female farmers.

## Field day 2023-24

**GOB fund.** Nineteen field days were conducted in selected demonstration sites at maturity stage during 2023-24 financial year. Nearly 1,700 progressive farmers, local leaders, extension personnel (DAE and NGO personnel) and public representatives participated in those occasions.

**Karmasuchi Fund.** Twenty-Six field days were organized in selected demonstration sites at maturity stage during 2023-24 funded by BRRI RS, Sonagazi Research and Development Karmasuchi. Almost 2,600 progressive farmers, local leaders, extension personnel and public representatives were participated in the occasions.

**Hybrid project fund.** Two field days were conducted under Hybrid rice project. In total 210 progressive farmers, local leaders, extension personnel (DAE and NGO personnel) and public representatives participated in those occasions.

## ENRICHMENT OF SEED STOCK

### Breeder Seed Production

**GOB fund.** A total of 12.75 ton breeder seeds were produced under GOB fund during the reporting period. All the breeder seeds of different varieties

were sent to the Genetic Resources and Seed Division, BRRI HQ, Gazipur.

**Karmasuchi fund.** A total of 19.5 ton breeder seeds were produced under Karmasuchi fund during the reporting period. All the Breeder seeds of different varieties were sent to the Genetic Resources and Seed Division, BRRI HQ, Gazipur.

### **Quality Seed (TLS) Production**

**GOB fund.** 20.22 tons TLS of modern rice varieties were produced by BRRI RS, Sonagazi during the reporting period.

**Karmasuchi fund.** A total of 52.25 ton TLS of modern rice varieties were produced by BRRI RS, Sonagazi during the reporting period.

### **F1 seed production of BRRI hybrid dhan5**

In Boro 2023-24 season, F1 seed production of BRRI hybrid dhan5 was conducted at the field of BRRI RS, Sonagazi, Feni. A total of 1,050 kg (0.98 t/ha) seed of BRRI hybrid dhan5 was obtained.

# **BRRI RS, Kushtia**

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| <b>430</b> | <b>Crop-Soil-Water Management</b> |
| <b>431</b> | <b>Socio-Economics and Policy</b> |
| <b>431</b> | <b>Technology transfer</b>        |
| <b>431</b> | <b>Variety demonstration</b>      |

## SUMMARY

A total of 51 experiments were conducted from Aus 2023 to Boro 2023-24 across different areas under Variety Development, Rice Farming Systems, Crop-Soil-Water Management, and Socio-Economics and Policy. In the Variety Development area, 43 trials (RYT, AYT, AGGRi Network, Early Morning Flowering, GE interaction) were held, with four trials during the Aus season, 14 in T. Aman, and 25 in Boro. In addition, 10 ALART trials were conducted during the Aman 2023 and Boro 2023-24 seasons. Additionally, four trials in farming systems, two in Crop-Soil-Water management, and two stability analysis experiments under the Socio-Economics and Policy programme were carried out.

During Aus 2023, four trials were conducted, including RYT#BB, RYT#BB-Path, RYT under favourable conditions, and AYT#1 (HDNT). In the RYT trials, none of the entries outperformed the check varieties. However, in the AYT trial, the entry IR18C1002 showed the highest yield at 6.02 t/ha, which was statistically greater than the check varieties BRRI dhan48 (5.08 t/ha), BRRI dhan98 (4.6 t/ha), and N22 (3.18 t/ha).

During T. Aman 2023, fourteen trials were conducted, including 12 for RYTs and two for AGGRi Network trials. In the RYT#RLR (Rainfed Lowland Rice), the highest yield was achieved by BR12005-6R-14 at 5.81 t/ha, significantly higher than the checks, which yielded 5.67 t/ha (BRRI dhan71) and 5.24 t/ha (BRRI dhan75). For the RYT#2 genotypes (Bacterial Blight Resistant Rice), BR12098-4R-71 recorded the highest yield at 6.23 t/ha, significantly higher than the check varieties BRRI dhan75 (5.39 t/ha), BRRI dhan87 (5.73 t/ha), and IRBB60 (4.71 t/ha). In the AGGRi Network Trial (Stage#1), the entry, IR22EL1742 yielded the highest at 6.46 t/ha, followed closely by IR22EL1846 (6.45 t/ha) and IR22EL1858 (6.44 t/ha). Among the local checks, BRRI dhan71 yielded 5.03 t/ha, BRRI dhan75 yielded 4.59 t/ha, BRRI dhan95 produced 5.10 t/ha, and BRRI Hybrid dhan6 yielded 5.41 t/ha.

During Boro 2023-24, twenty-five trials were conducted, including RYTs, genotype-environment interactions, and early morning

flowering trials. In most RYT trials, the tested entries did not produce statistically higher yields compared to the check varieties. In the RYT#STR trial, BR13113-4R-185 had the highest yield at 7.96 t/ha, outperforming the check varieties: BRRI dhan67 at 6.89 t/ha, BRRI dhan88 at 6.26 t/ha, and BRRI dhan28 at 6.33 t/ha. In the RYT#BAR trial, NGR 736-1 yielded 7.34 t/ha, which was higher than BRRI dhan74 at 6.60 t/ha. Lastly, in the RYT#DRR trial, BR12125-6R-14919 recorded the highest yield of 7.39 t/ha, significantly exceeding the check varieties: BRRI dhan88 at 6.38 t/ha, BRRI dhan89 at 6.81 t/ha, and BRRI dhan101 at 6.86 t/ha. In G/E interaction, none of the entries performed better over the check varieties. In the early morning flowering trial, the genotype BR28 (T)-qEMF3.6 achieved the highest yield of 4.8 t/ha, which was statistically significant compared to BRRI dhan28, which yielded 4.4 t/ha.

In Aman 2023, three trials were executed under ALART. In the ALART#SHR-1 trial, the genotypes BRH15-24-7B (6.84 t/ha) and BR17-23-8-2-7B (6.71 t/ha) produced significantly higher yields compared to the check variety BRRI dhan88 (5.46 t/ha). In the ALART#SHR-2 trial, the genotypes BRH11-7-17-10B (7.04 t/ha), BRH9-3-2B (6.76 t/ha), and BRH13-9-5-2B (6.83 t/ha) showed significantly higher yields than the check variety BRRI dhan81 (5.03 t/ha). During Boro 2023-24, seven ALART programmes were executed. In the ALART# FBR-Bio trial, the genotype, BR (Bio) 13028-AC24-1-2 (5.77 t/ha) produced significantly higher yields than the check variety BRRI dhan86 (5.89 t/ha).

In case of performance of different cropping patterns for year-round vegetable production under agro-forestry systems with exotic date palm (*Phoenix dactylifera*), the Carrot–Mukhikachu cropping pattern provided the highest gross margin of Tk 5,35,770 followed by the Fallow–Mukhikachu pattern with 4,64,900 taka. The lowest gross margin was observed in the Onion/Garlic–Okra pattern, which generated only 41,560 taka.

Under the evaluation of different rice-based cropping patterns in the same agro-forestry system, the DS Aman (BRRI dhan71)–Chilli combination achieved the highest gross margin of 1, 09, 620 taka, followed by DS Aman (BRRI dhan71)–Lentil at 86,080 taka. The DS Aman (BRRI dhan71)–Garden Pea pattern recorded the lowest gross margin of Tk 6,290. In another experiment on determining the optimum planting window for newly released T. Aman rice varieties, BRRI dhan87 had the highest yield (6.71 t/ha) when transplanted on 16 August, followed by BRRI dhan71 (5.74 t/ha). Yields declined with later transplanting dates. The maximum REY yield of 13.34 t/ha and the highest gross margin (1, 16, 470 Tk/ha) were obtained from cropping pattern CP2 (BARI Sorisha-14 – Bangabandhu dhan100 – BRRI dhan90), while CP3 (BARI Sorisha-14 – BRRI dhan63 – BRRI dhan90) followed with a gross margin of 1, 00, 340 Tk/ha. These results underscore the benefits of incorporating high-yielding varieties, such as BRRI dhan90, in the Mustard–Boro–T. Aman cropping system.

The missing nutrient element trial was conducted at BRRI RS farm, Kushtia during T. Aman 2023 and Boro 2023-24, using BRRI dhan87 and Bangabandhu dhan100. In T. Aman, the nutrient-controlled plot (4.36 t/ha) and N omitted plot (4.88 t/ha) had the lowest yields, while in the Boro season, applying N P K S and Zn significantly boosted rice yields. The control plot (without fertilization) had the greatest yield reduction (42%), followed by the N omitted plot (39%). So N is the most limiting nutrient element in BRRI Rs Kushtia farm.

In the experiment of stability analysis during Aman 2023, BRRI dhan87 had the highest yield at 6.78 t/ha among the short-duration varieties. For medium-duration varieties, BRRI dhan103 produced the highest yield at 7.15 t/ha. Among the long-duration varieties, BR10 yielded the most at 6.37 t/ha. In the Boro 2023-24 trial, BRRI dhan89 had the highest yield among long-duration varieties at 9.26 t/ha. For short-duration

varieties, BRRI hybrid dhan8 was the top performer with 8.98 t/ha.

BRRI RS, Kushtia promoted newly released high-yielding and hybrid varieties during the Aus, Aman, and Boro seasons in the 2023-24 reporting year, conducting 524 demonstrations across 23 upazilas in five districts under the Government of Bangladesh initiative. This included 103 demonstrations in Aus, 202 in Aman, and 219 in Boro. BRRI dhan98 had the highest yield in the Aus season, while BRRI dhan87 ranked first among Aman varieties. In the Boro season, BRRI hybrid dhan8 yielded the highest among the seven demonstrated varieties. Additionally, 17 demonstrations were executed under the LSTD project, and 390 demonstrations were conducted under the PARTNER project.

Nucleus seeds from the GRS Division were used to produce 7,232 kg of breeder seed during the Aman and Boro seasons, including BRRI dhan75, BRRI dhan87, and BRRI dhan63. Truthfully labelled seed (TLS) production occurred during the Aus, Aman, and Boro seasons. In the Aus season, 1,265 kg of TLS seeds were produced from BRRI dhan98, BRRI dhan48, and BRRI dhan83. During the Aman season, 890 kg of seeds were produced from BRRI dhan34, BRRI dhan71, BRRI dhan75, BRRI dhan87, BRRI dhan90, and BRRI dhan103. In the Boro season, 1,805 kg of seeds were produced from BRRI dhan63, BRRI dhan89, BRRI dhan92, BRRI dhan96, BRRI dhan101, and BRRI dhan102.

## VARIETY DEVELOPMENT

### **Regional/Advanced yield trial (RYTs/AYTs), Aus 2023**

The aim to select the best-performing advanced breeding lines with higher grain yield over the existing checks in on station condition.

### **AYT#1 High day and night temperature condition (HDNT), T. Aus 2023**

In this experiment, fourteen advanced breeding lines and three standard checks BRRI dhan48 and



BRRi dhan98 and N22 were tested. Among the tested lines, the yield of IR18C1002 was the highest (6.02 t/ha) (Table 1) which was statistically higher

yield over the check varieties, BRRi dhan48 (5.08 t/ha) and BRRi dhan98 (4.6 t/ha) and N22 (3.18 t/ha).

**Table 1. Performances of AYT#1 genotypes, HDNT, Aus 2023.**

| Designation      | BLUE_PH (cm) | BLUE_GD (day) | BLUE_Y(t/ha) |
|------------------|--------------|---------------|--------------|
| IR64             | 95           | 118           | 4.12         |
| IR18C1008        | 115          | 123           | 4.15         |
| IR18C1009        | 109          | 122           | 5.8          |
| IR18C1001        | 105          | 115           | 5.95         |
| IR18C1010        | 108          | 114           | 5.48         |
| IR18C1012        | 109          | 119           | 5.22         |
| IR18C1013        | 110          | 115           | 5.35         |
| IR18C1002        | 100          | 120           | 6.04         |
| IR18C1003        | 100          | 120           | 5.97         |
| IR18C1004        | 99           | 114           | 5.78         |
| BRRi dhan48 (ck) | 109          | 106           | 5.08         |
| BRRi dhan98 (ck) | 106          | 107           | 4.6          |
| N22 (Tol. ck)    | 118          | 96            | 3.18         |
| LSD              | 5            | 1.67          | 0.9          |
| Heritability     | 0.91         | 0.99          | 0.86         |

DS: 13 May 23

DT: 6 May 2023

#### **Regional/Advanced yield trial (RYTs/AYTs), Aman 2023**

The goal is to identify the top-performing advanced breeding lines compared to the existing checks in on station condition.

#### **RYT#Katari genotypes, Katari type rice, Aman 2023**

To select the top-performing advanced breeding lines with higher grain yield compared to the existing check varieties in on station trial. Three advanced breeding lines were tested alongside the standard check, Katari. All the lines, BRH9-3-14-2B (4.93 t/ha), BRH13-9-5-2B (5.34 t/ha), and BRH9-3-2B (5.31 t/ha) (Table 2), produced significantly higher yields than Katari (4.12 t/ha).

**Table 2. Performances of RYT#Katari genotypes, Katari type rice, Aman 2023.**

| Designation  | BLUE_PH (cm) | BLUE_GD (day) | BLUE_Y(t/ha) |               |
|--------------|--------------|---------------|--------------|---------------|
| BRH9-3-14-2B | 117          | 116           | 4.93         | BD-5%, HS-2%  |
| BRH13-9-5-2B | 117          | 117           | 5.34         | BD-10%, HS-3% |
| BRH9-3-2B    | 116          | 117           | 5.31         | BD-6%, HS-2%  |
| Katari (ck)  | 138          | 134           | 4.12         |               |
| LSD          | 3.83         | 1.2           | 0.74         |               |
| Heritability | 0.97         | 0.99          | 0.86         |               |

DS: 22 May 2023

DS: 20 Jul 2023

**RYT#RLR genotypes, Rainfed Lowland Rice,**

In this experiment, nine advanced breeding lines and two standard checks BRRI dhan71 and BRRI dhan75 were tested under this experiment. Among the tested lines, the yield of BR12005-6R-14 was

**Aman 2023**

the highest (5.81 t/ha) (Table 3) which was statistically higher yield over the check varieties BRRI dhan71 (5.67 t/ha) and BRRI dhan75 (5.24 t/ha).

**Table 3. Performances of RYT#RLR genotypes, Rainfed Lowland Rice, Aman 2023**

| Designation      | BLUE_PH (cm) | BLUE_GD (day) | BLUE_Y(t/ha) | Remarks      |
|------------------|--------------|---------------|--------------|--------------|
| BR12001-6R-205   | 128          | 109           | 4.94         | HS-2%, SR-6% |
| BR10795-6R-133   | 129          | 121           | 4.85         | SB-4%        |
| BR12005-6R-14    | 136          | 137           | 5.81         |              |
| BR10797-6R-140   | 110          | 108           | 5.33         | HS-1%        |
| BR10799-6R-104   | 126          | 126           | 5.06         |              |
| BR12007-6R-61    | 136          | 113           | 4.67         | SR-6%        |
| BR11333-6R-4     | 122          | 122           | 4.95         |              |
| BR11333-6R-84    | 110          | 116           | 5.41         |              |
| BR10799-6R-31    | 127          | 124           | 5.27         |              |
| BRRI dhan71 (ck) | 114          | 111           | 5.67         |              |
| BRRI dhan75 (ck) | 108          | 110           | 5.24         | HS-4%        |
| LSD              | 5.32         | 2.46          | 0.31         |              |
| Heritability     | 0.97         | 0.99          | 0.91         |              |

DS. 5 Jul 2023

DT. 30 Jul 2023

**RYT#2 genotypes, bacterial blight resistant rice, Aman 2023**

In this experiment, six advanced breeding lines were tested with three standard checks: BRRI dhan75, BRRI dhan87, and IRBB60. The highest

yield was from BR12098-4R-71, produced 6.23 t/ha (Table 4), which was significantly greater than the check varieties BRRI dhan75 (5.39 t/ha), BRRI dhan87 (5.73 t/ha), and IRBB60 (4.71 t/ha).

**Table 4. Performances of RYT#2 genotypes, Bacterial blight resistant rice, Aman 2023.**

| Designation      | BLUE_PH (cm) | BLUE_GD (day) | BLUE_Y(t/ha) |
|------------------|--------------|---------------|--------------|
| BR11986-4R-123   | 93           | 119           | 5.54         |
| BR12098-4R-117   | 131          | 123           | 6.00         |
| BR12098-4R-71    | 132          | 116           | 6.23         |
| BR12442-4R-49    | 103          | 117           | 5.68         |
| BR11869-5R-47    | 115          | 125           | 5.88         |
| BR11869-5R-72    | 114          | 131           | 5.17         |
| BRRI dhan75 (ck) | 109          | 110           | 5.39         |
| BRRI dhan87 (ck) | 119          | 123           | 5.73         |
| IRBB60 (ck)      | 88           | 114           | 4.71         |
| LSD              | 4.8          | 2.05          | 0.48         |
| Heritability     | 0.99         | 0.99          | 0.88         |

DS: 7 Sep 2023

DT: 8 Sep 2023

### Stage#1 genotypes, AGGRi Network trial, T. Aman 2023

In this experiment, 239 breeding lines were tested with five local checks, BRRI dhan71, BRRI dhan75, BRRI dhan95 and BRRI Hybrid dhan6 in Augmented RCBD. The yields of the tested varieties ranged from 1.72 t/ha to 6.54 t/ha. IR22EL1742 had the highest yield at 6.46 t/ha (Table 5), followed closely by IR22EL1846 (6.45 t/ha) and IR22EL1858 (6.44 t/ha). Other high-

yielding lines included IR22EL1816 (6.42 t/ha), IR22EL1797 (6.40 t/ha), IR22EL1779 (6.39 t/ha), and IR22EL1789 (6.36 t/ha). The yields of IR22EL1269 and IR22EL1734 were 6.33 t/ha and 6.30 t/ha, respectively, while IR22EL1784 produced 6.26 t/ha. Among the check varieties, BRRI dhan71 yielded 5.03 t/ha, BRRI dhan75 had 4.59 t/ha, BRRI dhan95 produced 5.10 t/ha, and BRRI hybrid dhan6 yielded 5.41 t/ha.

