

BRRRI Annual Report Summary 2011-12

Program Area: Varietal Development

Plant Breeding Division

Out of 360 crosses 272 were confirmed. In total 5,724 plants were selected from F_2 populations. From segregating generations 15,709 progenies and 855 fixed lines were selected. A total of 662 advanced lines were selected from observational and yield trials. The genotype OM1490 was selected for proposed variety trial from ALART in upland Aus rice. National seed board (NSB) approved the technical committee recommendation to release BRRRI dhan29-SC3-28-16-4-HR2 as BRRRI dhan58 for Boro season. In farmers field condition, this variety yielded 7.5 t/ha with growth duration of 150-155 days in Boro season (Table 2). BRRRI dhan58 showed grain yield similar to that of BRRRI dhan29 but it matured one week earlier. NSB technical committee evaluated two promising salt tolerant lines in six locations and genotype BR7105-4R-2 produced highest the yield (6.3 t/ha) followed by BRRRI dhan47 (6.2 t/ha) IR72579-B-3-2-3-3 (5.0 t/ha) and BRRRI dhan28 (4.6 t/ha) (Table 1). The grain type of BR7105-4R-2 was slender and IR72579-B-3-2-3-3 was medium bold and both were non-shattering type. These two genotypes were moved to variety release system as salt tolerant variety for Boro season. Field evaluations of BR7323-4B-1 and BW328 have been completed during Boro 2011-12 in PVT trials at seven locations of Bangladesh. BR7323-4B-1 yielded 0.8 t/ha and BW328 yielded 0.6 t/ha higher than BRRRI dhan28 but none of them exceeded BRRRI dhan29. However, both the lines matured one week later than BRRRI dhan28 (Table 4). In Boro season, BR7840-54-1-2-5 showing 6.4 t/ha and 149 days growth duration was recommended for evaluation in proposed variety trial. Field evaluation of BR7517-2R-27-3 has been completed during T. Aman 2011-12 in PVT trials at seven locations of Bangladesh. BR7517-2R-27-3 yielded (3.6 t/ha) similar to BRRRI dhan33 (3.7 t/ha) but matured 11 days earlier. BINA dhan7 yielded 0.4 t/ha higher than BR7517-2R-27-3 but matured 18 days later. Also, it has long slender grain with intermediate Zn content (20 ppm) in polished grain (Table 5). Through marker assisted breeding introgression of *SUB1* QTL into BRRRI dhan33, BRRRI dhan44 and BRRRI dhan49 have been advanced up to BC_4F_1 generation. Four Bangladeshi landraces viz Kalojoma, DG1-349, Putidepa, and Damshi were identified as new sources of submergence tolerances having other than *SUB1* QTLs and development of mapping population has been initiated. Developments of rice varieties with abiotic and biotic stress tolerance along with nutritional quality were emphasized.

Hybrid Rice Division

During T. Aman season 2011, fifty-five test crosses and 54 (A x R) crosses were made from source nursery. Sixty testcrosses (F_1 s) were evaluated for their pollen fertility status of which one entry has been shown complete sterile and it was immediately backcrossed with its corresponding male parent for conversion. Thirty-five BC_6 generations were designated as new CMS lines and included into CMS maintenance and evaluation nursery. Ninety-one CMS lines along with their respective maintainer lines were maintained by hand crossing.

Fifty-five (55) test crosses and 83 (A x R) crosses were made using 7 CMS lines in Boro season 2011-12 from source nursery. Twenty-two test crosses (F_1 s) were evaluated for their pollen fertility status of which one entry have been shown complete sterile and it was immediately back crossed with its corresponding male parent for conversion. Eight BC_6 generations were stable in terms of pollen sterility and other desirable agronomic characteristics and shifted to CMS nursery as new CMS line in the background of corresponding elite maintainer lines. A total of 104 CMS lines along with their respective maintainer lines were maintained by hand crossing.

At observational trial in Gazipur, during T. Aman 2011 only two hybrids viz Jin23A/BR7013-62-1-2R and BRRI11A/BRRI16R were shown about 1.5 t/ha (28.30%) and 1.7 t/ha (32.01%) yield advantage over BR11 and 1.2 t/ha (21.43%) and 1.4 t/ha (25.0%) over BRRI dhan49. In Boro 2011-12 seasons seven hybrid combinations out of 83 found higher yielder over BRRI dhan28, BRRI dhan29 and BRRI dhan50. All of the selected hybrids showed yield potentiality above 7.72 t/ha and produced yield more than 1 ton over BRRI dhan28 and 2 tons over BRRI dhan50 with growth duration around 150 days.

In T. Aman 2011, CMS line seed yield 85 kg/plot (2.0 t/ha) and 60 kg/plot (1.6 t/ha) were obtained from BRRI10A/B and IR58025A/B respectively. On the other hand, during Boro 2011-12 season, CMS line seed yield of 65 kg (2.30 t/ha), 58 kg (2.4 t/ha) and 45 kg (1.7 t/ha) were obtained from BRRI10A/B, BRRI11A/B and IR58025A/B respectively. A total of 50 kg (2.6 t/ha), 62 kg (2.85 t/ha) and 180kg (1.80 t/ha) hybrid seeds were collected from BRRI10A/BRRI10R, BRRI11A/BRRI15R and IR58025A/BRRI10R respectively.

During the reporting year, hybrid rice breeding component supplied 3,63.5 kg of parental lines and hybrid seeds among 34 growers including seven seed companies, BADC and farmers.

Biotechnology Division

The broad objectives of the BRRI Biotechnology Division are development of modern rice varieties through different biotechnological techniques, molecular characterization of important rice genotypes and carry out basic or upstream research pertinent to the development of improved variety. This division conducted 13 experiments under four projects. Twenty-seven plantlets were regenerated from BRRI dhan29 after transformed with *GlyI* and *GlyII*. Five putative transformants were confirmed by GUS test. In gene pyramiding of bacterial blight study, molecular screening was done on 20 BC₅F₁ progenies of BRRI dhan28*6/IRBB60 and three plants were selected having two BB resistant genes (*xa13* and *Xa21*). One plant showed resistance compared to resistant check. Three plants were also selected from BRRI dhan29*6/IRBB60 cross having only *Xa21* genes and one of them showed resistance compared to susceptible checks. Twenty-eight molecular markers were used to determine the inheritance pattern of yield enhancing QTLs in 238 individuals of BRRI dhan28/*Oryza rufipogon* (Ac.no.105890). Thirty-five molecular markers were used in F₂ population of BRRI dhan29/IR4630-22-2-5-1-3 to identify QTLs for salinity tolerance at both seedling and reproductive stages. A total of 127 Bangladeshi Aus genotypes (12 BRRI released and 115 landraces) were screened against 76 SSR markers and grouped into six clusters. All the BRRI developed modern Aus varieties were grouped in the same cluster. In *sub-1* gene introgression into BRRI dhan44, background selection was carried out in BC₄F₁ generation of BRRI dhan44/BRRI dhan52 with 31 SSR markers. Out of 31 markers tested, 24 were homozygous for recipient parent. Twelve plants were regenerated from anther culture of BRRI dhan29/FL378 cross combination. A total of 189 plants were regenerated from seed culture of BRRI dhan47. Among them seeds were harvested from 20 plants. In T. Aman 2011, 204 plants were selected. Ninety-four plants were selected in Boro 2011-12 and 70 homozygous lines were bulked from pedigree lines. All the selected materials will be evaluated in the following season under respective trials. Twelve apparently superior genotypes were selected from observational trial for further evaluation

Genetic Resources and Seed Division

Thirty Aus/Jhum, 264 Aman and 39 Boro germplasm were collected from different districts including hilly areas of Bangladesh during 2011-12. A total of 429 germplasm were characterized with 45 morpho-agronomic characters during T. Aman and Boro seasons.

Besides, 1,607 germplasm accessions including 109 new collections were rejuvenated during the reporting year. Apart from this, 82 new collections were registered as accession. Gene Bank database preparation is going on and about 100 accessions have been entered into the database with available information during the reporting year. Genetic diversity was pronounced in 38 traditional hilly rice germplasm and the varieties were grouped into five (5) clusters. Among the ten tested germplasm, three viz Joli, Rangpuri (Sada) and Mi-chocho have allelopathic potentials and more inhibitory character to suppress weeds in laboratory condition. Fifty-three materials were screened against gall midge. Among the tested 398 landraces, 67 materials found highly resistant against Bacterial blight. Among the tested 98 genotypes for submergence tolerance, nine genotypes were found with very good recovery status, having survivability score 3. Twenty-eight genotypes were found with good recovery status having survivability score 5. Thirty genotypes were found with fair recovery status having survivability score 7 and 26 genotypes were found with poor recovery status having survivability score 9. In another study, among the tested 100 genotypes, 25 genotypes were found better having 92-100% survivability its score was 3.

A total of 52 BRRI developed and recommended varieties were maintained as nucleus stock. A total of 115.90 tons of breeder seed of which 37.19 tons from 28 varieties in T. Aman and 78.71 tons from 10 varieties in Boro seasons were produced during 2011-12. About 29.39 tons from 23 varieties in T. Aman, 69.76 tons from 10 varieties in Boro and 2.86 tons from nine varieties in Aus seasons were distributed during 2011-12. Around 1.95 tons truthfully labeled seeds (TLS) from 22 varieties of T. Aman and 7.5 tons truthfully labeled seeds from nine varieties of Boro were available for distribution. Around 1.22 tons seeds from 20 varieties of T. Aman, 7.5 tons seeds from nine varieties of Boro and 168 kg from two varieties of Aus were distributed as quality seed (TLS) during 2011-12. Besides, two training programmes entitled 'Breeder seed production and preservation techniques of rice' were organized under breeder seed project for the BRRI scientists and scientific assistants. Four training programmes entitled 'Quality seed production and preservation techniques of rice' were organized under breeder seed project for the farmers during 2011-12.

