কৃষিই সমৃদ্ধি

ANNUAL REPORT

2023-24

BANGLADESH INSTITUTE OF NUCLEAR AGRICULTURE

August 2024

ANNUAL REPORT

2023-24

BANGLADESH INSTITUTE OF NUCLEAR AGRICULTURE
BAU CAMPUS, MYMENSINGH-2202, BANGLADESH

Compiled and Edited by:

- Dr. Md. Ekram-ul Haque, Director (Research)
- Dr. Md. Siddiqure Rahman, CSO (RC)
- Dr. Md. Roknuzzaman, SSO

Published by:

Bangladesh Institute of Nuclear Agriculture
BAU Campus, Mymensingh-2202, Bangladesh

Phone : (029966) 67834, 67835, 67837, 66127
Fax : (029966) 67842, 67843, 62131
E-mail : dirresearch@bina.gov.bd
Website : www.bina.gov.bd

Design and composed by:

Pallab Chandra Datta

Printed by:

Bhai Bhai Printing Press
Chotobazer, Mymensingh

BINA'S OBJECTIVES

- *To develop high yielding and better quality crop varieties using both mutation and conventional breeding techniques.*
- *To assess the fertilizer status of the soils of Bangladesh and efficiency of utilization of applied nutrients by crop plants using radioisotopic techniques.*
- *To develop means of water use efficiency for optimization of crop yields through radioisotopes and radiation techniques.*
- *To evolve control measure against major pests and diseases of crop plants.*
- *To assist national and international research programmes through cooperative support.*
- *To provide facilities to students of the Bangladesh Agricultural University for carrying out research leading to Masters and Ph.D. degree in Agriculture.*
- *To arrange training programmes for the research scientists on the peaceful use of atomic energy in agriculture.*

CONTENTS

PLANT BREEDING DIVISION

Rice

On-farm and on-station yield trial of bacterial leaf blight resistant rice lines during *Aman* season

Bacterial leaf blight (BLB) of rice, caused by *Xanthomonas oryzae pv. Oryzae (Xoo)*, is a major pathogen that negatively impacts rice production. Therefore, this experiment was carried out to assess high yield attributes of one BLB resistant rice lines along with check variety BRRI dhan75 tested in *Aman* season during 2023 at BINA HQs farm, Mymensingh and BINA farmers' field of Kishoreganj and BINA Sub-station farm Cumilla, Magura, Rangpur, & Sunamganj. Data on days to maturity, morphological and yield attributes and grain yield were recorded at harvest from five randomly selected competitive plants/plots. Recorded data were statistically analyzed. BLB-P-19 produced higher grain yield at all locations. Mean over location, BLB-P-19 achieved the highest grain yield (6.07 tha^{-1}) compared to the check variety BRRI dhan75 (5.54 tha^{-1}). Additionally, BLB-P-19 had almost same growth duration than BRRI dhan75 at almost all locations. Previously, by the molecular study BLB resistance genes *xa4, xa5* and *xa21* in BLB-P-19 derived from a cross between the rice varieties 'Tn-1' and 'IRBB60. Quality assessment was done based on kernel length and L/B ratio. The kernel shape and size of BLB-P-19 was long-slender and medium-slender where the BRRI dhan75 was medium. Both lines were found resistant to BLB while check showed susceptible in visual observation at all locations. Two DUS test have been completed of this line and will be sent to SCA for field evaluation to be released as a variety in next *Aman* season.

On-farm and on-station yield trial of bacterial leaf blight resistant rice lines at *Boro* season

This experiment was carried out to assess high yield attributes of one BLB resistant rice line BLB-P-19 along with one check BRRI dhan58 in *Boro* season during 2023-24 at BINA HQs farm, Mymensingh and BINA Sub-station farms at Ishurdi & Sunamganj and farmers field of Netrokona, Rangpur and Magura. Data on days to maturity, morphological and yield attributes and grain yield were recorded at harvest from five randomly selected competitive plants/plots. Recorded data were statistically analyzed. Over three locations, some characters exhibited significant differences, while others showed non-significant differences among the lines and the check varieties. Among the lines and check varieties, BLB-P-42 consistently had the longest plant height across all locations. It also recorded the highest number of effective tillers $hill^{-1}$ at nearly all locations, though not significantly different from the check variety. Additionally, BLB-P-42 had the highest number of filled grains $panicle^{-1}$ at most locations. At an average of all locations, BLB-P-42 produced a significantly higher yield of 6.87 tha^{-1} compared to the check variety, which yielded 6.20 tha^{-1}. The duration of BLB-P-42 was similar to that of the check variety, BRRIdhan58. However, BLB-P-42 had a lower thousand grain weight (21.31 g), indicating fine grain quality. Quality assessment based on kernel length and L/B ratio showed that BLB-P-42 had a long-slender grain shape, while BRRIdhan58 had a medium shape. Considering BLB resistance, long-slender grain and high yield performance, BLB-P-42 will be sent to SCA for DUS test to be released as a variety in next *Boro* season.

On-farm and on-station yield trial of blast resistant rice lines in *Aman* season

This experiment was carried out to assess the yield and yield attributes of one blast resistant rice lines along with one check variety BRRI dhan87 in *Aman* season during 2023 at BINA HQs farm, Mymensingh and BINA sub-station farms at Cumilla & Sunamganj and farmer's field of Kishorgonj and Rangpur. Data on days to maturity, morphological and yield attributes and grain yield were recorded at harvest from five randomly selected competitive plants/plots. Recorded data were statistically analyzed. On average, all characters exhibited significant differences among the lines and check varieties for both individual locations and the overall mean across locations. Among the lines and check varieties, BRRI dhan87 had the longest duration, taking 127 days at all locations. This line matured 8-10 days earlier than the check variety BRRI dhan87 at all locations. Quality assessment was done based on kernel length and L/B ratio. The kernel shape and size of BN-P-318 is long-slender where the BRRI dhan87 is medium. Based on the yield performance, earliness and resistance against blast and grain quality, BN-P-318 could be selected for further evaluation to release it as a blast resistant variety. Two DUS test have been completed of this line and will be sent to SCA for field evaluation to be released as a variety in next *Aman* season.

On-farm and on-station yield trial with blast resistant rice lines in *Boro* season

On-farm and on-station trials were carried out with two lines along with check varieties (BRRI dhan86) at BINA HQs farm, Mymensingh and BINA sub-station farms at Rangpur, Ishurdi & Sunamganj and farmer's field of Netrokona and Rangpur during *Boro* season of 2023. Data on days to maturity, morphological and yield attributes and grain yield were recorded at harvest from five randomly selected competitive plants/plots. Recorded data were statistically analyzed. Significant differences were observed among the lines and the check variety for yield and yield attributing character. BN-P-120 performed better among the lines and check variety in terms of yield. It produced the highest grain yield at all the locations except Sunamganj. Highest grain yield was found at BINA substation Rangpur (8.43 tha^{-1}) followed by BINA HQs farm Mymensingh (8.05 tha^{-1}). The higher grain yield of BN-P-120 is attributed by the higher number of effective tillers $hill^{-1}$ and number of filled grains $panicle^{-1}$. The duration of BN-P-120 was higher than the check variety BRRI dhan86 at all locations. Based on the yield performance and resistance against blast and grain quality, BN-P-120 could be selected for further evaluation to release it as a blast resistant variety. One DUS test has been completed of these lines and will be sent to SCA for 2nd DUS test to be released as a variety in next *Boro* season.

On-farm and on-station trial with iron and zinc enriched rice mutants

The experiment was carried out to assess overall performance for better grain quality and higher grain yield of two iron and zinc enriched rice lines along with one check variety BRRIdhan62 & Binadhan-20 during *Aman* season 2023 at BINA HQS farm Mymensingh, BINA Sub-station farm at Nalitabari, Cumilla and farmer's field at Kishorgonj, Rangpur. Data on days to maturity, morphological and yield attributes and grain yield were recorded at harvest from five randomly selected competitive plants/plots. Recorded data were statistically analyzed. Most of the characters showed significant differences among the lines and check for four individual locations

and mean over locations. From mean over locations, it appeared that the IZSD-26 had significantly longest panicle length (24.56 cm) and higher number of filled grains (143.95) at all locations than the check variety, BRRIdhan62. There was no significant difference between the test line and check for the number of effective tillers. Grain yield of IZSD-26 was significantly higher (5.86 tha^{-1}) at mean over locations than the check variety BRRIdhan62 (4.92 tha^{-1}) and Binadhan-20 (5.43 tha^{-1}). But the check variety BRRI dhan62 was matured 13 and 28 days earlier than the others, IZSD-26 (115 days) and Binadhan-20 (130 days). The mean grain Fe concentration of rice line IZSD-26 was 19 and 6 $mgkg^{-1}$ in unpolished & polished rice, respectively. The mean zinc concentration of rice line was 45 $mgkg^{-1}$ and 26 $mgkg^{-1}$ in unpolished & polished rice, respectively. Considering Fe, Zn content and higher yields, the line IZSD-26 will be sent to SCA for 1st DUS test to be released as Fe and Zn enriched variety in next *Aman* season.

Regional yield Trial of short duration rice lines for Haor areas

Five early maturing *Boro* rice lines BN-H-26, BN-H-28, BN-H-29, BNH-44 and BNH-317 were evaluated over locations along with check varietiey BRRI dhan88. The experiment was conducted at BINA HQs farm Mymensingh including haor regions farmer's field at Burishttal and Netrokona. The experiment followed RCB design with three replications. The size of unit plot was 5.0 m × 4.0 m. Plant to plant distance was 15cm and row to row distance was 20cm. Data on days to flowering, days to maturity, plant height, total number of tillers and effective tillers $plant^{-1}$, panicle length, filled and unfilled grains $panicle^{-1}$, 1000-grain weight and grain $yieldplot^{-1}$ were recorded after harvesting from five randomly selected competitive plants. Maturity was assessed plot basis. Plot seed yield was converted to tha^{-1}. The data were statistically analyzed. From the results, significant variations were observed for all the characters at all the locations. It was observed that BN-H-28 matured earlier (139 days) than the check variety BRRI dhan88 (141 days). BN-H-28 produced highest grain yield (7.19 tha^{-1}) followed by BN-H-26 (6.26 tha^{-1}). At farmer's field, the highest grain yield was found in BN-H-28 (7.08 tha^{-1}) at netrokona farmer's field followed by BN-H-26(6.51 tha^{-1}). Table 11). In our country flash flood usually comes at haor areas from the 1st week of April to 2nd week. It causes huge loss of *Boro* rice at Haor areas. The lines BN-H-28 and BN-H-26 are matured 139-142 days, it could escape early flash flood at Haor areas. Considering short duration and higher yield, the line BN-H-28 and BN-H-26 could be selected for further evaluation to release it as a variety for haor areas.

Advanced yield trial of submergence tolerant rice lines

Submergence have been the major constraint in rice production. Therefore, this experiment was conducted to evaluate rice lines for submergence tolerance with high yield attributes. Six rice lines along with two checks Binadhan-11 and BRRI dhan52 were tested in *Aman* season during 2023-24 at BINA HQs farm, Mymensingh and BINA sub-station farm at Jamalpur and farmer's fields of Jamalpur and Rangpur. Data on days to maturity, morphological and yield attributes and grain yield were recorded at harvest from five randomly selected competitive plants/plots. Recorded data were statistically analyzed. Results of mean over four locations, on an average, all other characters showed significant differences among the lines and check for both individual locations and mean over locations. IRSSTN FP-12 produced the highest grain yield at two locations, Mymensingh and Rangpur, while the check variety BRRI dhan52 yielded the most in

both Jamalpur sub-station and farmer's fields followed by IRSSTN FP-5, IRSSTN FP-8 and IRSSTN FP-10. In addition to higher grain yield, IRSSTN FP-5 and BRRI dhan52 exhibited longer days to maturity at nearly all locations. Furthermore, the grain yields of IRSSTN FP-5, IRSSTN FP-8, and IRSSTN FP-10 were lower compared to both IRSSTN FP-5 and BRRI dhan52 at the mean over location. Therefore, based on yield performance and duration, the three rice lines IRSSTN FP-5, IRSSTN FP-8, and IRSSTN FP-10 should be selected for evaluation in regional yield trials during the next *Aman* season.

Preliminary yield trial of International Low Land Rice Nursery (IRLON) rice lines

Total 10 International Low Land Rice Nursery Lines (IRLON) were evaluated for grain yield along with yield check Binadhan-11 and BRRI dhan79. The experiment was conducted during *Aman* season 2023-24 at BINA HQs farm and BINA sub-station farm Nalitabari, Sherpur with two replications. Data on days to maturity, morphological and yield attributes and grain yield were recorded at harvest from five randomly selected competitive plants. Recorded data were statistically analyzed. Four (4) lines were selected based on grain yield. The growth duration of the tested lines varied from 112 days (IRLON-4) to 133 days (IRLON-8) while the check matured in 115 and 131 days. The plant height ranged from 97cm (IRLON-23) to 123 cm (IRLON-14). The highest yield was produced by line IRLON-17 which was 7.14tha^{-1} while the check produced 5.51 & 5.26 tha^{-1} yield. Therefore, based on yield performance and duration, the three rice lines IRLON-4, IRLON-10, IRLON-17 and IRLON-19 should be selected for evaluation in regional yield trials during the next *Aman* season.

Preliminary yield trial of nine advanced salt tolerant rice lines

This trial was carried out with 7 advanced salt tolerant rice lines with 2 checks (Binadhan-10 and BRRI dhan97). The experiment was conducted at Bina sub-station farm Sathkhira & farmer's field at Harinkhola, Tala and Devhata region. Standard production practices for water and nutrition management, and disease and pest control were followed. Nine lines were selected from the trial based on their agronomic performance. The mutants matured in between 139 and 146 days. The plant height ranged from 89 (IRSSTN-21) to 108cm (Binadhan-10). Three lines produced higher grain yield ranged from 4.71 to 4.85 than check Binadhan-10. Based on yield contributing characters, SAL-52, IRSSTN-19 and IRSSTN-29 lines were selected for further evaluation in next *Boro* season.

On-farm and on-station trial for high yielding and short duration *Aman* rice lines suitable for rainfed condition

Aman rice covers approximately 4.4 million hectares in Bangladesh, significantly contributing to national food security, with average yields ranging from 3.0 to 3.5 tha^{-1}. The tested high-yielding varieties could potentially increase these averages, enhancing productivity in rainfed areas. This study evaluated the agronomic performance of high-yielding, short-duration Aman rice lines suitable for rainfed conditions through on-farm and on-station trials at BINA HQ in Mymensingh,

and farmers' fields in Rangpur and Ishwardi during the Aman season of 2023-2024. Rice lines were transplanted with row and plant spacings of 20 cm and 15 cm, respectively, using a Randomized Complete Block Design (RCBD) with three replications and a plot size of 4m × 5m, alongside recommended fertilizer applications.

Results indicated significant variation among genotypes across locations. BNCR-1 had the shortest plant height at 101.5 cm compared to the check variety BRRI dhan-87 (122.1 cm). BINA 12-250-1 recorded the highest effective tillers per hill (9.4), while BNCR-68 exhibited the longest panicle length at 26.1 cm. BRRI dhan-87 had the highest filled grains per panicle (119.8), and BNDR-55 achieved a yield of 4.98 tha^{-1}, just below BRRI dhan-87's yield of 5.41 tha^{-1}.

These findings highlight the potential of certain rice lines to enhance productivity and resilience in rainfed areas. Integrating these varieties into local farming could improve food security and sustainability in Bangladesh. Further optimization for local conditions is needed.

On farm and on station trial of short duration and high yielding *Boro* rice mutants/lines

This study evaluated the agronomic performance of short-duration, high-yielding *Boro* rice mutants across various locations in Bangladesh, including BINA Headquarters in Mymensingh, BINA Substation in Chapainawabganj, and farmers' fields in Ishwardi and Rangpur during the 2023-2024 *Boro* season. Approximately 1.6 million hectares are dedicated to *Boro* rice cultivation in Bangladesh, contributing around 54% of the country's total rice production. The average yield of *Boro* rice ranges from 4.5 to 5.5 tha^{-1}, depending on regional variations and farming practices. Selected lines were transplanted using a Randomized Complete Block (RCBD) design with three replications and a plot size of 4m × 5m. Recommended fertilizers were applied, and data on key agronomic traits were collected and statistically analyzed.

The results revealed significant variation among the rice lines and check varieties. Notably, the BNCR-23 line exhibited a plant height of 102.6 cm, surpassing the check varieties BRRI dhan102 (100.5 cm) and BRRI dhan58 (95.4 cm). The check BRRI dhan102 had the highest number of effective tillers at 10.6, while the highest panicle length (25.9 cm) was recorded for BNDR-18. BNDR-9 achieved the highest number of filled grains per panicle (163.5), while BNCR-14 produced the highest yield of 6.86 tha^{-1}. These findings indicate the potential of specific rice lines to enhance productivity in *Boro* rice cultivation, suggesting further exploration of these lines for integration into local farming systems to improve food security in Bangladesh.

Advanced yield trial of short duration and high yielding rice lines suitable for *Boro* season

This study assessed the agronomic performance of short-duration *Boro* rice mutants across multiple locations in Bangladesh, including BINA Headquarters in Mymensingh and BINA Substation in Rangpur, during the 2023-2024 *Boro* season. *Boro* rice is cultivated on approximately 1.68 million hectares, contributing around 57% of the country's total rice production, with average yields reported at 4.9 tha^{-1} according to recent Bangladesh Bureau of Statistics (BBS) data. Selected rice lines were transplanted using a Randomized Complete Block (RCBD) design with three replications and key agronomic practices were ensured. traits were measured and analyzed.

The results showed significant variation among the tested lines and check varieties. The check variety BRRI dhan89 exhibited the tallest plant height at 117.5 cm. Notably, BN-RM-P-5-1-2 demonstrated the highest yield at 6.53 tha^{-1}, surpassing both BRRI dhan58 (6.18 tha^{-1}) and BRRI dhan89 (5.92 tha^{-1}). The line BN-RM-P-2-2-4 recorded the highest number of filled grains per panicle (132.5), highlighting its potential for enhanced productivity. These findings underscore the promising prospects of integrating short-duration, high-yielding *Boro* rice lines into local farming systems, aiming to improve food security and agricultural sustainability in Bangladesh.

Advanced yield trial for high yielding and cold tolerant rice lines suitable for Haor areas

Boro rice cultivation in the Haor regions of Bangladesh spans approximately 1.5 million hectares, contributing nearly 50% of the country's total rice production. These areas rely on *Boro* rice grown during the dry season from November to April, when water levels are manageable despite seasonal flooding. This study evaluated the agronomic performance of advanced rice lines for high yield and cold tolerance during the *Boro* season of 2023-2024. Selected rice lines, along with the check variety BRRI dhan67, were planted in a randomized complete block design across four locations: BINA substation in Sunamganj and farmers' fields in Habiganj, Khaliyajhuri, and Tahirpur. Key parameters recorded included days to 50% flowering, days to maturity, plant height, effective tillers per hill, panicle length, and grain yield. Results showed significant variation among genotypes, with BNDR-18 exhibiting superior plant height (109.3 cm) and filled grains per panicle (119.3). The check variety BRRI dhan67 yielded the highest grain yield (6.55 tha^{-1}).

Challenges such as low temperatures during the early growth stage, sudden flash floods before harvesting, and the need for short-duration, high-yielding, and cold-tolerant varieties persist in the Haor regions. The findings emphasize the potential of these advanced lines to enhance agricultural productivity and sustainability in these areas.

Advanced yield trial of high yielding and cold tolerant boro rice lines suitable for northern part of Bangladesh

Cold stress significantly impacts rice production in northern Bangladesh, particularly during the *Boro* season, where average minimum temperatures can drop to 10-12°C from December to February. This chilling effect reduces germination rates by up to 30% and leads to yield losses of 20-30% in susceptible varieties. Cold stress during flowering can result in sterility rates of 30-50%, reducing filled grains per panicle. This study evaluates the agronomic performance of advanced high-yielding and cold-tolerant *Boro* rice lines suitable for northern Bangladesh during the 2023-2024 season. Conducted in Nilphamari, Panchagarh, and Thakurgoan, the trial included selected lines alongside check varieties (BRRI dhan87 and BRRI dhan86), using a randomized complete block design. Results showed significant variation among genotypes, with the BNCR-68 line demonstrating superior height (128.4 cm) and BNCR-44 achieving the highest yield (8.07 tha^{-1}).

Developing cold-tolerant rice varieties is crucial for combating cold stress, as they maintain better growth and yield under low temperatures. Agronomic practices like timely planting and using

plastic mulch can further mitigate cold impacts. These strategies enhance productivity and resilience in northern Bangladesh's challenging environment.

Advanced yield trial of some rice mutants for short duration and high yield grown under rainfed condition

This study evaluates the agronomic performance of selected rice mutants for short duration and high yield under rainfed conditions during the Aman season of 2023-2024 at BINA Headquarters, Mymensingh. Maintaining a plant-to-plant distance of 20 cm and a row-to-row distance of 15 cm. Two check varieties, Binadhan-17 and BRRI dhan87, were included in the experiment. The study followed a Randomized Complete Block design with three replications and utilized a plot size of 3m × 2m.

Key parameters recorded included days to maturity, plant height, effective tillers per hill, panicle length, filled and unfilled grains per panicle, and grain yield. Results indicated significant variations among genotypes. Notably, the line P-3-4 exhibited the highest yield (5.6 tha^{-1}) and the longest panicle length (24.1 cm). Lines P-16-1 and P-3-1 produced the highest number of effective tillers (8.8). In contrast, the line P-4-1 was the shortest at 89.8 cm. These findings underscore the potential of these advanced rice mutants to enhance productivity in rainfed environments, contributing to food security in Bangladesh.

Observation Yield trial of short duration and lodging tolerant Biroi type rice lines.

Rice is a vital staple food enriched with essential micronutrients, playing a crucial role in addressing malnutrition, particularly in developing regions. This study investigates the agronomic performance of short-duration and lodging-tolerant Biroi-type rice lines during the *Aman* season of 2023-2024 at BINA Headquarters, Mymensingh. Biroi rice, a local variety characterized by its red color and high micronutrient content, is particularly valuable for enhancing dietary diversity. Seeds were sown on July 30, 2023, with a plant-to-plant distance of 20 cm and a row-to-row distance of 15 cm. A check variety, the Biroi parent, was included in a Randomized Complete Block design with two replications and a plot size of 2m × 1m.

Key parameters measured included days to maturity, plant height, effective tillers per hill, panicle length, filled and unfilled grains per panicle, and grain yield. Results indicated significant variations among the lines. The line P-1-38-1-1 demonstrated the lowest plant height (85.7 cm) and the highest yield (4.32 tha^{-1}), significantly outperforming the Biroi parent (2.68 tha^{-1}). The line P-1-38-1-14 recorded the highest number of effective tillers (14.6) and the longest panicle length (25.2 cm). These findings suggest the potential of these advanced lines to enhance productivity and resilience in rice cultivation while promoting the nutritional benefits of micronutrient-rich Biroi rice.