**Table 5. Performances of Stage#1 genotypes, AGGRi Network trial, T. Aman 2023.**

| Designation       | BLUE_PH (cm) | BLUE_GD (days) | BLUE_Y(t/ha) |
|-------------------|--------------|----------------|--------------|
| IR22EL1742        | 120          | 127            | 6.46         |
| IR22EL1846        | 125          | 126            | 6.45         |
| IR22EL1858        | 128          | 129            | 6.44         |
| IR22EL1816        | 106          | 123            | 6.42         |
| IR22EL1797        | 118          | 126            | 6.4          |
| IR22EL1779        | 125          | 126            | 6.39         |
| IR22EL1789        | 107          | 125            | 6.36         |
| IR22EL1269        | 147          | 120            | 6.33         |
| IR22EL1734        | 111          | 127            | 6.3          |
| IR22EL1784        | 116          | 126            | 6.26         |
| BRRI dhan71       | 126          | 115            | 5.03         |
| BRRI dhan75       | 109          | 109            | 4.59         |
| BRRI dhan95       | 126          | 122            | 5.1          |
| BRRI Hybrid dhan6 | 118          | 110            | 5.41         |
| Range             | 92-147       | 104-132        | 1.72-6.54    |
| Average           | 116          | 120            | 4.84         |
| Heritability (%)  | 81%          | 94%            | 57%          |

DS: 7 Sep 2023

DT: 8 Sep 2023

### Regional/Advanced yield trial (RYTs/AYTs), Boro 2023-24

To select the best-performing advanced breeding lines with higher grain yield over the existing checks in on station condition.

### RYT#STR genotypes, Salt Tolerant Rice, Boro 2023-24

Twelve advanced breeding lines and three standard checks BRRI dhan67, BRRI dhan88 and BRRI dhan28 were tested under this experiment. Among the tested lines, the yield of I BR13113-4R-185 was the highest (7.96 t/ha) (Table 6) which was statistically higher yield over the check varieties, BRRI dhan67 (6.89 t/ha) and BRRI dhan88 (6.26 t/ha) and BRRI dhan28 (6.33 t/ha).

**Table 6. Performances of RYT#STR genotypes, salt tolerant rice, Boro 2023-24.**

| Designation           | BLUE_PH (cm) | BLUE_GD (day) | BLUE_Y(t/ha) |
|-----------------------|--------------|---------------|--------------|
| BR13113-4R-63         | 104          | 147           | 7.23         |
| BR13125-4R-92         | 100          | 146           | 7.53         |
| BR13118-4R-76         | 102          | 150           | 6.99         |
| BR13113-4R-185        | 96           | 147           | 7.96         |
| BR13111-4R-191        | 115          | 155           | 7.05         |
| BR13106-4R-469        | 113          | 151           | 6.78         |
| BR13106-4R-438        | 109          | 149           | 7.33         |
| BR13111-4R-63         | 106          | 146           | 6.86         |
| BR121064R-184         | 95           | 149           | 7.45         |
| BR13122-4R-136        | 104          | 151           | 7.57         |
| BR13113-4R-116        | 106          | 146           | 7.13         |
| BRRi dhan67 (T. Ck)   | 115          | 146           | 6.89         |
| BRRi dhan88 (Std. Ck) | 99           | 143           | 6.26         |
| BRRi dhan28 (Sus Ck)  | 104          | 143           | 6.33         |
| LSD                   | 4.94         | 1.49          | 0.65         |
| Heritability          | 0.93         | 0.97          | 0.66         |

DS: 13 Dec 2023

DT: 31 Jan 2024

**RYT#DRR genotypes, Disease Resistant Rice, Boro 2023-24**

In this experiment, 14 advanced breeding lines and three standard checks BRRi dhan88, BRRi dhan89 and BRRi dhan101 were tested. The highest yield

came from BR12125-6R-14919, which produced 7.39 t/ha (Table 7), significantly outperforming the check varieties BRRi dhan88 (6.38 t/ha), BRRi dhan89 (6.81 t/ha), and BRRi dhan101 (6.86 t/ha).

**Table 7. Performances of RYT#DRR genotypes, disease resistant rice, Boro 2023-24.**

| Designation            | BLUE_PH (cm) | BLUE_GD (day) | BLUE_Y(t/ha) |
|------------------------|--------------|---------------|--------------|
| BR11866-5R-277         | 98           | 151           | 7.24         |
| BR11867-5R-118         | 104          | 151           | 6.59         |
| BR11867-5R-119         | 95           | 146           | 6.18         |
| BR12437-4R-164         | 92           | 149           | 6.54         |
| BR12437-4R-109         | 101          | 152           | 7.03         |
| BR12125-6R-6           | 95           | 145           | 6.24         |
| BR12125-6R-79          | 91           | 149           | 6.76         |
| BR12125-6R-14919       | 102          | 149           | 7.39         |
| BR13793-5R-1/BR43      | 107          | 156           | 6.8          |
| BR13796-5R-102         | 105          | 145           | 5.9          |
| BRRi dhan88 (Std. Ck)  | 97           | 144           | 6.38         |
| BRRi dhan89 (Std. Ck)  | 107          | 152           | 6.81         |
| BRRi dhan101 (Res. Ck) | 106          | 145           | 6.86         |
| LSD                    | 3.98         | 1.25          | 0.61         |
| Heritability           | 0.93         | 0.98          | 0.56         |

DS: 17 Dec 2023

DT: 28 Jan 2024

### RYT#BAR genotypes, Favourable Boro Rice, Boro 2023-24

In this experiment, 14 advanced breeding lines and two standard checks BRRI dhan74 and BRRI dhan102 were tested in on-station condition. The

highest yield came from NGR 736-1, which produced 7.34 t/ha (Table 8), significantly outperforming the check variety BRRI dhan74 (6.60 t/ha).

**Table 8. Performances of RYT#BAR genotypes, Favourable Boro rice, Boro 2023-24.**

| Designation  | BLUE_PH (cm) | BLUE_GD (day) | BLUE_Y(t/ha) |
|--------------|--------------|---------------|--------------|
| NGR 350-2    | 93           | 144           | 6.89         |
| NGR 472-2    | 95           | 149           | 6.78         |
| NGR 736-1    | 98           | 155           | 7.34         |
| NGR 745-3    | 93           | 155           | 7.20         |
| NGR 994-1    | 93           | 153           | 7.10         |
| NGR 745-2    | 94           | 155           | 7.31         |
| NGR 749-2    | 94           | 152           | 7.32         |
| NGR 750-1    | 98           | 150           | 6.88         |
| NGR 796-2    | 95           | 152           | 6.73         |
| NGR 1161-3   | 92           | 150           | 7.01         |
| BRRI dhan74  | 93           | 146           | 6.60         |
| BRRI dhan102 | 97           | 153           | 7.30         |
| LSD          | 2.11         | 1.56          | 0.34         |
| Heritability | 0.83         | 0.97          | 0.79         |

DS: 09 Dec 2023

DT: 26 Jan 2024

### Advanced line adaptive research trial (ALARTs), Aman 2023

The aim to select the best-performing advanced breeding lines with higher grain yield over the existing checks in on station condition.

Two advanced lines along with one standard check variety BRRI dhan94 were evaluated under this trial. The advanced line BRH9392-6-2-1-3-4 produced the highest yield (5.35 t/ha) than the other advanced lines and check varieties which is significantly similar to the yield of check variety BRRI dhan94 with seven days longer growth duration (Table. 9)

### ALART for Swarna type grain (SHR-2), Aman 2023

**Table 9. Performance of some advanced genotypes (SHR-2) in ALART, T. Aman 2023**

| Designation           | Plant height (cm) | Growth duration (day) | Yield (t/ha) |
|-----------------------|-------------------|-----------------------|--------------|
| V1= BRH9392-6-2-1-3-4 | 140               | 146                   | 5.35         |
| V2= BR9396-6-2-2B     | 131               | 149                   | 5.21         |
| V3= BRRI dhan94 (ck)  | 134               | 139                   | 5.00         |
| CV (%)                | 0.97              | 0.50                  | 5.84         |
| LSD (0.05)            | 2.97              | 1.6                   | 0.64         |

DS-17 Jun 2023

DT-10 Jul 2023

**Advanced line adaptive research trial (ALARTs), Boro 2023-24**

The aim was to select the best-performing advanced breeding lines with higher grain yield over the existing checks in on station condition.

**ALART for superior high yielding rice [SHR-1 (Zira type)], Boro 2023-24**

Three advanced lines along with one standard check BRRI dhan88 were evaluated in this experiment. All the three advanced lines produced higher grain yield than the check variety BRRI dhan88 but the lowest growth duration was found in case of check variety. Among the three advanced lines BRH15-24-7B produced highest grain yield 6.84 t/ha (Table. 10) with lowest growth duration.

**Table 10. Performance of some advanced genotypes (SHR-1) in ALART, Boro 2023-24.**

| Designation           | Plant Height (cm) | Growth Duration (Days) | Yield (t/ha) |
|-----------------------|-------------------|------------------------|--------------|
| V1= BRH15-24-7B       | 90                | 143                    | 6.84         |
| V2= BR9392-1-7-5B     | 95                | 147                    | 5.84         |
| V3=BR17-23-8-2-7B     | 102               | 144                    | 6.71         |
| V4= BRRI dhan88 (ck)  | 95                | 138                    | 5.46         |
| CV (%)                | 2.03              | 0.52                   | 4.27         |
| LSD <sub>(0.05)</sub> | 1.58              | 0.61                   | 0.22         |

DS:18 Jan 2024

DT: 07 Mar 2024

**ALART for Superior high yielding rice [SHR-2 (Katari type)], Boro 2023-24**

In this experiment three advanced lines along with one standard check BRRI dhan81 were evaluated.

The advanced line BRH11-7-17-10B produced higher yield (7.04 t/ha) than all the other advanced lines and check variety BRRI dhan81 (Table.11)

**Table 11. Performance of some advanced genotypes (SHR-2) in ALART, Boro 2022-23**

| Designation           | Plant eight (cm) | Growth duration (day) | Yield (t/ha) |
|-----------------------|------------------|-----------------------|--------------|
| V1=BRH11-7-17-10B     | 105              | 143                   | 7.04         |
| V2= BRH9-3-2B         | 104              | 147                   | 6.76         |
| V3=BRH13-9-5-2B       | 102              | 146                   | 6.83         |
| V4= BRRI dhan81 (ck)  | 104              | 139                   | 5.03         |
| CV (%)                | 2.03             | 0.69                  | 6.32         |
| LSD <sub>(0.05)</sub> | 1.72             | 0.82                  | 0.33         |

DS: 18 Jan 2024

DT : 07 Mar 2024

**ALART for Favorable Boro Rice, Biotechnology (FBR-Bio), Boro 2023-24**

In this experiment three advanced lines along with two standard checks BRRI dhan86 and BRRI

dhan96 were evaluated. The advanced line BR (Bio) 13028-AC24-2-4 produced highest yield (6.14 t/ha) over all the advanced lines and check varieties BRRI dhan86 (5.21 t/ha) and BRRI dhan96 (5.89 t/ha) (Table.12)

**Table 12. Performance of some advanced genotypes (FBR-Bio) in ALART, Boro 2023-24.**

| Designation                | Plant Height (cm) | Growth Duration (day) | Yield (t/ha) |
|----------------------------|-------------------|-----------------------|--------------|
| V1=BR(Bio) 13028-AC24-1-2  | 110               | 143                   | 5.77         |
| V2= BR(Bio) 13028-AC24-2-3 | 105               | 138                   | 5.03         |
| V3= BR(Bio) 13028-AC24-2-4 | 105               | 142                   | 6.14         |
| V4= BRRI dhan86 (ck)       | 101               | 138                   | 5.21         |
| V5= BRRI dhan96 (ck)       | 100               | 142                   | 5.89         |
| CV (%)                     | 4.09              | 0.55                  | 9.23         |
| LSD <sub>(0.05)</sub>      | 3.47              | 0.63                  | 0.42         |

DS: 28 Dec 2023

DT: 5 Feb 2024

**RICE FARMING SYSTEMS****Performance of different cropping patterns for year-round vegetable production under agro-forestry systems with exotic date palm (*Phoenix dactylifera*).**

This experiment was conducted to ensure year-round vegetable supply for farm family and to

increase whole farm productivity with four cropping pattern. Among the four cropping patterns Carrot – Mukhikachu produced the highest gross margin of Tk 5, 35, 770 (Table 13) which was followed by Fallow – Mukhikachu cropping pattern (Tk 4, 64, 900). The lowest gross margin was observed from Onion/Garlic – Okra cropping pattern (Tk 41,560).

**Table 13. Productivity and economics of year-round vegetables growing cropping patterns under date palm agro-forestry systems 2023-24.**

| Cropping pattern<br>(Inter-cropping with date palm) | Yields of crop (t/ha) |       | Rice equivalent yield (t/ha) |       | Total (t/ha) | TVC ('000Tk/ha) | Gross return ('000Tk/ha) | Gross margin ('000Tk/ha) |
|-----------------------------------------------------|-----------------------|-------|------------------------------|-------|--------------|-----------------|--------------------------|--------------------------|
|                                                     | 1st                   | 2nd   | 1st                          | 2nd   |              |                 |                          |                          |
| T <sub>1</sub> = Carrot – Okra                      | 11.63                 | Fail  | 10.38                        | -     | 10.38        | 71.23           | 259.5                    | 188.27                   |
| T <sub>2</sub> = Carrot – Mukhikachu                | 13.53                 | 10.5  | 12.08                        | 13.12 | 25.2         | 225.43          | 761.2                    | 535.77                   |
| T <sub>3</sub> = Onion/Garlic – Okra                | 1.88                  | Fail  | 3.34                         | -     | 3.34         | 125.44          | 167                      | 41.56                    |
| T <sub>4</sub> = Fallow – Mukhikachu                | -                     | 14.13 | -                            | 17.66 | 1.66         | 153.20          | 618.1                    | 464.9                    |
| T <sub>5</sub> = Sole (no crop with date palm)      | -                     | -     | -                            | -     | -            | -               | -                        | -                        |

\*\*Price: Carrot-25 Tk/kg, Mukhikachu-35 Tk/kg, Garlic-50 Tk/kg, Rice-28 Tk/kg

The experimental plot of Okra was damaged due to high temperature and Musaic virus disease

**Evaluation of different rice-based cropping patterns under agro-forestry systems with exotic date palm (*Phoenix dactylifera*).**

This experiment was conducted to ensure food sufficiency for farm family and to increase whole farm productivity with five rice-based cropping patterns. Among the five cropping pattern DS

Aman (BRRI dhan71)–Chilli produced the highest gross margin of Tk 1,09,620 (Table 14) which was followed by DS Aman (BRRI dhan71) – Lentil cropping patterns (Tk 86,080). The lowest gross margin was observed from DS Aman (BRRI dhan71) –Garden Pea cropping pattern (Tk 6,290).

**Table 14. Productivity and economics of rice-based cropping patterns under date palm agro-forestry systems 2023-24.**

| Cropping pattern<br>(Inter-cropping with date palm) | Yields of crop<br>(t/ha) |      | Rice equivalent<br>yield (t/ha) |      | Total<br>(t/ha) | TVC<br>(‘000Tk<br>/ha) | Gross<br>return<br>(‘000Tk/ha) | Gross<br>margin<br>(‘000Tk/ha) |
|-----------------------------------------------------|--------------------------|------|---------------------------------|------|-----------------|------------------------|--------------------------------|--------------------------------|
|                                                     | 1st                      | 2nd  | 1st                             | 2nd  |                 |                        |                                |                                |
| T <sub>1</sub> = DS Aman (BRRI dhan71) – chilli     | 3.42                     | Fail | 3.42                            | -    | 3.42            | 59.99                  | 95.76                          | 35.77                          |
| T <sub>2</sub> = DS Aman (BRRI dhan71) – mustard    | 3.40                     | 0.42 | 3.40                            | 1.05 | 4.45            | 135.73                 | 168.7                          | 32.97                          |
| T <sub>3</sub> = DS Aman (BRRI dhan71) – garden pea | 3.41                     | Fail | 3.41                            | -    | 3.41            | 59.99                  | 95.48                          | 35.49                          |
| T <sub>4</sub> = DS Aman (BRRI dhan71) – grass pea  | 3.44                     | 1.44 | 3.44                            | 1.81 | 5.25            | 102.45                 | 160.27                         | 57.82                          |
| T <sub>5</sub> = DS Aman (BRRI dhan71) – lentil     | 3.48                     | 1.00 | 3.48                            | 2.68 | 6.16            | 124                    | 298.44                         | 174.44                         |
| T <sub>6</sub> = Sole<br>(No crop with date palm)   | -                        | -    | -                               | -    | -               | -                      | -                              | -                              |

\*\*Price: Rice-28 tk/kg, mustard-70 Tk/kg, grass pea-35 Tk/kg, lentil-75 Tk/kg, chilli-100 Tk/kg, garden Pea- 70 Tk/kg

#### Determination of optimum planting window of newly released T. Aman rice varieties in three cropped cropping pattern

To find out the effective rice varieties with appropriate planting time for increasing yield potential of T. Aman rice the experiment was conducted with three palnting times and four varieties. Among the four varieties of rice BRRI dhan87 showed the highest yield at 16<sup>th</sup> August transplanting which was 6.71 t/ha followed by BRRI dhan71 (5.74 t/ha) (Fig. 1). At this planting

time the lowest yield was found in case of BRRI dhan90 (4.98 t/ha). The yield of each varieties of rice decreased in accordance to transplanting at later date. The lowest yield of BRRI dhan87 (5.22 t/ha) was observed at 30<sup>th</sup> August transplanting and the yield of BRRI dhan90 was 4.29 t/ha. In late transplanting condition the highest yield was found in BRRI dhan87 (5.22 t/ha) followed by BRRI dhan71 (4.82 t/ha). So BRRI dhan71 and BRRI dhan87 are recommended for late transplanting condition.