Grain Quality and Nutrition Division

Four breeding lines of boro and five lines for T. Aman were analyzed for physico- chemical and cooking properties of grain. All the lines had satisfactory milling outturn, good to very good appearance, acceptable content was found in two lines and other lines contain intermediate amylose content. For all the lines, protein content was in satisfactory level. Cooking properties of all the lines were in acceptable level.

In total 62 local and high yielding cultivars were analyzed for physico-chemical properties. Among the varieties, 35 showed more than 70% milling yield. But head rice yield was unaccepted level. A wide range of cooking time was observed. Cooking properties were good for all the cultivars. Amylose content of all the varieties was low to intermediate level. Protein content of five cultivars was undesirable.

BR3 rice samples of Boro 2011-12 season collected from five different BRRI stations were analyzed for amylose and protein content. The range of protein content was 7.7-9 percent and the range of amylose content was found 21.1-25.7 percent. The experiment will be continued for the Aus and Aman seasons accordingly.

Physico-chemical properties of local varieties (12) of hill tract area were analyzed. Milling outturn was satisfactory but the range of head rice yield varied from 16.3-69.0 percent. Cooking time of the varieties was higher than high yielding varieties. Other cooking properties were desirable level. Among the varieties, four contain low amylose content which

can be selected for further breeding programme. Protein content was found more than 7.0 percent for all varieties.

Puffed, popped and flattened rice were produced from five modern varieties to evaluate the quality products. Comparing few parameters with BR16, none of the varieties produce better quality puffed rice, whereas these varieties might be used for production of popped rice. Among the varieties, BRRI dhan41, BRRI dhan42 and BRRI dhan45 produce similar/better quality flattened rice comparing with BR16.

Program Area: Crop Soil Water Management

Agronomy Division

It was possible to obtain sufficient tillers from BRRI dhan29 of the main plot, which was used to retransplant 3-4 times more area than main plot in 15 December and 30 January transplanting.

The highest grain yield was observed from 45days old seedlings with 20x20 cm spacing plus four seedlings per hill, which is followed by 35-day-old seedlings with 20- × 20-cm spacing plus four seedlings per hill.

BR7474-60-5-3 produced higher grain yield in T. Aman season than BR11 (check variety) but it was statistically similar with the check and the percent heterosis was not satisfactory.

None of the tested entries produced higher grain yield than BRRI dhan28, BRRI dhan47, BRRI dhan50 and BRRI dhan55 (the check varieties) in Boro season.

About 22 - 27 percent urea could be saved in Aman and Boro seasons respectively without sacrificing grain yield if 2/3rd of urea was applied as top dress along with 2-3 percent urea spraying maintaining 3.5 percent urea solution instead of last top dress. The study needs further evaluation.

Among the treatments weed free and herbicide + 1HW treated plot produced higher grain yield irrespective of fertilizer doses. Though weed free treated plot showed higher grain yield but herbicide + 1HW treated plot is economically more viable.

Among the treatments, the highest grain yield was obtained from 25 x 15 cm spacing (6.63 t ha^{-1}) when USG was deep placed followed by 20 x 20 cm spacing (6.20 t ha^{-1}) than 20 x 15 cm spacing (6.16 t ha^{-1}).

Among the tests different time of USG deep placement, the highest grain yield was obtained from 15 DAT USG deep placement (6.77 t ha^{-1}) followed by 10 DAT USG deep placement (6.72 t ha^{-1}) than 5 DAT USG deep placement (6.36 t ha^{-1}).

Almost three ton yield advantage over control and 500 kg over recommended rate was obtained though the nutrient amount was less than recommended rate.

Water hyacinth allowed to grown in waste water for 20-30 days and then this water might be used for irrigation to obtain similar grain yield of fresh water treated pot.

Though nutrient manger based fertilizer use may save fertilizer cost but it depends on knowledge level of the users. It is difficult to collect correct information for nutrient manager right now. It requires further improvement.

Grain yield and fertilizer dose of nutrients across the farmers' fields showed spatial variability. The application of appropriate fertilizer dose NPK @ 147, 25, 50 kg ha^{-1} may increase rice yield and minimize cost in all fertility grades of soil to a certain level, which is possible with farmers' present knowledge level.

Among the treatments recommended doses of fertilizer with USG application produced higher yield (4.66 t ha^{-1}) followed by recommended doses of fertilizer with 25% additional Gypsum application (4.52 t ha^{-1}) and recommended doses of fertilizer with LCC based nitrogen management (4.44 t ha^{-1}).

Soil test based (STB) fertilizer application produced the highest yield in Aman season.

Among the tested varieties/lines, Joli, Rangpuri (sada) and Mi-chocho have allelopathic potentials and more inhibitory character to suppress weeds in laboratory condition

Evaluation of herbicide with Pretilachlor, Butachlor, Pyrazosulfuran-ethyl, Mefenacet + Bensulfuran methyl, Bensulfuran methyl+ Acetachlor and Pyrazosulfuron ethyl 0.6%+ Pretilachlor 34.4% group control weed effectively in transplanted field.

On the basis of FGD, researchable issues were identified and accordingly adaptive trials and other related activities are in progress.

Soil Science Division

In Boro season, the estimated optimum N rate was 150 kg/ha for the tested lines BR7358-5-3-2-1, BR7358-30-3-1, BR7372-18-3-3 and BRRI dhan50. Along with them, the optimum rate of K for BRRI dhan51 and BRRI dhan54 was 100 kg/ha while it was 50 kg/ha for BRRI dhan52 and BRRI dhan53 in T. Aman season. In Boro 50 kg K/ha is enough to produce optimum rice yield for all the tested varieties (BRRI dhan28, BRRI dhan55, BRRI dhan57 and BRRI dhan58). Twenty-five percent higher N/NP/NK/PK fertilizers need to be applied with STB dose depending on location for obtaining optimum rice yield. Long term missing element trial in BRRI HQ, Gazipur revealed that omission of N or K from complete treatment (NPKSZn) significantly decreased yield in both Boro and T. Aman seasons. Higher yield decrease was observed in Boro than T. Aman season due to omission of P fertilizer. At both BRRI RS Rangpur and Barisal the omission of N or K in Boro significantly lowered yield while in T. Aman only N omission produced such results. Thus, to get optimum yield fertilization of NPKSZn is necessary. Soil test based (STB) dose is a good option for obtaining higher rice yield either in double or triple rice cropping pattern. Straw surface mulch immediately after establishment of rice with minimum tillage builds up soil organic carbon compared to rice straw incorporation in soil with minimum tillage. Higher level of water arsenic (193 – 462 ppb) of shallow tube well was found at two unions (Alibabad and Korola) of Faridpur sadar upazila and two unions (Keragachi and Jalalabad) of Kolaroa upazila under Satkhira district. Urea deep placement in the form of USG or NPK briquette is a key factor for efficient utilization of N fertilizer and obtaining higher rice yield as well as reduces N loss which perhaps decreases N₂O emission in the atmosphere.

Irrigation and Water Management Division

Irrigation applied by AWD practice when water level up to 15cm below soil surface produced the highest yield (5.56 t/ha) followed by continuous standing water and 30 cm AWD (5.33 t/ha) respectively. Higher yield was obtained from non-protected plots compared to protected plots covered with polythene sheet in levee. Thus, 15 cm AWD is the best water management practice for irrigated Boro production.

Considering specific discharge, an engine speed within 1500-1600 RPM is optimum for earthen canal. For polyethylene pipe with five and four inches diameter, 1450 to 1550 RPM is the optimum and for polyethylene and cotton pipe, 1400-1500 RPM is the optimum.

USG in AWD method produced slightly higher yield compared to prilled urea for Boro production. But application of USG alone cannot maintain higher yield in longer duration

Boro rice like BRRI dhan29. Therefore, BRRI recommended additional split of prilled urea as top dress should be incorporated in the USG treated plots for BRRI dhan29 cultivation.

Refinement of AWD experiment showed that irrigation (5-7 cm) application is economically more viable when water level goes below 15 cm from soil surface. It saved 20%-25 % water and Tk 4,931/ha compared to continuous standing water practice.

Short and long duration varieties like BRRI dhan33 and BR11 were tested to determine the drought sensitivity and to find optimum date of transplanting under climate change situation. Both short and long duration T. Aman varieties suffered less from drought and showed good yield when transplanted from 24 to 31 July. The early transplanting of T. Aman through supplemental irrigation showed effective mitigation of terminal drought at reproductive and vegetative stages in T. Aman production.

Among medium duration varieties, BRRI dhan31 and BRRI dhan49 were found less sensitive to drought stress. On the other hand, long duration varieties having growth duration between 153 and 155 days were found sensitive to drought stress.