Observation Yield Trial (OYT) for earliness and higher yield under rainfed condition

This study evaluates the agronomic performance of selected rice lines for earliness and higher yield under rainfed conditions during the *Aman* season of 2023-2024 at BINA Headquarters, Mymensingh. In Bangladesh, *Aman* rice accounts for approximately 40% of total rice production, with an average yield of around 2.5 to 3.5 tons per hectare. The selected lines were transplanted with a spacing of 20 cm between plants and 15 cm between rows, including the check varieties Binadhan-5 and Binadhan-24. The experiment utilized a Randomized Complete Block design with two replications and a plot size of 2m × 1m. Recommended fertilizers were applied, and data on plant height, effective tillers hill^{-1}, panicle length, filled and unfilled grains panicle^{-1}, and grain yield were collected.

Results revealed significant variation among the lines. The line P-4-3-1-1 exhibited the highest yield (6.86 tha^{-1}) and the greatest number of filled grains per panicle (173.15), while the line P-4-1-6-4 recorded the longest panicle length (25 cm). In contrast, the line P-4-3-1-9 had the highest number of effective tillers (8.5) but the lowest overall yield.

Compared to the check varieties Binadhan-24 and Binadhan-5, which yielded 4.56 tha^{-1} and 4.59 tha^{-1} respectively, the advanced lines demonstrated significant potential for enhancing productivity. These findings underscore the importance of selecting high-yielding, early-maturing rice lines to improve food security in rainfed regions.

Accelerating the genetic gains in Rice (AGGRi): IRRI NARES breeding networks using rapid cycle genomic selection to deliver annual genetic gains of 2% in rice
Location: BINA Substation, Satkhira; Season: Boro 2023-24

Genetic gain is crucial for enhancing agricultural productivity, particularly in staple crops like rice (*Oryza sativa L.*), which is a primary food source for over half the global population. The Accelerating Genetic Gains in Rice (AGGRi) initiative aims to improve rice yields through advanced breeding techniques. This study evaluated 168 rice genotypes, including 160 advanced lines developed by IRRI and 8 national check varieties, at the BINA substation in Satkhira during the Boro season 2023-24. Transplanted seedlings were assessed for key traits: days to 50% flowering (DFF), growth duration (GD), plant height (PH), and grain yield (GY). Significant variations were observed among the genotypes, with PH ranging from 98.8 cm to 152.6 cm and GY from 3.68 to 7.48 tha^{-1}. The top-performing genotype, IR21X1019, achieved a yield of 7.48 tha^{-1}, demonstrating the potential for substantial genetic gains in rice breeding.

These results emphasize the importance of selecting diverse genotypes with favorable traits to enhance breeding programs. The findings lay a strong foundation for developing high-yield and resilient *Boro* rice varieties, crucial for ensuring food security in Bangladesh amid challenges posed by a growing population and the impacts of climate change.

Accelerating the genetic gains in Rice (AGGRi): IRRI NARES breeding networks using rapid cycle genomic selection to deliver annual genetic gains of 2% in rice
Location: BINA Substation, Satkhira; Season: *Aman* 2023

To address the stagnation in rice yields in Bangladesh's rainfed conditions, a comprehensive evaluation of 192 breeding lines, including check varieties, was conducted at the BINA Sub-station in Satkhira during the *Aman* 2023 season. This study aimed to select high-performing lines with superior genetic merits, given that the yield per unit area of modern rice varieties has not improved significantly over the past two decades. Significant variability was observed in yield and yield-contributing traits, with plant heights ranging from 96.8 to 131.4 cm and grain yields varying from 0.45 to 7.1 tha^{-1}, alongside growth durations of 113 to 127 days. Among the 176 advanced breeding lines, the top 20 entries demonstrated impressive yields between 5.0 and 7.1 tha^{-1}, with growth durations ranging from 129 to 137 days. Notably, seven hybrid lines also yielded within this range. In contrast, local checks produced lower yields, with Binadhan-17, BRRI dhan49, BRRI dhan87, and BRRI dhan94 yielding 3.7, 4.2, 3.9, and 2.5 tha^{-1} respectively.

The findings highlight the critical need to broaden the genetic base in rice breeding by incorporating genetically diverse elite lines. This work not only identifies promising candidates for further breeding trials but also contributes significantly to the development of resilient rice varieties essential for ensuring food security in the context of Bangladesh's agricultural landscape.

Accelerating the genetic gains in Rice (AGGRi): IRRI NARES breeding networks using rapid cycle genomic selection to deliver annual genetic gains of 2% in rice
Location: BINA Substation, Rangpur; Season: Rainfed

To enhance genetic gains in rice breeding and improve yield performance in Bangladesh's rainfed conditions, a comprehensive evaluation of 130 IRRI-bred breeding lines alongside 13 international and 2 national check varieties was conducted at the BINA Sub-station in Rangpur during the Aman 2023 season. The trial revealed significant variation in grain yield, with the tested entries yielding between 2.5 $tha^{-1}$and 5.5 $tha^{-1}$and exhibiting plant heights ranging from 93.5 cm to 117 cm. Notably, the best-performing lines, including T-018, T-019, T-060, T-065, T-074, and E-088, yielded between 5.02 and 5.53 $tha^{-1}$with growth durations of 132 to 137 days, highlighting their potential as short-duration, high-yielding options for the Aman season.

The yield per unit area of modern rice varieties in favorable ecosystems has stagnated over the past two decades, primarily due to a narrow genetic base among parental lines. This trial aims to address that issue by evaluating genetically diverse elite lines with high breeding value. The identified top-performing entries will be prioritized for further evaluation in advanced yield trials, contributing to the development of resilient rice varieties essential for food security in Bangladesh's agricultural landscape. The findings underscore the importance of integrating short-duration, high-yielding varieties into breeding programs to meet the challenges of increasing food demand and changing climatic conditions.

4x4 diallel cross of NERICA-4, Binadhan-19, BRRI dhan48, BRRI dhan98 for developing short duration and high yielding aus rice lines

In an effort to develop high-yielding aus rice lines with short-duration characteristics, a 4x4 diallel cross was performed using the varieties NERICA-4, Binadhan-19, BRRI dhan48, and BRRI dhan98 during the 2023-24 aus season. This breeding strategy aimed to harness genetic diversity and improve yield potential in aus rice, a crucial crop for food security in Bangladesh. From the diallel crosses, approximately 200 F1 seeds were harvested, representing a significant step towards identifying superior progeny for further evaluation. The anticipated outcome of this breeding program is the development of aus rice lines that not only exhibit high productivity but also possess adaptability to varying environmental conditions, thereby enhancing the resilience of rice cultivation in the region. The findings from this project will contribute valuable insights into the breeding of aus rice, addressing the increasing demand for short-duration varieties in the face of changing climatic challenges.

Varietal improvement of rice

Observation yield trial of Chinigura and Kataribhog rice mutants

During Aman season 2023, selected mutants were tested for yield, yield attributing traits, and grain quality. The trial had 21 mutants (10 Chinigura and 11 Kataribhog), 2 parents, and BRRI dhan34 as checks. Individual plots measured 3m x 1m. Row-to-row and plant-to-plant spacing were 20cm. Shapiro-Wilk W test showed that all quantitative attributes had normal distribution patterns, indicating little or no variance in mean performance. This suggests the qualities are highly heritable and less affected by environmental variables. Mutant maturity takes 114–132 days. The mutant BN-R-3-400Gy-2-2 matured first (114.5 days), followed by BN-R-2-400-7-1 (115 days) and BN-R-2-250-16-1 (115.5 days). Mutant plants are 89.5–165 cm tall. The mutant BN-R-3-400Gy-1-2 exhibited the shortest plant height (89.5 cm), followed by BN-R-2-400-3-1 (92.5 cm) and BN-R-2-250-16-1 (93 cm). Mutant grain yields range from 1.78 to 4.30 tha^{-1}. Grain yield was highest for mutant BN-R-2-250-14-3 (4.30 tha^{-1}), followed by BN-R-2-250-3-1 (3.87 tha^{-1}) and BN-R-2-250-14-1 (3.81 tha^{-1}). The parents and check variety yielded 3.63, 3.40, and 2.70 t tha^{-1} grain, respectively. Mutants have 4.53–7.7 mm grain length. Mutant BN-R-2-250-30-1 has the largest grain length (7.7 mm), followed by BN-R-3-400Gy-1-2 (7.58 mm) and BN-R-3-400Gy-2-2 (7.43 mm The lowest grain length was 4.53 mm in BN-R-3-250Gy-7-1. Mutants have L/B ratios of 2.22–3.95. BN-R-2-250-30-1 had the greatest L/B ratio (3.95), followed by 2-250-16-1 (3.70) and BN-3-400Gy-1-2 (3.62). L/B ratio was lowest in mutant BN-R-3-250Gy-7-1 (2.22). Three mutants—BN-R-2-250-30-1, BN-R-3-250Gy-4-2, and BN-R-3-250Gy-7-1—had fragrance. After the replicated yield trial, 12 semi-dwarf lodging lodgings resistant, 7 better grain yield, and 3 aromatic mutants were chosen for breeding. This program produced genetically varied mutants that could improve Chinigura and Kataribhog landraces.

Growing M_1 generation of BRRI dhan34, BRRI dhan90, Tepiboro and Bansful

To create genetic variability in the background of aromatic rice landraces/varieties four rice genotypes namely BRRI dhan34, BRRI dhan90, Tepiboro, and Bansful were subjected to gamma

irradiation. Highly homogenous seeds of the genotypes were subjected to a radiosensitivity test in November 2023. For the radiosensitivity test 50 seeds with three replications, a total of 150 seeds per dose per genotype was used. For each genotype six gamma irradiation doses *viz.* 100, 200, 300, 400, 500, and 600 Gy were applied. The experiment was conducted by following the RCB design with 3 replications and planted in trays. Data were recorded on germination percentage, seedling height and seedling survivability. LD_{50} was calculated based on the seedling survivability. The LD_{50} for BRRI dhan34, BRRI dhan90, Bansful and Tepiboro were 320, 296, 316 and 280 Gy, respectively. Finally, 3 doses (LD_{50} and ±20% of LD_{50}) were selected for mutation induction. BRRI dhan34 was irradiated with 260, 320 and 380 Gy; BRRI dhan90 was irradiated with 240, 300 and 360 Gy; Bansful was irradiated with 260, 320 and 380 Gy and Tepiboro was irradiated with 240, 280 and 320 Gy of gamma rays. The M_1 population received optimum cultivation practices including supplemental irrigation, weed control, proper fertilization, and prevention of severe disease and insect attack levels. Tiller pruning was done three times before flowering to maintain a single primary tiller as there is a maximum chance of getting variations from the initial seeds of the primary tiller. Before flowering, the M_1 plants of each dose were separated from their parents through a physical barrier (polyethylene sheet) to prevent outcrossing. At maturity, 2-3 seeds from the tip of the panicle of main tiller of each plant were harvested and bulked dose wise.

Growing F_4:$_5$ generation of Kataribhog × Binadhan-17

With a view to develop lodging tolerant, high yielding and 'Chinigura' and 'Kataribhog' grain type aromatic rice lines, crosses were made between Chinigura/Kataribhog and Binadha-17. The desirable rice lines were selected following pedigree method. From the pedigree nursery, 14 aromatic rice lines (BN-R-C-6-3-11-2-1, BN-R-C-6-3-11-2-16, BN-R-C-6-3-11-2-17, BN-R-C-6-3-11-2-9, BN-R-C-6-3-11-2-10, BN-R-C-6-3-11-2-12, BN-R-C-6-3-11-2-15, BN-R-C-6-3-1-2-1, BN-R-C-6-3-1-2-2, BN-R-C-6-3-1-2-3, BN-R-C-6-3-1-2-4, BN-R-C-6-3-1-2-5, BN-R-C-6-3-1-2-6 and BN-R-C-7-4-2-1) having 'Chinigura', 'Kataribhog' and 'Extra Long Slender' type grain with a plant height in between 110 to 140 cm were selected from $F_{4:5}$ generation.

Growing F_2 generation of aromatic rice

A total of 1600 progenies of seven F_2 crosses (BRRI dhan87 × Bansful; Bansful × BRRI dhan87; Bansful × Binadhan-17; Chinigura × BRRI dhan87; Chinigura × Binadhan-17; Kataribhog × BRRI dhan87; Kataribhog × Binadhan-17) were advanced through field RGA following single seed descent method.

Hybridization of aromatic rice mutants and its parents

To develop lodging tolerant and high yielding aromatic rice lines 11 crosses between aromatic rice mutants and its parents were made during Boro 2023-24. The F_1 seeds were collected to grow F_1 population in the next season.

AGGRi Network trial of 2023 wet season

Stage 1 trial

This trial is composed of 130 plant materials, including 115 IRRI-developed advanced breeding lines and 13 global and 2 national check varieties. Twenty-five-day-old seedlings were

transplanted on August 7, 2023, in 260 plots following the alpha lattice design. The unit experimental plot size was 3.0 m^2 (15 hills × 5 rows). Two to three seedlings per hill were transplanted, maintaining a 20 cm distance between plant to plant and row to row. The Q-Q plot on five quantitatively measured traits, *viz.,* days to 50% flowering (DF), growth duration (GD), plant height (PH), panicle number (PN), plot yield (gm), suggests that the data points of the sample distribution and theoretical distribution fall close to the straight line, indicating the normal distribution of the observed data. Significant differences were found among the genotypes for DF, GD, PH, PN, and GY. DF, GD, PH, and PN ranged between 80 and 109 days, 110 and 132 days, 87 and 121 cm, and 8.47 and 11.46, respectively. The average DF, GD, PH, and PN were 91.32 days, 119.92 days, 105.77 cm and 9.76, respectively. The grain yield ranged from 0.93 to 3.67 tha^{-1}, with an average of 2.48 tha^{-1}. In addition, heritability is important to quantify the precision of field trials and determine the response to selection. Therefore, the heritability for DF, GD, PH, PN, and GY were calculated as 0.92, 0.88, 0.71, 0.32 and 0.62, respectively. The global check A69-1 produced the highest grain yield (3.67 tha^{-1}) followed by the test entry IR18A1251 (3.64 tha^{-1}) and IR16F1065 (3.49 tha^{-1}). The two local checks BRRI dhan79 and Binadhan-23 produced the grain yield of 3.04 and 2.50 tha^{-1}, respectively. The top ten test entries were selected based on gain yield for further evaluation.

Stage 2 trial

This trial is composed of 24 plant materials including 4 national check varieties. The germinated seeds were sown on 04 August 2023 in the seedbed. Twenty-five days old seedlings were transplanted on 29 August 2023 in 48 plots following RCB design with two replications. The unit experimental plot size was 3.0 m^2 (15 hills × 5 rows). Two to three seedlings per hill were transplanted, maintaining a 20 cm distance between plant to plant and row to row. Proper intercultural operations were performed to ensure the proper growth of the rice plants. All the rice plants were harvested from each plot separately, and data were collected on days to 50% flowering (DF), growth duration (GD), plant height (PH), panicle number (PN), number of harvested hills per plot, plot quality score, plot yield (gm), and grain moisture content (%). Plant height was recorded from randomly selected 3 hills of each plot. Grain yield (GY) data were adjusted to tha^{-1}. Finally, the collected data were tabulated and analyzed following single-environment analysis and Alpha-Lattice Design using RStudio version 4.1.1. Significant differences were found among the genotypes for DF, GD, PH, PN, and GY. DF, GD, PH, and PN ranged between 75–99 days, 108–130 days, 94–114 cm, and 7.7–14.3 cm, respectively. The average DF, GD, PH, and PN were 86.25, 118.10, 105.62, and 11.04, respectively. The grain yield ranged from 3.40 to 4.83 tha^{-1}, with an average of 4.14 tha^{-1}. In addition, heritability is important to quantify the precision of field trials and determine the response to selection. Therefore, the heritability for DF, GD, PH, PN, and GY were calculated as 0.96, 0.93, 0.92, 0.88, and 0.49, respectively. The test entry IR20R1209 produced the highest grain yield (4.83 tha^{-1}), followed by IR20R1778 (4.62 tha^{-1}). Among the check varieties, Binadhan-17 produced the highest grain yield of 4.40 tha^{-1}. The top five test entries were selected based on gain and yield for further evaluation.

IRRI-NARES Network Trial of 2023-24 Dry Season

Stage 1 trial

This trial is composed of 120 plant materials including 108 IRRI-developed advanced breeding lines and 6 global (IRRI 147, IRRI 239, IRRI 242, IRRI 241, IRRI 240, and IRRI 154) and 6 national (BRRI dhan67, Binadhan-10, BRRI dhan99, BRRI dhan97, BRRI dhan88 and BRRI dhan102) check varieties. The germinated seeds were sown on 17 December 2023 in the seedbed. Thirty-six-day-old seedlings were transplanted on 23 January 2024 in 240 plots following the row-column design. The unit experimental plot size was 3.2 m^2 (13 hills × 6 rows). Two to three seedlings per hill were transplanted, maintaining a 20 cm distance between plant to plant and row to row. Proper intercultural operations were performed to ensure the proper growth of the rice plants. All the rice plants were harvested from each plot separately, and data were collected on days to 50% flowering (DF), growth duration (GD), plant height (PH), number of harvested hills per plot, plot quality score, plot yield (gm), and grain moisture content (%). Plant height was recorded from randomly selected 3 hills of each plot. Grain yield (GY) data were adjusted to tha^{-1}. Finally, the collected data were tabulated and analyzed using single-environment analysis following row-column design. Significant differences were found among the genotypes for DF, GD, PH, and GY. DF, GD, and PH ranged between 107-138 days, 135-169 days, and 94-144 cm, respectively. The average DF, GD, and PH were 118.37 days, 146.48 days and 116.65 cm, respectively. The grain yield ranged from 2.41 to 7.47 $tha^{-1}$with an average of 5.64 tha^{-1}. In addition, heritability is important to quantify the precision of field trials and determine the response to selection. Therefore, the heritability for DF, GD, PH, and GY were calculated as 0.93, 0.94, 0.88, and 0.70, respectively. The line IR 145388-B-B-382-B produced the highest grain yield (7.47 tha^{-1}) followed by the line IR 145398-B-B-124-B (7.19 tha^{-1}) and IR 145388-B-B-73-B (7.14 tha^{-1}). Top ten test entries were selected based on gain yield for further evaluation.

Stage 2 trial

This trial is composed of 30 plant materials including 6 global (IRRI 241, IRRI 239, IRRI 240, IRRI 242, IRRI 147, and IRRI 154) and 6 national (BRRI dhan99, BRRI dhan67, BRRI dhan97, Binadhan-10, BRRI dhan102 and BRRI dhan88) check varieties. The germinated seeds were sown on 17 December 2023 in the seedbed. Thirty-six-day-old seedlings were transplanted on 23 January 2024 in 60 plots following row-column design. The unit experimental plot size was 5.2 m^2 (13 hills × 10 rows). Two to three seedlings per hill were transplanted, maintaining a 20 cm distance between plant to plant and row to row. Proper intercultural operations were performed to ensure the proper growth of the rice plants. All the rice plants were harvested from each plot separately, and data were collected on days to 50% flowering (DF), growth duration (GD), plant height (PH), number of harvested hills per plot, plot quality score, plot yield (gm), and grain moisture content (%). Plant height was recorded from randomly selected 3 hills of each plot. Grain yield (GY) data were adjusted to tha^{-1}. Finally, the collected data were tabulated and analyzed following the row-column design. Significant differences were found among the genotypes for DF, GD, PH, and GY. DF, GD, and PH ranged between 106-134 days, 135-165 days, and 96-135 cm, respectively. The average DF, GD, and PH were 119.87 days, 148.65 days, and 116.11 cm, respectively. The grain yield ranged from 2.26-7.31 $tha^{-1}$with an average of 5.47

tha^{-1}. In addition, heritability is important to quantify the precision of field trials and determine the response to selection. Therefore, the heritability for DF, GD, PH, and GY were calculated as 0.96, 0.97, 0.85, and 0.85, respectively. The national check BRRI dhan99 produced the highest grain yield (7.31 tha^{-1}) followed by BRRI dhan67, BRRI dhan97, IRRI 241, and Binadhan-10. Among the test entries, IR21LT1233 produced the highest grain yield (6.34 tha^{-1}) followed by IR21LT1240 (6.28 tha^{-1}). Three rice lines *viz.* IR21LT1233, IR21LT1240, and IR21LT1236 were selected based on gain yield for further evaluation.

Observation yield trial of rice lines/mutant suitable for T. Aus

This experiment was carried out with 18 rice lines/mutants along with seven yield checks. The experiment was conducted following RCB design with two replications during the Aus 2023 season at BINA HQ farm, Mymensingh. The size of the unit plot was 1.0m × 1.0m with a 15cm plant-to-plant distance and 20cm row-to-row distance. Data on days to maturity and grain yield per plot were recorded. Recorded data were subjected to proper statistical analyses. The lines IR 127165-1-27-9-1-B-B, IR 132084-B-1327-2-1-B-18, IR 93930-40-3-3-1, and IR 132084-B-763-1-1-B-15 required less time to mature among the test entries. The highest grain yield was produced by the line BN-UR1023 (413.57 g/m^2) followed by IR BN-UR1012, IR 132084-B-224-1-1-B-4, and IR 93930-40-3-3-1. These lines were selected for further evaluation.

Selection of high yielding direct seeded rice lines (Aus season)

Stage 1 (Set 2) trial

The field trials for the identification of drought-tolerant direct-seeded upland rice genotypes were conducted in 2023 at the drought hotspots of Bangladesh located at Kantinagar, Kushtia Sadar, Kushtia. The trial comprises two sets and is conducted under stress and non-stress conditions following an augmented RCB design. The total plant materials were 140. The plant material comprises 130 test entries including 30 local entries. There were five global checks *viz.* IR13LT799, IRRI 163, IRRI 176, SAHBHAGI DHAN and IRRI 201and 5 local checks *viz.* Binadhan-19, Binadhan-21, BR-24, BRRI dhan48 and BRRI dhan83 were included in the trial. The seeds were sown on 04 April, 2023 directly into the soil in a four-meter-long plot with four grams of seeds for each line. The non-stress condition plots comprised two lines for each entry while the stress condition plots had three lines for each entry. Line-to-line distance was 25 cm for the stress and non-stress trials. The soil type of the experimental plot is silty loam. The field capacity and wilting point of this field were approximately 30-33% and 14-16% (VWC), respectively. The experimental site encountered a maximum temperature of 43^0C during the seedling stage, rainfall was scarce in that period. Drought was supposed to be imposed at 45 DAS but due to extreme temperature, the seedlings received heat shock at the early vegetative stage. As the rainfall was minimal and extreme sunshine prevailed at the experimental site, drought symptoms occurred five times at 61 DAS, 71 DAS, 81 DAS, 92 DAS, and 112 DAS. Volumetric soil moisture was 17-18% at this wilting point. Irrigation was provided in these five dates. All the entries germinated and the germination score of the entries under stress condition ranged from 3 to 5 with an average of 5. The early vegetative vigor ranged from 3 to 7. Phenotypic acceptability varied from 3 to 7 with an average of 7. For the non-stress condition, the germination score ranged from 3 to 5, early vegetative vigor ranged from 3 to 7 while phenotypic acceptability varied from 3 to 7 with an average of 7. The days to maturity required for the entries under stress

conditions ranged from 129 to 162 days with an average of 140 days. Plant height varied from 60 to 112 cm with an average of 82 cm. The yield ranged from 0.04 to 0.91 tha^{-1}. For the non-stress condition, the days to maturity required for the entries ranged from 129 to 162 days with an average of 143 days. Plant height varied from 61 to 112 cm with an average of 82 cm. The yield ranged from 0.05 to 0.95 tha^{-1}. The reasons behind the longer maturity duration, shorter plant height and poor yield can be attributed to the severe heat shock at the early vegetative stage and higher number of drought cycles throughout the growing period. The whole experiment suffered from both extreme heat and drought stress and thus resulting in poor yield. Thus, top ten entries based on yield have been selected for the stage-2 trial. Among the checks BRRI dhan83 performed the best considering the yield and produced at the rate of 0.71 tha^{-1}. Two of the local test entries namely $N_4/M_7/P$-14(6) and $N_4/M_7/P1$-(1)-1, surpassed the highest yielding check and had 0.72 tha^{-1} and 0.91 tha^{-1} yield, respectively. Among the global test entries, IR21C1092 performed the best (0.46 tha^{-1}).