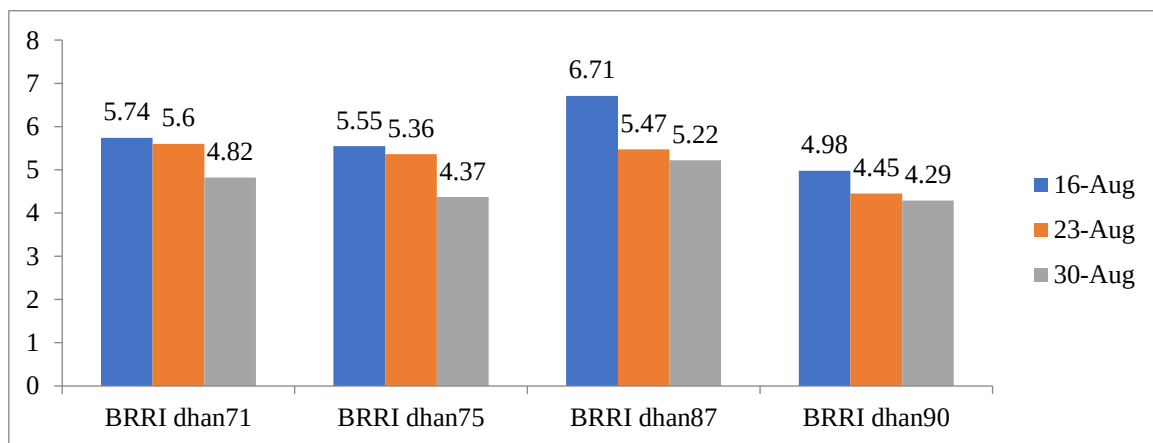


Fig. 1. Performance of different rice variety at different planting times.



To increase system productivity and profitability of existing cropping system the experiment was conducted with two improved and one control practice. Maximum REY (13.34 t/ha) and highest gross margin (1,16,470 Tk/ha) was obtained from CP2 followed by CP3 (1,00,340 Tk/ha) (Table 15)

was recorded from CP2 where fallow period was managed with BARI Sorisha-14 and check Aman variety was replaced by a promising HYV, BRRI dhan90. From the economic point of view, CP 2 showed its superiority over the other performed cropping patterns.

**Table 15. Performance of existing Mustard-Boro-T. Aman cropping patterns with different varietal combinations.**

| Cropping pattern |                                                                             | Season wise Yield (t/ha) |      |         | REY (t/ha) | TVC (000 Tk/ha) | Gross return (000 Tk/ha) | Gross margin (000 Tk/ha) |
|------------------|-----------------------------------------------------------------------------|--------------------------|------|---------|------------|-----------------|--------------------------|--------------------------|
|                  |                                                                             | Mustard                  | Boro | T. Aman |            |                 |                          |                          |
| CP1              | Farmers' practice (BARI Sorisha-14 - BRRI dhan28 - BRRI dhan34 / Badshavog) | 1.32                     | 5.10 | 2.40    | 9.08       | 335.79          | 371.55                   | 35.76                    |
| CP2              | Improved practice-1 (BARI Sorisha-14 - Bangabandhu dhan100 - BRRI dhan90)   | 1.51                     | 6.44 | 4.14    | 13.34      | 335.79          | 452.26                   | 116.47                   |
| CP3              | Improved practice-2 (BARI Sorisha-14 - BRRI dhan63* - BRRI dhan90)          | 1.50                     | 5.95 | 4.12    | 12.65      | 335.79          | 436.13                   | 100.34                   |

\*Due to lack of seed BRRI dhan63 was used as alternative of BRRI dhan104

\*\*Price: Rice (BRRI dhan34=57.50/-, BRRI dhan90=37.50/-, BRRI dhan28=28/-, Bangabandhu dhan100 and BRRI dhan63=30/-), Mustard (BARI Sorisha-14=68.75/-)

## CROP-SOIL-WATER MANAGEMENT

### Effect of missing nutrient elements on growth and grain yield of rice in BRRI RS, farm Kushtia

The experiment of missing nutrient element trial was conducted at BRRI RS farm, Kushtia to assess long-term yield trend of rice under different nutrient management practices using BRRI dhan87 and Bangabandhu dhan100 during T. Aman 2023 and Boro 2023- 24 respectively. This trial was carried out using seven treatments in RCB design with three replications. npkszn was applied at the rate of 95-14-50-12-1 kg ha<sup>-1</sup> in T. Aman and 145-

10-60-15-2 kg ha<sup>-1</sup> in Boro season. In T. Aman 2023, nutrient controlled plot (4.36 t/ha) and N omitted plot (4.88 t/ha) produced the lowest yield compared to the other fertilizer treatments (Table 13). In Boro season, application of N P K S and Zn significantly increased rice yield compared to the control and N omitted plot. However, insignificant variation in rice yield was observed between the missing of N solely and control treatment (Table 16). Control plot (without fertilization) reduced the highest yield level of (42%) followed by N omitted plot (39%). N is the most limiting factor for BRRI RS Kushtia Farm.

**Table 16: Effects of missing nutrient elements on the panicle, straw yield and grain yield of BRRI dhan87 and Bangabandhu dhan100 at T. Aman 2023 and Boro 2023-24 respectively.**

| Treatments | T. Aman 2023           |             |             |                                            | Boro 2023-24           |             |             |                                            |
|------------|------------------------|-------------|-------------|--------------------------------------------|------------------------|-------------|-------------|--------------------------------------------|
|            | Panicle/m <sup>2</sup> | Straw yield | Grain yield | Yield reduction (%) due to missing element | Panicle/m <sup>2</sup> | Straw yield | Grain yield | Yield reduction (%) due to missing element |
| T1         | 287                    | 4.90        | 5.91        | -                                          | 269                    | 4.04        | 6.09        | -                                          |
| T2         | 210                    | 4.32        | 4.88        | 17                                         | 226                    | 2.44        | 3.70        | 39                                         |
| T3         | 247                    | 5.01        | 5.49        | 7                                          | 255                    | 4.13        | 5.78        | 5                                          |
| T4         | 242                    | 4.84        | 5.38        | 9                                          | 268                    | 4.08        | 5.74        | 7                                          |
| T5         | 285                    | 4.49        | 5.45        | 8                                          | 259                    | 3.86        | 5.7         | 6                                          |
| T6         | 262                    | 4.63        | 5.44        | 8                                          | 254                    | 3.96        | 5.73        | 6                                          |
| T7         | 223                    | 4.02        | 4.36        | 26                                         | 213                    | 2.38        | 3.56        | 42                                         |
| CV         | 9.86                   | 7.79        | 10.24       |                                            | 5.72                   | 12.43       | 7.00        |                                            |
| LSD (0.05) | 43.98                  | 0.64        | 0.98        |                                            | 25.35                  | 0.79        | 0.65        |                                            |

T1=NPKSZn, T2=PKSZn (-N), T3= NKSZn (-P), T4= NPSZn (-K), T5= NPKZn (-S), T6= NPKS (-Zn), T7= Control (No fertilizer)

## SOCIO-ECONOMICS AND POLICY

### Stability analysis of BRRI varieties

To maintain season, year and location-wise database on the yield performance of BRRI varieties.

During the T. Aman 2023 trial, 48 varieties were evaluated. Among the short-duration varieties, BRRI dhan87 had the highest yield at 6.78 t/ha, while BRRI dhan62 had the lowest at 4.37 t/ha. For the medium-duration varieties, BRRI dhan103 produced the highest yield at 7.15 t/ha, and BR32 had the lowest at 3.63 t/ha. Among the long-duration varieties, BR10 yielded the highest at 6.37 t/ha, with BRRI dhan91 recording the lowest yield at 3.53 t/ha. In the Boro 2023-24 trial, 52 varieties were evaluated. Among the long-duration varieties, BRRI dhan89 achieved the highest yield at 9.26 t/ha, while BR17 recorded the lowest yield at 4.66 t/ha. For the short-duration varieties, BRRI hybrid dhan8 was the top performer with the yield of 8.98 t/ha, whereas BRRI dhan81 had the lowest yield at 4.72 t/ha.

## TECHNOLOGY TRANSFER

### Farmers' training and field day

In the reporting year, 20 batches of farmers' training were organized under GoB and four batches under PARTNER project in which 708 farmers participated. Modern rice varieties and relevant technologies were disseminated through field demonstrations. Under PARTNER project and GoB 12 field days were organized in which more than 1,200 farmers participated.

## VARIETY DEMONSTRATION

### Varietal Demonstration under GoB/LSTD/PARTNER

BRRI RS, Kushtia also focused on promoting newly released high-yielding and hybrid varieties during the Aus, Aman, and Boro seasons. In the

2023-24 reporting year, a total of 524 demonstrations were conducted across 23 upazilas in five districts under the government of Bangladesh (GoB) initiative. This included 103 demonstrations in the Aus 2023 season, 202 in Aman, and 219 in Boro. Among the demonstrated Aus varieties, BRRI dhan98 achieved the highest yield. In the Aman season, BRRI dhan87 ranked first in yield among 202 demonstrations. During the Boro 2023-24 season, seven varieties were demonstrated, with BRRI hybrid dhan8 yielding the highest. Additionally, 17 demonstrations were executed under the LSTD project, and 390 demonstrations were conducted under the PARTNER project.

### Enrichment of Seed Stock

#### Production of breeder seed

Nucleus seeds were provided by the Genetic Resources and Seed (GRS) Division for breeder seed production during the Aman and Boro seasons. In Aman 2023, 4,032 kg of BRRI dhan75 and BRRI dhan87 seeds were produced. During the Boro 2023 season, 3,200 kg of BRRI dhan63 seeds were produced. The total production of breeder seed was 7,232 kg, which was sent to the GRS Division during the 2023-24 fiscal year.

#### Production of truthfully labeled seed (TLS)

Truthfully labeled seed (TLS) production activities were carried out during the Aus, Aman, and Boro seasons in the 2023-24 reporting year. In the Aus season, approximately 1,265 kg of seeds were produced from BRRI dhan98, BRRI dhan48, and BRRI dhan83. During the Aman season, a total of 890 kg of seeds from BRRI dhan34, BRRI dhan71, BRRI dhan75, BRRI dhan87, BRRI dhan90, and BRRI dhan103 were produced. In the Boro season, 1,805 kg of seeds were produced from BRRI dhan63, BRRI dhan89, BRRI dhan92, BRRI dhan96, BRRI dhan101, and BRRI dhan102.



## **BRRI RS, Sirajganj**

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## SUMMARY

The results for all RYT trials in T. Aman 2023 are as follows. The genotype BRH9-3-2B produced significantly higher yield ( $6.36 \text{ tha}^{-1}$ ) over the check variety Katari ( $5.34 \text{ tha}^{-1}$ ) with shorter growth duration (18 days). All the genotypes of Zhira type produced significantly higher yield over the check varieties Zirashail and BRRI dhan62. The genotype BR12839-4R-124-2, under antioxidant enriched rice-1 produced significantly higher yield ( $4.08 \text{ tha}^{-1}$ ) over the check varieties. None of the tested entries for antioxidant enriched rice-2 produced significantly higher yield over check varieties BRRI dhan87 and BRRI dhan49. The genotype BR (Bio)10381-AC11-7-1 under low amylose content rice produced statistically similar yield ( $6.08 \text{ tha}^{-1}$ ) with check varieties BRRI dhan71 ( $5.54 \text{ tha}^{-1}$ ) and BRRI dhan87 ( $5.99 \text{ tha}^{-1}$ ) with similar growth duration of check variety BRRI dhan87 (130 days). The genotype for photosensitive IR13F652-1-P3, BR10212-5-3 and BR11196-5R-5 produced significantly higher yield over check variety BR22. The tested entry BR10799-6R-31 under RLR-1 produced significantly higher yield ( $6.44 \text{ tha}^{-1}$ ) over the check variety BRRI dhan71 ( $5.46 \text{ tha}^{-1}$ ). The check variety RLR-2 BRRI dhan87 produced the highest yield ( $5.51 \text{ tha}^{-1}$ ) over tested genotypes but yield was statistically similar with genotype BR12011-6R-178 ( $5.14 \text{ tha}^{-1}$ ). Among the tested entries under false smut-1 BR (Path) 13804-BC3-13 produced significantly higher yield ( $5.91 \text{ tha}^{-1}$ ) over check variety BRRI dhan49 ( $5.13 \text{ tha}^{-1}$ ). Test entry BR (Path) 13804-BC3-14 under false smut-2 produced statistically similar yield ( $5.46 \text{ tha}^{-1}$ ) compared to check BRRI dhan87 ( $5.90 \text{ tha}^{-1}$ ). None of the genotypes of Zinc enriched rice produced higher yield than the check varieties. The tested entry BR9892-8-2-2B and BR9392-6-2-1B produced significantly higher yield ( $5.25 \text{ tha}^{-1}$  and  $5.23 \text{ t ha}^{-1}$ ) over the check variety BRRI dhan76

( $4.50 \text{ t ha}^{-1}$ ). None of the tested entries of shallow deep-water rice (RYT# HBj) produced significantly higher yield over the check varieties in B. Aman 2023. All the RYT trial results in Boro 2023-24 are described here. The tested genotypes of FBR Barishal NGR 472-2 and NGR 736-1 produced significantly higher yield ( $7.97 \text{ tha}^{-1}$  and  $7.88 \text{ tha}^{-1}$ ) over the check variety BRRI dhan74 ( $6.85 \text{ tha}^{-1}$ ) and BRRI dhan102 ( $6.87 \text{ tha}^{-1}$ ). Genotype BR (Bio) 13028-AC1-2-3 produced significantly higher yield ( $6.68 \text{ tha}^{-1}$ ) over the check variety BRRI dhan96 ( $5.88 \text{ tha}^{-1}$ ). None of the tested entries under blast and bacterial blight resistant rice produced significantly higher yield over check varieties BRRI dhan28 and BRRI dhan88. The genotype BR11867-5R-119, BR12450-4R-108 and BR12437-4R-164 statistically similar yield with the check variety BRRI dhan101 but with significantly higher yield over check variety BRRI dhan88 and BRRI dhan89. No major BB and Blast infestation was observed in this trial. None of the tested entries of Zinc enriched rice produced significantly higher yield over the check varieties. All the tested entries gave under fine grain rice produced statistically similar yield with check variety BRRI dhan100. In ALART, B. Aman 2023 for direct seeded broad cast Aman, none of the tested entries produced significantly higher yield over the check varieties Fulkori and Dhaldigha. In ALART for BRRI dhan49 type short slender grain (SHR-1), genotype BRH13-2-14-2-1B produced significantly higher yield ( $5.13 \text{ tha}^{-1}$ ) over the check variety ( $3.71 \text{ tha}^{-1}$ ) with almost similar growth duration in T. Aman 2023. None of the tested entries of Swarna type grain (SHR-2) in T. Aman 2023 produced significantly higher yield over the check variety. None of the entries produced higher yield over the check variety, BRRI dhan70 under Antioxidant Enriched Rice, ALART, T. Aman 2023. For Bacterial blight and Blast resistant Rice, test entries BR (path)13800-BC3-134-8 and BR(path)13800-

BC3-224-44 produced significantly higher yield (5.13 tha<sup>-1</sup> and 5.00 tha<sup>-1</sup>) over the check varieties BRRI dhan89 (3.91 tha<sup>-1</sup>) and BRRI dhan92 (4.29 tha<sup>-1</sup>) with similar growth duration in Boro 2023-24. Tested entries of Bacterial blight resistant rice BR (path) 13800-BC3-8-9 and BR (path)13800-BC3-8-1 produced significantly higher yield (6.17 tha<sup>-1</sup> & 6.11 tha<sup>-1</sup>) over the check variety BRRI dhan89 (5.07 tha<sup>-1</sup>) and BRRI dhan92 (4.75 tha<sup>-1</sup>) with similar growth duration in Boro 2023-24. For ALART of Late Boro Rice, test entry BR11845-4R-62 produced statistically similar yield (7.35 tha<sup>-1</sup>) with check variety BRRI dhan98 (7.57 tha<sup>-1</sup>) and BRRI dhan28 (7.45 tha<sup>-1</sup>). For Short Duration Rice, ALART, the test genotype BR11903-5R-56 produced higher yield (6.03 tha<sup>-1</sup>) followed by genotype IR18A2119 (5.99 tha<sup>-1</sup>) which was statistically similar with check variety BRRI dhan96 (5.66 t/ha) in Boro 2023-24. The tested entry under (FBR-Bio) ALART BR (Bio) 13028-AC24-1-4 (5.68 tha<sup>-1</sup>) and BR (Bio) 13028-AC24-1-2 (5.66 tha<sup>-1</sup>) produced statistically identical yield with check variety BRRI dhan96 (5.85 tha<sup>-1</sup>) and BRRI dhan86 (5.78 tha<sup>-1</sup>) in Boro 2023-24. For Long Duration Rice in ALART, tested entry BR11318-5R-84 produced statistically similar yield (6.97 tha<sup>-1</sup>) with check variety BRRI dhan92 (6.56 tha<sup>-1</sup>) in Boro 2023-24. ALART for PQR, none of the tested entries produced significantly higher yield over check varieties but entry Zira, Nachol gave statistically similar yield

(7.96 tha<sup>-1</sup>) with check variety BINA dhan25 (8.07 tha<sup>-1</sup>) and BRRI dhan107 (7.67 tha<sup>-1</sup>) in Boro 2023-24. For ALART Superior High Yielding Rice (Ziratype), genotype BR17-23-8-2-7B produced higher yield (7.18 tha<sup>-1</sup>) compared to the variety BRRI dhan88 (6.23 tha<sup>-1</sup>) in Boro 2023-24. For ALART for Superior High Yielding Rice (Kataritype), all the tested entries gave significantly higher yield over the check variety BRRI dhan81 in Boro 2023-24. In Boro season, the highest number of panicle/m<sup>2</sup> (332) were recorded in K omitted plot. Significantly the lowest grain yield (4.19 tha<sup>-1</sup>) was recorded in N omitted plot, which was followed by (4.23 tha<sup>-1</sup>) in control treatment. A total of 8,900 and 5,500 kg of Breeder and TLS seeds were produced, respectively during 2022-23 season.