In Sonazagi area a good water bearing aquifer existed at a depth from 155 m to 180 m (salinity level ranged from 0.30 to 0.57 dS/m). BRRI dhan28, BRRI dhan47 and BRRI dhan55 were grown during Boro season and yields were 5.52 t/ha, 5.27 t/ha and 5.70 t/ha respectively. All the varieties performed well in irrigated condition. Thus, mono-cropped saline area has been converted into a double cropped area which is a good news for the coastal saline areas. The adjacent farmers have started installing tubewells for irrigating Boro rice. The findings may be disseminated to other areas where similar condition exists.

Rain water harvesting in a reservoir with 25 cm high embankment conserved more water than without embankment, which could increase irrigated Rabi crops area in the coastal region. Rainfed T. Aman (HYV) - Tomato with irrigation cropping sequence is more profitable than other cropping sequences. It was also evident that Rabi crop cultivation with pond water is also profitable in coastal saline areas.

In hilly areas, rain water harvesting, ring well renovation, rubber dam or river cross dam in Chegi river and Myani river, hill water conservation from small hill stream by making creek dam could be the good source of surface water in this region. Cultivable land can be increased by proper management of surface water from those sources.

Among the BRRI regional stations (RS) the highest depth of groundwater level (30.16 m) was found in Gazipur during March/April and lowest (1.4 m) in Kushtia area during September to October. In Barind area, the highest groundwater level depth (32 m) was observed in Nachol area, followed by Godagari (23 m) and Nawabganj (20 m). The overall trend indicates the lowering of groundwater level. The main reason for this declination was excess withdrawal due to increased demand for both domestic use and irrigation;

BRRI dhan54 could be a good option in Aman season in the polder 30 area (Khulna) considering the water height in Aman season and higher yield potential than local variety (2.4 to 2.8 t/ha). In polder 43/2F (Barguna), establishment of Boro rice in early November might be affected due to cold stress but it can be recovered after temperature increase. It

is possible to grow BRRI dhan28 having yield range of 4 to 6 t/ha in polder 30 and more than 6 t/ha in polder 43/2F;

Rabi crops can be grown in polder 43/2F (Barguna) under undrained or unmulched condition if sown in January. To achieve better establishment and better yield of mungbean it needs to be sown early and when the soil moisture is optimum. Therefore, all the Rabi crops can be established earlier with proper drainage, which needs further study for confirmation.

Irrigation cost for Boro production gradually increased over the last 15 years (1989 to 2003). It started to increase at faster rate from 2004 till 2011 with some exception in 2008. After 2011, the projected irrigation cost will increase gradually and it will reach to Tk 16,713/ha in 2031. Availability of irrigation water at the farm level is closely related to the crops grown. Therefore, steps should be taken to improve on farm water management practice. To ensure a regular water supply to crops, it requires an improved irrigation plan (ie, when to irrigate and how much water to apply). Thus, agricultural extension workers could assist in this regard. In general, policies should be taken to promote water management training to farmers for better understanding of on farm water management.

Plant Physiology Division

Based on the visual score and survivability, nine genotypes out of 41 were found saline tolerant in comparison with checks. Yield potential of advanced line IR72579 is higher compared to other genotypes though the yield (g/pot) was same as tolerant variety BRRI dhan47 at 3 and 6 dS/m salinity level. In submergence screening, among the tested genotypes, nine were found with very good recovery status of which survivability score is 3. Twenty eight genotypes were showed good recovery status with survivability score 5. Out of 71 genotypes seven performed well in deep rooting which could be used in further breeding programme. At maturity, 304 hills tolerant to cold at the reproductive stage were collected from 10 F₂ crossing line. For quality rice seedling production in winter, 12-hour water layered (2-4 cm) at night time in seedbed was suitable for healthy seedling raise avoiding cold injury. Twenty four-hour covered seedbed with polyethylene sheet was preferred for avoiding cold injury where water was not available or scarce. The seeds of Aman season's crop had high dormancy than that of Aus and Boro seasons. The seeds stored in freeze condition exhibited long viability period followed by polythene packet and motka storage. Among all the varieties stored in polythene packet and motka, BRRI dhan48 showed the highest viability up to 330 days. Automatic weather station (WatchDog 2900ET) can measure and record/log daily weather fluctuations more accurately than manual system.

Program Area: Pest Management

Entomology Division

- Overall insect pest incidence at BRRI HQ farm, Gazipur was low in the reporting year. However, GLH, WLH and GH dominated the pest population in all three seasons. The highest incidences of GLH and WLH were observed in Aus seed beds but the highest population of GH was found in the T. Aman seed bed.
- Higher numbers of natural enemies were found in the Aus and Boro seasons than Aman season. SPD, damselfly, CDB and LBB were the dominant natural enemy population in the reporting year in all three habitats. The domination of SPD population, irrespective of habitat, was observed in the Aus and Aman seasons, but

that of LBB was observed in seed beds, grass fallow lands and irrigated rice of the Boro season.

- In Sirajganj (a BPH prone area) BPH and WBPH surpassed the ETL in the Boro season. Small brown planthopper was not reported earlier in Bangladesh but has been recorded in the yellow sticky trap in this area.
- Chemical control by double nozzle sprayer has been found more effective than single nozzle sprayer in controlling BPH. In an outbreak situation chemical control is essential to avoid 'hopper burn' of rice.
- Wing span of gall midge varied from 3 to 4 mm. Female longevity was higher than male and the female laid 130-330 eggs during its life time.
- Developmental duration from egg to adult of *Trichogramma zehiri* at different temperatures showed that the duration decreased with the increase of temperature up to certain limit and it ranged from 7 to 15 days.
- Adult longevity of *T. zehiri* depends on diets and the highest longevity of female and male was found when host food plus 25% honey solution was supplied as food.
- BRRI dhan42 has been identified to show low yield loss (5%) despite a considerable level of hispa damage. This variety might be recommended for hispa prone areas. BRRI hybrid2 was also showed higher hispa damage tolerance than the BRRI hybrid dhan1 and BRRI hybrid dhan3.
- A total of 165 insecticides (114 against BPH, 29 against RH and 22 against YSB) were found effective out of 190 insecticides 2011-12.
- Thirty-five and four entries were found moderately resistant to BPH and GLH, respectively for further use.

Plant Pathology Division

Survey and monitoring shows that aromatic rice is more susceptible to neck blast disease than the other HYVs. Twenty-five advanced breeding lines were tested against BB and ShB disease and only five materials showed moderately resistance reaction to ShB. Among the tested 85 hybrid materials, only H42 and H61 showed resistant reaction to BB. Two hundred and twenty four INGER materials were tested and 10 of them showed resistance against the most virulent isolate (BXO9) of BB. The tested pyramid lines showed different types of reaction in different locations and seasons. In most cases, IRBB60, IRBB65 and IRBB66 performed best against BB pathogen. Among the tested 398 materials, 67 materials found highly resistant against BB with the cluster mean lesion length 1.19 cm. In total, 16 BB races were identified in Bangladesh based on nine NILs. Among them, race 1 is the major race that alone occupied 61 percent among the 172 tested isolates. Though *Xa21* gene showed susceptible reaction to some isolates, the resistant frequency of that gene was still 89.5 percent that may use as candidate gene for developing BB resistant rice variety in Bangladesh.

A total of 220 blast isolates were screened against MLs. Among the 24 resistant genes, *Pish*, *pi9*, *pita-2*, *piz-5* and *pita=pi4(t)* showed higher resistance (>80%) against the tested blast isolates. The frequencies of virulent blast isolates against 31 MLs varied widely from nine to 68 percent. Specific primers were used to confirm the presence of blast resistance genes in rice varieties having Japonica and Indica background. Out of 20 primers, 18 successfully produced bands from blast resistance MLs. The primer *pita* 440 for *pita* gene, OSM 89 and RM 7102 for *pita2* gene, AOL51, AOL54 and AOL351 for *pish* gene, NBS3, NBS4, NBS/LRR and NBL2 for *pi9* gene and primers RM 138, RM 166, RM 208 and SUB 3-4 for *pib* gene were effective in producing corresponding bands. In JIRCAS laboratory, Japan 26 blast isolates were tested and found 26 races based on 31 MLs. Blast isolates were

categorized into five groups; 10 U blast pathotypes, four for one blast pathotypes, eight for k blast pathotypes, seven for z blast pathotypes and seven for ta blast pathotypes. Dominant blast pathotypes were U73, I4, k100, z05 and z07 and ta403.

The mean mycelial growth of *R. oryzae-sativae* ranged from 0.28 to 0.45 mm/hr. Among the isolates, the highest mean growth rate (0.45 mm/hr) was recognized with the Mymensingh isolates followed by Jamalpur (0.42 mm/hr). All the isolates of *R. oryzae-sativae* showed virulence to the rice variety BR11. The highest mean lesion height was found from the isolate My1 followed by Na2. The growth of this fungus reduced at very strong acidic and alkaline pH. Abundant sclerotia were formed at pH level 7 while no sclerotia at pH level 3 and 4 after four days of inoculation. Among the six different C sources on *R. oryzae-sativae* growth, the best was found in Dextrose (0.43mm/hr) followed by Sucrose (0.42mm/hr). In case of duration of complete mycelium running, the minimum time was recorded in Dextrose (105 hrs.) and maximum time was found in Fructose (172 hrs.). The highest sclerotial formation was found in Dextrose.

Among six different N sources, the best mycelial growth of *R. oryzae-sativae* found in peptone (41.25mm) followed by yeast (38.25mm) after four days of incubation. Though peptone was found as the best for mycelial growth, no formation of sclerotia, while the control plate was fully covered with mycelia after 4 days of incubation and formed abundant sclerotia.