Stage 2 (Set 1) trial

The trial was also set at the same location on 19 March, 2023. The trial comprises two sets and is conducted under stress and non-stress conditions following an alpha lattice design. Total plant materials were 30. The plant material comprises 20 best performing test entries from the previous year's stage 1 trial. There were five global checks *viz.* Vandana, SAHBHAGI DHAN, IR 87707-445-B-B-B, Chiherang and IRRI 163 and 5 local checks *viz.* Binadhan-19, Binadhan-21, BR-24, BRRI dhan48 and BRRI dhan83 were included in the trial. The seeds were sown on 19 March, 2023 directly into the soil in a four-meter-long plot with four grams of seeds for each line. The non-stress and stress condition plots comprised five lines for each entry. Line-to-line distance was 25 cm for the stress and non-stress trials. All the entries germinated and the germination score of the entries under stress condition ranged from 3 to 9 with an average of 5. The early vegetative vigor ranged from 3 to 7 with an average of 5. As 25 entries were harvested, the phenotypic acceptability data were taken for those 25 entries. It varied from 3 to 7 with an average of 5. For the non-stress condition, the results for the visually scored traits were same as the stress condition. The days to maturity required for the entries under stress conditions ranged from 145 to 177 days with an average of 160 days. Plant height varied from 54 to 105 cm with an average of 87 cm. The yield ranged from 0.04 to 1.34 $tha^{-1}$with an average of 0.29 tha^{-1}. For the non-stress condition, the days to maturity required for the entries ranged from 145 to 177 days with an average of 159 days. Plant height varied from 55 to 101 cm with an average of 86 cm. The yield ranged from 0.04 to 1.06 tha^{-1}. The reasons behind the longer maturity duration, shorter plant height and poor yield can be attributed to the severe heat shock at the early vegetative stage, higher number of drought cycles throughout the growing period, cloudy weather for an elongated period of time. The whole experiment suffered from both extreme heat and drought stress and thus resulting in poor yield. But the local and global checks had also faced the same conditions and resulted in poor yield. Thus, top four entries based on yield have been selected for the Multi-location Trial (MLT). Among the checks BRRI dhan83 performed the best considering the yield and produced at the rate of 1.34 tha^{-1}. The local test entry namely BN-UR1012 was the highest yielding genotype with a yield of 0.56 tha^{-1}. Among the global test entries, IR18S1007 performed the best (0.20 tha^{-1}).

Screening of M_3 rice mutants of Binadhan-17 for heat tolerance at reproductive stage

To develop heat tolerant rice lines M_3 population derived from Binadhan-17 through gamma irradiation was screened under high temperature condition. At M_3 generation heat screening of 1000 progenies were done under polyvinyl shed. Temperature and relative humidity data were recorded from panicle initiation till harvesting. Day temperature and relative humidity ranged between 35 – 45^{o}C and 30 – 90%, respectively during that period. Finally, 36 putative mutants were selected based on pollen viability and spikelet fertility.

Advanced yield trial of rice mutants/lines suitable for favorable boro season

This experiment was carried out with nine rice lines/mutant including four IIRON (International Irrigated Rice Observation Nursery) lines, four NERICA rice mutants and one Binadhan-17 mutant and two yield checks *viz.* BRRI dhan89 and BRRI dhan92. The experiment was conducted following RCB design with three replications during Boro 2023-24 season at BINA HQ farm, Mymensingh, BINA sub-station farms at Rangpur and Ishurdi. Thirty-three days, 35 days and 40 days old seedlings were transplanted on 14 January 2024, 22 January 2024 and 08 February 2024 at Mymensingh, Rangpur and Ishurdi, respectively. The size of unit plot was 3.0m × 2.0m with a 15cm plant to plant distance and 20cm row to row distance. Significant differences were observed for the tested genotypes for days to flowering, days to maturity, plant height and grain yield over locations. At Mymensingh, the genotype N4-17-6 (122 days) matured earlier followed by N4-17-4 (125 days) and N4-17-3 (129 days). The genotype N4-17-6 had the shortest plant height (96 cm) followed by N4-17-3 (97 cm) and B17-17-8 (98 cm). The genotype N4-17-6 produced the highest grain yield (9.15 tha^{-1}) followed by N4-17-6 (8.55 tha^{-1}). At Rangpur, the genotype IIRON-13 (137 days) matured earlier followed by N4-17-3 (139 days) and N4-17-6 (142 days). The genotype IIRON-16 had the shortest plant height (90 cm) followed by N4-17-4 (97 cm). The genotype N4-17-4 produced the highest grain yield (7.08 tha^{-1}) followed by N4-17-6 (7.05 tha^{-1}) and IIRON-13 (7.03 tha^{-1}). At Ishurdi, the genotype IIRON-16 (126 days) matured earlier followed by N4-17-3, N4-17-3 and B17-17-8. The genotype N4-17-4 had the shortest plant height (91 cm) followed by N4-17-6 (92 cm) and IIRON-5 (96 cm). The genotype IIRON-5 produced the highest grain yield (8.30 tha^{-1}) followed by IIRON-12 (7.51 tha^{-1}) and N4-17-6 (7.47 tha^{-1}). Results mean over three locations, on an average, yield and attributing traits showed significant differences among the lines and check for both individual locations and mean over locations. All the tested entries matured earlier than the check varieties. Among the tested entries and check varieties, N4-17-6 matured earlier (131 days) followed by N4-17-4 (132 days). N4-17-3, N4-17-4 and N4-17-6 had the shortest plant height among the test entries and the checks. Moreover, N4-17-6 produced the highest grain yield (7.89 tha^{-1}) according to the mean over three locations followed by IIRON-5 (7.72 tha^{-1}) and N4-17-5 (7.53 tha^{-1}). These three lines/mutants were selected for further evaluation.

Advanced yield trial of rice lines suitable for rainfed lowland ecosystem

This experiment was carried out with nine rice lines including nine IIRON lines, one line derived from Binadhan-16×NERICA-4 and one yield check *viz.* BRRI dhan87. The experiment was conducted following RCB design with three replications during Aman 2023 season at BINA HQ farm, Mymensingh, BINA sub-station farms at Cumilla and Ishurdi. Twenty-five days, 23 days

and 21 days old seedlings were transplanted on 29 August 2023, 11 August 2023 and 27 July 2023 at Mymensingh, Cumilla and Ishurdi, respectively. The size of unit plot was 3.0m × 2.0m with a 15cm plant to plant distance and 20cm row to row distance. Significant differences were observed for the tested genotypes for days to flowering, days to maturity, plant height and grain yield over locations. At all the locations, the tested entries matured earlier than the check variety. All the test entries had shorter plant height than the check varieties at Mymensingh and Ishurdi. At Cumilla, the line B-32-2-3 had the longest plant height among the test entries and the check varieties. Most of the test entries produced significantly higher grain yield than the check variety. At Mymensingh, the lines IIRON-11 (6.34 tha^{-1}) produced highest grain yield followed by IIRON-12 (6.03 tha^{-1}); at Cumilla, the line IIRON-17 (7.15 tha^{-1}) produced the highest grain yield followed by IIRON-4 (7.05 tha^{-1}); at Ishurdi, the line IIRON-17 produced the highest grain yield of 8.07 tha^{-1} followed by IIRON-10 (7.44 tha^{-1}). From the mean over locations performance, the lines IIRON-10 and IIRON-17 were selected for further evaluation.

Advanced yield trial of stem borer nursery rice lines

This experiment was carried out with four IRSBN (International Rice of Stem Borer Nursery) rice lines and one yield check *viz.* BRRI dhan87. The experiment was conducted following RCB design with three replications during Aman 2023 season at BINA HQ farm, Mymensingh and BINA sub-station farm at Cumilla. Twenty-five days and 26 days old seedlings were transplanted on 29 August 2023 and 14 August 2023 at Mymensingh and Cumilla, respectively. The size of unit plot was 3.0m × 2.0m with a 15cm plant to plant distance and 20cm row to row distance. Significant differences were observed for the tested genotypes for days to flowering, days to maturity, plant height, and grain yield over locations. At Mymensingh, all the test entries matured earlier than the check variety except IRSBN-3. All the test entries had the shortest plant height than the check variety. In case of grain yield only one line namely IRSBN-1 produced higher grain yield (5.93 tha^{-1}) than the check variety although that is not statistically significant. At Cumilla, all the test entries matured earlier and had shorter plant height than the check variety. All the test entries had higher grain yield than the check variety except the line IRSBN-3. Considering the grain yield performance over locations the line IRSBN-1 and IRSBN-4 were selected for further evaluation.

Hybrid rice

Development of parental materials

Source Nursery

The objective of source nursery was to assemble at one place prospective maternal and paternal parents of diverse genetic origin, for making experimental rice hybrids and to use the assembled genotypes for making testcrosses with the available CMS lines. The nursery composed of stable CMS lines, released varieties and elite breeding lines. Thirty-three and 25 test crosses were made during Aman 2023 and Boro 2023-24, respectively using 2 CMS lines.

Test cross nursery

The study was carried out to identify potential restorer and maintainer lines in rice. The testcross nursery composed of F_1s made between CMS lines and elite lines included in the previous season's source nursery and respective pollen parents of each of the test crosses. Data were recorded on days to flowering (DTF), number of unfilled grains/panicle (UFG), number of filled grains/panicle (FG) and spikelet fertility (%). The open pollinated panicles of test cross F_1s for seed setting was observed in comparison to the corresponding male parent; if the seed set is comparable (>75%) then it is marked as Restorer (R), if seed setting is lower (50.1 – 75%) then it is marked as partial restorer (PR), if the seed setting is 0.1 – 50% then it is marked as partial maintainer (PM) and if the seed setting is 0% then it is marked as maintainer (M).

In T. Aman 2023, 12 test crosses (F_1s) were evaluated for their spikelet fertility status of which 7 entries have been found potential restorer. In *Boro* 2023-24, 31 test crosses (F_1s) were evaluated for their spikelet fertility status and 11 entries were found as potential restorer. Among the total 18 restorers identified, 11 best restorers with more than 80 per cent spikelet fertility were selected to check for fertility restoration ability with other CMS lines in the next season.

CMS maintenance and evaluation nursery

Two CMS lines were maintained by hand crossing for seed increase and maintaining genetic purity in Aman 2023 and in *Boro* 2023-24.

Improvement of maintainer lines through B×B crosses

Six thousand progenies from 6 B×B crosses were advanced to F_5 generation using field rapid generation advance (FRGA) technique.

Growing M_1 generation of BRRI dhan89 and BRRI dhan92

To induce genetic variability, 380 Gy of gamma irradiation was applied to BRRI dhan89 and BRRI dhan92. Total 6000 M_1 plants were grown and single panicles were harvested from each plant. In M_2 generation, panicle-progeny-row will be grown and fertility % of the plants will be observed.

Evaluation of rice lines against blast

The rice blast that is caused by *Magnaporthe oryzae* is the most important and potentially damaging rice diseases worldwide and is especially prevalent in Bangladesh. This disease is responsible for yield losses ranging from 35 to 50% and 10 to 30% in each year worldwide. In Bangladesh, the yield losses 30 to 100% due to the cause of rice blast as compared to the developed countries. Therefore, four blast resistant rice (BINA-BR-4-10-18, BINA-BR-4-10-12, BINA-BR-4-10-15 and BINA-BR-4-10-19) lines carrying *Pi9* derived from a cross between Binadhan-17 and Pongsu Seribu 2 were developed by foreground and background selection. The present study was conducted to confirm four blast resistant introgressed rice lines against blast resistance using specific blast isolates through artificial inoculation. This experiment was conducted at BINA HQ farm in a protected blast screening house by spraying four different isolates of the blast pathogen *Magnaporthe oryzae* onto the four introgressed

rice lines and two checks (1 BRRI Dhan 74, Moderately Blast resistant, 1 USV2, Universal susceptible variety) to observe the response of the rice blast disease and to assess the resistance of different genotypes against the four specific isolates followed randomized complete block design (RCBD) with 3 replications and every replication had 4 plants. Each replication had 6 rows for the 6 genotypes. Total 6 × 3 × 4 = 72 plants were sown in each Isolate specific plot. So, total plants were sown 72 × 4 = 288 for 4 Isolates specific areas. Sporulation, inoculation and disease scoring was followed by (JIRCA S) protocol. Among 6 genotypes, BINA-BR-4-10-12 showed the best resistance against all isolates followed by BINA-BR-4-10-15 and BRRI Dhan74 in case of Isolate 5 and Isolate 8, respectively. All checks and all introgressed lines showed susceptibility against isolate 7 except BINA-BR-4-10-12 and BINA-BR-4-10-15. It means that isolate 7 was the most virulent among four isolates. Different disease severity of the four-blast resistant introgressed lines and two checks varied in their disease reaction to four isolates. Highest disease severity (22, 70 & 96%) was observed at 7, 14 and 21 days after inoculation in USV2, (Universal susceptible variety) in case of isolate 7 followed by other isolates. Lowest disease severity (0, 4 & 8%) was observed at 7, 14 and 21 days after inoculation in BINA-BR-4-10-12 in case of all isolates followed by BRRI Dhan74 and other introgressed lines except line BINA-BR-4-10-19.

Regional yield trial of blast resistant rice line with grain aroma

This experiment was carried out with one blast introgressed rice line with grain aroma (BINA-BR-4-10-12) and BRRI dhan87 as a check to assess the yield potential in T. *Aman* season and BRRI dhan50 as a check in *Boro* season at different location under the supervision of BINA HQS and BINA Sub-stations. The experiment was followed RCB design with three replications. The size of the unit plot was 4.0 m × 5.0 m. Seedlings were transplanted at a 15 cm distance within rows of 20 cm apart. Recommended doses of nitrogen, phosphorus, potassium, sulphur and zinc were applied in the form of Urea, TSP, MoP, Gypsum and Zinc Sulphate. Necessary and intercultural practices were followed as and when needed. Data on plant height, number of total tillersplant^{-1}, effective tillersplant^{-1}, panicle length, filled and unfilled grains panicle-^{1} and thousand seed weight were recorded at harvest from 5 randomly selected competitive plants of each plot. Maturity was assessed plot basis. Grain yield was recorded from an area of 20 m^2 which was later converted to t ha-^{1}. Finally, all the recorded data were subjected to proper statistical analyses. In *Aman* season, results from combined mean over locations, it was revealed that BINA-BR-4-10-12 performed better in terms of grain yield (6.54 tha^{-1}) at BINA Sub-station and (5.95 tha^{-1}) at farmer's field than check (5.87 tha^{-1}) at BINA Sub-station and (5.66 tha^{-1}) at farmer's field. Quality assessment was done based on kernel length and L/B ratio. The kernel shape and size of both line and Check were medium-slender. The grain colour of BINA-BR-4-10-12 was observed as bright golden where check was white. In addition, BINA-BR-4-10-12 was observed as strong aroma during drying, milling and cooking whereas aroma of check was absent. Disease and pest evaluation also were done by following Standard Evaluation System (SES) of IRRI at different location under the supervision of BINA HQS and BINA Sub-stations. BINA-BR-4-10-12 showed resistance against Blast, Bacterial blight, Sheath blight, Stem borer, and Brown plant hopper whereas BRRI dhan87 (Check) showed susceptibility against Blast, Bacterial blight in visual observation at all locations. Considering the yield performance, resistance against disease

and pest and grain quality, BINA-BR-4-10-12 could be selected for further evaluation to release it as a variety. In *Boro* season, results from combined mean over locations, it was revealed that BINA-BR-4-10-12 performed better in terms of grain yield (7.69 tha-1) at BINA Sub-station and (7.52 tha-1) at farmer's field than check BRRI Dhan50 (6.22 tha-1) at BINA Sub-station and (6.14 tha-1) at farmer's field. Quality assessment was done based on kernel length and L/B ratio. The kernel shape and size of BINA-BR-4-10-12 was medium-slender where Check was long-slender. The grain colour of BINA-BR-4-10-12 was observed as bright golden where check was white. In addition, BINA-BR-4-10-12 was observed as strong aroma during drying, milling and cooking whereas aroma of check was present. Disease and pest evaluation also were done by following Standard Evaluation System (SES) of IRRI at different location under the supervision of BINA HQS and BINA Sub-stations. BINA-BR-4-10-12 showed resistance against Blast, Bacterial blight, Sheath blight, Stem borer, and Brown plant hopper whereas BRRI Dhan50 (Check) showed susceptibility against Blast, Bacterial blight in visual observation at all locations. Considering the yield performance, resistance against disease and pest and grain quality, BINA-BR-4-10-12 could be selected for further evaluation to release it as a variety.

Advanced yield trial of some selected blast resistant rice lines

This experiment was carried out with four blast introgressed rice lines (BINA-BR-4-10-19, BINA-BR-2-15, BINA-BR-4-10-15, and BINA-BR-23-1-25) and BRRI dhan87 as a check to assess the yield potential in T. *Aman* season at different location under the supervision of BINA HQS and BINA Sub-stations. The experiment was followed RCB design with three replications. The size of the unit plot was 4.0 m × 5.0 m. Seedlings were transplanted at a 15 cm distance within rows of 20 cm apart. Recommended doses of nitrogen, phosphorus, potassium, sulphur and zinc were applied in the form of Urea, TSP, MoP, Gypsum and Zinc Sulphate. Necessary and intercultural practices were followed as and when needed. Data on plant height, number of total tillersplant^{-1}, effective tillersplant^{-1}, panicle length, filled and unfilled grains panicle-^{1} and thousand seed weight were recorded at harvest from 5 randomly selected competitive plants of each plot. Maturity was assessed plot basis. Grain yield was recorded from an area of 20 m^2 which was later converted to t ha-^{1}. Finally, all the recorded data were subjected to proper statistical analyses. Results from combined mean over locations, it was revealed that BINA-BR-2-15 and BINA-BR-4-10-15 performed better in terms of grain yield (6.31 tha^{-1}) and (5.96 tha^{-1}) respectively than check (5.64 tha^{-1}). The plant height of BINA-BR-2-15 and BINA-BR-4-10-15 was 25cm lower than than the check. It means that lodging tendency is less than check. Quality assessment was done based on kernel length and L/B ratio. The kernel shape and size of all lines and Check were medium-slender except BINA-BR-4-10-19 is medium medium. The grain colour of of all lines and Check were observed as white where BINA-BR-2-15 was bright golden. Disease and pest evaluation also were done by following Standard Evaluation System (SES) of IRRI at different location under the supervision of BINA HQs and BINA Sub-stations. All lines showed resistance against Blast, Bacterial blight, Sheath blight, Stem borer, and Brown plant hopper whereas BRRI dhan87 (Check) showed susceptibility against Blast, Bacterial blight in visual observation at all locations. Considering the plant height and yield performance, resistance against disease and pest and grain quality, BINA-BR-2-15 and BINA-BR-4-10-15 could be selected for further evaluation to release as variety.

Growing of BC_1F_1 population of rice

For the development of blast resistant rice variety, the F_1 generations derived from 2 cross combinations between Binadhan-17(recurrent) x blast resistant line (*Pi9*) and Binadhan-17 (recurrent) x blast resistant line (*Pish*) were evaluated for hybridity using the *Pi9* and *Pish* linked molecular markers RM6836 and RM206 respectively. F_1 was backcrossed with Binadhan-17 to generate BC_1F_1 population. BC_1F_1 plants have been confirmed using blast resistant linked gene marker RM6836 and RM206 respectively. Rest of the plants was discarded. Then F_1 was backcrossed with Binadhan-17 to generate BC_1F_1 population.

Collection, isolation, identification, purification and preservation of different Isolates of rice blast

In total, 50 neck blast samples (*Magnaporthe oryzae*) were collected from hot spot area of Bangladesh. Sampling will be covered all of the administrative divisions of Bangladesh. Single spores were isolated from infected leaves or panicles incubated on moist filter paper in a petri dish at room temperature for 24 h in accordance with the protocols of Hayashi et al. (2009). Colonies from single conidia were grown on water agar for 5 to 7 days; two or three cut pieces of single colony were then transferred to sterile filter paper placed on water agar medium. Finally, to enable repeated access to the original isolates, the fungi were grown on filter paper and 15 isolates were stored aseptically in filter paper at −20℃ after the necessary drying for the study of morphological, molecular and pathogenicity test.

Molecular characterization and development of marker of rice blast fungus (*Magnaporthe oryzae*) through Ribosomal its (internal transcribed spacer) sequencing

Rice blast caused by the hemi biotrophic fungus *Magnaporthe oryzae*, is one of the most potent threats to rice production and causing tremendous yield loss worldwide and is especially prevalent in Bangladesh. The objectives of this study were to investigate how the rice blast pathogen undergoes mutation that will govern the likely development of the disease epidemic and performing a phylogenetic analysis. In the present study, nineteen *M. oryzae* isolates were collected from four districts of Sylhet division in Bangladesh. All isolates used in this study were determined to be *M. oryzae* by internal transcribed spacer (ITS) sequence confirmation. The phylogenetic analysis showed uniform distribution of 19 blast isolates into three clusters and indicated the existence of high genetic variation among blast isolates originated from the same location and existence of genetic similarity among blast isolates originated from different geographical origins. Among the three cluster, cluster-B have 18 noble blast isolates out of 19 isolates. Only W30216962_BN10_ITS5_F12 isolates found in cluster A and cluster C didn't have any noble blast isolate. This result reveals that those isolates found in cluster B are originated from same source. The outcome of the present work would help to formulate strategies for improved disease management against rice blast through resistance breeding, genetic studies and host-pathogen interaction.