## VARIETAL DEVELOPMENT PROGRAMME

### Regional yield trial (RYT) during T. Aman 2023 and Boro 2023-24

#### Development of Katari type rice, T. Aman 2023

Three genotypes were evaluated along with Katari as standard check at BRRI RS farm Sirajganj. The genotype BRH9-3-2B produced significantly higher yield (6.36 tha<sup>-1</sup>) over the check variety Katari (5.34 tha<sup>-1</sup>) with shorter growth duration (18 days). The genotypes BRH9-3-14-2B and BRH13-9-5-2B produced statistically similar yield with check variety Katari (Table 1).

**Table 1. Performance of different entries under RYT Kataritype grain during T. Aman 2023.**

| Designation         | GD (day) | Plant height (cm) | Panicle /hill | Yield (tha <sup>-1</sup> ) |
|---------------------|----------|-------------------|---------------|----------------------------|
| BRH9-3-14-2B        | 117      | 113.9             | 10            | 5.95±0.38                  |
| BRH13-9-5-2B        | 117      | 114.2             | 9             | 5.95±0.21                  |
| BRH9-3-2B           | 114      | 115.4             | 10            | 6.36±0.31                  |
| Katari              | 132      | 129.1             | 13            | 5.34±0.33                  |
| Lsd <sub>0.05</sub> | -        | 2.77              | 1.33          | 0.63                       |
| CV (%)              | -        | 1.17              | 6.45          | 5.34                       |

DS: 7 Jul 2023

DTP: 30 Jul 2023

### Development of Zira type rice, T. Aman 2023.

Four genotypes along with two check varieties Zirashail and BRRI dhan62 were tested at BRRI farm Sirajganj. All the tested genotypes produced

significantly higher yield over the check varieties Zirashail and BRRI dhan62 but growth duration was 7-10 days longer than both the check varieties (Table 2).

**Table 2. Performance of different entries of Zira type grain under RYT during T. Aman 2023.**

| Designation         | GD (day) | Plant height (cm) | Panicle /hill | Yield (tha <sup>-1</sup> ) |
|---------------------|----------|-------------------|---------------|----------------------------|
| BRH11-7-17-10B      | 113      | 117.6             | 9             | 5.14±0.28                  |
| BR17-23-8-2-7B      | 111      | 116.0             | 10            | 3.69±0.39                  |
| BRH14-2-1-7B        | 112      | 116.6             | 10            | 4.68±0.05                  |
| BRH9392-1-7-5B      | 111      | 117.6             | 9             | 4.60±0.30                  |
| Zirashail           | 103      | 121.3             | 13            | 2.69±0.35                  |
| BRRI dhan62         | 103      | 114.5             | 13            | 2.47±0.21                  |
| Lsd <sub>0.05</sub> | -        | 3.48              | 1.55          | 0.95                       |
| CV (%)              | -        | 1.63              | 8.05          | 13.51                      |

DS: 7 Jul 2023

DTP: 30 Jul 2023

(Note: Birds damaged Zirashail and BRRI dhan62)

### Development of antioxidant enriched rice-1, T. Aman 2023

Five entries were grown along with two check varieties BRRI dhan34 and BRRI dhan70 at BRRI

RS farm, Sirajganj. The tested genotypes BR12839-4R-124-2, BR12839-4R-51 and BR12836-4R-312 produced 4.08, 3.89, 3.34 tha<sup>-1</sup>, respectively which were significantly higher over both the check varieties (Table 3).

**Table 3. Performance of different entries of Antioxidant-1 under RYT during T. Aman 2023.**

| Designation         | GD (day) | Plant height (cm) | Panicle /hill | Yield (tha <sup>-1</sup> ) |
|---------------------|----------|-------------------|---------------|----------------------------|
| BR12836-4R-63       | 141      | 113.5             | 11            | 3.03±0.18                  |
| BR12836-4R-312      | 134      | 107.6             | 9             | 3.34±0.31                  |
| BR12839-4R-124-2    | 125      | 114.2             | 10            | 4.08±0.11                  |
| BR12839-4R-51       | 121      | 113.8             | 9             | 3.89±0.41                  |
| BR12838-4R-89-1     | 127      | 108.5             | 9             | 1.87±0.16                  |
| BRRI dhan34         | 141      | 137.7             | 12            | 2.02±0.19                  |
| BRRI dhan70         | 127      | 131.6             | 10            | 2.48±0.26                  |
| Lsd <sub>0.05</sub> | -        | 5.90              | 1.05          | 0.82                       |
| CV (%)              | -        | 2.81              | 5.97          | 15.50                      |

DS: 22 Jul 2023

DTP: 19 Aug 2023

### Development of Antioxidant enriched rice varieties-2, during T. Aman 2023.

Seven breeding lines were grown along with two check varieties BRRI dhan87 and BRRI dhan49 at BRRI RS farm, Sirajganj. None of the tested entries

produced significantly higher yield over the check varieties BRRI dhan87 (5.29 tha<sup>-1</sup>) and BRRI dhan49 (5.28 tha<sup>-1</sup>) but genotype BR12839-4R-34-1 produced statistically similar yield (4.75 tha<sup>-1</sup>) with both the check varieties (Table 4).

**Table 4. Performance of different entries under RYT Antioxidant -2 during T. Aman 2023.**

| Designation         | GD (day) | Plant height (cm) | Panicle /hill    | Yield (tha <sup>-1</sup> ) |
|---------------------|----------|-------------------|------------------|----------------------------|
| BR12839-4R-106      | 124      | 114.2             | 8                | 4.31±0.19                  |
| BR12839-4R-34-1     | 126      | 120.6             | 8                | 4.75±0.18                  |
| BR12839-4R-76       | 121      | 112.9             | 9                | 4.04±0.28                  |
| BR12839-4R-137      | 116      | 114.7             | 10               | 4.04±0.42                  |
| BR12839-4R-86-1     | 126      | 116.9             | 9                | 3.62±0.26                  |
| BR12839-4R-90-1     | 126      | 114.6             | 10               | 3.48±0.41                  |
| BR12839-4R-72       | 116      | 99.10             | 10               | 2.39±0.47                  |
| BRRI dhan87         | 126      | 123.9             | 11               | 5.29±0.27                  |
| BRRI dhan49         | 130      | 110.9             | 13               | 5.28±0.31                  |
| Lsd <sub>0.05</sub> | -        | 3.04              | 1.30             | 0.84                       |
| CV (%)              | -        | 1.54              | 7.80             | 11.69                      |
| DS: 22 Jul 2023     |          |                   | DTP: 18 Aug 2023 |                            |

#### Development of low amylose content rice varieties during T. Aman 2023

Three genotypes were grown along with two check varieties BRRI dhan71 and BRRI dhan87 at BRRI RS farm, Sirajganj. The genotype BR(Bio)10381-

AC11-7-1 produced statistically similar yield (6.08 tha<sup>-1</sup>) with check varieties BRRI dhan71 (5.54 tha<sup>-1</sup>) and BRRI dhan87 (5.99 tha<sup>-1</sup>) with similar growth duration of check variety BRRI dhan87 (130 days) (Table 5).

**Table 5. Performance of low amylose content entries under RYT during T. Aman 2023.**

| Designation           | GD (day) | Plant height (cm) | Panicle /hill    | Yield (tha <sup>-1</sup> ) |
|-----------------------|----------|-------------------|------------------|----------------------------|
| BR(Bio)10381-AC11-7-1 | 130      | 119.9             | 11               | 6.08±0.15                  |
| BR(Bio)10381-AC11-8-1 | 104      | 96.2              | 8                | 1.96±0.18                  |
| BR(Bio)13031-AC1-2    | 112      | 121.5             | 10               | 3.42±0.23                  |
| BRRI dhan71           | 112      | 123.4             | 10               | 5.54±0.45                  |
| BRRI dhan87           | 130      | 121.7             | 11               | 5.99±0.10                  |
| Lsd <sub>0.05</sub>   | -        | 6.21              | 2.16             | 0.77                       |
| CV (%)                | -        | 2.83              | 11.25            | 8.91                       |
| DS: 26 Jul 2023       |          |                   | DTP: 21 Aug 2023 |                            |

#### Development of photosensitive rice varieties, during T. Aman 2023

Eight breeding lines were grown along with two check varieties BR22 and BR23 at BRRI farm Sirajganj. The genotype IR13F652-1-P3, BR10212-

5-3 and BR11196-5R-5 gave statistically similar yield (5.24, 5.07 and 4.66 tha<sup>-1</sup>, respectively) with check variety BR23 (4.79 tha<sup>-1</sup>) but significantly higher yield over check variety BR22 (3.33 tha<sup>-1</sup>) (Table 6).

**Table 6. Performance of different entries under RYT Photosensitive rice during T.Aman 2023.**

| Designation      | GD (day) | Plant height (cm) | Panicle/hill | Yield tha <sup>-1</sup> |
|------------------|----------|-------------------|--------------|-------------------------|
| BR10212-17-3-2-2 | 151      | 127.8             | 11           | 4.05±0.32               |
| BR10212-4-3-1    | 147      | 133.6             | 11           | 3.97±0.09               |
| BR10211-30-2-1-4 | 147      | 124.1             | 10           | 3.29±0.43               |
| BR10212-5-3      | 146      | 129.3             | 12           | 5.07±0.67               |
| IR13F652-1-P3    | 151      | 121.4             | 11           | 5.24±0.47               |



| Designation         | GD (day) | Plant height (cm) | Panicle/hill     | Yield tha <sup>-1</sup> |
|---------------------|----------|-------------------|------------------|-------------------------|
| IR16F1097-P1        | 151      | 131.7             | 12               | 3.73±0.40               |
| BR11196-5R-5        | 155      | 116.5             | 11               | 4.66±0.27               |
| BR10211-7-5-1       | 146      | 132.9             | 12               | 4.34±0.38               |
| BR22                | 155      | 134.0             | 10               | 3.33±0.49               |
| BR23                | 155      | 134.0             | 10               | 4.79±0.29               |
| Lsd <sub>0.05</sub> | -        | 7.55              | 1.64             | 0.62                    |
| CV (%)              | -        | 3.42              | 8.67             | 8.94                    |
| DS: 12 Jul 2023     |          |                   | DTP: 17 Aug 2023 |                         |

#### Development of rainfed low land rice-1 (RLR-1) T. Aman 2023

Nine genotypes were evaluated along with BRRI dhan71 and BRRI dhan75 as standard check in BRRI RS, Sirajganj. The tested entry BR10799-6R-31 produced

significantly higher yield (6.44 tha<sup>-1</sup>) over the check variety BRRI dhan71 (5.46 tha<sup>-1</sup>) but statistically similar yield with check the variety BRRI dhan75 (6.40 tha<sup>-1</sup>) (Table 7).

**Table 7. Performance of different entries of RLR-1 under RYT during T.Aman 2023.**

| Genotype            | GD (day) | Plant height (cm) | Panicle/hill     | Yield (t ha <sup>-1</sup> ) |
|---------------------|----------|-------------------|------------------|-----------------------------|
| BR12001-6R-205      | 111      | 142.1             | 11               | 5.50±0.07                   |
| BR10795-6R-133      | 113      | 145.3             | 10               | 5.09±0.17                   |
| BR12005-6R-14       | 130      | 146.3             | 10               | 5.33±0.10                   |
| BR10797-6R-140      | 113      | 123.4             | 13               | 5.33±0.13                   |
| BR10799-6R-104      | 113      | 140.7             | 11               | 5.64±0.10                   |
| BR12007-6R-61       | 111      | 155.5             | 11               | 2.72±0.02                   |
| BR11333-6R-4        | 113      | 128.1             | 11               | 5.12±0.08                   |
| BR11333-6R-84       | 113      | 115.7             | 12               | 5.39±0.12                   |
| BR10799-6R-31       | 113      | 145.2             | 10               | 6.44±0.04                   |
| BRRI dhan71         | 113      | 123.3             | 11               | 5.46±0.16                   |
| BRRI dhan75         | 111      | 114.5             | 11               | 6.40±0.20                   |
| Lsd <sub>0.05</sub> | -        | 4.094             | 1.236            | 0.333                       |
| CV (%)              | -        | 1.79              | 6.67             | 3.69                        |
| DS: 19 Jul 2023     |          |                   | DTP: 13 Aug 2023 |                             |

**\*\* Spacing of the table (17) need to be minimized**

#### Development of Rainfed low land rice-2 (RLR-2) T. Aman 2023.

Seven genotypes along with two standard check varieties BRRI dhan49 and BRRI dhan87 were grown at BRRI RS, Sirajganj. The check variety

BRRI dhan87 produced the highest yield (5.51 tha<sup>-1</sup>) over tested genotypes but yield was statistically similar with genotype BR12011-6R-178 (5.14 tha<sup>-1</sup>) (Table 8).

**Table 8. Performance of different entries of RLR-2 under RYT during T.Aman 2023.**

| Genotype       | GD (day) | Plant height (cm) | Panicle/hill | Yield (tha <sup>-1</sup> ) |
|----------------|----------|-------------------|--------------|----------------------------|
| BR12011-6R-178 | 124      | 128.7             | 12           | 5.14±0.08                  |
| BR10797-6R-24  | 128      | 138.8             | 11           | 4.26±0.05                  |
| BR10799-6R-70  | 128      | 133.3             | 11           | 4.23±0.10                  |
| BR11343-6R-51  | 135      | 109.0             | 12           | 4.92±0.06                  |
| BR11227-6R-98  | 140      | 160.5             | 12           | 4.46±0.14                  |
| BR10802-6R-66  | 140      | 140.4             | 11           | 4.63±0.27                  |

| Genotype            | GD (day) | Plant height (cm) | Panicle/hill    | Yield (tha <sup>-1</sup> ) |
|---------------------|----------|-------------------|-----------------|----------------------------|
| BR11336-6R-10       | 140      | 157.0             | 13              | 4.66±0.26                  |
| BRRI dhan49         | 140      | 111.3             | 13              | 5.40±0.02                  |
| BRRI dhan87         | 128      | 128.1             | 13              | 5.51±0.12                  |
| Lsd <sub>0.05</sub> | -        | 4.839             | 1.300           | 0.437                      |
| CV (%)              | -        | 2.08              | 6.30            | 5.27                       |
| DS: 6 Jul 2023      |          |                   | DTP: 2 Aug 2023 |                            |

#### Development of disease resistant (false smut 01) rice varieties during T.Aman 2023

Nine genotypes were grown along with check varieties BRRI dhan49 and BRRI dhan87 at BRRI

RS, Sirajganj. Among the tested entries BR (Path) 13804-BC3-13 produced significantly higher yield (5.91 tha<sup>-1</sup>) over the check variety BRRI dhan49 (5.13 tha<sup>-1</sup>) which was statistically similar with BRRI dhan87 (5.90 tha<sup>-1</sup>) (Table 9).

**Table 9. Performance of different entries under RYT false smut 01 during T. Aman 2023.**

| Genotype                    | GD (day) | Plant height (cm) | Panicle /hill     | Yield (t ha <sup>-1</sup> ) |
|-----------------------------|----------|-------------------|-------------------|-----------------------------|
| BR(Path) 13804-BC3-4        | 124      | 115.8             | 12                | 5.49±0.18                   |
| BR(Path) 13804-BC3-9        | 124      | 124.7             | 12                | 4.28±0.06                   |
| BR(Path) 13804-BC3-13       | 124      | 112.4             | 12                | 5.91±0.19                   |
| BR(Path) 13804-BC3-14       | 124      | 111.9             | 12                | 4.72±0.04                   |
| BR(Path) 13804-BC3-16       | 124      | 120.3             | 11                | 5.07±0.08                   |
| BR(Path) 13804-BC3-18       | 124      | 121.8             | 12                | 5.00±0.19                   |
| BR(Path) 13804-BC3-20       | 124      | 112.1             | 12                | 5.22±0.07                   |
| BR(Path) 13804-BC3-21       | 124      | 111.2             | 12                | 5.78±0.09                   |
| BR(Path) 13804-BC3-134-21-1 | 110      | 118.3             | 10                | 3.03±0.18                   |
| BRRI dhan49                 | 138      | 110.6             | 12                | 5.13±0.06                   |
| BRRI dhan87                 | 128      | 123.3             | 11                | 5.90±0.14                   |
| Lsd <sub>0.05</sub>         | -        | 2.513             | 1.148             | 0.348                       |
| CV (%)                      | -        | 1.27              | 5.69              | 4.05                        |
| DS: 20 Jul 2023             |          |                   | D/TP: 20 Aug 2023 |                             |

#### Development of disease resistant (false smut 02) rice varieties during T. Aman 2023.

Nine genotypes were grown along with check varieties BRRI dhan79 and BRRI dhan87 at BRRI RS, Sirajganj. Among the tested entries check

variety BRRI dhan87 produced the highest yield (5.90 tha<sup>-1</sup>) which was statistically similar with genotype BR (Path) 13804-BC3-14 with the yield of 5.46 tha<sup>-1</sup> (Table 10).