The optimum temperature for *F. moniliforme* growth was 25°C but did not grow at 5°C. The rate of sporulation was high at 30°C after nine days of incubation. The maximum colony diameter was observed at medium pH 6. Colony diameter was identical on the third day at pH 7 compared with 59.45 and 58.48 mm on the same day of incubation for pH 6 and 8. Maximum sporulation was found at pH 6. The number of spore production was the lowest ($1.80 \times 10^6/\text{ml}$) at pH 10.

Among the three tested fungicides only Dizole 300 EC performed better, which reduced fungal growth 87.31%. Among the tested 19 fungicides only Power Blast effectively control sheath blight disease and the average disease reduction was 82.07%. Among the tested 19 fungicides against blast only Roton 75WP performed better, which reduced the disease severity 81 percent over control. The rate of seed infection of tested seeds was very low. All of the seeds were free from *Bipolaris*. The tested chemical Vitaflo 200 was insensitive to *Fusarium* but controlled 100 percent *Curvularia* and *Trichoconis*. Effects of this chemical on seed germination, seedling growth and yield was insignificant.

Program Area: Rice Farming Systems

Rice Farming Systems Division

Interventions of farming systems technologies increased the income of landless and small farmers by 17.97 and 36% respectively compared to base year at FSR and D site, Kapasia, Gazipur. Rearing of layer, pigeon and goat helped farmers to increase their income. Spraying mango trees with pesticides and fertilization of jackfruit trees also increased production. LCC based N management practice saved 11 kg and 20.10 kg N/ha and increased the yield of BRRI dhan46 in T. Aman and BRRI dhan28 in Boro season respectively over the farmers' practice. Small farmers who adopted water saving technologies, saved irrigation cost and increased rice yield. Growing vegetables, turmeric and ginger as well as rearing *rohu*, silver carp, *mrigal* and *sorputi* increased farmer's income.

Yield gap experiment at Kapasia showed that the BRRI management practice ie the use of quality seed, LCC and USG contributed to higher yield.

Cropping patterns evaluation in medium highland irrigated ecosystem indicates that the highest rice equivalent yield (REY) could be found from Potato-DT Boro-T. Aman followed by Potato-T. Aus-T. Aman and Boro-T. Aus-T. Aman.

Sesbania application as green manure and weed management in T. Aman rice in Boro-Fallow-T. Aman cropping pattern indicates that *Sesbania* incorporation before T. Aman rice significantly influenced rice yield. *Sesbania* incorporation by applying herbicide 30 days after seeding produced the highest yield.

Use of selective herbicide at 15 DAS is sufficient for Aman rice production in Maize-DS Aus (brown manured by *Sesbania*)-DS Aman cropping pattern. One hand weeding was saved in Aman season, which might be due to weed suppression effect of *Sesbania* incorporated during Aus season. Maize intercropped with grasspea-DS Aus with herbicide followed by one hand weeding-DS Aman with herbicide followed by one hand weeding produced the highest REY.

Double transplanting under late situation produced significantly higher yield than that of normal transplanting in both T. Aman and Boro seasons.

In a long-term study with four cropping patterns, Potato-Boro-T. Aman cropping pattern produced the highest REY and gross margin than Boro-Fallow-T. Aman, Boro-T. Aus- T. Aman and Maize- Mungbean-T. Aman in both Rangpur and Gazipur.

Among the three rice cropping patterns the highest yield was obtained from BRRI dhan28-BRRI dhan48-BRRI dhan46 (12.18 t/ha) which was 11-15% higher than the farmer's patterns.

Boro rice grown in costal saline area using fresh reserve water produced 33.70% higher gross return in Boro-Fallow-T. Aman cropping pattern compared to Fallow-Fallow-T. Aman cropping pattern.

Among different cropping patterns with vegetables, Tomato-BRRI dhan42-BRRI dhan33 yielded the highest REY in partially irrigated ecosystem.

Dry seeded Aman rice, BRRI dhan49 produced the highest grain yield at 30 June seeding under Rice-Wheat-Mungbean cropping pattern. While BRRI dhan33 produced the highest yield on 30 July and BRRI dhan53 produced the highest yield on 10 July seeding.

Several activities on validation and delivery of farming systems technologies were carried out in different locations of the country. The activity included promotion of improved cropping pattern packages, demonstration of poultry manure as a source of phosphorus fertilizer, promotion of improved varieties of turmeric cultivation in the homestead and multilocation testing of BRRI dhan46/49-BRRI dhan29-Fallow cropping patterns.

Program Area: Farm Mechanization

Farm Machinery and Postharvest technology Division

Prime mover of the existing BRRI Winnower was replaced by a 4 hp diesel engine. The winnowing capacity of the modified winnower was increased to 550-600 kg/hr. Cleaning efficiency and operation costs of modified winnower was found same as previous version winnower.

BRRI USG applicator was re-designed as adjustable type considering line to line and plant to plant spacing of 18 x 20 cm, 20 x 20 cm and 22 x 20 cm. Adjustable mechanism of the re-designed applicator was also modified.

Mechanical transplanting of rice is the process of transplanting specifically raised seedling of rice. The seedlings were raised on polythene sheet and cut into slices of 28 × 58 cm size to feed into the seedling holding trays of the transplanter. A total of 14 (fourteen) treatments combining with different seed covering materials and dry and sprouted seed were used to conduct the study. Cow-dung mixed soil and without cow-dung mixed soil were also used as base soil treatment for this experiment.

Walking type mechanical rice transplanter was tested in different NATP founded DUART project locations during Boro/2012 season. During test, flexible plastic tray (58 x 28 x 2.5 cm) was used to raise seedling for the transplanter. Yield performance of rice transplanting by mechanical rice transplanter were compared with hand transplanting method.

BRRI USG applicator was re-designed as adjustable one considering line to line spacing 18cm, 20cm and 22cm. During Boro 2012, the modified applicator performance was evaluated in 10 locations under the NATP funded DUART project. In field operation, field capacity was found 0.15 ha/hr whereas, manual USG application capacity was 0.019 ha/hr. Yield variation was not observed in USG application by hand and applicator in studied ten locations. In all the cases, USG gave higher yield compared to hand broadcasting of prilled urea. USG also produced around 0.6 ton/ha more yield than prilled urea.

Minimum tillage along with crop residue retention, after three years, slightly improved physical properties of soil such as bulk density and penetration resistance. In rice maize cropping system, bulk density and penetration resistance under different tillage options along with residue retention are observed below the critical value which was regarded as sufficient to promote the growth and development of crops.

Energy input in conventional tillage, Single pass wet tillage in rice followed by zero tillage in maize, bed planting and Strip tillage was 49, 42, 42 and 41 GJ ha⁻¹, respectively in rice-maize cropping system. Maximum energy was consumed for chemical fertilizers. The lowest energy input was required for maize and highest for rice due to less irrigation water requirement in maize.

The physical and thermo chemical properties of rice husks were characterized to use as a feedstock for energy conversion process. As a source of biomass fuel, the characteristics of rice husk of four varieties are determined under this study.

In the year reporting 190 demonstration cum informal training programmes were conducted at different places under FMTD project.. About 3800 participants including farmers, machine operators and Sub-Assistant Agricultural Officers (SAAO) attended the demonstration cum informal training programmes. As a result, awareness was created among the farmers on the benefit of using BRRI farm machinery and they also wanted to purchase the machine with subsidised prices. Besides demonstration, BRRI machines were also displayed in the Agricultural Machinery Fair 2011-12 with the Cooperation of Department of Agricultural Extension (DAE) of Kushtia and Gazipur office, BARI, Gazipur and RDA, Bogra .

We conducted 69 two-day-long training programmes during Aman and Boro seasons 2011-12 in different locations within the project areas. Altogether 1380 participants mostly farm machinery operators attended the formal training programmes as trainee. A basic idea (how to operate new engine; when need to change air, oil and fuel filter etc) on operation, repair and maintenance of diesel engine has given to the participants. Trained operator was able to repair minor defects of the machine themselves. After training, the operators operated all machinery successfully.

A total of nine training program on ‘Seedling raising techniques for mechanical rice transplanter and operation and maintenance of farm machinery’ was conducted during Aman 2011 and Aus 2012. Different categories of farmers, manufacturer and traders participated in the training as trainee. Participants awarded about seedling raising techniques and operation of rice transplanter and USG Applicator. Soil collection, seedling tray preparation, rice transplanter and USG applicator operation was the parts of the training activities.

Workshop Machinery and Maintenance Division

The imported self-propelled reaper and existing BRRI developed self-propelled reaper were tested in BRRI RS, Rajshahi in Boro 2011-12 and T. Aman 2010-11 seasons. During the field operation of the reaper with 1.2m head, average field capacity of imported reaper were found 0.236 ha/hr (58.29 decimal/hr) and 0.232 ha/hr (57.24 decimal/hr) in Boro 2011-12 and T. Aman 2010-11 seasons respectively. On the other hand average field capacity of the existing BRRI developed self-propelled reaper with the same head in Boro 2011-12 and T. Aman 2010-11 seasons were found 0.278 ha/hr (68.66 decimal/hr) and 0.267 ha/hr (65.84 decimal/hr) respectively. The average fuel consumption of imported reaper and BRRI developed reaper were 0.827 l/hr and 0.765 l/hr respectively. The purchase price of imported reaper is almost double of BRRI self-propelled reaper. According to the analysis it is clear that the overall performance of the BRRI developed reaper was better than that of the imported reaper. All the information regarding repair and maintenance are still recorded manually. It is really a burdensome work when some queries have to be faced. Therefore, last year, using access built-in features and wizard, a simple data base programme (version: 01) was developed . But it had some limitations. To overcome these limitations 2nd version of database programme has been developed.