Growing of BC_2F_4 generation of rice for salt tolerance, early maturity and higher yield

The development of salt-tolerant rice varieties is the most effective way to increase rice production in coastal regions that are prone to salinity. The most economical and environmentally friendly method is marker-assisted backcross breeding, which speeds up breeding activities to

develop salt-tolerant rice varieties and transfer the *Saltol* QTL to HYVs. Eight BC_2F_4 populations crossing from MR297 and Binadhan-10 were seeded at the farm of BINA Headquarters in Mymensingh. The parents were also included in the experiment by keeping a gap of 15 cm between plants and 20 cm between rows. A non-replicated design was used in the experiment. The dimensions of a unit plot were 2 m by 1 m. The recommended amounts of nitrogen, phosphorus, potassium, sulphur and zinc were applied as Urea, TSP, MoP, gypsum, and zinc sulphate. When necessary, intercultural practices were implemented. Five competing hills were randomly selected at maturity, and data on plant height, panicle length, no. of panicle $hill^{-1}$, days to maturity, no of filled grain $panicle^{-1}$, and grain yield $hactare^{-1}$ were recorded. On a pot basis, maturity was evaluated. The majority of the lines showed notably reduced plant height in comparison to the parent Binadhan-10. The line BC_2F_4-18 showed the maximum plant height (115.67 cm) in comparison to the other progenies and parents. The line BC_2F_4-27 had the highest panicle length (30.79 cm) in comparison to the other lines and checked variety. The line BC_2F_4-27 had the highest number of panicles (16) in comparison to the other progenies and checked variety. The lowest days to maturity (142 days) was shown in the line of BC_2F_4-16 in comparison to the other lines and checked variety. The line BC_2F_4-27 exhibited a significantly higher number of filled grains per panicle in comparison to other lines and checked variety and this line also showed the highest grain yield (9.29 tha^{-1}) in comparison to the other lines and parents.

Growing of BC_2F_4 generation of rice for early maturity, higher yield and better grain quality

Rice (*Oryza sativa* L.) is a staple food for more than half of the world's population. 13 BC_2F_4 populations crossing from Binadhan-17 and Binadhan-10 were seeded at the farm of BINA Headquarters in Mymensingh. The parents were also included in the experiment by keeping a gap of 15 cm between plants and 20 cm between rows. A non-replicated design was used in the experiment. The dimensions of a unit plot were 2 m by 1 m. The recommended amounts of nitrogen, phosphorus, potassium, sulphur and zinc were applied as Urea, TSP, MoP, gypsum, and zinc sulphate. When necessary, intercultural practices were implemented. Five competing hills were randomly selected at maturity, and data on plant height, panicle length, no. of panicle $hill^{-1}$, days of maturity, no of filled grain $panicle^{-1}$, and grain yield were recorded. On a pot basis, maturity was evaluated. The mean agro-morphological characteristics of the 13 selected BC_2F_4 populations were recorded as follows: plant height (111.42 cm), panicle length (26.20 cm), number of panicles $hill^{-1}$ (10.15 nos.), days to maturity (143.85 days), number of filled grain $panicle^{-1}$ (145.85 nos) and yield (7.84 tha^{-1}). The line BC_2F_4-54 showed the maximum plant height (118.37 cm) in comparison to the other progenies. The line BC_2F_4-70 had the highest panicle length (28.32 cm), highest panicle number (15 nos), higher number of filled grains (168 nos), and highest grain yield (8.84 tha^{-1}) in comparison to the other lines and checked variety. Lowest days to maturity (137 days) were shown in the line of BC_2F_4-38 in comparison to the other lines and checked variety.

Growing of M_1 Generation of rice landraces

Rice (*Oryza sativa* L.) is a staple food for more than half of world's population, its growth and productivity are continually threatened by several biotic and abiotic stresses among which salinity

is one of the major hindrances. To create variability in the genetic background of Dhukshail, Ghunshi, Khute Patnai for salt tolerance, high yielding and early maturity; seeds were irradiated with 100, 150, 200, 250, 300 & 350Gy of gamma rays. Seeds of M_2 generation were collected at BINA Headquarters farm, Mymensingh during Aman season 2023.

Introgression of *Xa*21 gene in the BINA dhan26 rice variety for diseases resistances

Rice (*Oryza sativa* L.) is the staple food of many countries, ranked the second-highest food crop in the world serving as the primary food source of more than 3.5 billion people worldwide. In Bangladesh rice is the main food crop. This experiment aimed to introgress bacterial leaf blight (BLB) resistance genes using marker-assisted backcross breeding methods. BINA dhan26 is a high-yielding Aman rice variety but susceptible to BLB. IRBB60 is a BLB-resistant genotype. So, through Marker-assisted backcross breeding, there is a huge scope to develop early maturing, high-yielding and better grain quality and BLB-resistant rice varieties in the country. The F_1 seeds were obtained from crosses between BINA dhan26 and IRBB60. The 58 F_1 plants were generated from the F_1 seeds and foreground polymorphism markers were utilised to test for heterozygosity. Using *pTA248* promoter-linked foreground marker, 48 F_1 plants were confirmed to be heterozygous true F_1 plants and scored as "H". These 48 heterozygous progenies were used for backcrossing to recurrent parent BINA dhan26 to produce BC_1F_1 seeds. After hybridization, the true BC_1F_1 seeds were again backcrossed with recurrent parent BINA dhan26 to produce BC_2F_1 seeds.

Wheat

Preliminary yield trials of blast resistant wheat mutants (Collaboration with Plant Pathology Div.)

The experiment evaluated the agronomic performance of mutant rice lines across four locations: BINA Headquarters, Mymensingh, BINA substation Ishwardi, and farmers' fields in Madaripur and Mujibnagar. Conducted in a randomized complete block design (RCBD) with three replications, each plot measured 3.0 m × 3.0 m. The experimental setup maintained a plant-to-plant distance of 15 cm and a row-to-row distance of 20 cm, with recommended doses of nitrogen, phosphorus, potassium, sulfur, zinc, and boron applied. Key growth and yield parameters, including days to first flowering, plant height, and grain yield, were recorded from ten randomly selected plants. Significant variations were observed among mutant lines and checks for most traits across locations. Notably, mutant lines exhibited enhanced plant height, with the tallest reaching 95.39 cm compared to the check variety BRRI Gom-26 (84.26 cm). The line PCW-14/22 showed the highest number of effective tillers (13.05) compared to BARI Gom-33 (7.35). Spike length of PBG-33/44 was recorded at 13.52 cm, surpassing both checks. The highest 1000-seed weight was noted in BARI Gom-33 (55.36 g) followed closely by PBG-33/44 (54.24 g). Additionally, lines PCW-2/44, PCW-2/33, PBG-14/22, and PCW-14/33 yielded significantly more (3.95 tha^{-1}, 3.88 tha^{-1}, 3.70 tha^{-1}, and 3.64 tha^{-1}, respectively) than the check varieties. Given their promising performance, these lines will be prioritized for further evaluation in subsequent trials.

Screening of F_2, F_3 & F_4 generation for earliness and high yielding

The objective of this research was to select desirable population on the basis of phenotypic performance for advancing the generation. A large number of F_4, F_3 and F_2 variants were developed from various cross between BARI Gom-33 × Bina-800-1-3, BARI Gom-33× Sonalika, BARI Gom-33× BWMRI-1, BARI Gom-33× BWMRI-2 were grown at BINA Head quarter farm, Mymensingh. The seeds were sown during 15-20 November 2023. All the seeds of F_2 were planted in separate pot and F_3 and F_4 seeds were sown in field. Recommended fertilizer was applied and necessary actions were taken to grow the crop uniformly.

Total sixty-nine (69) segregating population was evaluated for yield and yield contributing characters. All of the segregating populations were obtained from earlier generation that had been selected from previous trials. Twenty-three (23) from F_4 were selected for future generation advancement. The selection was facilitated considered the early maturity period with other yield contributing characters.

Growing M_2 generation of heat tolerant wheat lines

To create genetic variability for high yield and heat tolerance, seeds of 28 germplasm including four popular wheat varieties BARI gom-33, BWMRI gom-1, BWMRI gom-2 and Sonalika were irradiated with 150, 200, 300 and 400 Gy of gamma rays. Seeds were sown on 20 November 2023 at BINA Headquarters farm, Mymensingh. This experiment was followed by non-replicated design and sown separately (variety and dose wise). Finally, the survived plants produced seeds were harvested separately for growing M_3 population.

Pulse Crops

Mungbean

Project: Varietal improvement of Mungbean using mutation breeding technique

Evaluation of promising summer mungbean mutant for earliness and higher seed yield

Mungbean (*Vigna radiata* L.) commonly known as green gram, is a long cultivated pulse crop that originated in South East Asia and is a member of the Papilionoideae family. To evaluate the overall performance of the mutant for earliness and higher seed yield, an experiment was set up at different locations (BINA sub-station Ishwardi, and farmer's field, Natore). For this experiment, the mutant line MBM-656-51-2 with the check variety BARI Mung-6 was used during Kharif-I season of 2024. The experiment was followed RCBD design with three replications. The size of unit plot was 5.0 m × 6.0 m. Row to row and plant to plant distance were 40 and 10-15 cm, respectively. Normal intercultural operation were done. Data on days to maturity, plant height, pods plant^{-1}, pod length, seeds pod^{-1} and seed yield (tha^{-1}) were recorded. Maturity was assessed plot basis. The data for the characters under study were statistically analyzed wherever applicable. Data were analyzed using statistics10 package. Results revealed that significant variations were observed among the mutant and the check variety at different locations. It was observed from the Table 86 that, MBM-656-51-2 had shorter plant height than the check varieties at all the locations.

From mean over locations, the tested mutant matured earlier (61.84 days) than check variety. The highest number of pods plant^{-1} (25.99) was found in MBM-656-51-2. In respect of seed yield, this mutant produced the highest seed yield of 1.77 tha^{-1} followed by BARI Mung-6 (1.56 tha^{-1}).

Advanced yield trial of mungbean lines for earliness and higher seed yield

Mungbean (*Vigna radiata* L.) commonly known as green gram and it is primarily farmed for human consumption and it is a cheap source of protein. For this experiment, In BINA sub-station, Ishwardi the mutant lines BMS-37, BMS-1, BMS-26, BMS-27, BMS-30, BMS-40 with the check variety BARI Mung-6 and Binamoog-8 were used during Kharif-I season of 2024. The experiment was followed RCBD design with three replications. The size of unit plot was 4m × 5m. Row to row and plant to plant distance were 40 and 10-15 cm respectively. Normal intercultural operation was done. Data on days to maturity, days to flowering (50%), plant height, pods plant^{-1}, pod length, seeds pod^{-1},100 seed wt. (g) and seed yield (tha^{-1}) were recorded. Maturity was assessed plot basis. The data for the characters under study were statistically analyzed wherever applicable. Data were analyzed using statistics10 package. Results revealed that significant variations were observed among the mutants and the check varieties at BINA sub-station Ishwardi. It was observed that BMS-40 had the highest no. of pods plant^{-1}, shorter duration and highest seed yield than the check varieties. From mean, the tested mutant matured earlier (62.66 days) than check variety. The highest number of pods plant^{-1} (36) was found in BMS-40. In respect of seed yield, this mutant produced the highest seed yield of 1.78 tha^{-1}followed by Binamoog-8 (1.71 tha^{-1}) and BARI Mung-6 (1.58 tha^{-1}). Further evaluation will be done in different locations.

Growing of M_5 generation of mungbean for synchronous pod maturity

To identify synchronous pod maturity mungbean genotypes, a number of 15 M_4 populations and 1 check variety (Binamoog-8) were grown in plant progeny rows for selecting desirable mutant at BINA sub-station, Ishwardi during Kharif-I season 2024. Intercultural operations like weeding, thinning, application of pesticides, etc., were done for the proper growth and development of plants in each plot. Harvesting was done depending on the maturity of the lines. A total of 10 mutant variants have been selected primarily for next generation. BMS-30/P-2(1) showed highest no. of pod plant^{-1} (36) and took 62 days to maturity.

Growing of M_3 generation of mungbean for synchronous pod maturity

In this experiment, a number of 40 M_3 populations and 3 check varieties (Binamoog-5, Binamoog-8, and & Binamoog-10) were grown in plant progeny rows for selecting desirable mutant at BINA sub-station, Ishwardi during Kharif-I season 2024. The experiment was followed by non-replicated design and sown separately (variety and dose wise). Intercultural operations like weeding, thinning, application of pesticides, etc., were done for the proper growth and development of plants in each plot. Harvesting was done depending on the maturity of the lines. A total of 28 mutant variants have been selected primarily for next generation. BMS-99/P-8(1) showed the highest no. of pod plant^{-1} (39) and took 60 days to maturity.

Lentil

Project: Varietal improvement of lentil through induced mutation

On-farm and on-station yield trial with four promising lentil mutants along with a check BARI Mashur-8

Four promising mutants (LM-99-8, LM-118-9, LM-20-4 & LM-206-5) along with one check variety BARI Masur-8 were evaluated through this trial. This experiment was conducted at BINA sub-station farms at Ishwardi, Magura & farmer's field at Ishwardi & Magura during October 2023 to March 2024. The mutants and the check variety were laid out in a randomized complete block design with three replications. Unit plot size was $20m^2$ (4m × 5m) and line to line spacing was maintained 30cm. Seeds were sown on October 2023. Recommended production packages i.e., application of fertilizers, weeding, thinning, irrigation, application of pesticide etc. were followed to ensure normal plant growth and development. Data on days to maturity, plant height, number of primary branches $plant^{-1}$ and pods $plant^{-1}$ were recorded from 10 randomly selected plants from each plot. Seed yield of each plot was converted into kg ha^{-1}. Appropriate statistical analyses were performed for comparison of mean of each character. On an average, days to maturity ranged from 104 to 112 days. All the mutants matured earlier than the check variety BARI Masur-8 (111 days). BARI Masur-8 produced the tallest plant (41.4 cm) and mutant LM-118-9 produced the shortest plant height of 38.3 cm followed by LM-20-4 (38.5 cm) & LM-99-8 (40.2cm). On an average, all the mutants and check variety produced almost similar number of primary branch (3.1-3.4). LM-99-8 produced the highest number of pods $plant^{-1}$ (129). The average highest seed yield 1834 kg ha^{-1} was recorded for LM-20-4 followed by LM-99-8 (1712 kg ha^{-1}) and LM-206-5 with 1506 kg ha^{-1}. In case of 100-seed weight, higher weight was found in LM-20-4 (3.90 g) at Magura followed by LM-99-8 (2.15 g). From the above trials it was observed that, LM-20-4 was the best mutant among the mutants and check.

Advanced yield trial with some selected mutants of lentil

The advanced yield trial was conducted with four mutants along with a check variety, BARI Mashur-8, at Magura during the Rabi season of 2023 (October to mid-November). Seeds were sown in randomized complete block design with three replications. The unit plot size was 3m x 2m, and rows were 30cm apart. Normal cultural practices were followed. Data on days to maturity, plant height, number of primary branches and pods $plant^{-1}$ were recorded from 10 randomly selected plants from each plot. Plot seed yield was converted into kgha^{-1}. Results revealed that significant variations were observed among the mutants and the check variety for most of the characters except the number of primary branches per plant. On average, the maturity period varied from 97 days to 108 days, with the mutant LM-250 being the earliest among the mutants and the check variety. The mutants LM-11 and LM-150 produced the highest number of pods $plant^{-1}$ followed by LM-250, and the highest seed yield was produced by LM-11 (1888 kg ha^{-1}) followed by LM-150 (1739 kg ha^{-1}). Further trials will be conducted in the next season in different lentil-growing areas.

Growing of M_7/M_6 generation of lentil

A total of 8 M_6 plants were harvested from four doses: 150 Gy, 200 Gy and 250 Gy. Seeds of these M_6 plants were grown in plant-progeny-rows at BINA farm in Magura, along with the mother variety. Another set of 9 M_6 lines were grown at BINA farm Magura. Each row was 2 m long with 30 cm row to row distance. Normal cultural practices were followed. Selection was done on the basis of earliness, number of pods plant^{-1}, seed yield, and erect plant type, and disease reactions. Altogether, 5 M_6 and 6 M_7 lines were selected on the basis of higher yield, earliness, and disease reactions. These lines will be grown for further selection in the next generation.

Blackgram

Project: Varietal improvement of blackgram through induced mutation

On-station yield trial with two promising blackgram mutants along with a check BARI Mash-3

The trials were conducted with two promising blackgram mutants along with a check variety. BARI Mash-3 at BINA substations Magura, Ishwardi, Chapainawabganj, and Gopalganj during the Kharif-2 season of 2023. The experiment was laid out in a randomized complete block design with three replications. The unit plot size was 12 m^2 (4 m × 3 m). Plant to plant distance was from 5 to 6 cm in a row while line to line distance was 40 cm. Intercultural operations, like weeding, thinning, application of pesticides, etc., were done for the proper growth and development of plants in each plot. Harvesting was done depending on maturity of the lines. Data on various characters such as plant height, number of primary branches plant^{-1}, pods plant^{-1}, number of seeds pod^{-1}, 100-seed weight were recorded from 10 randomly selected plants in each plot. Seed yield plot^{-1} was recorded and converted into kg ha^{-1}. Appropriate statistical analyses were performed by Statiatics-10 software. Results revealed that there were significant differences for most of the characters except the number of primary branches at Magura. BM-4 was the shortest among the mutants and check at Magura, Ishwardi, Chapainwabganj, and Gopalganj. In terms of primary branches per plant, BM-4 had the highest number of branches, seeds pod^{-1} and 100-seed weight among the check variety, BARI Mash-3. Combined over the three locations, the highest seed yield was recorded for BM-4 (1796 kg/ha**)** because of its bigger seed size and higher number of pods plant^{-1}. Applications will be made to register this mutant line as a variety this year.

On-farm yield trial with two promising blackgram mutants along with a check variety

The trial was conducted with two promising blackgram mutants along with a check variety, BARI Mash-3, at three locations, Chapainwabganj, Magura, and Gopalganj during the Kharif-2 season of 2023. The experiment was laid out in a randomized complete block design with three replications. The unit plot size was 20 m^2 (5 m × 4 m). Plant to plant distance was from 5 to 6 cm in a row while line to line distance was 40 cm. Intercultural operations such as weeding, thinning, application of pesticides, etc., were done for the proper growth and development of plants in each plot. Harvesting was done depending on the maturity of the lines. Data on various characters such as plant height, number of primary branches plant^{-1}, pods plant^{-1}, number of seeds pod^{-1}, 100-seed

weight were taken from 10 randomly selected plants in each plot. Seed yield plot^{-1} was recorded and converted into kg ha^{-1}. Appropriate statistical analyses were performed by Statiatics-10 software. The mutant, BM-4 was the shortest among the mutants and check. The mutant line BM-4 had the highest number of pods plant^{-1} and 100-seed weight among the mutant and the check variety, BARI Mash-3. Combined over the three locations, the highest seed yield was recorded for BM-4 (1654 kg/ha**)** because of its bigger seed size and higher number of pods plant^{-1}. Applications will be made to register this mutant line as a variety this year.

Advanced yield trial with five promising blackgram mutants

The trials were conducted with five promising blackgram mutants along with a check variety, BARI Mash-3, at Chapainwabganj. The experiment was laid out in a randomized complete block design with three replications. Unit plot size was 2 m × 1.6 m. Plant to plant distance was from 5 to 6 cm in a row while line to line distance was 40 cm. Intercultural operations like weeding, thinning, application of pesticides, etc., were done for the proper growth and development of plants in each plot. Harvesting was done depending on the maturity of the lines. Data on various characters such as plant height, number of primary branches plant^{-1}, number of seeds pod^{-1}, 100-seed weight were recorded from 10 randomly selected plants in each plot. Seed yield plot^{-1} was recorded and converted into kg ha^{-1}. Appropriate statistical analyses were performed by Statistics 10. Results revealed that there were significant differences for most of the characters except the number of branches per plant. The check variety, BARI Mash-3, was the tallest among the mutants. In terms of the number of pods plant^{-1} BM-63 and BM-46 had the highest number of pods plant^{-1} among the other mutants and the check variety, BARI Mash-3. The highest number of seeds pod^{-1} and 100-seed weight was observed in BM-63, followed by BM-46. The highest seed yield was recorded for BM-63 followed by BM-46, because of their higher number of pods plant^{-1} and seeds pod^{-1}. Further trials will be done with the three selected mutants, BM-235, BM-46, and BM-63.

Grasspea

Project: Varietal improvement of grasspea through induced mutation

On-station and on-farm yield trial with four promising grasspea mutants along with two check varieties during Rabi 2023-24

The on-farm yield trials were carried out with four selected mutants along with two check varieties (Binakheshari-1 and BARI Khasari-2) at BINA sub-stations Magura, Gopalganj and Barisal farmers' field during the Rabi season of 2023-24. The experiment was conducted in a randomized complete block design with three replications. The unit plot size was 4 m × 3 m with 40 cm row to row distance. Normal cultural practices were followed. Data on days to maturity, plant height, primary branches plant^{-1}, pods plant^{-1} and 100-seed weight were recorded from 10 randomly selected plants from each plot. Plot seed yield was converted into kgha^{-1}.

Results revealed that significant variations were found for all the characters except number of primary branches plant^{-1}. It was observed that both the mutants GM-1 and GM-3 were earlier than other mutants and check varieties. The mutant GM-1 produced the highest seed yield 2245 kg ha^{-1} and 2263 kg ha^{-1} both on-station and on-farm in Magura, respectively. The mutant GM-1 produced the highest number of pods and highest seed yield, followed by mutant GM-3 all over the locations. Combined over the six locations, the highest seed yield was recorded for mutant

GM-1 (1984 kg ha^{-1}) followed by GM-3 (1857 kg ha^{-1}) and GM-2 (1586 kg ha^{-1}), respectively. The mutant GM-1 will be applied to the NSB for release as a new variety this year.

Growing of M_4/M_6 generation of grasspea

To create variability, Binaheshari-1 and BARI Kheshari-2 were irradiated with 250 Gy, 300 Gy and 350 Gy of gamma rays and were grown at BINA farm, Magura. A total of 22 M_4 plants were harvested separately from three doses: 250 Gy, 300 Gy and 350 Gy and the subsequent generation of selection was done on the basis of earliness, the number of pods, and disease reactions. A total of 4 M_6 mutants were selected on the basis of earliness, the number of pods, and disease reactions. Further selection will be done in the next generation.