**Table 10. Performance of different entries under RYT false smut 02 during T. Aman 2023.**

| Genotype              | GD (day) | Plant height (cm) | Panicle /hill | Yield (t ha <sup>-1</sup> ) |
|-----------------------|----------|-------------------|---------------|-----------------------------|
| BR(Path) 13804-BC3-4  | 124      | 112.9             | 12            | 4.88±0.08                   |
| BR(Path) 13804-BC3-9  | 124      | 120.5             | 11            | 5.10±0.14                   |
| BR(Path) 13804-BC3-13 | 124      | 106.9             | 11            | 4.95±0.05                   |
| BR(Path) 13804-BC3-14 | 124      | 111.3             | 11            | 5.46±0.27                   |
| BR(Path) 13804-BC3-16 | 124      | 116.6             | 11            | 4.62±0.19                   |
| BR(Path) 13804-BC3-18 | 124      | 115.9             | 13            | 4.99±0.21                   |
| BR(Path) 13804-BC3-20 | 124      | 108.3             | 12            | 5.27±0.16                   |
| BR(Path) 13804-BC3-21 | 124      | 106.2             | 11            | 5.16±0.13                   |

|                             |     |       |                  |           |
|-----------------------------|-----|-------|------------------|-----------|
| BR(Path) 13804-BC3-134-21-1 | 116 | 111.5 | 11               | 3.77±0.12 |
| BRRI dhan79                 | 130 | 106.7 | 9                | 4.53±0.07 |
| BRRI dhan87                 | 130 | 115.7 | 11               | 5.90±0.06 |
| Lsd <sub>0.05</sub>         | -   | 1.873 | 1.315            | 0.46      |
| CV (%)                      | -   | 0.98  | 6.85             | 5.44      |
| DS: 9 Aug 2023              |     |       | DTP: 30 Aug 2023 |           |

#### Development of zinc enriched rice during T. Aman 2023.

Four genotypes were tested along with four standard checks namely BRRI dhan49, BRRI dhan72, BRRI dhan87 and BRRI dhan93 at BRRI RS, Sirajganj. There was no statistical difference in

yield of tested genotype BR10854-4-1-1-2-8 (5.59  $\text{tha}^{-1}$ ) and check varieties BRRI dhan72 (5.66  $\text{tha}^{-1}$ ), BRRI dhan87 (5.49  $\text{tha}^{-1}$ ) and BRRI dhan49 (5.15  $\text{tha}^{-1}$ ). No genotypes gave higher yield than check varieties (Table 11).

**Table 11. Performance of different entries of zinc enriched rice under RYT during T. Aman 2023.**

| Genotype            | GD (day) | Plant height (cm) | Panicle/hill     | Yield (t $\text{ha}^{-1}$ ) |
|---------------------|----------|-------------------|------------------|-----------------------------|
| BR10854-4-1-1-2-8   | 136      | 132.5             | 11               | 5.59±0.03                   |
| BR10855-3-2-5-2-5   | 136      | 147.4             | 10               | 4.10±0.24                   |
| BR10863-8-3-5-3-2   | 136      | 120.9             | 11               | 4.50±0.38                   |
| BR11176-16-7-4-4-2  | 136      | 146.9             | 11               | 4.44±0.09                   |
| BRRI dhan49         | 136      | 113.0             | 13               | 5.15±0.13                   |
| BRRI dhan72         | 136      | 125.8             | 12               | 5.66±0.30                   |
| BRRI dhan87         | 130      | 132.7             | 12               | 5.49±0.11                   |
| BRRI dhan93         | 136      | 125.8             | 11               | 4.42±0.12                   |
| Lsd <sub>0.05</sub> | -        | 4.595             | 2.981            | 0.606                       |
| CV (%)              | -        | 2.01              | 15.02            | 7.04                        |
| DS: 13Jul 2023      |          |                   | DTP: 10 Aug 2023 |                             |

#### Development of long duration tall variety (LD tall), T. Aman 2023

Four genotypes were evaluated along with BRRI dhan76 and BRRI dhan71 as standard check at the field of BRRI Sirajganj. The tested entry BR9892-8-2-2B and BR9392-6-2-1B produced significantly

higher yield (5.25  $\text{tha}^{-1}$  and 5.23  $\text{tha}^{-1}$ ) over the check variety BRRI dhan76 (4.50  $\text{tha}^{-1}$ ). Check variety BRRI dhan91 (2.77  $\text{tha}^{-1}$ ) produced lowest yield due to lodging at flowering stage (Table 12).

**Table 12. Performance of different entries under RYT LD tall during T. Aman 2023.**

| Genotype            | GD (day) | Plant height (cm) | Panicle/hill | Yield (t $\text{ha}^{-1}$ ) |
|---------------------|----------|-------------------|--------------|-----------------------------|
| BR9892-8-2-2B       | 138      | 125.9             | 10           | 5.25±0.06                   |
| BR10247-14-18-7-3   | 138      | 129.2             | 10           | 3.43±0.12                   |
| BR10238-5-1-9-2B    | 138      | 130.7             | 11           | 4.49±0.13                   |
| BR9392-6-2-1B       | 138      | 151.2             | 12           | 5.23±0.07                   |
| BRRI dhan76         | 138      | 154.5             | 13           | 4.50±0.08                   |
| BRRI dhan91         | 138      | 164.3             | 11           | 2.77±0.14*                  |
| Lsd <sub>0.05</sub> | -        | 8.743             | 1.715        | 0.347                       |
| CV (%)              | -        | 3.37              | 8.28         | 4.46                        |

DS: 12 Jul 2023

DTP: 7 Aug 2023 \*Lower yield due to lodging at flowering

### Development of shallow deep-water rice (RYT# HBj), B. Aman 2023

The experiment was conducted at the farmer's field of Baghbari, Shahjadpur, Sirajganj. Five genotypes

including two checks BRRI dhan91 and local check Dhaldigha was evaluated. The experiment was laid out in a RCB design with three replications. None of the tested entry produced significantly higher yield over the check varieties (Table 13).

**Table 13. Performance of different entries under RYT of shallow deep-water rice (RYT# HBj), B. Aman 2023 at Shahjadpur, Sirajganj.**

| Genotype             | GD (day) | Plant height (cm) | Panicle m <sup>-2</sup> | Yield (tha <sup>-1</sup> ) |
|----------------------|----------|-------------------|-------------------------|----------------------------|
| BR7730-1-1-2B        | 171      | 266.4             | 97                      | 0.84±0.49                  |
| BR7918-1-2-3B        | 170      | 257.9             | 80                      | 0.93±0.54                  |
| BR7919-1-1-3B        | 174      | 231.8             | 87                      | 1.07±0.62                  |
| BRRI dhan91 (ck)     |          |                   | Damaged                 |                            |
| Dhaldigha (local ck) | 172      | 285.2             | 77                      | 1.20±0.69                  |
| Lsd <sub>0.05</sub>  |          | 3.4               | 16.4                    | 0.23                       |
| CV (%)               |          | 0.7               | 9.4                     | 12.1                       |

DS: 30 May 2023

### Development of favourable Boro rice (Barishal) during Boro 2023-24.

Ten entries were grown along with two check varieties BRRI dhan74 and BRRI dhan102 at BRRI RS farm, Sirajganj. The tested genotypes NGR 472-

2 and NGR 736-1 produced significantly higher yield (7.97 tha<sup>-1</sup> and 7.88 tha<sup>-1</sup>) over the check variety BRRI dhan74 (6.85 tha<sup>-1</sup>) and BRRI dhan102 (6.87 tha<sup>-1</sup>) (Table 14).

**Table 14. Performance of different entries under RYT (Barishal) for Favourable Boro Rice during Boro 2023-24.**

| Designation         | GD (day) | Plant height (cm) | Panicle /hill | Yield (tha <sup>-1</sup> ) |
|---------------------|----------|-------------------|---------------|----------------------------|
| NGR 350-2           | 147      | 96.97±0.75        | 9.67±0.33     | 6.78±0.13                  |
| NGR 472-2           | 150      | 98.33±0.74        | 11.00±0.58    | 7.97±0.44                  |
| NGR 736-1           | 155      | 102.50±1.25       | 10.67±0.67    | 7.88±0.45                  |
| NGR 745-3           | 155      | 101.73±1.13       | 11.67±0.67    | 7.30±0.15                  |
| NGR 994-1           | 156      | 105.20±1.23       | 12.00±0.58    | 6.89±0.25                  |
| NGR 745-2           | 155      | 100.09±1.51       | 11.67±0.33    | 7.35±0.28                  |
| NGR 749-2           | 153      | 102.23±2.62       | 11.33±0.88    | 7.46±0.30                  |
| NGR 750-1           | 156      | 114.07±0.41       | 11.67±0.33    | 7.58±0.23                  |
| NGR 796-2           | 153      | 104.40±0.35       | 11.67±0.33    | 6.71±0.21                  |
| NGR 1161-3          | 153      | 101.73±0.34       | 11.67±0.67    | 7.18±0.23                  |
| BRRI dhan74         | 147      | 97.60±1.00        | 10.33±0.33    | 6.85±0.28                  |
| BRRI dhan102        | 158      | 103.63±0.80       | 12.00±0.00    | 6.87±0.20                  |
| Lsd <sub>0.05</sub> | -        | 2.79              | 1.02          | 0.77                       |
| CV (%)              |          | 1.61              | 5.33          | 6.30                       |

DS: 5 Dec 2023

DTP: 16 Jan 2024

### Development of favourable Boro rice during Boro 2023-24

Six breeding lines were grown along with two check varieties BRRI dhan86 and BRRI dhan96 at BRRI RS, Sirajganj. The tested genotype BR (Bio)

13028-AC1-2-3 produced significantly higher yield (6.68 tha<sup>-1</sup>) over the check variety BRRI dhan96 (5.88 tha<sup>-1</sup>) but statistically similar yield with the check variety BRRI dhan86 (6.07 tha<sup>-1</sup>) (Table 15).

**Table 15. Performance of different entries under RYT Favourable Boro during Boro 2023-24.**

| Designation           | GD (day) | Plant height (cm) | Panicle /hill | Yield (tha <sup>-1</sup> ) |
|-----------------------|----------|-------------------|---------------|----------------------------|
| BR(Bio)13029-AC6-2-6  | 150      | 106.6             | 13            | 5.72±0.21                  |
| BR(Bio)13028-AC1-2-2  | 142      | 115.7             | 14            | 3.91±0.15                  |
| BR(Bio)13028-AC1-2-3  | 150      | 120.6             | 12            | 6.68±0.23                  |
| BR(Bio)13028-AC1-2-4  | 152      | 107.6             | 12            | 6.02±0.39                  |
| BR(Bio)13028-AC1-2-7  | 158      | 113.0             | 13            | 5.90±0.17                  |
| BR(Bio)13030-AC13-2-2 | 148      | 96.9              | 12            | 6.06±0.24                  |
| BRRI dhan86           | 145      | 100.4             | 11            | 6.07±0.26                  |
| BRRI dhan96           | 147      | 85.9              | 11            | 5.88±0.34                  |
| Lsd <sub>0.05</sub>   | -        | 4.33              | 1.77          | 0.71                       |
| CV (%)                | -        | 2.34              | 8.18          | 7.04                       |

DS: 30 Nov 2023

DTP: 15 Jan 2024

### Development of blast and bacterial blight resistant rice during Boro 2023-24.

Six breeding lines were grown along with two check varieties BRRI dhan28 and BRRI dhan88 at BRRI RS, Sirajganj. No major infestation by blast and BB was observed in plants. None of the tested

entry produced significantly higher yield over the check varieties BRRI dhan28 and BRRI dhan88. But genotype BR (path) 13802-BC3-11-10-13 produced higher yield 0.58 tha<sup>-1</sup> and 0.72 tha<sup>-1</sup>, respectively over the check varieties BRRI dhan28 and BRRI dhan88 (Table 16).

**Table 16. Performance of different entries under RYT for Blast and bacterial blight resistance during Boro 2023-24.**

| Designation                     | GD (day) | Plant height (cm) | Panicle /hill | Yield (tha <sup>-1</sup> ) |
|---------------------------------|----------|-------------------|---------------|----------------------------|
| BR (path)13802-BC3-10-11-12     | 148      | 103.8             | 12            | 6.43±0.29                  |
| BR (path)13802-BC3-11-10-13     | 143      | 112.4             | 9             | 6.62±0.18                  |
| BR (path)13802-BC3-12-10-14     | 142      | 94.5              | 11            | 6.28±0.34                  |
| BR (path)13784-BC3-17-10-6-HR18 | 139      | 110.1             | 11            | 5.77±0.21                  |
| BR (path)13784-BC3-18-11-7-HR19 | 143      | 118.6             | 13            | 5.82±0.06                  |
| BR (path)13784-BC3-19-12-8-HR20 | 145      | 119.5             | 12            | 5.23±0.29                  |
| BRRI dhan28                     | 145      | 106.5             | 11            | 6.04±0.21                  |
| BRRI dhan88                     |          | 97.7              | 12            | 5.90±0.18                  |
| Lsd <sub>0.05</sub>             | -        | 4.79              | 1.26          | 0.73                       |
| CV (%)                          | -        | 2.53              | 6.42          | 6.93                       |

DS: 5 Dec 2023

DTP: 12 Jan 2024

### Development of Bacterial blight (BB) and blast resistant rice during Boro 2023-24

Fourteen breeding lines were grown along with BB resistant check BRRI dhan101 and susceptible check varieties BRRI dhan88 and BRRI dhan89 at BRRI RS, Sirajganj. No major BB and Blast infestation was observed in the plants. The

genotype BR11867-5R-119, BR12450-4R-108 and BR12437-4R-164 produced statistically similar yield with the check variety BRRI dhan101 but significantly higher yield over the check variety BRRI dhan88 and BRRI dhan89. However, the highest yield (8.24 tha<sup>-1</sup>) was obtained from genotype BR11867-5R-119 (Table 17).

**Table 17. Performance of different entries under RYT BB and blast during Boro 2023-24.**

| Designation            | GD (day) | Plant height (cm) | Panicle /hill | Yield (tha <sup>-1</sup> ) |
|------------------------|----------|-------------------|---------------|----------------------------|
| BR11866-5R-277         | 158      | 103.6             | 12            | 7.35±0.15                  |
| BR11867-5R-118         | 151      | 107.9             | 11            | 7.62±0.16                  |
| BR11867-5R-119         | 151      | 102.7             | 11            | 8.24±0.16                  |
| BR11867-5R-331         | 154      | 117.9             | 12            | 7.58±0.20                  |
| BR11869-5R-148         | 141      | 109.4             | 11            | 5.61±0.17                  |
| BR12437-4R-164         | 149      | 102.5             | 11            | 7.99±0.18                  |
| BR12437-4R-109         | 152      | 113.4             | 11            | 7.21±0.22                  |
| BR12125-6R-6           | 140      | 101.1             | 11            | 6.33±0.18                  |
| BR12125-6R-79          | 145      | 101.9             | 11            | 6.35±0.22                  |
| BR12125-6R-149         | 145      | 114.4             | 11            | 5.78±0.26                  |
| BR12450-4R-24          | 148      | 118.0             | 11            | 7.34±0.15                  |
| BR12450-4R-108         | 145      | 108.0             | 12            | 8.05±0.13                  |
| BR13793-5R-1           | 152      | 111.2             | 10            | 7.41±0.25                  |
| BR13796-5R-102         | 145      | 119.1             | 9             | 6.24±0.16                  |
| BRRi dhan88 (Std. ck)  | 145      | 98.2              | 13            | 6.57±0.18                  |
| BRRi dhan89 (Std. ck)  | 160      | 121.9             | 12            | 7.42±0.27                  |
| BRRi dhan101 (Res. ck) | 151      | 130.0             | 11            | 7.84±0.17                  |
| Lsd <sub>0.05</sub>    | -        | 7.63              | 1.19          | 0.41                       |
| CV (%)                 | -        | 4.14              | 6.45          | 3.46                       |

DS: 5 Dec 2023

DTP: 17 Jan 2024

**Development of zinc enriched rice (ZER) during Boro 2023-24.**

Six breeding lines were grown along with three check varieties BRRi dhan74, and BRRi dhan89 and BRRi dhan100 at BRRi RS, farm Sirajganj.

None of the tested entry produced significantly higher yield over the check varieties but genotype BR10571-15-6-8-5 and BR10552-1-1-3-4 produced statistically similar yield with the check varieties (Table 18).

**Table 18. Performance of different entries under RYT zinc enriched rice (ZER) during Boro 2023-24.**

| Designation         | GD (day) | Plant height (cm) | Panicle /hill | Yield (tha <sup>-1</sup> ) |
|---------------------|----------|-------------------|---------------|----------------------------|
| BR10552-1-1-3-4     | 156      | 127.3             | 10            | 6.39±0.13                  |
| BR10552-1-1-4-6     | 150      | 118.9             | 9             | 5.85±0.25                  |
| BR10570-29-7-3-2    | 150      | 96.5              | 10            | 4.43±0.25                  |
| BR10571-15-6-8-5    | 148      | 96.8              | 8             | 6.47±0.15                  |
| BR10572-2-7-1-4     | 150      | 119.5             | 9             | 5.04±0.14                  |
| BR9674-1-4-1-3-P1   | 156      | 120.3             | 9             | 5.95±0.22                  |
| BRRi dhan74 (ck)    | 145      | 105.1             | 10            | 6.22±0.15                  |
| BRRi dhan89 (ck)    | 154      | 111.6             | 12            | 6.70±0.14                  |
| BRRi dhan100 (Ck)   | 149      | 115.2             | 12            | 6.05±0.10                  |
| Lsd <sub>0.05</sub> | -        | 4.85              | 1.42          | 0.51                       |
| CV (%)              | -        | 2.49              | 8.28          | 5.02                       |

DS: 21 Dec 2023

DTP: 4 Feb 2024

**Development of Fine grain Rice during Boro 2023-24**

Four breeding lines were grown along with check variety BRRI dhan100 at BRRI RS, Sirajganj. All

the tested entries produced statistically similar yield with the check variety BRRI dhan100 (Table 19).