Program Area: Socio-economics Policy

Agricultural Economics Division

BRRI dhan28 and BRRI dhan29 were the most popular varieties in Boro season. BR11 is still the dominant variety covering about 22 percent of the total T. Aman area. In Aus season, the area coverage of BRRI dhan28 was the highest (16%) followed by BR3 (6.95%). BRRI dhan29 was the top yielder in both Boro (5.41 t/ha) and Aus (4.58 t/ha) seasons. BRRI dhan44 ranked top in terms of per unit yield (4.25 t/ha) in T. Aman season. Some hybrid and Indian varieties are being adopted as replacement of MV Aus and Aman due to higher yield performance.

Rice farmers used more seed than the recommended rate and applied lower amount of TSP and MP fertilizer. They received lower amount of gross return from MV Aus and MV Boro owing to higher production cost and lower market price; although, per hectare yield of Boro is higher. MV T. Aman growers received higher net return due to better market prices.

Area under hybrid rice has been declining and area under BRRI dhan29 and other MVs has been fluctuating over the period of 2002-11. Although, the yield performance (about 7 t/ha) of hybrid rice and MVs varied in different districts, the yield of hybrid was higher than BRRI dhan 28 (5 t/ha) and BRRI dhan 29 (6 t/ha). Almost all the producers showed their enthusiasm to continue growing hybrid rice only expecting better yield.

In southern region, major cropping patterns were Rabi/Khesari-T.Aus-T.Aman, Rabi-Fallow-T. Aman, Fallow-T. Aus-T. Aman and Boro-Fallow-Fallow, indicating there is a lot of scope to grow rice and other crops in the Boro and Aus seasons. Whereas the major cropping patterns in northern region were Boro-Potato-T. Aman, Boro-Fallow-T. Aman, and Tobacco-Jute-T. Aman. The farmers of Barisal region need mainly insect, disease resistant and longer seedlings varieties along with harvester, transplanter, applicator of USG, dryer etc; while the farmers of Rangpur region need mainly insect, disease and drought resistant varieties with long seedlings harvester, transplanter, USG applicator and dryer.

The technology users were enthusiastic to use the given variety for next season. The average volume of sale of Aman paddy (1.69 ton) was higher after the project intervention compared to than that of (1.09 ton) before the project. Average production of Boro was lower in 2011 (4.08 ton) than that of (5.03 ton) 2010 due to cold and drought problem.

During 1971-72 to 1983-84, the growth in area for Aus, Aman and Boro slowed down while the production growth accelerated due to adoption of BRRI developed high yielding rice

varieties. There are significant differences in the area, production and yield of different food grains between the period of pre and post establishment of BRRI. It also showed the structural changes in the area and production of different food grains between the periods due to initiation by the World Bank and govt. subsidies on inputs.

Agricultural Statistics Division

- In the reporting period BRRI dhan32, BRRI dhan40, BRRI dhan41 and BR11 were found most stable in T. Aman season, while BR3, BRRI dhan51 and BRRI dhan52 appeared to be unstable among the non-aromatic rice. In case of aromatic rice, BRRI dhan38 appeared to be most stable followed by BRRI dhan37.
- BRRI dhan28 and BRRI dhan29 were the most stable varieties and BR1, BR2, BR6, BR8 and BR18 appeared to be unstable in Boro season. In case of fine rice BRRI dhan50 appeared to be below average stable in Boro season.
- BRRI variety contributes about 90% of total production of the country. It does not reflect in field label because of BRRI variety is being sold in different brand names. For example BRRI dhan28 is sold as Nizersail and BRRI dhan29 as Jhingasail and Miniket etc. Pure consumers were found to prefer rice varieties on the basis of taste, slenderness and availability.
- Three mathematical models have been developed for consumer and producer preference to rice varieties by using four locations/districts farmers' data of Bangladesh in terms of rice deficit and rice surplus area. These three models are used to determine factors affecting producers' decision on varieties for rice cultivation and can provide an indication of the factors affecting consumers' preference to rice varieties.
- The average As content in grain was 0.31 mg/kg at command area level and at upazila level it was 0.40 mg/kg, while groundwater As level was 178.6 ppb and 126.3 ppb, respectively. Out of 490 upazilas 68 are at high risk, 103 are at medium risk, 130 are at low risk and 189 upazilas are risk free. In about 46% of the total area of Bangladesh As concentration is below 10 $\mu\text{g l}^{-1}$. Approximately, in 72% area of Bangladesh arsenic concentrations is within 50 $\mu\text{g l}^{-1}$. About 14% area of Bangladesh appears as low As risk with arsenic concentrations in water between 50 $\mu\text{g l}^{-1}$ to 100 $\mu\text{g l}^{-1}$. About 9% area falls under medium risk and about 6% under high risk.
- Combining the total As of grain and water (drinking water and water for rice cooking) more than 800 and 700 ppb, respectively in command area level and upazila level consumed per person per day, which may accumulate at least a small amount of As in human body. Thus, consumption of rice containing a small amount of As per day may lead to accumulation of large amount of As in human body in the long run.
- A total of 106 different analyses were performed during the reporting year. Besides, a number of maps were prepared using GIS and supplied to the scientists of other divisions whenever required.

Farm Management Division

An experiment was conducted at the West Byde of BRRI HQ farm, Gazipur during Boro 2011-12 season to determine the relative profitability of different sources of N (PU and USG) and weed control methods (herbicide Refit, herbicide Super Clean and hand weeding) in relation to labour utilization for rice cultivation. The treatments were arranged in a randomized complete block design with three replications. BRRI dhan29 was used for

experimental purpose. In PU applied plots, hand weeding produced the highest number tiller m^{-2} and grain panicle-1. Super Clean produced the highest number panicle-1. Weeding method had no significant effect on grain yield. All the parameters were higher in USG applied plots than PU applied plots. USG applied plots required higher number (6%) of labor than PU applied plots. Application of Super Clean instead of Refit produced Tk 4,160 ha-1 more profit but application of Super Clean instead of hand weeding produced Tk 10,060 ha-1 more profit. However, application of Refit instead of hand weeding made more profit of Tk 5,900 ha-1 and application of USG instead of PU made more profit of Tk 6,209 ha-1.

Another experiment was conducted during Aus 2011, T. Aman 2011 and Boro 2011-12 seasons at the West Byde of the BRRI HQ farm, Gazipur to determine the cost and return of HYV rice cultivation in present situation. The rice varieties BR26, BRRI dhan41 and BRRI dhan29 were tested in Aus, Aman and Boro seasons, respectively. Labour requirement in Aus, Aman and Boro seasons, was 269, 269 and 273 man days (md) ha-1 respectively. The total variable cost, gross return and gross margin for one hectare of land was the highest in Boro season followed by Aman and the lowest in Aus season, but the cost of production of one kg rice was the highest in Aus season (Tk 14.9) followed by Aman (Tk 12.3) and Boro seasons (Tk 12.2). The BCR was 1.46, 1.71 and 1.64 in Aus, Aman and Boro seasons, respectively.

An experiment was conducted during T. Aman 2011 season at the West Byde of BRRI HQ farm, Gazipur to find out the effect of different period of direct supervision on labour efficiency. The treatments were different level of direct supervision such as 100%, 80%, 60%, 40%, 20% and no direct supervision. Labour requirements for different operations such as seedling uprooting, transplanting, weeding, harvesting and postharvest operation were taken. Cent percent supervision required less number of labour and it was increased with decreasing of supervision period. Labour requirement was the highest under no supervision. Therefore, to increase the labour efficiency supervision must be confirmed.

Survey and monitoring labourers' wage rate were conducted throughout the year at Joydebpur, Chowrasta, Salna, Board Bazar, Konabari, Tongi. The average wage rate per day varies from Tk 300 to 330. The wage rate per day during the peak periods of the year were Tk 460 to 470 in May, Tk 275 to 330 in July-August and Tk 320 to 400 in December-January. The wage rate varied between Tk 200-225, 200-225, 200-230, 225-250, 250-300, 225-250, 250-300 and 300-350 at Habiganj, Rangpur, Rajshahi, Barisal, Sonagazi, Comilla Satkhira and Khulna, respectively.

About 17,003 kg of rice was produced consisting of 10,722 kg seed and 6,281 kg mixed rice. In addition 7,215 kg breeder seed and 1,574 kg TLS were also produced.

BRRI had a total of 485 labourers (227 were regular and 258 were irregular). In BRRI HQ, total labourers were 289 of which 129 were regular and 160 were irregular. The institute has 274 ha of land including 163 ha of cultivable land.

Total labour utilization in different divisions was 63,345.5 man days of which 59.57, 33.54 and 6.88% were utilized for research, support service and holidays, respectively.

A total of Tk 75,83,587.12; Tk 42,70,232.88 and Tk 8,76,192.54 were paid to the labourers for research work, support service works and leaves respectively.

About 85.3 ha of land was utilized by different divisions in different seasons where 13.9 ha was used in Aus, 37 ha in Aman and 34.4 ha in Boro season.

In addition to research, this division is also responsible for the management of BRRI garden to maintain the aesthetic view of the campus with colourful flower garden around the year.