Chickpea

Project: Varietal improvement of chickpea for problem areas through induced mutation

Advanced yield trial of chickpea mutants

The chickpea or chick pea (*Cicer arietinum* L.) is an annual legume of the family Fabaceae, subfamily Faboideae. Chickpea is a valued crop and provides nutritious food for an expanding world population and will become increasingly important with climate change. For varietal improvement of chickpea an experiment was conducted with nine lines along with check variety BARI sola-7 BINA at sub-station, Ishwardi and BINA sub-station, Magura during 2023-24. Seeds were sown in randomized complete block design with three replications. For this experiment, the genotypes CIEN-SA-33, CIEN-SA-15, CAT-29-38, CAT-23-29, CIEN-SSA-(6-10), CIEN-SSA-(32-26), CIEN-MED-32, CIEN-SSA-(15-41) and CAT-11-28 with the check variety BARI sola-7 were used during Rabi season of 2023-24. Unit plot size was 3m x 2m and rows were 30 cm apart. Normal intercultural practices were done. Data on days to maturity, plant height, number of primary branches, days to flowering (50%), pods $plant^{-1}$, no. of seeds pod^{-1}, 100 seed wt. (g) and seed yield (tha^{-1}) were recorded from 10 randomly selected plants from each plot. Plot seed yield was converted into tha^{-1}. Data were analyzed using statistics10 package. Results revealed that significant variations were observed among the mutant and the check variety at different locations. Combined performance over the locations (BINA at sub-station, Ishwardi and BINA sub-station, Magura), CIEN-SSA-(32-26) showed highest seed yield (1.93 tha^{-1}) and pods $plant^{-1}$ (76.45) than the check variety (BARI sola-7) as well as other lines which takes only 120.17 days to maturity. Further trial will be conducted in the next season at different chickpea growing areas.

Preliminary yield trial of some selected mutants of Chickpea

The preliminary yield trials were conducted with six lines with two check varieties Binasola-6 and BARI sola-7 at BINA sub-station, Ishwardi during 2023-24. For this experiment, the genotypes CIEN-SA-23, CIEN-MED-28, CIEN-SA-13, CIEN-SSA-(6-10), CIEN-SSA-(18-17) and CIEN-MED-4 with two check varieties BARI sola-7 and Binasola- 6 were used during Rabi season of 2023-24. Seeds were sown in randomized complete block design with three replications. Unit plot size was 3m x 2m and rows were 30 cm apart. Normal intercultural practices were done. Data on

days to maturity, plant height, number of primary branches, Days to flowering (50%), no. of pods plant^{-1}, no. of seeds pod^{-1}, 100 seed wt. (g) and seed yield (tha^{-1}) were recorded from 10 randomly selected plants from each plot. Plot seed yield was converted into tha^{-1}. In the location of BINA sub-station, Ishwardi CIEN-SSA-(6-10) mutant showed highest seed yield (1.84 tha^{-1}) and pods plant^{-1} (74.86) than the check varieties (Binasola-6 and BARI sola-7) as well as other mutants. Besides this CIEN-SSA-(6-10) mutant also showed earliest in maturity than the check varieties (Binasola-6 and BARI sola-7) as well as other mutants which took only 119.33 days. Further trial will be conducted in the next season at different chickpea growing areas.

Growing of M_2 generation of chickpea

To create genetic variability for earliness, higher seed yield and disease tolerance an experiment was set up at BINA sub-station, Ishwardi during Rabi season 2023-24. Bulk Seeds of Binasola-6 and BARI Sola-11 were sown dose wise and the non-irradiated seeds were used as control of parents. Intercultural operations like weeding, thinning, application of pesticides, etc., were done for the proper growth and development of plants in each plot. Harvesting was done depending on the maturity of the lines. M_2 populations were grown and fifty-eight mutant lines were selected on the basis of earliness, seed yield and disease tolerance. Plant height ranged from 59-100 cm, no. of pod plant^{-1} ranged from 51-105 and days to maturity ranged from 110-127 days.

Screening (Morphological) of exotic chickpea lines for earliness and higher seed yield at BINA sub-station, Ishwardi

To select desirable lines with early maturity, high seed yield and tolerance to diseases, an experiment was set up at BINA sub-station, Ishwardi during Rabi 2023-24. Intercultural operations like weeding, thinning, application of pesticides, etc., were done for the proper growth and development of plants in each plot. Harvesting was done depending on the maturity of the lines. Forty-six lines were used in this experiment based on their yield and yield contributing character. Among 46 exotic chickpea lines and check variety (Binasola-8), 34 lines were selected. Maximum and minimum pod plant^{-1} was observed in exotic line ICCV 191326 (75.77) and ICCV 181117 (55.23) respectively. Days to maturity ranged from 123-138 days. Better performed exotic lines with yield and days to maturity will be used for further varietal improvement programs.

Screening (Morphological) of exotic chickpea lines for early maturity and higher yield at BINA sub-station, Magura

To select desirable lines with early maturity and high seed yield an experiment was set up at BINA sub-station, Magura during Rabi 2023-24. Intercultural operations like weeding, thinning, application of pesticides, etc., were done for the proper growth and development of plants in each plot. Harvesting was done depending on the maturity of the lines. Seventy lines were used in this experiment based on their yield and yield contributing character. Among 70 lines, exotic chickpea lines and check variety (Binasola-8), 41 lines were selected on basis of days to maturity and no. of pods plant^{-1}. Maximum and minimum pods plant^{-1} was observed in exotic line ICCV 181603 (72.42) & ICCV 171118 (54.34) respectively. Days to maturity ranged from 121-135 days. Better performed exotic lines with yield and days to maturity will be used for further varietal improvement programs.

Pigeon pea

Project: Varietal improvement of pigeon pea using mutation breeding techniques

Growing of M_5 generation of pigeon pea

Dose wise seventeen mutant varieties were grown at BINA Headquarter farm during July 2023-24. Intercultural operations like weeding, thinning, application of pesticides, etc., were done for the proper growth and development of plants in each plot. Harvesting was done depending on the maturity of the lines. Data on days to maturity, plant height, number of primary branches, Days to flowering (50%), no. of pods plant^{-1}, no. of seeds pod^{-1}, 100 seed wt. (g) and seed yield (tha^{-1}) were recorded from 10 randomly selected plants. Ten mutant variants were selected based on shorter plant height, higher seed yield and disease tolerance for further evaluation. M_5-P-22(1) takes only 252 days to maturity and showed the highest number of pods plant^{-1} (2258). Further experiment will be conducted in the next season.

Growing of M_2 generation of pigeon pea

Dose wise twenty-five mutant lines were grown at BINA Headquarter farm during July 2023-24. Fourteen mutant lines were selected based on shorter plant height, higher seed yield and disease tolerance for further evaluation. Data on days to maturity, plant height, number of primary branches, Days to flowering (50%), no. of pods plant^{-1}, no. of seeds pod^{-1}, 100 seed wt. (g) and seed yield (tha^{-1}) were recorded from 10 randomly selected plants from each plant. N-P-150(37) took 240 days to maturity and showed the highest number of pods plant^{-1} (2165). Further experiment will be conducted in the next season.

Garden pea

Project: Varietal improvement of garden pea using mutation breeding techniques

Growing of M_4 generation of garden pea

Dose wise forty mutant lines were grown at BINA sub-station, Ishwardi during Rabi season 2023-2024. Eighteen mutant lines were selected based on bolder seed size, higher seed yield and disease tolerance for further evaluation. Normal intercultural practices were done. Data on days to maturity, Days to flowering (50%) and no. of pods plant^{-1} were recorded from 10 randomly selected plants. Among all mutants, Motorshuti (40Gy)-1(1)/P-1 showed the highest number of pods plant^{-1} (15) and earliest (53 days) than others mutants and check variety BARI Motor-3 (Control). Further evaluation will be conducted in the next season.

Growing of M_2 generation of garden pea

Dose wise bulk seeds were sown at BINA sub-station, Ishwardi during Rabi season 2023-24. Intercultural operations like weeding, thinning, application of pesticides, etc., were done for the proper growth and development of plants in each plot. Harvesting was done depending on the maturity of the lines. Dose wise thirty mutant lines were selected based on bolder seed size,

higher seed yield and disease tolerance for further evaluation. Normal intercultural practices were done.

Growing of M_1 generation of garden pea

Seeds of BARI Motor-3 and BARI Motor-2 were irradiated with Co_{60} gamma rays. Irradiation doses were 20, 40, 60 and 80Gy at BINA sub-station, Ishwardi during Rabi season 2023-24. Normal intercultural practices were done. Dose wise bulk seeds were collected.

Oilseeds
Rapeseed-Mustard

Project: Varietal improvement of rapeseed-mustard through induced mutation and other advanced breeding techniques

On-station and on-farm yield trial with M_8 rapeseed (*B. rapa* var. *toria*) mutants

Two rapeseed (*B. rapa* var. *toria*) mutants (RT-35 and RT-38) along with two check varieties Tori-7 and BARI Sarisha-17 were evaluated to assess overall performance for earliness and yield attributes. This trial was conducted at BINA Headquarters farm, Mymensingh, BINA Sub-station farms at Rangpur, Ishwardi, Magura, Jamalpur, Nalitabari and farmer's field at Tangail & Manikgonj. The experiment was laid out in a randomized complete block design with three replications. Seeds were sown on 01 November 2023 at all the locations. Unit plot size was $20m^2$ (4m × 5m) and line to line distance was 25cm. Recommended production packages i.e., application of fertilizers, weeding, thinning, etc. were followed to ensure normal plant growth and development. Data on plant height, branches $plant^{-1}$, siliquae $plant^{-1}$ and seeds $siliqua^{-1}$ was taken from 10 randomly selected plants from each plot. Maturity period was counted when 90% siliquae were matured in a plot. Seed yield of each plot was recorded after harvest with proper drying and then converted into kg ha^{-1}. Appropriate statistical analyses were performed for comparison of mean of each character.

Significant variation was observed among the lines and check varieties for most of the characters in each location and combined over all locations. Average maturity period ranged from 78 to 84 days. BARI sarisha-17 required longest maturity period of 84 days and RT-38 required the earliest 80 days, whereas Tori-7 required 78 days. In case of plant height, RT-38 produced the tallest plant (110.17cm) followed by RT-35 (104.83cm). RT-35 and RT-38 produced the highest number of branches $plant^{-1}$ (7) and other genotypes had similar number of branches $plant^{-1}$ (5-6). RT-38 produced the highest number of siliquae $plant^{-1}$ (145) followed by RT-35 (135). The number of seeds $siliquae^{-1}$ and siliquae length is a good indicator for contributing seed yield. The longest siliquae was found in RT-38 (5.27cm) whereas; the shortest (3.40cm) was in Tori-7. Among the genotypes, mutant RT-38 produced highest seed yield 1301 kg ha^{-1} followed by RT-35 (1191 kg ha^{-1}) which was statistically different from seed yield of check variety BARI Sarisha-17 (1194 kg ha^{-1}). The mutant RT-38 will be applied to the NSB for release as a new variety.

Regional yield trial with M_7 rapeseed (*B. napus*) mutants

Five rapeseed mutants (RM-28, RM-34, RM-35, RM-39 and RMT-14) along with the two check varieties BINA Sarisha12 and Binasharisha-9 were taken in the present investigation to assess

overall performance for earliness and yield attributes. This trial was conducted at BINA HQs farm, Mymensingh and BINA sub-station farms at Ishwardi, Magura, Noakhali and Satkhira. The experiment was laid out in a randomized complete block design with three replications. Seeds were sown on 01 November 2023 at all locations. Unit plot size was $20m^2$ (4m×5m) and line to line distance was 25cm. Recommended production packages i.e., application of fertilizers, irrigation and pesticide, weeding, thinning, etc. were followed to ensure normal plant growth and development. Data on plant height, branches $plant^{-1}$, siliquae $plant^{-1}$, siliqua length and seeds $siliqua^{-1}$ was taken from 10 randomly selected plants from each plot. Maturity period was counted when 90% siliquae were matured in a plot. Seed yield of each plot was recorded after harvest and proper drying and then converted into kg ha^{-1}. Appropriate statistical analyses were performed for comparison of the mean of each character.

Significant variation was observed among the lines and checks variety for most of the characters in the individual locations and combined over all locations. On average, the maturity period ranged from 79 to 96 days. The check variety BINA Sarisha12 required the longest maturity period of 96 days and RM-27 required the shortest maturity period of 79 days. RM-34 (93cm) and BINA Sarisha12 (92cm) had the tallest plant height followed by RM-35 (89cm). Check variety Binasharisha-9 (80cm) was a comparatively dwarfed plant. The mutants RM-28, RM-35 and RM-39 produced a similar number of branches (5) which is higher than all other genotypes and check varieties. RM-39 produced the highest number of siliquae $plant^{-1}$ (67) followed by RM-34 and RM-35 which produced 63 and 62 siliqua $plant^{-1}$, respectively. Number of seeds $siliquae^{-1}$ and siliquae length is a good indicator contributing to seed yields. BINA sarisha12 produced the highest seed yield (1404kgha^{-1}) but among the five mutants and other check Binasarisha-9; RM-34 produced highest seed yield (1357kgha^{-1}) followed by RMT-14 (1312kgha^{-1}) and RM-35 (1256kgha^{-1}). It was concluded that the mutants RM-34, RM-35 and RMT-14 performed better than other mutants. Further trials will be needed to confirm the result.

Advanced yield trial with M_6 rapeseed (*B. campestris*) mutants

Four rapeseed mutants (RM-27, RMT-22, RMT-25 and RMT-26) along with the two check varieties BARI sarisha-14 and Binasarisha-11 was taken in the present investigation to assess overall performance for earliness and yield attributes. This trial was conducted at BINA HQs farm, Mymensingh and BINA sub-station farms at Rangpur, Cumilla, Nlitabari and BINA regional station Gazipur. The experiment was laid out in a randomized complete block design with three replications. Seeds were sown on 03-10 November 2023 at all locations. Unit plot size was $20m^2$ (4m×5m) and line to line distance was 25cm. Recommended production packages i.e., application of fertilizers, irrigation and pesticide, weeding, thinning, etc. were followed to ensure normal plant growth and development. Data on plant height, branches $plant^{-1}$, siliquae $plant^{-1}$, siliqua length and seeds $siliqua^{-1}$ was taken from 10 randomly selected plants from each plot. Maturity period was counted when 90% siliquae were matured in a plot. Seed yield of each plot was recorded after harvest and proper drying and then converted into kg ha^{-1}. Appropriate statistical analyses were performed for comparison of the mean of each character.

Significant variation was observed among the lines and checks variety for most of the characters in the individual locations and combined over all locations. On average, the maturity period ranged from 81 to 86 days. RMT-26 required the longest maturity period of 86 days and Binasarisha-11 required the shortest maturity period of 81 days. RMT-26 (117cm) and RMT-25

(113cm) had the tallest plant followed by RMT-22 (112cm). RMT-27 (108cm) had comparatively dwarf plant. The mutants RMT-22 and RMT-25 produced similar number of branches (6) which was the highest of all genotypes and check varieties. RMT-22 produced the highest number of siliqua plant^{-1} (135) followed by RMT-25 which produced 126 siliqua plant^{-1}. Two most important characters seeds siliqua^{-1} and siliqua length contribute to seed yield of rapeseed showed significant variations among the genotypes. RMT-22 produced the highest seed yield (1348 kgha^{-1}) followed by Binasarisha-11 (1185 kgha^{-1}) and BARI sarisha-14 (1122 kgha^{-1}).

Preliminary yield trial with M_6 rapeseed (*B. napus*) mutants

Six mutants (RM-12, RM-13, RM-15, RM-17, RM-19 and RT-39) and two checks (Binasarisha-9 and BARI Sarisha-18) were evaluated in this trial to assess overall performance for earliness and yield attributes. The trial was conducted at BINA Head quarter farm, Mymeningh and BINA Sub-station farm at Rangpur, Jamalpur and Nalitabari. This experiment was laid out in a randomized complete block design with three replications. Unit plot size was 16m^2 (4m × 4m) and line to line spacing was 25cm. Seeds were sown on 03-07 November 2023 at all locations. Production packages, data recording and statistical analysis were the same as followed in the first experiment. Significant variation was observed among the lines and check varieties for most of the characters in both of individual location and combined over location. Average maturity period ranged from 80 to 112 days. The check variety BARI Sarisha-18 required the longest maturity period of 112 days while RM-12 required the shortest maturity period of 80 days. RM-17 (114cm) and BARI Sarisha-18 (118cm) had produced the tallest plant followed by RM-13 (110cm). The mutants RM-13, RM-17 and RT-39 produced similar number of branches (3). Binasarisha-9 produced the highest number of siliquae plant^{-1} (89) followed by RM-17 and RM-19 which produced 69 and 79 siliqua plant^{-1}, respectively. BARI Sarisha-18 produced the highest seed yield (2004 Kg ha^{-1}) which was significantly different compared to the mutants with 112 days for maturity. Considering growth duration, agronomic performances and yield, RM-15 and RM-17 were selected as promising mutants for further breeding program of rapeseed.

Screening of mustard mutants for salinity tolerance in hydroponic culture

In hydroponic culture solutions, it is easy to maintain the accuracy of salinity in respective treatments. Thus, this study was aimed to find out the salt tolerant genotypes using hydroponic screening technique. Uniform seeds of RL-13, RL-14, RL-17 and Tori-7 were used in the present investigation. Salinity treatment (6, 8 and 10 dSm^{-1}) was applied after every seven days when the entire seedling was established in hydroponic culture. Data on various characters such as plant height, leaf number, leaf area, shoot and root dry weight were taken from five randomly selected plants of each tray at reproductive stage.

All the characters were sharply decreased due to salt injury. The plant height ranged from 32.3 to 49.9cm with a mean of 43.1cm in the control plants. However, at 8 dSm^{-1} salinity, the plant height ranged from 28.63 to 43.6cm with a mean of 33.8cm. Number of leaves per plant ranged from 14.0 to 19.3 with a mean of 15.2 in the control plants. At 8 dS m^{-1} salinity, that was reduced and found from 8.0 to 20.0 with a mean of 15.2; and 31.7-48.8 with a mean of 29.8 for leaf area (cm^2 plant^{-1}). Like other traits root and shoot dry weight also decreased due to salinity effect. Among the different plant characters, leaf number as well as leaf area was more sensitive to salinity than

others. RM-13 and RM-14 were found moderately salt tolerant than other genotypes and these two genotypes can be used as a breeding material for developing salt tolerant varieties in near future.

Screening of M_6 generation of rapeseed mutant

Eight rapeseed mutants (RMT-41, RMT-42, RMT-43, RMT-44, RMT-45, RMT-46, RMT-47 and RMT-48) along with the two check varieties Binasharisha-4 and Binasharisha-9 were taken in the present investigation. This trial was conducted at BINA HQS farm, Mymensingh. The experiment was laid out in a non-replicated design. Seeds were sown on 09 November 2023 at BINA HQS farm, Mymensingh. Plot size was $150m^2$ and line to line distance was 25cm. Recommended production packages i.e., application of fertilizers, irrigation and pesticide, weeding, thinning, etc. were followed to ensure normal plant growth and development. Data on plant height (cm), no. of branch plant^{-1}, siliqua length (cm), no. of silique plant^{-1}, no. of seed silique^{-1}, seed yield (kg ha^{-1}), 1000 seed weight (gm), days to flowering and days to maturity were taken from 5 randomly selected plants from each plot. Maturity period was counted when 90% siliqua was matured in a plot. Seed yield of each plot was recorded after harvest and proper drying and then converted into kgha^{-1}. Appropriate statistical analyses were performed for comparison of the mean of each character.

Significant variation was observed among the lines and check variety for most of the characters at BINA HQS farm, Mymensingh. On average, the maturity period ranged from 80 to 88 days. Binasarisha4 required the longest maturity period of 88 days and RMT-46 required the shortest maturity period of 80 days. RMT-45 and RMT-47 (117cm) produced the tallest plant followed by RMT-43 (113cm). RMT-46 (104cm) was a comparatively dwarfed plant. The mutants RMT-42 and RMT-48 produced a similar number of branches (7) which was higher than all other genotypes and check varieties. RMT-42 and RMT-48 produced the highest number of siliqua plant^{-1} (137) followed by Binasarisha-4 and Binasarisha-9 which produced 136 siliqua plant^{-1}, respectively. Number of seeds siliqua^{-1} and siliqua length is a good indicator contributing to seed yields**.** Maximum seeds siliquae^{-1} and siliquae length was obtained from RMT-42 and RMT-48 that was significantly different from other mutants and check. Among the genotypes, mutant RMT-42 produced higher seed yield of 1458 kg ha^{-1} which was statistically similar to seed yield of RMT-48 (1448 kg ha^{-1}). The mutants RMT-42 and RMT-48 have been selected for future trial based on their better yield performance.

Growing of F_5 to F_2 population of rapeseed generation

The objective of this research was to select desirable population on the basis of phenotypic performance for advancing the generation. A large number of F_5, F_4, F_3 and F_2 variants were developed from various cross between Binasarisha-9×BARI Sarisha-14, Binasarisha-9×Tori-7, Binasarisha-9×BARI Sarisha-18, Tori-7×BARI Sarisha-18 were grown at BINA Head quarter farm, Mymensingh. The seeds were sown during 4-6 November 2023. All the seeds were planted in 3m long five rows with 30cm row spacing. Recommended fertilizer was applied and necessary actions were taken to grow the crop uniformly.

Total sixty-three (63) segregating population were evaluated for yield and yield contributing characters. Among them twelve (30) were segregating families and other twenty five (32) were single plant. All of the segregating populations were obtained from earlier generation that had

been selected from previous trials, whereas single plant population was from earlier generation of F_4 to F_2. Seven (07) populations from F_5 and twelve (12) from F_4 were selected for future generation advancement. The selection was facilitated considered the early maturity period (79-82 days) with other yield contributing characters. Thirty-two (32) single plants have been evaluated and harvested separately for future utilization of varietal improvement program. A total of twenty (20) single plants were selected primarily for further selection that will be grown respective advance generation on the basis of their agronomic performances.

Growing of M_5 to M_2 generation of rapeseed mutants

A large number of M_5, M_4, M_3 and M_2 variants were developed from different irradiated materials were grown for selecting desirable mutant at BINA Head quarter's farm, Mymensingh. The seeds were sown during 4-6 November 2023. All the seeds were space planted in 3m long five rows with 30cm row spacing. Recommended fertilizer was applied and necessary steps were taken to grow the crop uniformly.

Total 100 segregating population was evaluated for yield and yield contributing characters. Among these, 30 segregating families (M_5 and M_4) and others were (70) single plant. All of these segregating populations were obtained from earlier generation, that have been selected from previous trials, whereas, single plant population was from earlier generation of M_3 and M_2. Total six (06) populations from M_5 and fourteen (14) from M_4 were selected for future advancement of generation. The basis of the selection was considering the maturity period (78-83 days) with other yield contributing characters. From various early generation single plant also selected considering maturity period, seed color, no. of silique and other agronomic traits. Seventy (70) single plants also evaluated and harvested separately for future utilization of varietal improvement program. From all of these variants a total of forty-five (45) single plants have been selected primarily. For further selection the selected mutants will be grown for respective advance generation based on their agronomic performances.

Growing of M_1 generation of rapeseed

The well dried seed of BARI Sarisha-18, Binasarisha-11, Binasarisha-9 and Tori-7 were used for the advancement of new generation. Thirty seeds were exposed to four doses of gamma rays (500, 600, 700, and 800 Gy). Prior to mutagenic treatment, seeds were kept in desiccators for moisture equilibration. The seeds were irradiated by gamma rays (^{60}Co irradiator) at BINA Mymensingh. The response variables, percent germination and survival rate were recorded after 21 days of sowing.