**Table 19. Performance of different entries under RYT Fine grain Rice during Boro 2023-24.**

| Designation         | GD (day) | Plant height (cm) | Panicle /hill | Yield (tha <sup>-1</sup> ) |
|---------------------|----------|-------------------|---------------|----------------------------|
| BRH9-3-14-2B        | 145      | 106.0             | 13            | 8.16±0.07                  |
| BR10247-14-18-4     | 150      | 116.4             | 12            | 8.16±0.08                  |
| BR10247-4-7-4B      | 145      | 115.4             | 13            | 8.19±0.22                  |
| IR12A177            | 143      | 113.9             | 12            | 8.08±0.05                  |
| BRRI dhan100        | 150      | 113.1             | 12            | 7.85±0.17                  |
| Lsd <sub>0.05</sub> | -        | 3.34              | 2.44          | 0.45                       |
| CV(%)               | -        | 1.57              | 10.52         | 2.95                       |

DS: 17 Dec 2023

DTP: 22 Jan 2024

**Advanced line adaptive research trial (ALART)****Direct seeded broad cast Aman, deep areas (100-150 cm water depth), 2023**

The experiment was conducted at the farmer's field of Baghbari, Shahjadpur, Sirajganj. Four genotypes

including two checks Fulkori and local check Dhaldigha were evaluated. None of the tested entry produced significantly higher yield over the check varieties (Table 20).

**Table 20. Performance of different entries under ALART (DWR), Shahjadpur, Sirajganj during T. Aman 2023.**

| Genotype              | GD (day) | Plant height (cm) | Panicle m <sup>-2</sup> | Yield (tha <sup>-1</sup> ) |
|-----------------------|----------|-------------------|-------------------------|----------------------------|
| BR10230-7-19-2B       | 169      | 271.5             | 118                     | 1.48±0.06                  |
| BR9390-6-2-1B         | 169      | 293.1             | 107                     | 1.47±0.13                  |
| Fulkori (ck.)         | 170      | 284.5             | 102                     | 1.43±0.06                  |
| Dhaldigha (local ck.) | 174      | 286.2             | 117                     | 1.54±0.02                  |
| Lsd <sub>0.05</sub>   |          | 7.4               | 9.7                     | 0.27                       |
| CV (%)                |          | 1.3               | 4.4                     | 9.2                        |

DS: 30 May 2023

**BRRI dhan49 type Short slender grain (SHR-1) T. Aman 2023.**

The experiment was conducted at the farmer's field of Sadar upazila in Bogura. Three genotypes with a check variety BRRI dhan49 were evaluated.

Genotype BRH13-2-14-2-1B produced significantly higher yield (5.13 tha<sup>-1</sup>) over the check variety (3.71 tha<sup>-1</sup>) with almost similar growth duration (Table 21).

**Table 21. Performance of BRRI dhan49 type short slender grain (ALART SHR-1) Sadar, Bogura during T. Aman2023.**

| Genotype            | TGD (Day) | Plant height (cm) | Panicle m <sup>-2</sup> | Yield (tha <sup>-1</sup> ) |
|---------------------|-----------|-------------------|-------------------------|----------------------------|
| BRH13-2-14-2-1B     | 128       | 120               | 217                     | 5.13±8.84                  |
| BR13-7-9-3-2B       | 135       | 110               | 232                     | 3.88±6.73                  |
| BRRI dhan49 (ck)    | 126       | 92                | 243                     | 3.71±6.43                  |
| Lsd <sub>0.05</sub> |           | 5.7               | 24.6                    | 0.59                       |
| CV (%)              |           | 2.4               | 4.7                     | 5.6                        |

DS: 6 Jul 2023

D/TP: 2 Aug 2023

**Swarna type grain (SHR-2), T. Aman 2023**

The experiment was conducted at the farmer's field of Sadar upazila in Bogura. Three genotypes including a check variety BRRI dhan94 was

evaluated. None of the tested entries produce significantly higher yield over the check variety (Table 22).

**Table 22. Performance of Swarna type grain (ALART, SHR-2) at Sadar, Bogura during T. Aman 2023.**

| Genotype            | GD (day) | Plant height (cm) | Panicle m <sup>-2</sup> | Yield (tha <sup>-1</sup> ) |
|---------------------|----------|-------------------|-------------------------|----------------------------|
| BRH93292-6-2-1-3-4  | 136      | 118.8             | 229                     | 4.31±0.15                  |
| BR9396-6-2-2B       | 125      | 132.4             | 236                     | 2.97±0.29                  |
| BRRI dhan94 (ck)    | 135      | 105.6             | 245                     | 4.45±0.08                  |
| Lsd <sub>0.05</sub> | -        | 4.4               | 16.3                    | 0.78                       |
| CV (%)              | -        | 1.6               | 3                       | 8.8                        |

DS: 6 Jul 2023

D/TP: 2 Aug 2023

**Antioxidant enriched rice, ALART, T. Aman 2023.**

The experiment was conducted at the farmer's field of Sadar in Bogura. Four genotypes including two checks (BRRI dhan34 and BRRI dhan70) were

evaluated. The experiment was laid out in a RCB design with three replications. None of the entries produced higher yield over the check variety BRRI dhan70 (Table 23).

**Table 23. Performance of antioxidant enriched rice entries under ALART at Sadar, Bogura during T. Aman 2023.**

| Genotype            | TGD (day) | Plant height (cm) | Panicle m <sup>-2</sup> | Yield (tha <sup>-1</sup> ) |
|---------------------|-----------|-------------------|-------------------------|----------------------------|
| BR12836-4R-63       | 127       | 105.7             | 209                     | 2.96±0.17                  |
| BR12836-4R-312      | 127       | 110.3             | 185                     | 2.93±0.11                  |
| BRRI dhan34 (ck)    | 147       | 126.3             | 231                     | 2.33±0.07                  |
| BRRI dhan70 (ck)    | 120       | 143.7             | 244                     | 3.69±0.11                  |
| Lsd <sub>0.05</sub> | -         | 3.65              | 56.37                   | 0.65                       |
| CV (%)              | -         | 1.88              | 12.15                   | 7.28                       |

DS: 14 Jul 2023

DTP: 10 Aug 2023

**Bacterial blight and blast resistant Rice, Boro 2023-24**

Three genotypes including two checks BRRI dhan89 and BRRI dhan92 were evaluated at farmer's field of Kamarkhand upazila, Sirajganj. The tested entry BR (path)13800-BC3-

134-8 and BR (path)13800-BC3-224-44 produced significantly higher yield (5.13 tha<sup>-1</sup> & 5.00 tha<sup>-1</sup>) over the check variety BRRI dhan89 (3.91tha<sup>-1</sup>) and BRRI dhan92 (4.29 tha<sup>-1</sup>) with similar growth duration (Table 24).

**Table 24. Performance of different entries under ALART (BB and Blast), Boro 2023-24 at Kamarkhand, Sirajganj.**

| Genotype                  | GD (day) | Plant height (cm) | Panicle m <sup>-2</sup> | Yield (tha <sup>-1</sup> ) |
|---------------------------|----------|-------------------|-------------------------|----------------------------|
| BR (path)13800-BC3-134-8  | 165      | 104.6             | 277                     | 5.13±0.00                  |
| BR (path)13800-BC3-134-25 | 166      | 103.2             | 269                     | 4.84±0.08                  |
| BR (path)13800-BC3-224-44 | 166      | 111.6             | 279                     | 5.00±0.35                  |
| BRRI dhan89 (check)       | 165      | 115.2             | 223                     | 3.91±0.13                  |
| BRRI dhan92 (check)       | 165      | 120.3             | 296                     | 4.29±0.10                  |
| Lsd <sub>0.05</sub>       |          | 4.94              | 28.57                   | 0.59                       |
| CV (%)                    |          | 2.37              | 5.65                    | 6.72                       |

DS: 23 Nov 2023

DT: 11 Jan 2024



### Bacterial blight resistant rice, ALART, Boro 2023-24.

Three genotypes including two checks BRRI dhan89 and BRRI dhan92 were evaluated at the farmer's field of Kamarkhand upazila of Sirajganj.

Tested entries BR (path) 13800-BC3-8-9 and BR (path)13800-BC3-8-1 produced significantly higher yield ( $6.17 \text{ tha}^{-1}$  &  $6.11 \text{ tha}^{-1}$ ) over the check variety BRRI dhan89 ( $5.07 \text{ tha}^{-1}$ ) and BRRI dhan92 ( $4.75 \text{ tha}^{-1}$ ) with similar growth duration (Table 25).

**Table 25. Performance of different entries under ALART (BB), Boro 2023-24, at Kamarkhand, Sirajganj.**

| Genotype                  | GD (day) | Plant height (cm) | Panicle $\text{m}^{-2}$ | Yield ( $\text{tha}^{-1}$ ) |
|---------------------------|----------|-------------------|-------------------------|-----------------------------|
| BR (path)13800-BC3-8-1    | 165      | 106.9             | 282                     | $6.11 \pm 0.21$             |
| BR (path)13800-BC3-8-9    | 166      | 110.0             | 264                     | $6.17 \pm 0.21$             |
| BR (path)13800-BC3-224-28 | 166      | 111.7             | 289                     | $5.62 \pm 0.11$             |
| BRRI dhan89 (ck)          | 165      | 112.8             | 271                     | $5.07 \pm 0.31$             |
| BRRI dhan92 (ck)          | 165      | 113.4             | 289                     | $4.75 \pm 0.05$             |
| Lsd <sub>0.05</sub>       |          | 3.63              | 52.66                   | 0.57                        |
| CV (%)                    |          | 1.74              | 10.02                   | 5.47                        |

DS: 23 Nov 2023

DT: 11 Jan 2024

### Late Boro rice, ALART, Boro 2023-24.

One genotype including three checks BINA dhan14, BRRI dhan28 and BRRI dhan98 were evaluated at the farmer's field of sadar upazila of

Bogura. The tested entry BR11845-4R-62 produced statistically identical yield ( $7.35 \text{ tha}^{-1}$ ) with the check varieties BRRI dhan98 ( $7.57 \text{ tha}^{-1}$ ) and BRRI dhan28 ( $7.45 \text{ tha}^{-1}$ ) (Table 26).

**Table 26. Performance of different entries under ALART (FBR-LB) at sadar, Bogura during Boro 2023-24.**

| Genotype            | GD (day) | Plant height (cm) | Panicle $\text{m}^{-2}$ | Yield ( $\text{tha}^{-1}$ ) |
|---------------------|----------|-------------------|-------------------------|-----------------------------|
| BR11845-4R-62       | 116      | 100.0             | 277                     | $7.35 \pm 0.13$             |
| BINA dhan14         | 109      | 95.6              | 286                     | $6.03 \pm 0.16$             |
| BRRI dhan28         | 112      | 115.2             | 323                     | $7.45 \pm 0.20$             |
| BRRI dhan98         | 114      | 106.6             | 305                     | $7.57 \pm 0.11$             |
| Lsd <sub>0.05</sub> |          | 4.31              | 34.71                   | 0.53                        |
| CV (%)              |          | 2.06              | 5.83                    | 3.76                        |

DS: 3 Feb 2024

DT: 4 Mar 2024

### Short duration rice, ALART, Boro 2023-24.

Two genotypes including two checks BRRI dhan88 and BRRI dhan96 were evaluated in farmer's field of Kamarkhand upazila of Sirajganj. The tested

genotype BR11903-5R-56 produced higher yield ( $6.03 \text{ tha}^{-1}$ ) followed by genotype IR18A2119 ( $5.99 \text{ tha}^{-1}$ ) which was statistically similar to the check variety BRRI dhan96 ( $5.66 \text{ tha}^{-1}$ ) (Table 27).

**Table 27. Performance of different entries under ALART (FBR-SD) at Kamarkhand, Sirajganj during Boro 2023-24.**

| Genotype            | GD (day) | Plant height (cm) | Panicle $\text{m}^{-2}$ | Yield ( $\text{tha}^{-1}$ ) |
|---------------------|----------|-------------------|-------------------------|-----------------------------|
| BR11903-5R-56       | 155      | 101.4             | 297                     | $6.03 \pm 0.21$             |
| IR18A2119           | 155      | 99.0              | 302                     | $5.99 \pm 0.08$             |
| BRRI dhan88         | 145      | 89.1              | 239                     | $5.36 \pm 0.12$             |
| BRRI dhan96         | 145      | 89.3              | 271                     | $5.66 \pm 0.10$             |
| Lsd <sub>0.05</sub> |          | 4.54              | 33.07                   | 0.51                        |
| CV (%)              |          | 2.40              | 5.97                    | 4.39                        |

DS: 26 Nov 2023

DT: 15 Jan 2024

### Favourable Boro rice biotechnology (FBR-Bio), ALART, Boro 2023-24.

Three genotypes including two checks BRRI dhan86 and BRRI dhan96 were evaluated in the farmer's field of Kamarkhand upazila of Sirajganj.

The tested entry BR (Bio)13028-AC24-1-4 (5.68  $\text{tha}^{-1}$ ) and BR(Bio)13028-AC24-1-2 (5.66  $\text{tha}^{-1}$ ) produced statistically identical yield with check variety BRRI dhan96 (5.85  $\text{tha}^{-1}$ ) and BRRI dhan86 (5.78  $\text{tha}^{-1}$ ) (Table 28).

**Table 28. Performance of different entries under ALART (FBR-BIO) at Kamarkhand, Sirajganj during Boro 2023-24.**

| Genotype              | GD (day) | Plant height (cm) | Panicle/ $\text{m}^{-2}$ | Yield ( $\text{tha}^{-1}$ ) |
|-----------------------|----------|-------------------|--------------------------|-----------------------------|
| BR(Bio)13028-AC24-1-2 | 150      | 118.1             | 362                      | 5.66 $\pm$ 0.11             |
| BR(Bio)13028-AC24-1-3 | 149      | 105.8             | 354                      | 5.23 $\pm$ 0.06             |
| BR(Bio)13028-AC24-1-4 | 150      | 105.4             | 340                      | 5.68 $\pm$ 0.07             |
| BRRI dhan86           | 146      | 96.1              | 377                      | 5.78 $\pm$ 0.04             |
| BRRI dhan96           | 149      | 89.1              | 341                      | 5.85 $\pm$ 0.19             |
| Lsd <sub>0.05</sub>   | -        | 7.31              | 36.23                    | 0.37                        |
| CV (%)                | -        | 3.77              | 5.42                     | 3.49                        |

DS: 26 Nov 2023

DT: 15 Jan 2024

### Long duration rice, ALART, Boro 2023-24

One genotype including one check BRRI dhan92 were evaluated in farmer's field of Kamarkhand upazila of Sirajganj. The tested entry BR11318-

5R-84 gave statistically similar yield (6.97  $\text{tha}^{-1}$ ) with the check variety BRRI dhan92 (6.56  $\text{tha}^{-1}$ ) (Table 29).

**Table 29. Performance of different entries under ALART (FBR-LD), Boro 2023-24, at Kamarkhand, Sirajganj.**

| Genotype            | GD (day) | Plant height (cm) | Panicle $\text{m}^{-2}$ | Yield ( $\text{tha}^{-1}$ ) |
|---------------------|----------|-------------------|-------------------------|-----------------------------|
| BR11318-5R-84       | 172      | 116.0             | 298                     | 6.97 $\pm$ 0.25             |
| BRRI dhan92         | 167      | 116.5             | 297                     | 6.56 $\pm$ 0.09             |
| Lsd <sub>0.05</sub> |          | 5.42              | 55.57                   | 0.91                        |
| CV (%)              |          | 1.33              | 5.32                    | 3.83                        |

DS: 22 Nov 2023

DT: 16 Jan 2024

### ALART for premium quality rice (PQR), Boro 2023-24

Five genotypes including three checks BRRI dhan104, BRRI dhan107 and BINA dhan25 were evaluated in farmer's field of sadar upazila of Bogura. None of the tested entries produced

significantly higher yield over check varieties but entry Zira, Nachol produced statistically similar yield (7.96  $\text{tha}^{-1}$ ) with the check variety BINA dhan25 (8.07  $\text{tha}^{-1}$ ) and BRRI dhan107 (7.67  $\text{tha}^{-1}$ ) (Table 30).

**Table 30. Performance of different entries under ALART (PQR), Boro 2023-24, at sadar, Bogura.**

| Genotype           | GD (day) | Plant height (cm) | Panicle $\text{m}^{-2}$ | Yield ( $\text{tha}^{-1}$ ) |
|--------------------|----------|-------------------|-------------------------|-----------------------------|
| BR10645-6-4-8-1-2  | 170      | 119.4             | 311                     | 6.58 $\pm$ 0.24             |
| BR10646-3-2-2-4-3  | 169      | 122.2             | 304                     | 6.83 $\pm$ 0.20             |
| BR10648-12-1-3-4-1 | 168      | 115.7             | 336                     | 6.45 $\pm$ 0.14             |
| Zira, Nachol       | 170      | 109.3             | 419                     | 7.96 $\pm$ 0.19             |
| Katari, Shibganj   | 172      | 114.0             | 348                     | 6.45 $\pm$ 0.17             |

| Genotype            | GD (day) | Plant height (cm) | Panicle m <sup>-2</sup> | Yield (tha <sup>-1</sup> ) |
|---------------------|----------|-------------------|-------------------------|----------------------------|
| BRRi dhan104 (Ck)   | 169      | 103.0             | 331                     | 7.05±0.19                  |
| BRRi dhan107 (Ck)   | 174      | 108.1             | 320                     | 7.67±0.17                  |
| BINA dhan25 Ck)     | 169      | 132.7             | 302                     | 8.07±0.31                  |
| Lsd <sub>0.05</sub> |          | 6.67              | 37.24                   | 0.66                       |
| CV (%)              |          | 3.30              | 6.37                    | 5.31                       |

DS: 22 Nov 2023

DT: 18 Jan 2024

### Superior high yielding rice (Ziratype), ALART for Boro 2023-24

The experiment was conducted at the farmer's field of Kamarkhand upazila of Sirajganj. Three genotypes including one check BRRi dhan88 were

evaluated. The tested genotype BR17-23-8-2-7B produced higher yield (7.18 tha<sup>-1</sup>) followed by genotype BRH15-24-7B (6.28 tha<sup>-1</sup>) which was statistically similar with the check variety BRRi dhan88 (6.23 tha<sup>-1</sup>) (Table 31).