Program Area: Technology Transfer

Adaptive Research Division

In ALART 2011, OM1490 was found suitable for proposed variety trial (PVT) in both T. Aus and B. Aus. Among the genotypes for ALART (PQR and RLR) in T. Aman 2011, BR7465-1-4-1 and BR7875-*5 (NIL)-52-HRI as PQR and BR7465-1-2-4 as RLR were considered for PVT. As PQR in Boro 2012, BR7358-5-3-2-1 and BR7358-30-3-1 from tested genotypes were considered for PVT, if disease reaction of those lines is accepted by the pathologist. Micronutrient dense BR7840-54-1-2-5 was also considered for PVT in Boro 2012.

During Aus and Aman 2011 and Boro 2012, SPDPs were conducted by using different BRRI technologies at different locations of Bangladesh under different programmes like SRRPP, BRRI core, AFACI, Climate change etc. Under these programmes, 468 demonstrations were conducted from which about 265 tons of quality seeds were produced and 80 tons seeds were retained by the farmers for next year cultivation.

Under the Minimizing Rice Yield Gap Project (BRRI part), research activities were carried out in 75 upazilas under 25 districts of Bangladesh. In Aman 2011, it was seen that on average 26.44% yield was increased by BRRI recommended practice and in Boro 2012, yield increase was 18.24% over traditional farmers' practice.

On-farm farmers' participatory adaptive research trials were conducted under yield gap minimization in rice using integrated crop and resource management (ICRM) practices in nine upazilas of five districts during T. Aman 2011 and Boro 2012. It was found that yield increased in ICRM practices was 0.8-1.2 t/ha over farmers' practice during Aman season and 0.9-1.7 t/ha during Boro season.

During the reporting period, the Adaptive Research Division (ARD) conducted 153 farmers' training at different locations of the country in which 5,355 trainees (4,590 farmers and 765 SAAOs of DAE) participated. ARD conducted 54 field days at different locations of the country. A total of about 10,397 persons participated in those occasions.

A total of 5785 kg quality seeds of the current rice varieties were produced at BRRI HQ farm, Gazipur for adaptive trials in different locations of the country in Aus, Aman and Boro seasons.

Training Division

The Training Division has conducted 87 training programmes in the reporting period with a course duration from 1-day to 1-week depending on their nature and requirement. A total of 2,853 participants from different government and non-government organizations and farmers were trained through these courses. The highest number of participants was from the Department of Agricultural Extension (DAE) followed by farmers. The overall improvement of knowledge for extension personnel of 1-week rice production training (RPT) varied widely and it was 153% for AEO of DAE, 204-314% for SAAO of DAE from different region and 149% for special programme (Junior Agronomist and officers of different NGO). From 1974 to June 2012, BRRI completed 2,398 training programmes through which 67,539 participants were trained on different aspects of rice production technologies. The trainees expressed positive views about the course content and training method. Most of the BRRI's speakers' performance was very good to excellent. Training Division also organized three 3-day workshops on development and utilization of Bangladesh Rice Knowledge Bank (BRKB).

Regional Station

BRRI RS, Barisal

A total of 397 progenies and 22 fixed lines were selected from F₄ and F₅ generations from the pedigree nursery (F₄ – F₆ generation) with emphasis on height, tolerance to tidal submergence, earliness, plant type, grain type and high yield potential. From long-term

missing element trial, it may be concluded that BRRI RS, Barisal farm needed complete (NPKSZn) fertilization to obtain maximum yield. Omission of any one nutrient element from complete treatment decrease yield and the extend of yield decrease depends on each nutrient missing. IRBB60, IRBB65 and IRBB66 performed best against BB pathogen in Barisal regions. About 4-5 number of irrigation could be saved by using AWD technology, which was also increased water productivity in Barisal regions.

BRRI RS, Comilla

Twenty-nine crosses were made and 47 crosses were confirmed and 326, 213, 116 and 312 plant progenies with desirable plant type and high yield potential were selected from F₂, F₃, F₄ and F₅ generations, respectively and five plant progenies were selected for bulk under the varietal development programme. Twenty-six genotypes were selected from OT for uniformity in desirable characters and high yield potential in Boro season.

In PYT-E (T. Aman), one genotype BR7472-16-2-1-2-3 was selected for better yield. None of the genotypes were selected from PYT-L. In PYT # PQR, genotypes BR7369-52-3-2-1-1, BR7357-6-2-1-1 and BR7647-16-2-2-2-1-1 were selected for higher yield advantage. For T. Aman, in SYT #1 (RLR) two genotypes (BR7044-1-5-1 and BR7473-12-2-2-6) were selected as compared with standard check BRRI dhan31 for yield and earlier growth duration. In SYT # 2, none of the genotypes were selected from SYT #2 for comilla region. In SYT, PQR genotype BR7357-11-2-4-1-1 was selected for its better yield and earliness.

In RYT #1 (PQR, Boro) two genotypes (BR7358-36-2-2-1 and BR7372-18-2-1-HR1) were selected as compared with standard checks BRRI dhan28, BRRI dhan50 and Minikit for yield and earliness. In RYT #2 (PQR, Boro) BR7358-35-2-1-1 and BR7372-30-1-1 were selected for better yield performance and earliness but genotype BR7358-35-3-2-1 was selected only for better yield performance as compared to standard checks. In RYT Boro (Micronutrient) genotype BR7830-16-1-5-3 was selected for better yield performance as compared to BRRI dhan28 and for earliness as compared with BRRI dhan29.

In Boro season, from multilocation trials of CSISA genotypes, five genotypes BR7372-117-3-4-3, BR7358-5-3-2-1, BR7358-56-2-2-1, BR7372-18-2-1-HR1 and BRRI dhan29-SC3-28-16-10-8 were selected as compared with BRRI dhan28 in terms of yield and growth duration. In Boro, multilocation trials of hybrid rice, genotype BIO 452 was selected for its highest yield as compared with checks BRRI dhan28 and BRRI hybrid dhan2 and showed growth duration 137 days, which was similar to checks. But all the entries were highly susceptible to lodging except BRRI hybrid dhan2.

In AYT (Boro) trials, four genotypes were selected for earliness as compared to BRRI dhan28 and BRRI dhan45. From IRLON, nine genotypes were selected considering better phenotypic performance as compared to standard checks.

In T. Aman, 500kg BRRI dhan33 and 892 kg BRRI dhan49 and in Boro, 12283 kg BRRI dhan28, 3060 kg BRRI dhan29 and 2620 kg BRRI dhan50 breeder seeds were produced.

Twenty-four T. Aman and 24 Boro rice varieties were evaluated at BRRI RS, Comilla farm to identify stability index. Considering yield performance, the top five varieties were BRRI dhan41, BRRI dhan49, BRRI dhan44, BRRI dhan46 and BRRI dhan31 in T. Aman and BRRI dhan29, BR8, BR3, BRRI dhan28 and BR9 in Boro.

Thirty-farmers (23 male and 7 female) of Daudkandi of Comilla district were trained by day long one training programme on rice production technologies during the reporting year.

Besides, twenty UAO and ten DAE, BARI, BADC personnel of Comilla region were trained by day long one training programme on recently released Boro variety BRRI dhan58 and T. aman variety BRRI dhan49 during the reporting year.

BRRI RS, Comilla also participated in one agricultural fair of Daudkandi upazila.

BRRI RS, Habiganj

In B. Aman season, 73 desirable homozygous plants of DWR were selected. In RYT, all the tested entries yielded higher than check Hbj. Aman. In Boro season, 85 F₇ plants from 18 F₆ populations, 98 F₇ plants from 10 F₆ populations and 48 F₅ plants from five F₄ populations were selected with desirable characters for the development of varieties suitable for haor areas. Four tested entries yielded higher than BRRI dhan28 (6.5 tha⁻¹) with similar growth duration in PYT. In RYT#1, BR7325-4B-1 and BR7226-19-1-3 yielded higher than BRRI dhan29 (6.5 tha⁻¹). One of the tested lines BR7742-79-24L4-10 (6.12 tha⁻¹) out yielded BR19 (5.97 tha⁻¹) in RYT#2. But in RYT#3, all the lines out yielded BRRI dhan45 (5.2 tha⁻¹) and IR83140-B-32-B-B, IR83141-B-18-B-B, IR80416-B-32-3, PSBRC82 yielded higher than BRRI dhan28 (5.7 tha⁻¹) with almost similar growth duration. Tested entries (BR7840-54-2-5-1, BR7830-16-1-5-3, BR83294-9-1-3-2-3 and BR7840-54-1-2-5) yielded higher than BRRI dhan28 (4.9 tha⁻¹) in RYT#4, but none of the entries out yielded BRRI dhan29 (6.1 tha⁻¹). In MLT#1, none of the line out yielded BRRI dhan28 (5.3 tha⁻¹) but two entries (BR7372-117-3-4-3 and BR7873-5*(NIL)-51-HR6) yielded closed to BRRI dhan28 with similar growth duration. Among the advanced breeding lines in MLT#2, three entries viz BIO 452 (6.44 tha⁻¹), BIO 459 (6.32 tha⁻¹), and BIO 605 (6.29 tha⁻¹) yielded higher than BRRI dhan28 (5.70 tha⁻¹) and BRRI Hybrid dhan2 (6.05 tha⁻¹) with almost similar growth duration. Out of 84, only three entries viz PK 8601-1-10-3 (6.75 tha⁻¹), PR33993-B-15-2-1-4-5-3-2-2 (6.42 tha⁻¹) and IR 09A102 (7.21 tha⁻¹) were selected from IIRON-2011 according to their yield performance, phenotypic acceptance and growth duration.