Hybridization of Tori-7 × Binasarisha-11 and BARI Sarisha-18 × Binasarisha-9

The aim of this study is to create genetic variability for varietal development process of rapeseeds. Binasarisha-9 was crossed with BARI Sarisha-18. The seeds were sown on 10 days interval from 4-13 November 2023. In early morning the recipient parent was emasculated and pollinated by the respective donor parents followed by bagging and tagging. After 3-5 days the bag was removed and seed setting siliqua was considered as success of cross.

Maximum cross was conducted between Binasarisha-9×BARI Sarisha-18 followed by Tori-7 × Binasarisha-11 and success rate were higher in Binasarisha-9×BARI Sarisha-18, 50%. F_1 seeds were harvested separately for growing F_2 population.

Groundnut

On- station and on-farm yield trial with bold seeded groundnut mutants

The experiment evaluated six mutant groundnut lines alongside three check varieties (Binachinabadam-4, BARI Chinabadam-8, and BARI Chinabadam-9) through on-farm and on-station trials conducted at BINA sub-station in Rangpur, Khagrachari, and Ishwardi, as well as various farmer fields at Ishwardi, Char Kalibari, Gangachara, Hossenpur, Lalmonirhat and Panchagar, during the Kharif-II season of 2023. Utilizing a randomized complete block (RCB) design with three replications, each plot measured 3.0 m × 3.0 m, with seeds sown at a density of 15 cm within rows spaced 30 cm apart. Fertilizer recommendations were followed, and irrigation was unnecessary due to sufficient rainfall. Key parameters such as plant height, pod number, pod yield per plant, and 100-pod and kernel weight were recorded from ten competitive plants at maturity. The results indicated significant variations among the lines and check varieties in terms of yield and related traits. Mutant BCB-4-2-2 consistently performed well in yield across most locations, achieving an average yield of 2.95 tha^{-1}, higher than all check varieties. The check variety Binachinabadam-4 exhibited the highest plant height (61.07 cm) and pod number per plant (21.32), while mutant BCB-3-1-2 demonstrated superior 100-pod weight (121.21 g) and shelling percentage (70.60%). Given its high yield, shelling percentage, and overall performance, BCB-4-2-2 has been released as a new variety, BINA Chinabadam-12, suitable for Rabi and Kharif seasons across all groundnut-growing regions in Bangladesh. This research was part of a project focused on developing climate-resilient crop varieties and enhancing agricultural productivity in diverse environments under the Ministry of Agriculture.

Regional yield trial with bold seeded mutants of groundnut

The experiment aimed to identify high-yielding mutant lines of groundnut, specifically BCB-4-2-2, over the standard varieties Binachinabadam-4 and BARI Chinabadam-8. The experiment conducted at five locations BINA Headquarters, Mymensingh, BINA Sub-station, Rangpur, and two farmer fields in Ishwardi. Using a randomized complete block design (RCBD) with three replications, each plot measured 4.0 m × 3.0 m, with seeds sown 15 cm apart in rows spaced 30 cm apart. Recommended fertilizer doses and cultural practices were adhered to, and data on plant height, pod number, pod yield per plant, and 100-pod and kernel weights were recorded from ten competitive plants at maturity. Significant variations were observed among the mutants and the check varieties. The mutant BCB-4-2-2 exhibited the highest pod number per plant (17.18) and shelling percentage (68.77%), surpassing the checks. Additionally, BCB-4-2-2 yielded 2.67 tha^{-1}, outperforming both Binachinabadam-4 (2.51 tha^{-1}) and BARI Chinabadam-8 (2.50 tha^{-1}). Although other mutants showed well performance, BCB-4-2-2 demonstrated the best performance across environments, suggesting its potential as a new variety for groundnut cultivation in Bangladesh. This research contributes to enhancing groundnut production through the development of superior mutant varieties suited for diverse agro-ecological conditions.

Advanced yield trial with bold seeded mutants of groundnut

The experiment aimed to evaluate nine mutant groundnut lines alongside the check variety Binachinabadam-10 across five locations: BINA Headquarters, Mymensingh, and BINA substations in Rangpur, Khagrachari, and Ishwardi, as well as a farmer's field in Mymensingh. The experiment, conducted in a randomized complete block design (RCBD) with three replications, utilized a plot size of 3.0 m × 3.0 m, with seeds sown 15 cm apart in rows spaced 30 cm apart. No irrigation was required due to adequate rainfall. Data were collected on plant height, pod number, pod yield per plant, and 100-pod and kernel weights from ten randomly selected competitive plants at maturity. Significant variations were observed among the mutants and the check for most traits across locations. The average plant heights ranged from 65.69 cm to 84.6 cm, with the check variety Binachinabad-10 yielding the highest pod number per plant (25.35). The mutant BCB-BB-GC-1-4 recorded the highest 100-pod weight (118.42 g), while BCB-GC-MY-9 and BCB-BB-B4-7 exhibited the highest 100-kernel weights (44 g and 44.3 g, respectively). The mutant BCB-GC-MY-8 demonstrated a shelling percentage of 59.12%, significantly higher than the check. Additionally, BCB-BB-B4-7 and BCB-M-MY-5 achieved the highest yields (3.56 tha^{-1} and 3.52 tha^{-1}) compared to Binachinabad-10 (3.36 tha^{-1}). This research highlights the potential of mutants BCB-BB-GC-1-4, BCB-GC-MY-9, BCB-BB-B4-7, BCB-GC-MY-8, and BCB-M-MY-5 for further evaluation in subsequent growing seasons.

Screening of F_2 & F_3 populations of groundnut for long and bigger pods with 3-4 kernels

The objective of this research was to select desirable population on the basis of phenotypic performance for advancing the generation. A large number of F_3 and F_2 variants were developed from various cross between four groundnut parent genotypes viz., GC-1, Binachinabadam-4, Morocco and Myanmar Badam at BINA Head quarter farm, Mymensingh, during the period of August 2022 to December 2023. Recommended fertilizer was applied and necessary actions were taken to grow the crop uniformly.

Total fourty five (45) segregating population was evaluated for yield and yield contributing characters. All of the segregating populations were obtained from earlier generation that had been selected from previous trials. Fifteen (15) from F_3 were selected for future generation advancement. The selection was facilitated considered the early maturity period with other yield contributing characters

Screening of M_2 and M_3 populations of groundnut for long and bigger pods with 3-4 kernels.

To create genetic variability, seeds of five groundnut variety Lory, Binachinabadam-9, BARI Chinabadam-11 and GC-1were irradiated with physical (150, 180, 200 and 250 Gy) mutagen. Seed were sown at BINA HQSs farm, Mymensingh. The experiment was followed by non-replicated design and sown separately (variety and dose wise). Survived plants produced seeds were harvested separately for growing M_3 and M_4 generation.

Maintenance of groundnut mutant germplasm

Sixty-two germplasm were grown at BINA Headquaters, Mymensingh. After harvest, seeds of all germplasm were collected and preserved as breeding materials.

Sesame

Project: Varietal improvement of sesame through induced mutation and other advanced breeding techniques

On-station and on-farm yield trial with M_8 sesame mutants

Two promising mutants (SM-25 & SM-27) along with two check varieties Binatil-1 and BARI til-5 were evaluated through this trial. This experiment was conducted at BINA HQS, Mymensingh, BINA sub-station farms at Ishwardi, Magura & Chapainowabgonj, farmer's field at Ishwardi, Cumilla, & Magura during March to June 2024. The mutants and the check variety were laid out in a randomized complete block design with three replications. Unit plot size was $20m^2$ (4m × 5m) and line to line spacing was maintained 25cm. Seeds were sown on 03-07 March 2024. Recommended production packages like application of recommended doses of fertilizers, irrigation, weeding, thinning, etc. were followed to ensure normal plant growth and development. Data were taken on plant height, number of branches $plant^{-1}$, number of capsules $plant^{-1}$ and number of seeds $capsule^{-1}$ from 10 randomly selected plants of each plot. Maturity period was counted when 80% capsules were matured and most of the plants turned into straw or yellowish color in each plot. Seed yield of each plot was converted into kg ha^{-1}. Appropriate statistical analyses were performed for comparison of mean of each character.

Significant variations were found among the mutants and the check variety for most of the characters in both of individual location and combined over locations. No-significant variation was observed for days to maturity, branches $plant^{-1}$ (no.) and capsule length (cm). On an average, days to maturity ranged from 84 to 88 days. The mutant SM-25 & SM-27 matured earlier (84 days) than the check varieties Binatil-1 (87 days) & BARI Til-5 (88 days). Binatil-1 produced the tallest (102cm) plant and mutant SM-27 produced the shortest plant height of 93cm followed by BARI Til-5 (94) and the mutant SM-25 (95cm). BARI Til-5 produced 3 branches where the mutant SM-27 bear 2 branches but the mutant SM-25 and the check variety Binatil-1 were uniculm type. BARI Til-5 produced significantly higher number of capsules $plant^{-1}$ (56) followed by the mutant SM-27 (47) and SM-25 (46cm). BARI Til-5 produced only 38 number of capsules $plant^{-1}$. The mutant SM-25 had the highest number of seeds $capsaules^{-1}$ (71) with long capsule (3.41cm) size followed by BARI Til-5 (70). The mutant SM-25 had 67 number of seeds $capsaules^{-1}$ with 3.02cm long where as Binalit-1 had 66 numbers of seeds $capsaules^{-1}$ with 3.49cm capsule length. On an average, SM-25 produced the highest seed yield of 1357 kg ha^{-1} followed by the check variety BARI Til-5 (1279 kg ha^{-1}) and the mutant SM-27 produced lowest seed yield of 1153 kg ha^{-1}. Location-wise performance showed that the highest seed yield was produced at BINA sub-station field, Ishwardi (1378kg ha^{-1}) followed by farmer's Field Ishwardi (1301kg ha^{-1}). From this trial it was observed that, white seed-coated SM-25 was the best mutant among the mutants and check. This mutant has been released as new variety BINA Til6.

On-station yield trial with M_7 sesame mutants

Three promising mutants along with two check varieties Binatil-4 and BARI til-4 were evaluated through this trial. This experiment was conducted at BINA HQs farm Mymensingh and BINA Sub-station's farm at Ishwardi, Magura and Chapainowabgonj during March to June 2024. The mutants and the check varieties were laid out in a randomized complete block design with three replications. Unit plot size was $20m^2$ (4m × 5m) and line to line spacing was maintained 25cm.

Seeds were sown on March 2024. Recommended production packages like application of recommended doses of fertilizers, irrigation, weeding, thinning, etc. were followed to ensure normal plant growth and development. Data were taken on plant height, number of branches plant^{-1}, number of capsules plant^{-1} and number seeds capsule^{-1} from 10 randomly selected plants from each plot. Maturity period was counted when 80% capsules were matured and most of the plants turned into straw or yellowish color in each plot. Seed yield of each plot was converted into kg ha^{-1}. Appropriate statistical analyses were performed for comparison of means of each character.

Significant variations were observed among the mutants and two checks for most of the characters in both of individual locations and combined over locations. Days to maturity ranged from 83 to 96 days in different locations. Mutant ESE-03 (111cm) and check varieties Binatil-4 (111cm) and BARI til-04 (116cm) produced comparatively the tallest plant whereas mutant's ESE-01 (106cm), ESE-04 (107cm) and ESE-06 (106cm) produced the shortest plant height. Both the mutants and checks were profusely branched and ESE-03 produced maximum (3.03) branches plant^{-1} followed by the other mutants and check varieties (2.92) whereas the lowest from ESE-01 (2.38). Binatil-4 produced significantly higher number of capsules plant^{-1} (61) followed by mutants ESE-06 (59) and ESE-03(58) which is statistically different from ESE-01 (44) and ESE-04 (49). The check variety BARI til-4 produced the highest number of seeds capsaule^{-1} (99) followed by the mutant ESE-03 (89). Binatil-4 had long capsule length (2.69cm) and ESE-01 also comparatively long capsule length (2.55cm) than others. Highest thousand seed weight (3.03g) in ESE-03, which is statistically identical from others. On an average, Mutants ESE-03 and ESE-06 produced the highest seed yield of (1300 kg ha^{-1}) and (1289 kg ha^{-1}), respectively followed by check varieties Binatil-4 (1270 kg ha^{-1}) and BARI til-4 (1276 kg ha^{-1}). Location-wise performance showed that the highest seed yield was produced at BINA sub-station Jamalpur (1278 kg ha^{-1}) followed by BINA sub-station Magura (1244 kg ha^{-1}) and BINA HQS farm, Mymensingh (1231 kg ha^{-1}). From this result, it was concluded that mutants ESE-03 and ESE-06 performed better in yield and other yield contributing characters. Further trials will be needed to confirm this result.

Advanced yield trial with promising M_7 sesame mutants

Three promising mutants (SHM-1, SHM-2 and SHM-3,) along with two check varieties Binatil-1 and BARI Til-5 were evaluated through this trial. This experiment was conducted at BINA Sub-station's farm at Ishwardi and Magura, Cumilla & Nalitabari during March to June 2024.The mutants and the check variety were laid out in a randomized complete block design with three replications. Unit plot size was 12m^2 (4m × 3m) and line to line spacing was maintained 25cm. Seeds were sown on 06 March 2024. Recommended production packages like application of recommended doses of fertilizers, irrigation, weeding, thinning, etc. were followed to ensure normal plant growth and development. Data were taken on plant height, number of branches plant^{-1}, number of capsules plant^{-1} and number seeds capsule^{-1} from 10 randomly selected plants from each plot. Maturity period was counted when 80% capsules were matured and most of the plants turned into straw or yellowish color in each plot. Seed yield of each plot was converted into kg ha^{-1}. Appropriate statistical analyses were performed for comparison of means of each character.

Significant variations were observed among the mutants and check for most of the characters in both of individual locations and combined over locations. Days to maturity ranged from 86 days (Binatil-1) to 98 days (SHM-1). The mutants SHM-3 produced the tallest plant (115cm) followed by BARI Til-5 (113cm) whereas mutant SHM-1 produced the shortest plant height (103cm). The check variety Binatil-1 is unicalm but the mutants and other check were profusely branched and SHM-1, SHM-2 and BARI Til-5 provided maximum (3) branches plant^{-1} and the mutant SHM-3 produced minimum branches (2). BARI Til-5 produced the highest number of capsules plant^{-1} (64) followed by the mutant SHM-2 (61). Binatil-1 produced significantly higher number of seeds capsaule^{-1} (92) followed by BARI Til-5 (83) and mutant SHM-2 (82). The lowest number of capsules plant^{-1} (62) was obtained from SHM-3. Binatil-1 had long capsule length (2.54cm) and lowest capsule length had observed in SHM-1 (2.15cm). Highest thousand seed weight (3.23g) found in SHM-2, which is statistically deferential from others. On an average, mutants SHM-2 produced the highest seed yield of (1266 kg ha^{-1}) followed by BARI Til-5 (1264kg ha^{-1}) and Binatil-1 (1242kg ha^{-1}). Location-wise performance showed that the highest seed yield was produced at BINA sub-station Magura (1185kg ha^{-1}) followed by BINA sub-station Ishwardi (1174kg ha^{-1}) and BINA sub-station Nalitabari (1172kg ha^{-1}).

Regional yield trial with M_6 sesame mutants

Four promising mutants (SES-05, SES-08, SES-10 and SES-11) along with two check varieties Binatil-4 & BARI til-6 were evaluated through this trial. This experiment was conducted at BINA Sub-station's farm at Ishwardi and Rangpur during March to June 2024. The mutants and the check varieties were laid out in a randomized complete block design with three replications. Unit plot size was 12m^2 (4m × 3m) and line to line spacing was maintained 25cm. Seeds were sown on 03-06 March 2024. Recommended production packages like application of recommended doses of fertilizers, irrigation, weeding, thinning, etc. were followed to ensure normal plant growth and development. Data were taken on plant height, number of branches plant^{-1}, number of capsules plant^{-1} and number seeds capsule^{-1} from 10 randomly selected plants from each plot. Maturity period was counted when 80% capsules were matured and most of the plants turned into straw or yellowish color in each plot. Seed yield of each plot was converted into kg ha^{-1}. Appropriate statistical analyses were performed for comparison of means of each character.

Significant variations were observed among the mutants and check for most of the characters in both of individual locations and combined over locations. Days to maturity ranged from 88 days (SES-10) to 92 days (SES-11). Mutants SES-11 produced the tallest plant (108cm) whereas mutant SES-08 produced the shortest plant height (95cm). The mutant SES-08 is unicalm but the other mutants and check were profusely branched and BARI Til-6 provided maximum (4) branches plant^{-1} followed by the mutant SES-05, SES-11 and Binatil-4 (3). Mutant SES-11 produced significantly higher number of capsules plant^{-1} (61) which is statistically different from others. The lowest number of capsules plant^{-1} (43) was obtained from SES-10. Mutant SES-11 produced the highest number of seeds capsaule^{-1} (83) followed by the BARI Til-6 (77) and mutant SES-05 (76). Mutant SES-08 had long capsule length (3cm) and highest thousand seed weight (3.27g) in SES-11, which is statistically identical from others. On an average, Mutants SES-11 produced the highest seed yield of (1372 kg ha^{-1}) followed by mutants SES-05 (1356kg ha^{-1}) and lowest seed yield was produced by SES-10 (1107kg ha^{-1}). Location-wise performance showed

that the highest seed yield was produced at BINA HQS farm, Mymensingh (1314kg ha^{-1}) followed by BINA sub-station Ishwardi (1274kg ha^{-1}).

Preliminary yield trial with promising M_6 sesame mutants

Five promising mutants (SKM-1, SKM-2, SKM-3, SKM-4 & SKM-5) along with two check varieties Binatil-1 & Binatil-2 were evaluated through this trial. This experiment was conducted at BINA H.Q. Mymensingh and BINA Sub-station's farm at Chapainawabgonj and Magura during March to June 2024. The mutants and the check variety were laid out in a randomized complete block design with three replications. Unit plot size was $12m^2$ (4m × 3m) and line to line spacing was maintained 25cm. Seeds were sown on 03-06 March 2024. Recommended production packages like application of recommended doses of fertilizers, irrigation, weeding, thinning, etc. were followed to ensure normal plant growth and development. Data were taken on plant height, number of branches $plant^{-1}$, number of capsules $plant^{-1}$ and number seeds $capsule^{-1}$ from 10 randomly selected plants from each plot. Maturity period was counted when 80% capsules were matured and most of the plants turned into straw or yellowish color in each plot. Seed yield of each plot was converted into kg ha^{-1}. Appropriate statistical analyses were performed for comparison of means of each character.

Significant variations were observed among the mutants and check for most of the characters in both of individual locations and combined over locations. Days to maturity ranged from 92 days (SKM-1) and Binatil-2 to 95 days (SKM-5). Mutants SKM-4 produced the tallest plant (114cm) whereas mutant Binatil-2 produced the shortest plant height (101cm). The mutant SKM-5 and Binatil-1 are unicalm but the other mutants and check was profusely branched and SKM-1, SKM-2 & SKM-4 provided maximum (3) branches $plant^{-1}$. Binatil-1 produced significantly higher number of capsules $plant^{-1}$ (66) followed by the mutant SKM-2 (65) and SKM-4 (64). The lowest number of capsules $plant^{-1}$ (46) was obtained from SKM-5. Mutant SKM-4 produced the highest number of seeds $capsaule^{-1}$ (83) followed by Binatil-1 (80), SKM-2 (79) and SKM-1 (78). Binatil-1 had long capsule length (2.95cm) and Binatil-2 had short capsule length (2.29cm). The highest thousand seed weight (3.23g) in SKM-1 followed by Binatil-1 and SKM-4 (3.19). On an average, Mutants SKM-4 produced the highest seed yield of (1396 kg ha^{-1}) followed by SKM-2 (1379 kg ha^{-1}) and Binatil-1 (1378 kg ha^{-1}). Location-wise performance showed that the highest seed yield was produced at BINA HQS farm, Mymensingh (1361kg ha^{-1}) followed by BINA sub-station Chapainawabgon (1306kg ha^{-1}).

Growing of M_5 to M_2 generation of sesame mutants

A large number of M_6, M_5, M_4, M_3 and M_2 variants were developed from different irradiated materials were grown for selecting desirable mutant at BINA Head Quarter farm, Mymensingh. The seeds were sown during March 2023. All the seeds were space planted in 3m long five rows with 25cm row spacing. Recommended fertilizer was applied and necessary steps were taken to grow the crop uniformly. Total 75 segregating population was evaluated for yield and yield contributing characters. Among these, 25 segregating families (M_5 & M_4) and others were (50) single plant. All of these segregating populations were obtained from earlier generation, that have been selected from previous trials, whereas, single plant population was from earlier generation of M_4, M_3 and M_2. Total four (04) populations from M_5 and six (06) from M_4 were selected for future advancement of generation. The basis of the selection was considering the maturity period

(84-95 days) with other yield contributing characters. From various early generation single plant also selected considering maturity period, seed color, no. of capsule and other agronomic traits. Twenty two single plants was also selected and harvested separately for future utilization of varietal improvement program. From all of these variants a total of thirty two (32) were selected primarily for further selection that will be grown for respective advance generation on the basis of their agronomic performances.

Growing of M_1 population

To create genetic variability, seeds of popular sesame varieties Binatil-1, Binatil-2 and BARI til-5 were irradiated earlier with 600, 700 and 800Gy of gamma rays. Seeds were sown on 04 April 2024 at BINA HQS farm, Mymensingh. This experiment was followed by non-replicated design and sown separately (variety and dose wise). Finally, the survived plants that produced seeds were harvested separately for growing M_2 population.

Hybridization of sesame

The aim of this study is to create genetic variability for varietal development process of sesame. Binatil-2 was crossed with BARI Til-4, local atshira, SM-26, BINA Til5 and vise-versa. The seeds were sown on 10 days interval from 4-13 November 2023. In early morning the recipient parent was emasculated and pollinated by the respective donor parents followed by bagging and tagging. After 3-5 days the bag was removed and seed setting siliqua was considered a success of cross. F_1 seeds were harvested separately for growing F_2 population.

Soybean

Project: Varietal improvement of soybean through induced mutation

On-station and on-farm yield trial with selected M_8 soybean mutants

Three promising mutants (SBM-22, SBM-23 and SCM-11) along with two checks Binasoybean-5 and BARI Soybean-6 were evaluated through this trial. The experiment was conducted at BINA HQS farm Mymensingh, BINA sub-station farms at Barishal and farmers' field at Subornochor, Kamalnagar, Haimchar and Barishal during January to April 2024. This experiment was laid out in a randomized complete block design with three replications. Sowing was done within first week of January. Spacing between rows was 30cm and 5-8cm between plants in a row. Unit plot size was $20m^2$ (5m × 4m). Recommended management practices were followed to ensure proper growth and development of plants. Data on various characters such as plant height, number of branches $plant^{-1}$, pods $plant^{-1}$ and seeds pod^{-1} were taken from 10 randomly selected plants of each plot. Maturity period was counted when the plant and pods of each plot turned into yellowish brown color and almost all the leaves spill. Seed yield of each plot was recorded and converted into kg ha^{-1}. Data recorded from the experiment was analyzed following appropriate statistical analysis.