**Table 31. Performance of different entries under ALART (Ziratype) at Kamarkhand, Sirajganj during Boro 2023-24.**

| Genotype            | GD (day) | Plant height (cm) | Panicle m <sup>-2</sup> | Yield (tha <sup>-1</sup> ) |
|---------------------|----------|-------------------|-------------------------|----------------------------|
| BRH15-24-7B         | 157      | 93.7              | 283                     | 6.28±0.32                  |
| BR9392-1-7-5B       | 157      | 93.1              | 255                     | 5.93±0.13                  |
| BR17-23-8-2-7B      | 152      | 90.8              | 282                     | 7.18±0.30                  |
| BRRi dhan88         | 152      | 89.3              | 273                     | 6.23±0.27                  |
| Lsd <sub>0.05</sub> |          | 4.03              | 80.09                   | 1.03                       |
| CV (%)              |          | 2.20              | 14.67                   | 8.04                       |

DS: 30 Nov 2023

DT: 16 Jan 2024

### ALART for superior high yielding rice (Kataritype), Boro 2023-24

The experiment was conducted at the farmer's field of Kamarkhand upazila of Sirajganj. Three genotypes

including one check BRRi dhan81 were evaluated. All the tested entries produced significantly higher yield over the check variety BRRi dhan81 (Table 32).

**Table 32. Performance of different entries under ALART (Kataritype), Boro 2023-24, at Kamarkhand, Sirajganj.**

| Genotype            | GD (day) | Plant height (cm) | Panicle m <sup>-2</sup> | Yield (tha <sup>-1</sup> ) |
|---------------------|----------|-------------------|-------------------------|----------------------------|
| BRH11-7-17-10B      | 159      | 101.8             | 312                     | 6.76±0.22                  |
| BRH9-3-2B           | 157      | 99.0              | 344                     | 7.10±0.08                  |
| BRH13-9-5-2B        | 155      | 99.8              | 336                     | 7.05±0.17                  |
| BRRi dhan81         | 149      | 99.5              | 276                     | 5.80±0.18                  |
| Lsd <sub>0.05</sub> |          | 4.61              | 39.50                   | 0.47                       |
| CV (%)              |          | 2.31              | 6.24                    | 3.51                       |

DS: 30 Nov 2023

DT: 16 Jan 2024

## CROP SOIL WATER MANAGEMENT

### Long-term missing element trial during T.Aman, 2023 and Boro 2023-24

The experiment was initiated in a permanent layout at BRRi RS farm, Sirajganj to study the changes in soil physico-chemical and biological properties and

the effect of long-term nutrient omission on rice yield. No significant effect on yield was found in T. Aman 2023 as the initial stage of this experiment. In Boro season, the highest number of panicle/m<sup>2</sup> (332) were recorded in K omitted plot and significantly the lowest grain yield (4.19 tha<sup>-1</sup>) was recorded in N omitted plot (Table 33).

**Table 33. Effect of long-term missing element on the panicle and grain yield of BRRI dhan89 at BRRI RS farm, Sirajganj during Boro 2023-24.**

| Treatment                | Panicle /m2 | Yield (tha <sup>-1</sup> ) |
|--------------------------|-------------|----------------------------|
| T <sub>1</sub> (Control) | 204         | 4.23±0.21                  |
| T <sub>2</sub> (NPKSZn)  | 303         | 9.97±0.50                  |
| T <sub>3</sub> (-N)      | 191         | 4.19±0.17                  |
| T <sub>4</sub> (-P)      | 326         | 9.66±0.52                  |
| T <sub>5</sub> (-K)      | 332         | 9.88±0.06                  |
| T <sub>6</sub> (-S)      | 319         | 10.41±0.31                 |
| T <sub>7</sub> (-Zn)     | 319         | 10.07±0.28                 |
| Lsd <sub>0.05</sub>      | 79.48       | 1.04                       |
| CV (%)                   | 15.67       | 6.99                       |

#### PEST MANAGEMENT PROGRAMME

##### Effect of different trap designs for the management of rats in the rice field

The experiment was conducted in the rice field of BRRI Sirajganj to determine the efficacy of 3 types

of traps for rat catching during T. Aus and T. Aman 2023. The efficacy of different kinds of traps varied significantly in both the seasons. Among them, Bamboo made trap performed better than other traps in terms of rat catching (Table 34 and 35).

**Table 34. Effect of different trap design for the management of rat during T. Aus 2023.**

| Different type trap   | Observation day | Total number of trapped rats | Trapped rats/trap (no.) |
|-----------------------|-----------------|------------------------------|-------------------------|
| Bamboo made trap      | 29 days         | 35                           | 5.2a                    |
| Box type live trap    |                 |                              | 1.2b                    |
| Snap trap             |                 |                              | 0.6b                    |
| Level of significance |                 |                              | **                      |
| LSD <sub>0.05</sub>   |                 |                              | 1.34                    |
| CV%                   |                 |                              | 39.51                   |

\*\*= Significant at the 1% level of probability

**Table 35. Effect of different trap design for the management of rat during T. Aman 2023.**

| Different type trap   | Observation day | Total number of trapped rats | Trapped rats/trap (no.) |
|-----------------------|-----------------|------------------------------|-------------------------|
| Bamboo made trap      | 81 days         | 101                          | 15.6a                   |
| Box type live trap    |                 |                              | 3.4b                    |
| Snap trap             |                 |                              | 1.2b                    |
| Level of significance |                 |                              | **                      |
| LSD <sub>0.05</sub>   |                 |                              | 2.57                    |
| CV%                   |                 |                              | 26.22                   |

\*\*= Significant at the 1% level of probability

#### ENRICHMENT OF SEED STOCK

##### Breeder seed and Truth fully leveled seed production

Nucleus seed stock was collected from GRS Division, BRRI HQ, Gazipur. Breeder seeds were

produced in T. Aman 2023 and Boro 2023-24 and TLS were in T. Aus 2023 seasons. A total of 8.90 and 5.50 tons of breeder and TLS were produced respectively in three seasons (Table 36).

**Table 36. Breeder seed and TLS production at BRRI Sirajganj during Aus, Aman, Boro 2023-24.**

| Variety             | Season       | Breeder Seed (kg) | TLS (kg) |
|---------------------|--------------|-------------------|----------|
| BRRI dhan98         | T. Aus 2023  | -                 | 300      |
| BRRI dhan75         |              | -                 | 450      |
| BRRI dhan87         |              | -                 | 200      |
| BRRI dhan90         | T. Aman 2023 | 3000              | 600      |
| BRRI dhan93         |              | -                 | 500      |
| BRRI dhan103        |              | -                 | 1000     |
| BRRI dhan89         | Boro 2023-24 | 3000              | 900      |
| Bangabandhu dhan100 |              | 2900              | 550      |
| BRRI dhan101        |              |                   | 200      |
| BRRI dhan104        |              |                   | 200      |
| BRRI dhan105        |              |                   | 600      |
| Total               |              | 8,900 kg          | 5,500 kg |

**TECHNOLOGY TRANSFER****Head-to-Head adaptive trial (HHAT) of recent modern rice varieties at farmer's field**

A trial on HHATs was conducted at four locations of Kamarkhanda upazila in Sirajganj during T. Aman 2023 season to investigate the performance

of promising five varieties compared to the popular mega variety. Among them, BRRI dhan87 produced the highest yield (6.25 tha<sup>-1</sup>) followed by BRRI dhan93 (5.84 tha<sup>-1</sup>) and Guti Shorna (5.47 tha<sup>-1</sup>) (Table 37).

**Table 37. Average grain yield of modern varieties under head-to-head adaptive trials (RLR-LD) during T. Aman 2023 in Kamarkhanda, Sirajganj.**

| Variety                    | Growth duration (days) | Yield (tha <sup>-1</sup> ) |
|----------------------------|------------------------|----------------------------|
| BRRI dhan51                | 140                    | 4.91                       |
| BRRI dhan87                | 128                    | 6.25                       |
| BRRI dhan93                | 133                    | 5.84                       |
| BRRI dhan94                | 133                    | 5.17                       |
| BRRI dhan 95               | 128                    | 5.04                       |
| Guti Shorna (mega variety) | 150                    | 5.47                       |

**Training and field day**

A total of twenty-one farmer's training on modern rice production technology was conducted at

different upazilas of Bogura region along with 22 field days in collaboration with DAE under GoB and PARTNER project (Table 38 and 39).

**Table 38. Farmers training conducted by BRRI Sirajganj during 2023-24.**

| Funding source | Training (#) | Participating farmers (#) |
|----------------|--------------|---------------------------|
| GoB            | 15           | 450                       |
| PARTNER        | 06           | 180                       |
| Total          | 21           | 630                       |

**Table 39. Field day conducted by BRRI Sirajganj during 2023-24.**

| Funding source      | Field day (#) |
|---------------------|---------------|
| GoB                 | 15            |
| PARTNER Project     | 02            |
| Hybrid Rice Project | 04            |
| LSTD Project        | 01            |
| Total               | 22            |

**Advisory and clinical service**

Different problems related to rice production at farmers' field were addressed duly in co-operation with the Department of Agricultural Extension

(DAE), Bangladesh Agricultural Development Corporation (BADC) and Seed Certification Agency (SCA). Clinical services were also provided to the farmers, extension workers and other stakeholders as well.



# **BRRI RS, Gopalganj**

**454    Summary**

**454    Varietal development**

**459    Rice germplasm collection and characterization**

**459    Technology transfer**



## SUMMARY

In the proposed variety trial (PVT), three sets of the inbred trial in T Aman 2023 were evaluated at BRRI RS, Gopalganj. BRRI RS, Gopalganj conducted ten advanced lines adaptive research trials (ALART) in the Gopalganj and Bagerhat districts during the reporting year 2023–24.

Seven RYT, namely RYT (Zira type), RYT (Katari type), RYT (STR-1 and STR-2), RYT (Photosensitive), RYT (Tall breeding materials) and RYT (Low amylose) were conducted during T Aman 2023. Ten RYT, such as RYT (FBR-Barishal), RYT (FBR-Bio), RYT(STR), RYT (STR On-farm), RYT (Tall), RYT (BB-Blast), RYT-2 (Blast-LD), RYT-3 (Blast-MD), RYT-4 (Blast-SD) and RYT (PQR) were conducted at BRRI RS, Gopalganj during Boro 2023-24.

A total of 239 Aman rice germplasm was rejuvenated for further use. Forty-eight T Aman germplasm were morphologically characterized using the Rice Germplasm and Evaluation Farm of GRSD.

During the Aman season 2023, five varietal replacements through Head-to-Head (HTH) trials with six rice varieties were conducted in the Gopalganj, Bagerhat, and Narail districts.

Five varietal block demonstrations were conducted in five locations during T. Aus 2023, T. Aman 2023 and Boro 2023-24 season.

A total of 1210 (750 in GoB, 350 in partner projects, 50 in LSTD projects, and 60 in Hybrid rice projects) field demonstrations were conducted in 2010 bigha land in different farmers' fields in the Gopalganj, Bagherhat, and Narail districts. On the other hand, 34 farmers' training and 22 field days in various locations of BRRI RS, Gopalganj recommended areas were organized.

In the reporting year, five tons of breeder seeds of different BRRI varieties were produced and delivered to the GRS division, BRRI HQ Gazipur. Additionally, about eight tons of TLS of BRRI rice varieties were produced by BRRI RS, Gopalganj.

## VARIETY DEVELOPMENT

**Hybridization:** In the T. Aman 2023 season, 32 crosses were made, and 1050 F<sub>1</sub> seeds were produced for developing high-yielding deep-water and stagnation-tolerant rice varieties with emphasis on kneeing ability, nodal tillering, earliness, and awnless good grain quality.

Investigators: M Z Islam and K M Iftekharuddaula

**Field RGA:** A total of 800 plants of F<sub>2</sub>- F<sub>3</sub> generation were grown in Boro 2023-24 following the Field RGA technique and about 600 progenies of F<sub>3</sub>- F<sub>4</sub> generation were harvested under the breeding programme for developing high-yielding homozygous lines from cultivated popular Hybrid rice varieties.

Investigators: M Z Islam and K M Iftekharuddaula

**PVT (Inbred trial) T. Aman.** Three sets (Set-I, Set-II and Set-III) of inbred trials Aman 2023 were evaluated under PVT at BRRI RS, Gopalganj.

**Set-I (DWR).** The advanced line I-0063 produced a higher yield (4.56 t ha<sup>-1</sup>) than the line coded as 1-0064 (4.03 t ha<sup>-1</sup>) with seven days longer growth duration.

**Set-II (Tidal).** The advanced breeding line I-0071 produced a higher yield (5.29 t ha<sup>-1</sup>) than the line coded as 1-0072 (4.01 t ha<sup>-1</sup>) with similar growth duration (142 days).

**Set-III (STR).** The advanced breeding line I-0074 produced a higher yield (6.13 t ha<sup>-1</sup>) than the line coded as 1-0073 (5.30 t ha<sup>-1</sup>) with a similar growth duration (122 days).

Investigators: M Z Islam and S C Das

**ALART (Anti-oxidant), Aman.** None of the tested advanced lines performed better than the standard checks.

**ALART (Swarna) Aman.** One advanced line BRH9392-6-2-1-3-4 produced a higher yield (6.63 t ha<sup>-1</sup>) than the standard check BRRI dhan94 (5.89 t ha<sup>-1</sup>) with ten days longer growth duration.

**ALART (DWR), Aman.** None of the tested advanced lines performed better than the standard checks Fulkori and Debmoni.

**ALART [SHR-1(Zira type)], Boro.** Three advanced lines produced a higher yield (7.82-8.26 t ha<sup>-1</sup>) than the standard check BRRI dhan88 (6.99 t ha<sup>-1</sup>) with similar growth duration (Table 1).

**ALART (FBR-Bio), Boro.** One advanced line BR (Bio) 13028-AC24-1-2 produced a higher yield (7.42 t ha<sup>-1</sup>) than the standard check BRRI dhan86 (6.26 t ha<sup>-1</sup>) with six days longer growth duration.

**ALART (PQR), Boro:** None of the tested advanced lines performed better than the standard check BRRI dhan107.

**ALART (FBR-SD), Boro.** Two advanced lines produced a higher yield (7.67-7.86 t ha<sup>-1</sup>) than the standard check BRRI dhan96 (6.70 t ha<sup>-1</sup>) with similar growth duration (Table 2).

**ALART (FBR-LD), Boro.** One advanced line BR11318-5R-84 produced a higher yield (8.99 t ha<sup>-1</sup>) than the standard check BRRI dhan92 (7.89t ha<sup>-1</sup>) with a similar growth duration (Table 3).

**ALART [SHR-2 (Katari type)], Boro.** All advanced lines produced a higher yield (7.42-8.13 t ha<sup>-1</sup>) than the standard check BRRI dhan81 (6.54 t ha<sup>-1</sup>) with a similar growth duration (Table 4).

**ALART (STR), Boro.** None of the tested advanced lines performed better than the standard check BRRI dhan67.

**Investigators:** M Z Islam, S C Das, MHR Mukul, Shamsunnahar, H Kabir, A Zahan, M N Morshed, KK Ahmed and M R Islam

**RYT (Zira type), Aman.** One advanced line BRH11-7-17-10B produced a higher yield (5.10 t ha<sup>-1</sup>) than the checks (4.33-4.43 t ha<sup>-1</sup>) with similar growth durations (Table 5).

**RYT (Katari), Aman.** Two advance lines produced a higher yield (5.03-5.07 t ha<sup>-1</sup>) than the standard check Katari (4.37 t ha<sup>-1</sup>) (Table 6).

**RYT (STR-1), Aman.** None of the advanced lines produced higher yield (4.13-5.20 t ha<sup>-1</sup>) than the standard checks (5.33-5.80 t ha<sup>-1</sup>).

**RYT (STR-2), Aman.** Three advanced lines produced a significantly higher yield (5.17 t ha<sup>-1</sup>) than the two checks (4.40-4.73 t ha<sup>-1</sup>).

**RYT (Photosensitive), Aman.** One advanced line BR10212-17-3-2-2 produced a higher yield (5.10 t ha<sup>-1</sup>) than the standard checks (4.03-4.23 t ha<sup>-1</sup>) (Table 7).

**RYT (Tall), Aman.** None of the advanced lines produced higher yield (2.17-3.57 t ha<sup>-1</sup>) than the standard check BRRI dhan76 (4.27 t ha<sup>-1</sup>).

**RYT (Low Amylose), Aman.** None of the advanced lines produced higher yield (3.23-4.24 t ha<sup>-1</sup>) than the standard checks BRRI dhan71 (5.10 t ha<sup>-1</sup>) and BRRI dhan87 (6.00 t ha<sup>-1</sup>).