Balanced fertilization with complete treatment significantly increased the rice grain yield. The highest rice yield (5.2 tha⁻¹) was obtained with complete fertilizer dose of NPKS and the lowest rice yield (2.3 tha⁻¹) was obtained with all missing treatment.

The recommended patterns (BRRI dhan46-BRRI dhan29-Fallow) produced 14% higher grain yield and gross margin over existing farmers' patterns (BR22-BRRI dhan28-Fallow). The recommended cropping pattern produced 12.15 tha⁻¹ yield that earned gross margin of Tk 1,94,400/ha. In Boro season, normal transplanting and double transplanting (DT) produced significantly higher grain yield than the delayed planting.

BRRI RS, Kushtia

Six lines were tested in RYT, upland rice (Aus) 2011. The yield of the tested lines were ranged from 3.3 to 4.0 t/ha. The line BR6855-2B-11-3-5 was the highest yielder (4 t/ha) followed by BR7181-2B-2-6, BR7384-2B-5 and BR6976-2B-11-1. The rest two lines namely, BR7178-2B-19 and BR7976-2B-15 produced lower yield (3.3 t/ha) among the tested lines.

Three lines were tested in ALART, upland rice (Aus), 2011. The yield of the tested lines ranged from 3.4 to 3.9 t/ha and were similar that of the standard check BRRI dhan43 but 0.8-1.3 t/ha higher yield than the local check Hashikalmi. The line OM1490 produced the highest yield (3.9 t/ha) with the highest number of panicles/m² (278.3) and the shortest plant height (80.5 cm).

In RYT, T. Aus 2011, the tested materials produced similar yield to the check BRRI dhan48, but 0.2-0.9 t/ha higher than BR26 except Zirasail. Zirasail showed the lowest yield

(4.0 t/ha) as well as the longest growth duration (120 days) and the tallest plant height (122.4 cm).

The yield of the tested line, OM1490 (5.3 t/ha) was similar to the checks, BR26 and BRRI dhan48 in the ALART, T. Aman 2011. Growth duration, plant height and thousand grain weights were also similar to the checks.

The highest yield (3.7 t/ha) was found with BR7642-11-2-2 in the trial against rice gall midge. Yield advantage for this line was 0.6 and 1.7 t/ha over the susceptible and resistant checks respectively. Higher number of panicles/m² with a few number of onion shoot was observed in the lines, BR7640-42-3-3, BR7640-44-2-1 and BR7642-11-2-2. Therefore, these BRRI developed lines may be resistant against rice gall midge.

The highest yield (3.8 t/ha) was found in the tested line IR83377-B-B-93-3 followed by IR83873-B-B-47-4 (3.6 t/ha) and IR82635-B-B-145-1 (3.6 t/ha) in the PVS in T. Aman 2011 season. Yield of the other eleven lines ranged from 2.0 to 3.4 t/ha. Among the lines, IR83377-B-B-93-3, BR IR83376-B-B-130-2, IR83383-B-B-129-4 was ranked in the 1st, 2nd and 3rd position respectively in the farmers' opinion.

The highest yield (5.9 t/ha) was found in the tested line BR7358-5-3-2-1 followed by BR7358-56-2-2-1 (5.7 t/ha), BR7372-117-3-4-3 (5.6 t/ha) and BRRI dhan29-Sc3-28-16-10-8 (5.6 t/ha) in MLT, CSISA, Boro 2011-12. The lowest yield having the lowest panicles/m² was observed in the tested line BRRI dhan29-Sc3-28-16-10-2 (4.1 t/ha) and BRRI dhan29-Sc3-28-16-10-6 (4.2 t/ha).

The early transplanting of T. Aman through supplemental irrigation ensured that T. Aman effectively mitigated the terminal drought occurred at reproductive stage and at vegetative stage during T. Aman 2011. Both the short and long duration T. Aman varieties suffered less drought and showed good yield performance if they were transplanted on 24 to 31 July. In T. Aman 2011, suitable transplanting dates were between 24 July and 31 July for BRRI dhan33 and BR11 respectively.

Application of supplemental irrigation at three water levels below ground surface showed that there was no considerable yield difference among the treatments. The highest yield was found in T₃ (5.6 t/ha) and the lowest was found in T₂ (5.3 t/ha) and yield difference was only 6%. However, further trials are needed to draw a conclusion.

Efficiency of natural enemies was studied at Kushtia sadar upazila in T. Aman 2011. Two parasitoids - one *Elasmus* sp. (Elasmidae) and one *Eulophid* were found to parasitize the leaf folder larvae. *Elasmus* sp. parasitized 8.3% to 14.3% in different occasions. The *Eulophid* parasitoid was found in one occasion only and its parasitism rate was only 5%.

Yield and growth duration of 23 BRRI varieties were studied in T. Aman 2011. Among the 23 varieties 18 were found to give higher yield than the standard yield determined for them. The other varieties yielded similar or lower than the standard yield. Growth duration of some of the test varieties decreased (up to 12 days as in the case of BR10), whereas in some varieties it increased up to 28 days as in the case of BRRI dhan46. On the other hand, four were found to give higher yield and the other varieties yielded lower than the standard yield among the 23 varieties in Boro 2011-12. In this season, growth duration of some of the test varieties decreased up to 9 days as in the case of BRRI dhan18, whereas in some varieties it increased up to 35 days as in the case of BRRI dhan26.

Yield of BRRI dhan49, BR10 in T. Aman and BRRI dhan28 in Boro season under farmers managed and BRRI managed conditions were compared in Shaillkupa, sadar and Kotchandpur upazilas of Jhenaidah. The yield of the fields having BRRI recommended practices was higher than those having farmer's practices in all of three locations. Overall, yield was increased by 25% in the T. Aman and 11% in the Boro season.

In total, five farmer's trainings were conducted in which around 150 farmers participated. Four field day programme were organized to demonstrate BRRi developed technologies. We also participated in the agricultural fair.

BRRi RS, Rajshahi

The selected 50 genotypes in OYT yielded from 1.2 to 3.5 t/ha under reproductive stage stress compared to check varieties 0.7-2.1 t/ha. The genotype IR87656-21-1-1-4 produced the highest yield (3.5 t/ha) and showed about 100 days growth duration for stress conditions and 110 days for control. Nineteen genotypes out of 39 from AYT stress were selected. IR83377-B-B-93-3 and IR83376-B-B-86-3 produced the highest yield (3.1 t/ha) with harvest index (0.45).

IR83377-B-B-42-3 and IR83383-B-B-140-2 both produced the highest yield (3.1 t/ha) at stress condition and was a little lower than moderately drought tolerant check variety Apo and BRRi dhan33 (3.3 t/ha).

IR87707-446-B-B-B produced the highest yield (1.9 t/ha) in stress condition compared to BINA dhan7 (1.2 t/ha) from NIL. The growth duration was 12-16 days shorter than the control condition.

IR82635-B-B-145-1, IR82635-B-B-75-2 and IR82589-B-B-84-3 stood 1st, 2nd and 3rd drought stress in PVS trial and IR83383-B-B-141-2, IR83383-B-B-129-4 and IR82635-B-B-145-1 in control condition. IR82635-B-B-145-1 showed the preference for both rain-fed drought stress and control.

Only 15 of 58 hybrids yielded more than 8 t/ha. The entry H-791 produced the highest yield (9.02 t/ha) with a growth duration of 160 days.

All the test genotypes for RYT T. Aus gave better yield compared to the standard check BR26 (2.48 t/ha) and BRRIdhan48 (2.55t/ha). BR7413-14-3-3 produced the highest yield (3.37 t/ha) followed by BR7417-6-1-2 (3.07 t/ha).

All the genotypes from RYT T. Aman showed tolerance to lodging. Yield was the highest (5.16t/ha) for the check BRRi dhan49 followed by IR51491-AC5-4-SC3-20-3-15 (4.91 t/ha).

Among the tested entries from RYT 1 Boro, BR7372-18-2-1-HR1 produced the highest yield (5.56 t/ha) followed by BR7358-19-3-1-1 (5.29 t/ha) but none found better than the check Minikit (5.62 t/ha).

BR7358-35-2-1-1 produced the highest yield (5.96 t/ha) from RYT 2 Boro, followed by BR7358-35-3-2-1 (5.54t/ha) which produced 1.0-1.5 t/ha more yield advantage than the check varieties BRRi dhan28 (4.49 t/ha) and BRRi dhan50 (4.36 t/ha).

BR7831-74-1-5-2 (5.44 t/ha) and BR7840-54-2-5-1 (5.22 t/ha) yielded better than the standard check BRRi dhan28 (4.16 t/ha) and BRRi dhan29 (5.17 t/ha) from micro-nutrient dense rice.

Grain yield amazingly declined with increased seedling age. Irrespective of genotypes the highest mean grain yield (4.74 t/ha) was obtained with 25-day-old seedlings transplanted. IR83377-B-B-93-3 produced the highest mean grain yield (4.67 t/ha) that was at par with IRRI 123 (4.66 t/ha). In general, grain yield reduced with increased seedling age conceivably due to less vegetative growth and less effective tillers.