Significant variations were observed among the mutants and check varieties for most of the characters in both of individual locations and combined over locations. On an average, maturity period ranged from 106 to 130 days and there were no statistical differences among the mutants and check varieties. The mutant SBM-23 was earlier than others and it required 106 days to mature where the mutants SCM-11 & SBM-22 required highest 120 & 130 days to mature,

respectively. Binasoybean-5 & BARI soybean-6 required 109 days to mature. Plant height ranged from 46cm in SBM-23 to 100cm in SBM-22. There were no significant differences for Branches plant^{-1} among the mutants and check varieties. The mutant SBM-22, SCM-11, Binasoybean-5 & BARI soybean-6 produced the highest number of branches plant^{-1} (4) and the mutant SBM-23 produced lowest number of branches plant^{-1} (2). The mutant SBM-22 produced highest (78) numbers of pods plant^{-1} and two check varieties BARI Soybean-6 and Binasoybean-5 produced 71 & 70 pods plant^{-1}, respectively. Pod length ranged from 3.28cm (Binasoybean-5) to 2.62cm (SBM-23). The highest hundred seed weight was found from the mutants SBM-11 (17.64g) followed by SBM-23 (12.18g). Mutant SCM-11 produced the highest seed yield of 3055 kg ha^{-1} followed by two check varieties Binasoybean-5 (2827 kg ha^{-1}) and BARI Soybean-6 (2848 kg ha^{-1}). Among the locations the highest seed yield was obtained from BINA sub-station farm Barishal (2829 kg ha^{-1}) followed by farmer's field Subornochor (2786 kg ha^{-1}) & Kamalnagar (2761 kg ha^{-1}). From this trial, it was observed that SCM-11 showed better yield performance than other mutant and check varieties.

Regional yield trial with selected M_7 soybean mutants

Four promising mutants (SCM-5, SCM-8, SCM-15 and SCM-17) along with check varieties Binasoybean-6 & Lokon were evaluated through this trial. This experiment was conducted at BINA HQS farm Mymensingh and BINA Sub-station farms at Barishal & Satkhira during January to April 2024. This experiment was laid out in randomized complete block design with three replications. Sowing was done on 1st week of January 2024. Spacing between rows was 30cm and 7-10cm between plants in a row. Unit plot size was 12m^2 (4m × 3m). Recommended management practices were followed to ensure proper growth and development of plants. Data on various characters such as plant height, number of branches plant^{-1}, pods plant^{-1} and seeds pod^{-1} were taken from 10 randomly selected plants of each plot. Maturity period was counted when the plant and pods of each plot turned into yellowish brown color and almost all the leaves shed. Seed yield of each plot was recorded and converted into kg ha^{-1}. Data recorded from the experiment were analyzed following appropriate statistical design.

On an average, maturity period ranged from 115 days (SCM-5) to 134 days (SCM-08). Plant height ranged from 33cm (SCM-11) to 105cm (Lokon) and branches plant^{-1} ranged from 1 (SCM-17 & Lokon) to 4 (SCM-8 & Binasoybean-6). The mutant SCM-5 produced highest number of pods plant^{-1} (69); whereas, the mutant SCM-15 & SCM-17 produced lowest number of pods plant^{-1} (23). SCM-5 had the highest pod length (2.93) followed by Binasoybean-6 (2.92) and the mutants SCM-15 had the lowest pod length (2.25). Hundred seed weight was higher in SCM-5 (15.40g) and lower hundred seed weight was obtained from Lokon (11.57g). Seed yield obtained from the mutants and checks significantly differed from each other. Mutant SCM-5 produced the highest seed yield of 2517 kg ha^{-1} followed by SCM-15 (2153 kg ha^{-1}) and the check variety Binasoybean-6 produced 2169 kg ha^{-1}. Among the locations the highest seed yield was obtained from BINA HQS farm Mymensingh (2100 kg ha^{-1}) followed by the BINA sub-station farm at Barishal (1998 kg ha^{-1}) and Satkhira (1968 kg ha^{-1}). From this experiment, it concluded that SCM-5 was performed better than other mutants and the check. Further trials will be needed to confirm the result.

Preliminary yield trial with selected M_6 soybean mutants

Six promising mutants (SBM-31, SBM-32, SBM-33, SBM-34, SBM-35 and SBM-36) along with check variety Binasoybean-3 were evaluated through this trial. This experiment was conducted at BINA HQS farm Mymensingh and BINA Sub-station farms at Barishal & Satkhira during January to April 2024. This experiment was laid out in randomized complete block design with three replications. Sowing was done on 1st week of January 2024. Spacing between rows was 30cm and 7-10cm between plants in a row. Unit plot size was $12m^2$ (4m × 3m). Recommended management practices were followed to ensure proper growth and development of plants. Data on various characters such as plant height, number of branches $plant^{-1}$, pods $plant^{-1}$ and seeds pod^{-1} were taken from 10 randomly selected plants of each plot. Maturity period was counted when the plant and pods of each plot turned into yellowish brown color and almost all the leaves shed. Seed yield of each plot was recorded and converted into kg ha^{-1}. Data recorded from the experiment were analyzed following appropriate statistical design.

On an average, maturity period ranged from 118 days (SBM-35) to 131 days (SBM-31). Plant height ranged from 42cm (SBM-15) to 95cm (Binasoybean-3) and branches $plant^{-1}$ ranged from 3 (SBM-31, SBM-32, SBM-35 & Binasoybean-3) to 4 (SBM-33, SBM-34 & SBM-36). The check variety Binasoybean-3 produced highest number of pods $plant^{-1}$ (56); whereas, the mutant SBM-33, SBM-34, SBM-35, SBM-36 produced 43,40,38,37 pods $plant^{-1}$ respectively and the mutants SBM-31 & SBM-32 produced lowest number of pods $plant^{-1}$ (27 & 29). The highest number of seeds pod^{-1} (3) produced by SBM-33, SBM-34, SBM-35, SBM-36 & Binasoybean-3, where the lowest number of seeds pod^{-1} (2) produced by SBM-31 & SBM-32 . SBM-36 had the highest pod length (3.25) followed by Binasoybean-3 (2.88) & SBM-31 (2.85). Hundred seed weight was higher in SBM-33 (22.03g) and lower hundred seed weight was obtained from Binasoybean-3 (12.66g). Seed yield obtained from the mutants and checks significantly differed from each other. The mutant SBM-33 produced the highest seed yield of 3440 kg ha^{-1} followed by SBM-35 (2955 kg ha^{-1}) and SBM-34 (2861 kg ha^{-1}); where the check variety Binasoybean-3 produced 2833 kg ha^{-1}. Among the locations the highest seed yield was obtained from BINA sub-station farm at Barishal (2798 kg ha^{-1}) followed by BINA HQS farm Mymensingh (2773 kg ha^{-1}) and BINA sub-station farm at Satkhira (2766 kg ha^{-1}).

From this experiment, it was concluded that the mutant SBM-33, SBM-35 and SBM-34 performed better than other mutants and the check. Further trials will be needed to confirm the result.

Growing of M_5 to M_2 generation of soybean mutants

A large number of M_5, M_4, M_3 and M_2 variants were developed from different irradiated materials were grown for selecting desirable mutant at BINA Head Quarter farm, Mymensingh. The seeds were sown during January to April 2024. All the seeds were space planted in 3m long five rows with 30cm row spacing. Recommended fertilizer was applied and necessary steps were taken to grow the crop uniformly.

Total 71 segregating population was evaluated for yield and yield contributing characters. Among these, 26 segregating families (M_5 & M_4) and others were (25) single plant. All of these segregating populations were obtained from earlier generation, that have been selected from

previous trials, whereas, single plant population was from earlier generation of M_3 and M_2. Total four (05) populations from M_5 and ten (10) from M_4 were selected for future advancement of generation. The basis of the selection was considering the early maturity period with other yield contributing characters. From various early generations single plant also selected considering maturity period, bold seed, no. of pod and other agronomic traits. Nineteen single plants were also selected and harvested separately for future utilization of varietal improvement program. From all of these variants a total of thirty-two (34) were selected primarily for further selection that will be grown for respective advance generation on the basis of their agronomic performances.

Growing of M_1 population of soybean

To create genetic variability, seeds of soybean variety BU-2, BU-3 and BU-4 was irradiated with 250, 300 and 350Gy. Seeds were sown during January to April 2024 at BINA HQS farm, Mymensingh. This experiment was followed non-replicated design and sown separately (variety and dose wise). At maturity stage the survived plants produced seeds were harvested separately for growing M_2 population.

Maintenance of germplasm (mutants, local and exotic collections)

Fifty germplasms along with four stable mutants were grown at BINA HQS farm, Mymensingh. After harvest, seeds of all germplasms were collected and preserved as breeding materials for future breeding programme.

Sunflower

Project: Varietal improvement of sunflower through induced mutations

Advanced yield trial of dwarf inbred line of M_6 Sunflower mutant

Two sunflower mutants (SDM-3 & SDM-5) along with the check variety (BARI Surjomukhi-3) were grown in plant progeny-rows at BINA HQ farm, Mymensingh and BINA sub-station farm at Satkhira, Barishal and Noakhali. The experiment was conducted in RCBD design with 3 replications and unit plot size was 4m × 3m with row to row and Plant to plant distance: 50 cm and 25 cm, respectively. Recommended production packages i.e., application of fertilizers, irrigation, weeding, thinning etc. were followed to ensure normal plant growth and development. Data on plant height (cm), head diameter (cm) and seeds/head were taken from 5 randomly selected plants from each plot. Maturity period was counted when 90% heads were matured in a plot. Appropriate statistical analysis was performed for comparison of mean of each character.

Data was recorded on average plant height (cm), head diameter (cm) and seeds/head from 5 randomly selected plants of each plot. On an average, maturity period ranged from 106-111 days. SDM-3 required shortest maturity period of 106 days and SDM-5 required the longest maturity period of 111 days. Plant height ranged from 75.14-85.87cm. BARI Surjomukhi-3 produced the tallest plant (85.87cm). Head Diameter (cm) ranged from 18.03-22.66cm. Among the genotypes, SDM-5 produced highest number of seeds head^{-1} (580) followed by SDM-3 (550). Further trials will be needed to confirm the results of selected promising mutants.

Preliminary yield trial with promising M_6 sunflower mutant

Two sunflower mutants (SFM-2 & SFM-5) along with the check variety (BARI Surjomukhi-2) were grown at BINA HQ farm, Mymensingh and BINA sub-station farms at Jamalpur & Nalitabari. The experiment was conducted in RCBD design with 3 replications and unit plot size was 4m × 3m with row to row and Plant to plant distance: 50 cm and 25 cm, respectively. Recommended production packages i.e., application of fertilizers, irrigation, weeding, thinning etc. were followed to ensure normal plant growth and development. Data on plant height (cm), head diameter (cm) and seeds/head were taken from 5 randomly selected plants from each plot. Maturity period was counted when 90% heads were matured in a plot. Appropriate statistical analysis was performed for comparison of mean of each character.

Data was recorded on average plant height (cm), head diameter (cm) and seeds/head from 5 randomly selected plants of each plot. On an average, maturity period ranged from 95-120 days. SFM-2 and SFM-5 required shortest maturity period of 95 days and 100 days, respectively. The check variety BARI Surjomukhi-2 required the longest maturity period of 120 days. Plant height ranged from 115 to 202cm. SFM-5 produced the tallest plant (202cm) followed by SFM-2 (115cm). SFM-2 was comparatively dwarf having 115cm plant height. Head Diameter (cm) is one of the major yields contributing characters of sunflower, it was ranged from 11.5-18.0cm. Among the genotypes, SFM-2 produced highest number of seeds $head^{-1}$ (441) followed by SFM-5 (408). Considering yield contributing traits further trials will be needed to confirm the results of selected promising lines.

Screening M_5 generation of sunflower

Three mutants (SDPN-1, SDPN-3 and SDPN-4) were used in this experiment for earliness and dwarf with higher seed yield. Seeds were grown in plant progeny-rows at BINA HQ farm, Mymensingh. The experiment was conducted in a non-replicated design and unit plot size was $24m^2$ (4m × 6m) with 50cm line to line spacing and 25cm from plant to plant within a line. Recommended production packages i.e., application of fertilizers, irrigation, weeding, thinning etc. were followed to ensure normal plant growth and development. Data on plant height (cm), head diameter (cm) and seeds/head were taken from 5 randomly selected plants from each plot. Maturity period was counted when 90% heads were matured in a plot. Appropriate statistical analysis was performed for comparison of mean of each character.

Data was recorded on average plant height (cm), head diameter (cm) and seeds/head from 5 randomly selected plants of each plot. On an average, maturity period ranged from 100-112 days. SDPN-1 required shortest maturity period of 100-104 days and SDPN-3 required the longest maturity period of 112 days. Plant height ranged from 143.9-184.6cm. SDPN-4 produced the tallest plant (184.6cm). Head Diameter (cm) is one of the major yields contributing characters of sunflower, it was from 17.3-21.1cm. Among the mutants, SDPN-1 produced highest number of seeds $head^{-1}$ (380) followed by SDPN-4. Further trials will be needed to confirm the results of selected promising mutants.

Growing of M_4 to M_2 generation of sunflower mutants

A large number of M_4, M_3 and M_2 variants developed from different irradiated materials with three checks BARI Surjomukhi-2, BARI Surjomukhi-3 and LP were grown for selecting desirable mutant at BINA Head Quarter farm, Mymensingh following augmented block design. All the mutants were grown in a non-replicated design and unit plot size was $24m^2$ (4m × 6m) with 50cm line to line spacing and 25cm from plant to plant within a line. Recommended fertilizer was applied and necessary steps were taken to grow the crop uniformly.

Total 52 segregating population was evaluated for yield and yield contributing characters. Among them 12 was segregating families and other 40 was single plant. A total of five (5) families from M_4, seven single plant (7) from M_3 and five (5) families & ten (10) single plant from M_2 was selected and mass for future generation advancement. Ten families and seventeen (17) single plants have been selected and harvested separately for future utilization of varietal improvement program.

Growing of M_1 population of sunflower

To create genetic variability, seeds of sunflower variety BARI Surjomukhi-3 was irradiated with 250, 300 and 350Gy of gamma rays. Seeds were sown on 22 December 2023 at BINA HQS farm, Mymensingh. This experiment was followed non-replicated design and sown separately (dose wise). At maturity stage the survived plants produced seeds were harvested separately for growing M_2 population.

Perilla

Project: Varietal improvement of Perilla through induced mutations

Growing of M_2 generation of perilla mutants

Twelve M_2 seeds have been harvested from five groups to grow M_3 population in subsequent generations.

Jute

Growing M_2 generation of Jute

Six bulk population (0.5, 0.75, 1.0 and 1.5 % of EMS using) of jute (var. O- 9897, O-795, O-72,), kenaf (var. HC-95), Mestapat-1 and BJRI deshi patshak-1 were grown for selecting desirable mutants at BINA HQS farm, Mymensingh. The experiment was set at 5 to 7 cm distances within rows and 30 cm between plants to plant. A unit plot size was 4.0 m × 3.0 m. recommended doses of nitrogen, phosphorus, potassium, sulphur and zinc were applied in the form of Urea, TSP, MoP, Gypsum and Zinc Sulphate. Intercultural practices were followed as and when required. At harvest, data on plant height and base diameter were recorded from 5 randomly selected plants and, fiber weight, stick weight were recorded also from selected 5 plants after proper sun drying which was converted into kg $plant^{-1}$. From them primarily a total of 36 mutant variants were selected based on their performances for subsequent generations.

Cotton

Growing M_2 generation of Hill cotton-1 and Hill cotton-2

With a view to develop short duration and short statured plant, induced mutation was applied to two hill cotton (*Gossypium arboreum*) varieties *viz.* Hill Cotton-1 and Hill Cotton-2. The seeds of M_2 generation of the two varieties were sown on 26 June, 2023 during Kharif-I season. The time for 1st flowering of two parents were 100 days. The time for 1st flowering of the M_2 population was varied from 86-106 days with a SD of 6.17 and 86-113 days with a SD of 4.26 in HC-1 and HC-2 population, respectively. The plant height was 143 and 125 cm in HC-1 (parent and HC-2 (parent), respectively. Plant height varied between 61-183 cm with a SD of 32.08 and 38-122 cm with a SD of 22.11 in the M_2 population of HC-1 and HC-2, respectively. Total 10 putative mutants were selected based on days to 1st flowering and shorter plant height for further validation.

BIOTECHNOLOGY DIVISION

PROGRAM AREA I: GENETIC ENGINEERING AND TISSUE CULTURE

Expression, detection and Cloning of *OsMGD* gene for salinity and drought tolerance crop variety development

One rice cultivar FR13A was used in this study. *OsMGD* gene-driven MGD activity synthesizes galactolipids, ensuring chloroplast membrane stability and photosynthesis under salinity stress, while also aiding chloroplast function and recovery of photosynthesis after submergence, enhancing rice tolerance to flooding. In salinity stress the plants were stressed by adding NaCl at a final concentration of 150mM and for submergence stress sample were kept under 20cm below standing water in a plastic container. The sample was collected at different time points. In case of salinity stress, e.g. control (0)h, (1)h, (6)h, (12)h, (18)h, (24)h and (72)h and for submergence stress control (0)d, (1)d, (3)d, (5)d, (6)d and (7) days samples were collected. All samples were stored in -80^{0}C freezer until RNA isolation. To assess the effect of salt and submergence on the expression of *OsMGD, g*ene, total RNA was isolated and the expression levels of the gene were evaluated RT-qPCR. The results indicated that expressions of *OsMGD in* salinity stress, higher expression were found 36 hours followed by 18 hours and 72 hours and in submergence stress higher expression was found in 5 days followed by 7days and 2days. The *OsMGD* gene was amplified by PCR and to get the actual size of the gene, optimization of PCR protocol is on-going.

Expression and cloning of *CaChiVI2* gene in *Capsicum annuum L.* for resistance against heat stress

Two genotypes (CKN-1 and CKN-8) were selected from 11 exotic sweet pepper lines through an extensive phenotypic study in Biotechnology Division, BINA. Utilizing cotyledonary leaf and cotyledonary node explants, MS basal medium enriched with 3% sucrose, 0.8% agar, various concentrations and combinations of growth regulators including BAP (4, 6, 8 mgl^{-1}), IAA (0.5 and 1 mgl^{-1}) and IBA (0.25, 0.5 and 1 mgl^{-1}) were tested for shoot and root regeneration. A successful optimization of an effective and reproducible direct *in vitro* regeneration protocol was achieved, where cotyledonary node was observed to be more effective in inducing both shoot and root formation. Based on previous extensive phenotypic and tissue culture studies, CKN-8 was identified as the best genotype among those collected for this experiment. Seeds were grown in a growth chamber at 25°C with a photoperiod of 16 hours light/8 hours dark and 70–80% relative humidity. For the heat treatment, stress was imposed to plants for 6 hours at flowering stage. Samples were maintained in glass house and collected at temperatures of 27°C, 32°C, 37°C, 42°C and 47°C. The first fully expanded leaves from the top of each plant were sampled (three replicates) from both the control and treatment groups. All samples were stored at −80 °C for expression study and subsequent operations will proceed after getting the necessary chemicals and primers.

Identification, genomic wide distribution, and expression profiling of *CDPK* genes from white jute under saline stress

Calcium-Dependent Protein Kinases (CDPKs) are key signaling molecules in plants, crucial for abiotic stress responses like salinity. In white jute (*Corchorus capsularis*), the identification and analysis of CDPK genes provide insights into mechanisms of saline tolerance. This study aimed to identify and characterize CDPK genes, analyze their structural and functional features, and assess their expression in saline-tolerant jute genotypes under salt stress.Using genomic mining and validated sequences from Arabidopsis, cacao, and grape, CDPK homologs were identified in white jute through alignment with NCBI data. The conserved domains of CDPKs were analyzed, and phylogenetic relationships were established. A total of 18 CDPK genes were identified, distributed across chromosomes and scaffolds. Expression profiling via qRT-PCR revealed that *CcCDPK10* and *CcCDPK12* genes were significantly upregulated in saline-tolerant genotypes under 250 mM NaCl treatment.The study demonstrated that CDPK genes are involved in regulating jute's response to salinity, with higher expression in tolerant genotypes. These findings suggest potential targets for breeding programs aimed at improving salinity tolerance in jute. Further studies on gene function and regulation are recommended to enhance stress resilience in crops.

Optimization of *in-vitro* germination, callus induction, root formation, and acclimatization of BJRI 10 jute (*Corchorus capsularis l.*) plantlets

Jute (Corchorus capsularis L.) is a vital natural fiber crop, and the BJRI 10 variety was selected for its superior qualities. This study aimed to optimize tissue culture protocols for improved propagation, genetic enhancement, and sustainable cultivation. The objectives included optimizing callus induction, root formation, and enhancing genetic transformation techniques to introduce traits like stress resistance and improved fiber quality.BJRI 10 seeds were tested for germination using water agar and wet tissue, with the highest germination rate (83%) observed on water agar. Surface sterilization with 5% NaOCl for 35 minutes resulted in the lowest contamination (7.3%) and highest germination (88.3%). The optimal sucrose concentration for callus induction was 15 g/L, achieving an 88.67% induction rate within 12.67 days. The best hormone combination for callus induction was 0.5 mg/L IAA + 3 mg/L BAP + 0.5 mg/L NAA, resulting in a 77.67% induction rate in cotyledon explants. Root formation was best achieved with 0.25 mg/L IBA, with 71.33% root initiation in 20 days. Plantlets were acclimatized by gradually transferring them to soil.Optimizing these tissue culture protocols can enhance jute propagation and genetic improvement, contributing to sustainable cultivation and improved fiber quality.

Transfer of salinity and drought tolerant genes into rice through *agrobacterium* mediated gene transformation

The existing protocols for transformation and regeneration of indica rice are tedious, lengthy, and highly genotype-specific with low efficiency of transformation. In the present study, we have followed a highly efficient and reproducible *A. tumefaciens* mediated transformation protocol using mature seeds as explants. Experiments were conducted to establish efficient gene transformation protocol for rice and to find effective method for *Agrobacterium* mediated

transformation for developing transgenic rice variety with enhanced salt tolerance. Here, we used one gene *OsCAL* (Calmodulin like protein1) and embrygenic calli of three rice genotypes (IR64, Nipponbare and Kasalath) because of their higher callus producing ability and subsequently regeneration ability. The results reveled that callus induction and embryogenic callus induction were found higher in Nipponbare (69.99% and 67.33 %) followed by Kasalth (64.66 and 62.32 %) and IR64 (56.99% and 50.33 %). After 4 days, only embryogenic calli were sub-cultured subjected to Agro-infection using *Agrobacterium* carrying the gene construct and co-cultivated for ~48 hours on co-cultivation medium. Once the growth of *Agrobacterium* could be visualized at the periphery of the individual calli, these were shifted to 1st selection medium. After ~12 days the creamish colored calli were then transferred to freshly selection medium for a second selection cycle where small micro calli started growing on the mother calli. These micro calli were gently separated from the mother calli and transferred to fresh MS selection medium for the third selection. During the research period a number of embryogenic calli were infected by *OsCAL* gene through A*grobacterium* mediated gene transformation. The research work has been done several times. The transformed calli were shown bacterial over growth in selection and also in regenerated stage. This work is continuing on and optimization will be needed for control the bacterial over growth for infected transformed calli.