**SYT (DWR-GPG).** None of the tested genotypes (1.99 -2.96 t ha<sup>-1</sup>) performed better than the standard check BRRI dhan91 (2.73 t ha<sup>-1</sup>). The yield of deep-water rice varieties was reduced due to rat damage.

**RYT (FBR-Barishal), Boro.** One advanced line NGR 736-1 produced a higher yield (7.54 t ha<sup>-1</sup>) than the standard checks BRRI dhan74 (7.38 t ha<sup>-1</sup>) and BRRI dhan102 (7.40 t ha<sup>-1</sup>) with similar growth duration. On the other hand, all the advanced lines produced a higher yield (7.43-8.23 t ha<sup>-1</sup>) than the standard check BRRI dhan88 (6.53 t ha<sup>-1</sup>).

**RYT (FBR-Bio), Boro.** Three advanced lines produced higher yield (7.17—7.53 t ha<sup>-1</sup>) than the standard check BRRI dhan86 (6.11 t ha<sup>-1</sup>) and BRRI dhan96 (6.97 t ha<sup>-1</sup>) with similar growth durations.

**RYT-STR, Boro.** Seven advanced lines produced higher yield (7.05—8.18 t ha<sup>-1</sup>) than the standard checks (5.92-6.66 t ha<sup>-1</sup>) with similar growth durations (Table 8).

**RYT- STR (On farm), Boro.** Five advanced lines along with BRRI dhan28 and BRRI dhan88 as checks were grown at BRRI RS Gopalganj during Boro 2023-24. Five advanced lines produced a higher yield (8.26-9.31 t ha<sup>-1</sup>) than the standard checks (6.01-7.10 t ha<sup>-1</sup>) with similar growth duration (Table 9).

**RYT-Tall, Boro:** None of the tested genotypes performed better than the standard check BRRI dhan102.

**RYT-BB (Blast), Boro.** Five advanced lines produced higher yield (7.04-7.32 t ha<sup>-1</sup>) than the standard checks (5.72-6.55 t ha<sup>-1</sup>) with similar growth durations.

**RYT-2 (Blast- LD), Boro.** One advanced line namely BR (Path)15855-BC2-3HR-23 produced higher yield (7.73 t ha<sup>-1</sup>) than the standard check BRRI dhan29 (7.26 t ha<sup>-1</sup>) with 17 days shorter growth duration and other advanced lines yielded similar results with BRRI dhan29.

**RYT-3 (Blast-MD), Boro.** None of the tested genotypes performed better than the standard checks BRRI dhan58 and BRRI dhan89.

**RYT-4 (Blast-SD), Boro.** One advanced line BR (Path) 15641-3HR-12 produced higher yield (7.75 t ha<sup>-1</sup>) than the standard checks (75.93-6.69 t ha<sup>-1</sup>).

**RYT (PQR), Boro.** A total of 20 premium quality rice including checks BRRI dhan50, BRRI dhan63, BRRI dhan81, BRRI dhan104 and Tepi Boro were evaluated. From RYT (PQR), five genotypes were selected from 20 genotypes based on yield performances.

Investigators: M Z Islam, S C Das, ASM Masuduzzaman, MA Rahman, S Ghosal, MA Kader, J Ferdous, T Saha, TH Ansari and MA Latif

**Table 1. Grain yield and ancillary characters of ALART superior high-yielding rice [SHR-1(Zira type)], genotypes during Boro 2023-24.**

| Designation         | Plant height(cm) | Growth duration(day) | Grain yield(t/ha) |
|---------------------|------------------|----------------------|-------------------|
| V1=BRH15-24-7B      | 88.47            | 147                  | 7.82              |
| V2=BR9392-1-7-5B    | 82.20            | 148                  | 7.99              |
| V3=BR17-23-8-2-7B   | 87.27            | 146                  | 8.26              |
| V4=BRRI dhan88 (Ck) | 90.70            | 143                  | 6.99              |
| CV                  | 3.92             | 0.40                 | 3.73              |
| LSD                 | 6.8              | 1.15                 | 0.58              |

**Table 2. Grain yield and ancillary characters of ALART (FBR -SD) genotypes during Boro 2023-24.**

| Designation      | Plant height(cm) | Growth duration(day) | Grain yield(t/ha) |
|------------------|------------------|----------------------|-------------------|
| V1=BR11903-5R-56 | 98.60            | 146                  | 7.86              |
| V2=IR18A2119     | 95.10            | 146                  | 7.67              |
| V3=BRRI dhan88   | 87.20            | 141                  | 7.23              |
| V4=BRRI dhan96   | 78.10            | 144                  | 6.70              |
| CV               | 6.31             | 0.40                 | 6.55              |
| LSD              | 11.30            | 1.15                 | 0.96              |

**Table 3. Grain yield and ancillary characters of ALART (FBR-LD) genotypes during Boro 2023-24.**

| Designation      | Plant height(cm) | Growth duration(day) | Grain yield(t/ha) |
|------------------|------------------|----------------------|-------------------|
| V1=BR11318-5R-84 | 99.60            | 159.00               | 8.99              |
| V2=BRRI dhan92   | 95.07            | 156.00               | 7.89              |
| CV               | 2.83             | 0.45                 | 2.13              |
| LSD              | 9.69             | 2.48                 | 0.63              |

**Table 4. Grain yield and ancillary characters of ALART [SHR-2 (Katari type)] genotypes during Boro 2023-24.**

| Designation | Plant height(cm) | Growth duration(day) | Grain yield(t/ha) |
|-------------|------------------|----------------------|-------------------|
|-------------|------------------|----------------------|-------------------|

|                     |       |      |      |
|---------------------|-------|------|------|
| V1=BRH11-7-17-10B   | 91.23 | 145  | 7.42 |
| V2=BRH9-3-2B        | 90.17 | 146  | 7.83 |
| V3=BRH13-9-5-2B     | 90.53 | 146  | 8.13 |
| V4=BRRI dhan81 (ck) | 97.03 | 143  | 6.54 |
| CV                  | 5.53  | 0.55 | 2.37 |
| LSD                 | 9.79  | 1.59 | 0.35 |

**Table 5. Grain yield and ancillary characters of RYT (Zira type) genotypes during T. Aman 2023.**

| Designation      | Plant height(cm) | Growth duration(day) | Grain yield(t/ha) |
|------------------|------------------|----------------------|-------------------|
| BRH11-7-17-10B   | 103.13           | 115                  | 5.10              |
| BR17-23-8-2-7B   | 104.80           | 112                  | 4.47              |
| BRH14-2-1-7B     | 103.40           | 112                  | 4.67              |
| BR9392-1-7-5B    | 106.93           | 112                  | 4.10              |
| Zirasail (ck)    | 117.60           | 111                  | 4.43              |
| BRRI dhan62 (ck) | 103.60           | 111                  | 4.33              |
| CV               | 3.82             | 0.21                 | 6.72              |
| LSD              | 7.41             | 0.42                 | 0.55              |

**Table 6. Grain yield and ancillary characters of RYT (Katari type) genotypes during T. Aman 2023.**

| Designation  | Plant height(cm) | Growth duration(day) | Grain yield(t/ha) |
|--------------|------------------|----------------------|-------------------|
| BRH9-3-14-2B | 104.00           | 118                  | 5.03              |
| BRH13-9-5-2B | 102.73           | 118                  | 5.07              |
| BRH9-3-2B    | 103.27           | 117                  | 4.67              |
| Katari (ck)  | 116.73           | 116                  | 4.37              |
| CV           | 2.05             | 0.63                 | 2.76              |
| LSD          | 4.38             | 1.48                 | 0.26              |

**Table 7. Grain yield and ancillary characters of RYT (Photosensitive) genotypes during T. Aman 2023.**

| Designation      | Plant height(cm) | Growth duration(day) | Grain yield(t/ha) |
|------------------|------------------|----------------------|-------------------|
| BR10212-17-3-2-2 | 101.67           | 116                  | 5.10              |
| BR10212-4-3-1    | 107.33           | 128                  | 3.47              |
| BR10211-30-2-1-4 | 112.33           | 127                  | 3.13              |
| BR10212-5-5-3    | 112.00           | 129                  | 3.80              |
| IR13F652-1-P3    | 112.33           | 131                  | 4.43              |
| IR16F1097-P1     | 114.00           | 130                  | 3.83              |
| BR11196-5R-5     | 108.67           | 130                  | 3.53              |
| BR10211-7-5-1    | 109.67           | 128                  | 3.17              |
| BR22 (ck)        | 113.67           | 148                  | 4.03              |

| Designation | Plant height(cm) | Growth duration(day) | Grain yield(t/ha) |
|-------------|------------------|----------------------|-------------------|
| BR23 (ck)   | 109.00           | 148                  | 4.23              |
| CV          | 3.32             | 0.56                 | 5.95              |
| LSD         | 6.27             | 1.28                 | 0.39              |

**Table 8. Grain yield and ancillary characters of RYT- STR genotypes during Boro 2023-24.**

| Designation          | Plant height(cm) | Growth duration(day) | Grain yield(t/ha) |
|----------------------|------------------|----------------------|-------------------|
| BR13113-4R-63        | 91.17            | 148                  | 6.63              |
| BR13125-4R-92        | 83.63            | 148                  | 6.16              |
| BR13118-4R-76        | 97.07            | 150                  | 7.28              |
| BR13113-4R-185       | 90.63            | 150                  | 7.05              |
| BR13111-4R-191       | 99.20            | 153                  | 7.09              |
| BR13106-4R-469       | 111.97           | 149                  | 8.18              |
| BR13108-4R-232       | 101.30           | 151                  | 7.11              |
| BR13106-4R-438       | 101.60           | 151                  | 7.77              |
| BR13111-4R-63        | 97.03            | 151                  | 7.37              |
| BR13106-4R-184       | 84.87            | 152                  | 6.81              |
| BR13122-4R-136       | 105.20           | 152                  | 5.86              |
| BR13113-4R-116       | 94.47            | 151                  | 6.40              |
| BRRI dhan67 (Tol.ck) | 98.57            | 143                  | 6.06              |
| BRRI dhan88 (Sus.ck) | 93.13            | 141                  | 6.66              |
| BRRI dhan28 (Sus.ck) | 95.03            | 139                  | 5.92              |
| CV                   | 6.84             | 0.99                 | 3.39              |
| LSD                  | 11.09            | 2.45                 | 0.38              |

**Table 9. Grain yield and ancillary characters of RYT- STR (On-farm) genotypes during Boro 2023-24.**

| Designation      | Plant height(cm) | Growth duration(day) | Grain yield(t/ha) |
|------------------|------------------|----------------------|-------------------|
| BR13113-4R-63    | 97.53            | 145                  | 8.60              |
| BR13106-4R-184   | 100.70           | 147                  | 8.26              |
| BR13113-4R-116   | 89.70            | 149                  | 9.31              |
| BR13122-4R-136   | 107.43           | 150                  | 9.07              |
| BR13111-4R-63    | 102.53           | 148                  | 8.75              |
| BRRI dhan28 (ck) | 106.53           | 141                  | 6.01              |
| BRRI dhan88 (ck) | 97.13            | 141                  | 7.10              |
| CV               | 5.03             | 0.70                 | 2.97              |
| LSD              | 8.97             | 1.82                 | 0.43              |

# RICE GERMPLASM COLLECTION AND CHARACTERIZATION

**Germplasm collection and rejuvenation.** Two hundred thirty-nine Aman rice germplasm were collected from Faridpur and Khulna regions. This rice germplasm was rejuvenated to produce more seeds for further evaluation and utilization.

Investigator: M Z Islam

**Morphological Characterization.** One experiment was conducted to characterize 48 T. Aman rice germplasm through 51 agro-morphological traits (20 quantitative and 31 qualitative characters) using the Rice Germplasm Investigators: M Z Islam and S C Das

Descriptors and Evaluation Form, GRSD, BRRI. The experiments were conducted in BRRI RS Gopalganj.

The majority of the observed attributes of the T. Aman rice germplasm in the present study show notable diversity. A UPGMA dendrogram was generated using 48 T. Aman rice germplasm, and the Euclidean distance was estimated using quantitative data. Using the Euclidean distance of 0.21 as the cutoff, cluster analysis indicated that the 48 T. Aman rice germplasm were divided into three categories. (Fig. 1). Cluster II consisted of a maximum of 34 germplasm, while Cluster II comprised of seven germplasm and Cluster I had also seven germplasm.

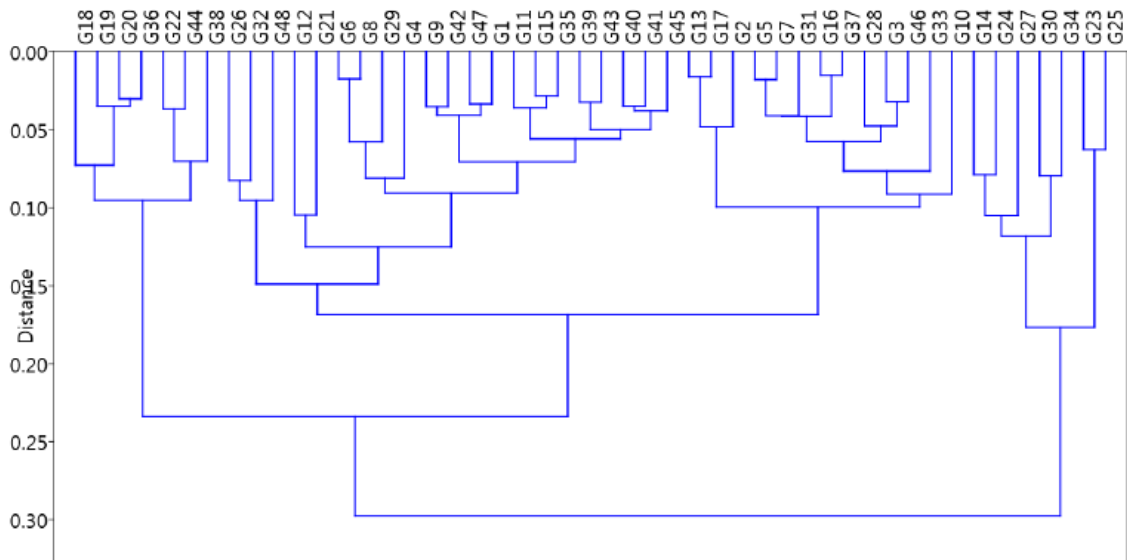


Fig.1. UPGMA dendrogram of 48 T. Aman rice germplasm based on their morphological and yield component traits.

## TECHNOLOGY TRANSFER

### Activity 1. Head-to-head adaptive trials during T. Aman 2023 under the TRB-BRRI project

In the T. Aman 2023 season, six (6) different rice varieties—BRRI dhan39, BRRI dhan71, BRRI dhan75, BINA dhan7, BINA dhan16 and BINA dhan17 were used for trials in the Gopalganj, Bagerhat and Narail districts. The farmers chose BRRI dhan75 and BINA dhan17 in every location due to grain appearance and high yield.

### Activity 2. Block demonstration

Five varietal block demonstrations were conducted in five locations during T. Aus 2023, T. Aman 2023 and Boro 2023-24 season in the reporting year.

### Activity 3. Field demonstration

A total of 750 (30 in Aus, 220 in T. Aman and 500 in Boro) field demonstrations (about 1 bigha each) of newly released BRRI modern rice varieties were conducted in different farmers' fields in Gopalganj, Bagherhat and Narail districts. BRRI Hybrid dhan7

and BRRI dhan98 in T. Aus season; BRRI dhan75, BRRI dhan87, BRRI dhan103, BRRI Hybrid dhan6 in T. Aman Season, and BRRI dhan67, BRRI dhan74, BRRI dhan92, Bangabandhu dhan100, BRRI dhan101, BRRI dhan102, BRRI dhan105, BRRI Hybrid dhan3, BRRI Hybrid dhan5 and BRRI Hybrid dhan8 in Boro season were used. Farmers were highly motivated to cultivate for its grain size, panicle length, and high yield.

In Boro 2023-24 season, a total of 350 field demonstrations were (about one Acre each) of newly released latest BRRI rice varieties such as Bangabandhu dhan100, BRRI dhan101, BRRI dhan102, BRRI dhan104, BRRI dhan105 and BRRI hybrid dhan8 were conducted in different farmers' field in Gopalganj and Bagherhat districts funded by (PARTNER) Project. A total of 50 field demonstrations were (about one Acre each) of modern BRRI rice varieties such as BRRI dhan67, BRRI dhan74, BRRI dhan89, BRRI dhan92 BRRI dhan97, BRRI dhan99, BRRI hybrid dhan3 and BRRI hybrid dhan5 were conducted in different farmers' fields in Gopalganj and Narail districts funded by LSTD Project.

Besides, sixty (20 in Aus, 20 in T. Aman and 20 in Boro) field demonstrations (about one bigha each) were conducted in different farmer's fields in Gopalganj, Bagherhat and Narail districts.

#### **Activity 4. Farmers training**

In the reporting year, 34 farmers' training programmes on modern rice production technology were organized in different locations in Gopalganj, Bagerhat and Narail districts.

#### **Activity 5. Breeder and TLS seed production**

In the reporting year, 360 kg, 2,352 kg and 5,290 kg truthfully labelled seed (TLS) were produced in T. Aus 2023, T. Aman 2023 and Boro 2023-24 season, respectively. 2,250 kg of breeder seed was produced in T. Aman season and 2,750 kg of breeder seed of different BRRI varieties was produced in Boro season. Moreover, 816 kg of F<sub>1</sub> seeds were produced from BRRI Hybrid dhan8 (BRRI99A / BRRI37R) at BRRI RS, Gopalganj during Boro season

#### **Activity 7. Farmers field day**

Twenty-two field days were conducted in the block demonstration in the Gopalganj, Bagerhat and Narail districts during T. Aus 2023; T. Aman 2023 and Boro 2023-24 seasons funded by GoB, PARTNER Project and LSTD project.

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