Irrespective of genotype and planting date, the highest mean grain yield (4.82 t/ha) was obtained that transplanted on 16 July and was at par with 1 August planting (4.71 t/ha). Among rice genotypes, IR83377-B-B-93-3 produced the highest yield (4.74 t/ha) followed by IRRI 123 (4.65 t/ha) in rain-fed environment. It turned out from the experiments that 16 July to 1 August is the suitable time for transplanting of the promising drought tolerant rice genotypes.

Most of the pyramid lines showed resistant reaction against the bacterial blight pathogen under artificial inoculation. The susceptible check Purbachi and TN1 showed very sensitive reaction. IRBB54, IRBB55 and IRBB57 exhibited most resistant reactions against BB in Rajshahi region.

Only Power blast was found effective in controlling (89.48%) sheath blight disease.

The fungicide Controller reduced 57% disease over control plot but was not up to the mark (80%). Fungal infection level in the silage at divisional and local district storage was similar. A total of 46 samples of rice tested for the presence of aflatoxins. None of the samples contained aflatoxin B₁ above the UNICF/WHO/FAO maximum permissible level of 30 µg/kg (ppb) in foods for human consumption. Aflatoxin B₁ was not detected in the tested samples.

Stem borer (SB), green leaf hopper (GLH), brown plant hopper (BPH) and white leaf hopper (WLH) were the most prevalent insect pests. Among the natural enemies, staphylinid beetles were the most prevalent predator followed by carabid beetles, earwig, ladybird beetles and damselfly. Most of the insect pests had one peak of occurrence in October and natural enemies had two peaks of occurrence in November and April.

The highest panicle/m² (194) was recorded in conservation tillage. There were significant variation of grain yield due to the treatments. Conventional transplanting method produced the highest mean yield (4.28 t/ha) and permanent bed showed the highest gross margin (Tk 25879).

In Aman season, 400, 160 and 160 kg seeds of BRRI dhan49, BRRI dhan53 and BRRI dhan54, respectively were produced and 2390, 445 and 455 kg seeds of BRRI dhan28, BRRI dhan29 and BRRI dhan50 respectively in Boro. Five one-day farmers training on rice technologies were conducted under climate change project in which 175 farmers including 10 female farmers and four SAAO participated.

BRRI RS, Rangpur

An on station experiment was conducted with four entries to evaluate submergence tolerant varieties under submerged condition. Among them IR64-Sub1 showed higher survival rate (90%).

PVS function was arranged as on-station PVS mother trial of Sub1 entries at Rangpur. Participating farmers selected PVS-2 (Cheharang-Sub1) and PVS-3 (IR64-Sub1) as the best material.

In pedigree experiment 291 tolerant progenies and 61 bulk populations were selected with desirable agronomic characters at maturity in 18 days submergence.

Seventeen genotypes of IRRI origin selected from OT along with one check variety were evaluated under controlled stagnant water stress condition. The yield performances of the test entries for medium stagnant water ranged from 2.74 to 3.3 t/ha and the range of growth duration was 168 to 177 days. Based on overall performances, it might not be possible to promote any entries to further yield trials due to very long growth duration.

Three mother trials were conducted through GO/NGO collaboration in three different locations of northern district of Bangladesh. PVS function was arranged as on-farm PVS mother trial of Sub1 entries at Alambiditor, (Gongachora, Rangpur) for preference analysis during Aman 2011. Participating farmers selected PVS-3 (IR64-Sub1) as the best material.

Both in Aman and Boro season soil test based (STB) fertilizer recommendation produced the highest yield among all treatments followed by fresh poultry litter Applied at 6 t/ha.

Twelve hours water layered at night time appeared to better compared to the other treatments for quality seedlings against cold weather in winter season.

In rice-maize-mungbean system, maize grown under conventional tillage after puddle transplanted rice produced significantly lowest yield (7.4 t/ ha) compared to the rest of the treatments (8.0-8.5 t/ ha). In case of rice the highest rice yield (4.77 t/ha) was found in ZTDSR plots (After ZT maize).

The effect of plant population on yield and yield components of maize in 2011-12 was studied. Grain yield was significantly the highest (8.7-9.2 t/ ha) for 75000 plants/ ha (60×22cm) and 82000 plants/ ha (55×22cm).

Dry direct seeded rice with short duration variety and crop diversification is a suitable technology for northern part of Bangladesh to overcome climate change situation. Dry DSR by PTOS produced the highest grain yield (4.56 t/ha).

The trial was conducted in control condition (inside tank) during T. Aman with different nutrient management in nursery bed and seedling age was used as treatments. N2D2T2 (N₂=N:P2O₅:K₂O::75:40:40(25kg N through 5t/ha of FYM and remaining 50 kg N, D₂=25g/m², T₂=40 days old seedlings) found the best treatment of all parameters studied.

From the spacing management trial the output of the experimental observation showed, 15 x 20 cm plant spacing is suitable for BRRI dhan51 and BRRI dhan52 showed the best result with 20 x 20 cm spacing. Two seedlings per hill appeared as the best option for both varieties.

In nitrogen management after de-submergence for quick recovery experiment showed that 10 days after flood water recession was the best for recovery, survivality and yield. N3 fertilizers option showed better performance for yield and survivality.

A total of 12,541 kg breeder seeds of six varieties and 7519 kg TLS of fifteen varieties were produced and disseminated during 2010-11.

BRRI RS, Satkhira

The short duration rice variety like BRRI dhan28, BRRI dhan 50 successfully survive than BRRI dhan 47 and BINA 8 rice variety because from the 01 March to 30 March, soil and water salinity become increasing day by day (5.95ds/m to 15ds/m); in this condition, seeding of BRRI dhan 28 and BRRI dhan 50 on 01 November and transplanting on 01 December, it would be harvested on end of March but long duration rice variety is very difficult to cultivate in the saline affected area due to increasing salinity from 01 March to May very rapidly.

In T.Aman season, soil salinity and water salinity become reduced due to heavy rainfall and rice cultivation depends on rain fed condition. Heavy rainfall, wash out soil salinity and water salinity from the month of July to September.

The leaking requirements, the quality of the irrigation water used to leak salts below the root zone is an important factor in managing the soil salinity.

Maintaining the soil near field capacity with frequent watering dilutes. Light leeching before planting or light irrigation after planting moves salt below the planting and early rooting zone.

Potato and Onion with Jute and BRRI dhan 34 and BRRI dhan 46 and BRRI dhan 37 deeply helped to obtain higher economic return than a system without T.Aman Rice

Better production and net profit per hector was found in Boro (BRRI dhan 50-Jute-BRRI dhan 39) and followed by Boro (BRRI dhan 28)-Jute-(BRRI dhan 33) T.Aman cropping pattern. The results implied that short duration Aman varieties BRRI dhan 33 and BRRI dhan 39 deeply helped to obtain higher economic return than a system without Aman Rice

BRRI dhan28 in Boro season and BRRI dhan 48 in T. Aus deeply helped to obtain higher economic return than a system with out T. Aus rice and it also increased cropping intensity.

In Boro and B.Aman season, BRRI dhan 28 in Boro season and the advanced lines and Laxmidigha local aman variety deeply helped to obtain higher economic return than a system without B. Aman rice and also increased cropping intensity

BRRI dhan 28 in Boro season and the advanced lines BR6716-B-B-11, BR224-2B-2-5, Hbj-A.IV and laxmidgha would be deeply helped to obtain higher economic return than a system without B. Aman rice.

Yield gap optimizing Program would minimize yield gap and disseminated the technologies and varieties among the farmers.

Sharputi, Salmn, Carp and Tablet Fish could be raised successfully in DWR field without any hampering Rice yield. This Rice, Fish systems provide a great source of protein and additional income to the farmers. This technology can be help, if the farmers are provided with necessary training to adopt the Rice + Fish culture systems would make available much needed protein to the users, would raised their income and create self employment.

At farmer's level, it is necessary to facilitate seed production technology transfer and assist in the spread of a variety at the grass root level. A seed producing farmer will not only be able to know about a new variety but also to use it profitably furthermore, the seed production plot well serve as a demonstration plot through which farmers will be motivated and inspired to accept a variety.

BRRI RS, Sonagazi

The highest grain yield (4.60 t/ha) was recorded when 25% additional N fertilizer was added with STB during T. Aman season at BRRI RS, Sonagazi.

A good water bearing aquifer exists at a depth from 155 m to 180 m in BRRI RS, Sonagazi farm having 0.30- 0.57 dS/m salinity. Rainwater harvesting in a reservoir with 25 cm high embankment conserved more water than without embankment, which could increase irrigated area of Rabi crops profitably in coastal area.

Eight salt tolerant genetically fixed Aus lines were selected for further trial. Fourteen salt tolerant genotypes from OT were selected during Aus season. Genotypes OMCS 2000 and AS996 produced 0.3-0.9 t/ha higher grain yield compared to BRRI dhan27 and Binnatoa.

IRBB66 produced 3.52 t/ha grain yield with 4% leaf damage caused by BB as T. Aman crop followed by IRBB21 (3.27 t/ha, 3% leaf damage, which are better than IR24, Purbachi and TN1. Dizole 300EC, Emiscore and Fiscal 10 EC reduced growth of *Rhizoctonia solani* by 70.63-87.31 %. Five major diseases viz brown spot (BS), bacterial leaf blight (BLB), false smut, narrow brown spot (NBS) and sheath blight (ShB) were recorded during T. Aman season.

A total of 120 farmers were trained on modern rice production techniques. About 11.5 ton breeder seed and 11 ton TLS were produced.