Optimization of regeneration protocol for Binadhan 17

Binadhan-17 is a high-yielding, short-duration rice cultivar, and optimizing its regeneration protocols is essential for improving tissue culture efficiency and facilitating genetic transformation. This study aimed to identify optimal hormone concentrations for maximizing callus initiation and refine regeneration protocols to support somaclonal variation and genetic modifications.The effect of 2,4-D concentrations on callus formation was tested, with the highest callus formation (75.5%) observed at 5 µg/mL. Higher or lower concentrations resulted in reduced efficiency. Similarly, the combination of Kinetin and NAA in Treatment 2 (2 mL/L Kinetin + 0.01 µg/mL NAA) showed the highest regeneration percentage (65.96%) in calli, suggesting it as the most effective for regeneration.For acclimatization, plants were gradually exposed to outdoor conditions to enhance survival. Five Binadhan-17 plants showed varying growth characteristics, with B17T3 being the tallest (91 cm) and B17T1 having the most effective tillers (26 total).In conclusion, optimizing 2,4-D and hormone combinations for callus formation and regeneration, along with a controlled acclimatization process, enhances tissue culture efficiency in Binadhan-17. These results can support future genetic improvements and sustainable rice cultivation.

Transformation of *$OsNHX_2$* Gene in Binadhan 17 through Agrobacterium-Mediated Transformation

The transformation of the *OsNHX2* gene in Binadhan-17 using Agrobacterium-mediated transformation is critical for enhancing the plant's stress tolerance. This method allows targeted genetic modifications, making it a valuable tool for advancing genetic research in rice cultivars. The main objective of this study was to successfully introduce the *OsNHX2* gene into Binadhan-17 and optimize transformation conditions.The effect of bacterial cell concentration and infection time on callus viability was examined. The optimal bacterial concentration for transformation was

found to be OD600 of 0.16, which resulted in 100% callus viability. An infection time of 1.5 to 2 minutes also achieved 100% viability, with minimal bacterial growth. Antibiotic concentrations were optimized for controlling bacterial growth without affecting callus viability. The best treatment was 2 µL/mL Cefotaxime + 2 µL/mL Timentin+ 1 µL/mL A + 2 µL/mL B, which completely suppressed bacterial growth and maintained 100% callus viability.In conclusion, optimizing bacterial concentration, infection time, and antibiotic use is essential for successful Agrobacterium-mediated transformation in Binadhan-17, facilitating the introduction of desirable traits like enhanced stress tolerance through genetic engineering.

Development of high amylose containing rice line through mutagenesis of *Wx* gene using CRISPR/Cas9

The rice *Waxy* (*Wx*) gene plays a major role in seed amylose synthesis and consequently controls grain amylose content. The *Wx* gene expression is highly regulated at the post-transcriptional level. In particular, the GT/TT polymorphism at the 5′splicing site of its 1st intron greatly affects this intron's splicing efficiency. The *Wx* gene is a major gene controlling amylose content in rice endosperm and plays a decisive role in rice cooking and eating quality (ECQ). During the research periods for this program, three advanced rice lines were selected namely, Bina (bio)-BC2-5-2-3-14, Bina (bio)-BC2-5-2-3-42 and Bina (bio)-BC2-5-2-11-27. The selected lines are high yield potentials (>7.50 t/ha), short duration and semi dwarf type but amylose content is low (<22.0%). The highest callus induction was observed in Bina (bio)-BC2-5-2-11-27 (90%) followed by Bina (bio)-BC2-5-2-3-14 (82%) and Bina (bio)-BC2-5-2-3-42 (70%). Before constructing an editing vector, we employed the online software CHOPCHOP (http://chopchop.cbu.uib.no) to identify proper editing target sites using the Nipponbare *Wx* gene (LOC_Os06g04200) as a reference. Two target sites located within the 1st intron but close to the 5′ or 3′ splicing site were selected. We amplified and sequenced fragments, including the targeted sequences and their flanking sequences from genomic DNA of all three advance inbred lines, using primer sets WxP1_F/WxP1_R (for Target1) and WxP2_F/WxP2_F-R (for Target2). The CRISPR/Cas9 vector pRGEB31 targeting the first intron of the *Wx* was selected for construction. The vector used in this study was based on the vector pCambia1300 backbone. The editing vector pRGEB31 contained a Cas9 expression cassette driven by the Rice snRNA U3 and dual 35S promoterand two sgRNA expression cassettes driven by the rice U3 or U6 snRNA promoters. The editing vector pRGEB31will be transferred into *Agrobacterium tumefaciens* strain GV3101 by heat-shock and consequently delivered into three selected materials cells via *Agrobacterium* mediated transformation.

Development of high yield aromatic rice lines through mutagenesis of *OsBADH2* gene using CRISPR/Cas9

Aroma is considered as one of the most preferred quality parameters next to cooking quality, taste and elongation after cooking. The compound 2-acetyl-1-pyrroline (2AP) was reported to be the principal compound producing aroma. It is reported that dominant *BADH2* converts γ-amino butyraldehyde (GABald) to gamma amino butyric acid (GABA). In the absence of a functional *BADH2* i.e., non-functional *BADH2* with an 8 bp deletion in exon 7 of *BADH2* gene, GABald is

converted into an aromatic compound 2-Acetyl 1-Pyrroline. Development of aromatic rice genotypes possessing high yield and desirable grain quality traits through conventional breeding or marker assisted breeding is time consuming and labor intensive. Among the SSNs, Clustered Regularly Interspaced Short Palindromic Repeats (CRISPR)-associated endonuclease Cas9 (CRISPR/Cas9) is becoming popular due to its efficiency in creating precise mutations. That's why, we take a research program for developing the high yielding aromatic rice variety development. Here we used BINA Dhan-25 Boro rice cultivar for developing the high yielding aromatic rice variety as an explant. BINA Dhan-25 is a high yielding fine quality slender type non-aromatic rice variety. The selected variety yield is 6.5 to 7.5 t/ha). The highest embrygenic callus induction percentage was found at 2.5 mgl^{-1} dose of 2,4-D (47.20%) followed by 3.0 mgl^{-1} dose of 2,4-D (40.20%). The best two doses of 2,4-D derived embrygenic calli subsequently used for shoot regeneration additionally supplemented with NAA (0.5 mgl^{-1}) and Kinetin (10 mgl^{-1}). Nucleotide sequence encoding for functional *BADH2* (LOC_Os08g32870) was retrieved from MSU rice genome annotation project database (http://rice.plantbiology.msu.edu/). Synthetic guide RNA and subsequently flanking primers was design using the soft of CHOPCHOP (*https://chopchop.cbu.uib.no*) on the 7th exon of *BADH2*. Oligomer of designed sgRNA was synthesized and cloned into pRGEB31 binary vector carrying Cas9 gene.

CRISPR/Cas-9-Targeted Mutagenesis of *BanFAE1* Genes confers Low-Erucic Acid in *Brassica napus*

Rapeseed (*Brassica napus*) is an important oilseed crop widely planted in the world, providing substantial edible oil and other nutrients for mankind. The composition of fatty acids affects the edible and processing quality of vegetable oils, among which erucic acid (EA) is potentially to cause health problems. Therefore, low erucic acid (LEA) has always been a breeding trait of *B. napus*. Fatty acid elongase1 (FAE1) plays a decisive role in the synthesis of EA. The main objectives in this study to developed low erucic acid (5-10%) mustard variety. Here we used the cultivar Binasarish-4, Binasarish-9, Binasarish-12 and BARI sarisha14 as a explant for genome editing research work. For *In vitro* regeneration, cotyledonary nodes performed the best with 100% in Binasarisha-4, 98.33% in BARI Sarisha-14 and 91.67% in Binasarisha-9. Binasarisha-4 demonstrated 76.67% callus induction, 70.83% shoot initiation, 91.82% shoot outgrowth, and 40% root initiation with hypocotyl, followed by BARI Sarisha-14 (76.67%, 58.33%, 75.00%, and 23.33%, respectively) and Binasarisha-9 (52.78%, 47.78%, 49.04%, and 11.11%). The gRNA design, vector construction and primers for genome editing work is on-going.

Growing of T_2 –T_4 generation of rice lines developed through tissue culture at field condition

The BRRIdhan-89, BRRIdhan-29, and land race Fatema calli were treated with 0.2% EMS resulted in the generation of a diverse population of plants. From the BRRIdhan-89 total 50 plants were selected from T3-T4 generation and grown in field conditions those were selected on the basis of their earliness, disease resistance, and yield. The most promising individuals showing desirable traits were selected for further evaluation and multiplication in the next generation.

PROGRAMME AREA II: MARKER ASSISTED SELECTION/MARKER ASSISTED BACKCROSS BREEDING

Advanced yield trial with high yielding and short duration rice lines

It was reported that *Oryza rufipogon* allele at two QTL loci on chromosome 1 and 2 were associated with an 18 and 17% increase in grain yield per plant, respectively, without delaying maturity or increasing plant height. This discovery suggested the innovative use of wild and exotic germplasm for rice crop improvement through molecular markers. Therefore, the proposed study is set to increase yield or break down the yield ceiling of Binadhan16 (a short duration and medium high yielding rice mutant variety) to introgressions useful genes from accessions of *O. rufipogon*. In Boro, 2023-24 a total six advance rice lines were grown with three standard checks viz Binadhan-16, BRRI dhan96 and Binadhan-17. The tested lines and the check differed significantly for grain yield, plant height and also maturity. The line Bina(bio)-BC2-5-2-3-42 produced the higher yield (8.79 t/ha) followed by line Bina(bio)-BC2-5-2-3-14 (8.74 t/ha) and line Bina(bio)-BC2-5-2-3-50 (8.18 t/ha). Highest plant height was found line Bina(bio)-BC2-5-2-3-48 (131cm) followed by line Bina(bio)-BC2-5-2-3-41 (127cm) and the lowest was BRRI dhan96 (98cm) followed by Bina(bio)-BC2-5-2-3-14 (109cm). The yield of the selected lines other agronomic characters needs further evaluation. So, selected lines will be transplanted in the next season.

Development of lodging resistance and high yield premium quality rice variety through marker assisted selection

The aromatic rice variety Kataribhog is medium long type, fine grained and highly scented and high priced. But the cultivar is weak stem, highly lodging susceptible, very long growth duration, low grain weight and poor yield. Binadhan-13 is another aromatic rice variety, but this variety has same problem. Farmers mainly grow these varieties for their own consumption and ceremonial purposes. Under these circumstances a program was taken to improve these varieties for yield potential and lodging resistance through hybridization with *Oryza rufipogon* and BR5 (Donor parents). The size of unit plots was 0.50m x 1.0m. Plant to plant distance was 15cm and row to row distance was 20cm using single seedling/hill. Fertilizer was applied at 120:25:40:10:4 of NPKSZn kg/ha and standard agronomic practices were followed. In T. aman 2023 about 17 F_5 plants were selected from 55 segregating F_4 populations best on better plant types compare to the parents. The molecular work was done for testing the presence of fragrance gene (BADH2) in the selected lines. On the other hand, only 11 F_5 plants/lines were selected in T. aman 2023 from the 101 (Binadhan-13x BR5) F_3 populations. The seeds of selected plants were harvested and store for in the next season further evaluation.

PROGRAMME AREA III: MICROBIAL BIOTECHNOLOGY

Isolation, characterization and symbiotic performance evaluation of *Rhizobium* Strains from root nodules of Chickpea (*Cicer arietinum*)

The global food system faces challenges in meeting the growing demand for food, and chickpea, a nutrient-rich legume, can play a key role by improving soil fertility through symbiotic nitrogen fixation with rhizobia. This study aimed to isolate and characterize rhizobial strains from chickpea root nodules in Bangladesh, assess their genetic diversity, and evaluate their efficiency in enhancing plant growth and yield. Samples were collected from nine districts, yielding 32 rhizobial strains. Morpho-physiological characterization, salt, pH, and temperature tolerance, phosphate solubilization, and indole acetic acid (IAA) production were analyzed. Chickpea nodulation tests and *nifH* gene amplification were also conducted.Results showed that 31 strains grew at 37°C and 11 tolerated 5% NaCl. Vigorous growth occurred at pH 6 and 7, with moderate growth at higher and lower pH levels. Seven strains solubilized phosphate, and 21 produced IAA. In nodulation tests, 32 strains formed nodules, with BCR-37 showing the highest nodule count and dry matter production, and BCR-40 exhibiting the highest nitrogen content in shoots.The study concluded that strains BCR-31, BCR-37, and BCR-40, which performed well under different environmental conditions, could be used as biofertilizers to enhance chickpea production and soil health in Bangladesh.

SOIL SCIENCE DIVISION

Project No. 1: Determination of critical limit of nutrients for major soils and crops using nuclear techniques

Experiment No. 1: Determination of critical limit of Sulphur for Soybean (*Glycine max.)*(Pot trial)

A pot experiment was conducted during the Rabi season of 2024 to determine the critical limit of sulfur (S) for soybean (*Glycine max* L.). Nine bulk soils were collected from the surface layer (0-15 cm) in Noakhali, processed and conducted in a completely randomized design (CRD). The trial included two treatments: with sulfur and without sulfur, and three replications. Based on soil analysis, nutrients were used at the rate of $N_{23}P_{30.5}K_{50}S_{23}Zn_3B_2Mo_1$ kg/ha for the soybean which was $N_{160}P_{152}K_{250}S_{113}Zn_5B_{11}Mo_{12}$ mg per pot. Reagent grade chemical (Gypsum for S) was used as the sources of nutrient. Soybean seeds (Binasoybean-7) were sown on 12 February 2024, and the plants were harvested on 31 March 2024. The dry matter yields of soybean was ranged from 28.0-37.9 g pot^{-1} without S and 30.6-39.7 g pot^{-1} with S application. The percent relative yield was ranged from 103-250 with a mean value of 176.75. The study revealed that the critical sulfur level for soybean was 31$\mu g g^{-1}$, which is significantly higher than the previously recommended value of $\mu g g^{-1}$ in FRG-2018. This revised critical level emphasizes the importance of region-specific sulfur management strategies for optimizing soybean yield and quality.

Project No. 2: Integrated Plant Nutrition System (IPNS) for soil fertility management and increased crop production using nuclear techniques

Experiment No. 2: Potential effect of different sources of liming materials for increase soil pH and increase crop production

The soil reaction of the northern areas of Bangladesh is going down to 4.5 which is alarming for the agricultural crop production. To increase the soil pH, an experiment was conducted in the low pH soil at BINA substation, Rangpur. There were seven treatments for the study (T_1: Control Recommended chemical fertilizer (RCF), T_2: RCF + lime @ 2 t ha^{-1}, T_3: RCF + poultry manure @ 3 t ha^{-1}, T_4: RCF + biochar @ 2 t ha^{-1}, T_5: RCF + lime @ 1 t ha^{-1} + poultry manure @ 1.5 t ha^{-1}, T_6: RCF + lime @ 1 t ha^{-1} + biochar @ 1 t ha^{-1} and T_7: RCF + biochar @ 1 t ha^{-1} + poultry manure @ 1.5 t ha^{-1}) and was randomize complete block design with three replication. The sesame variety Binatil-2 was used as a test crop in this study. The results revealed that all treatments, except the control, significantly increased soil pH over the two seasons. The most noticeable improvements in soil pH were observed in treatment T_6 (RCF + lime @ 1 t ha^{-1} + biochar @ 1 t ha^{-1}), where pH increased from an initial value of 4.8 to 5.7 in 2023 and 6.05 in 2024. This increase in pH was accompanied by improvements in soil organic matter content and nutrient availability, especially phosphorus and sulfur. Treatment T_6 also resulted in the highest sesame seed yield, reaching 1.40 t ha^{-1} in 2022-23 and 1.42 t ha^{-1} in 2023-24, which was statistically similar to the treatments T_2, T_4, and T_5. The combination of lime and biochar in T_6 proved effective in enhancing sesame yield and improving soil health, as biochar contributed to better soil structure and nutrient retention. The findings of this study emphasize the potential of integrated nutrient management strategies for improving crop yield and soil fertility in acidic soils. Specifically, the combination of lime and biochar (T_6) was the most effective treatment in both seasons, significantly increasing soil pH and crop yield compared to other treatments.

Experiment No. 3: Effect of organic amendments for rice production in saline soil of Bangladesh

Soil salinity is a major constraint for rice production in the coastal areas of Bangladesh, where salinity stress can significantly reduce crop yields, posing a threat to food security and livelihoods. This study aimed to explore the potential of organic amendments, wooden ash, rice straw, and rice husk ash—in mitigating the adverse effects of soil salinity on rice production during the Boro season. The field experiment was conducted at Talaupazila in the Satkhira district, where Binadhan-10, a saline-tolerant rice variety, was grown. Five treatment combinations were tested: T_1 (Recommended Chemical Fertilizer - RCF), T_2 (RCF + wooden ash 2.0 t ha^{-1} + rice straw 2.5 t ha^{-1}), T_3 (RCF + rice husk ash 2.0 t ha^{-1} + rice straw 2.5 t ha^{-1}), T_4 (RCF + wooden ash 2.0 t ha^{-1} + rice husk ash 2.0 t ha^{-1}), and T_5 (RCF + wooden ash 1.5 t ha^{-1} + rice husk ash 1.5 t ha^{-1} + rice straw 2.0 t ha^{-1}). The effects of organic amendments were assessed in terms of soil salinity, plant growth, and rice yields over two growing seasons (2022-23 and 2023-24). The application of organic amendments significantly improved the growth parameters and yield-contributing characteristics of rice. Soil salinity was reduced across all organically treated plots, especially in the T_2 treatment, which demonstrated the most substantial reduction in electrical conductivity (EC). T_2 (RCF + wooden ash + rice straw) produced the highest grain yield of 5.71 t ha^{-1} in 2022-23 and 5.3 t ha^{-1} in 2023-24, followed by the treatment T_5 and the treatment T_4. The combined effect of wooden ash and rice straw not only enhanced soil fertility but also helped in reducing salinity stress, leading to improved physiological development of the rice plants. The results suggested that organic amendments, particularly the combination of wooden ash and rice straw were effective in mitigating salinity stress in rice cultivation. These amendments could be an environmentally friendly and sustainable approach for improving rice productivity in the saline-prone regions of Bangladesh.

Experiment No. 4: Effect of nano fertilizer to increase nutrient use efficiency (NUE) and crop yield

A pot experiment was conducted to investigate the effect of nano fertilizers on rice yield and nutrient use efficiency (NUE). The study was designed by a Completely Randomized Design (CRD) with five treatments: T_1 (Control with full dose prilled urea), T_2 ($1/3^{rd}$ urea + one nano spray), T_3 ($1/3^{rd}$ urea + two nano sprays), T_4 ($1/3^{rd}$ urea + three nano sprays), and T_5 (three nano sprays) and all the treatments replicated in thrice. The nitrogen source was urea, with foliar applications of IFFCO nano-urea (@ 4 ml L^{-1}). Standard cultural practices and split nitrogen applications were followed. The IFFCO nano-urea was a white, water-soluble liquid with a pH of 5.89 and 4.35% total nitrogen. The Binadhan-24 was used as test crop. Significant differences were observed across treatments in yield and growth parameters. The highest plant height (94.00 cm) was achieved with the treatment T_3 (two nano sprays), while the highest grain yield was recorded in the control treatment T_1(66.33 g/pot), followed by the trearment T_5 (three nano sprays) with 64.67 g/pot. Panicle length, effective tillers per hill, and filled grains per panicle showed minor variations across the treatments, with no significant differences. The weight of 1000 seeds was significantly higher in the treatment T_1, followed by treatments T_2 and T_3. The findings revealed that applying 100% prilled urea, or combining prilled urea with nano-urea sprays (especially T_3 and T_5), improved growth performance and nutrient efficiency in rice.

However, nano-urea applications also offered a significant potential for reducing urea usage while maintaining high crop yields. Therefore, integrating nano fertilizers into rice production can enhance crop productivity and NUE.

Experiment No. 5: Improvement of nutrient use efficiency (NUE) and crop productivity through nitrogen rates and irrigation in a rice-rice cropping system

Two field experiments were conducted in a rice-rice cropping system to investigate the effects of nitrogen (N) application rates and irrigation systems on yield, nitrogen recovery (R_EN), and nutrient use efficiency (NUE) by rice crops during 2023-2024. The experiments were conducted at the BINA sub-station Nalitabari farm, using two rice varieties: BINA Dhan25 during the Boro season and Binadhan-17 during the T. Aman season. The experiments were designed as a split-plot where the treatments were three irrigation systems such as farmer's practice (FP), continuous standing water (CSW), and alternate wetting and drying (AWD), in main plots, and four nitrogen rates (0%, 80%, 100%, and 120% of the recommended fertilizer dose) in sub-plots. Results showed that nitrogen application and irrigation systems significantly affected rice yield, total dry matter (TDM), and nitrogen uptake in both Boro and T. Aman rice. The highest grain yield (6.44 t ha^{-1}) was observed in the 100% N treatment (N_2) under the CSW conditions followed by the AWD with a similar yield, suggesting AWD as a viable water-saving practice without compromising yield. The highest total nitrogen uptake and recovery efficiency were also recorded in N_2 under the CSW and the AWD. Nitrogen use efficiency (NUE) was significantly higher under the AWD compared to the CSW and FP, with the 100% N rate consistently out performing with other nitrogen treatments in terms of yield, NUE, and R_EN. The results revealed that the AWD combined with the 100% N application, optimizes grain yield, nitrogen recovery, and nutrient use efficiency, while also saved water. The results also highlighted the potential for AWD to be a sustainable irrigation practice that maintains rice productivity in water-scarce regions.

Project No.3: Development of nutrients rich vermicompost for increased crop production and soil fertility

Experiment No. 6: Integrated effects of phosphorus and potassium rich vermicompost (PK-VC) with inorganic fertilizer on T. aman rice

A field experiment was conducted to reduce the chemical fertilizers with the integrated use of phosphorus and potassium rich vermicompost (PK-rich VC) with chemical fertilizers (CF) on T. aman rice (Binadhan-17) at the BINA farm, Mymensingh during 2023-24. Six treatments were used in the experiment which were T_1: 100% PKS, T_2: 100% NPKS from chemical fertilizer (CF), T_3: 100% P from PK-VC+ 100% NKS from CF (IPNS), T_4: 100% P from PK-VC+ 100% NKS from CF (Non-IPNS), T_5: 50% K from PK-VC+50% K from CF +100% NPS from CF (IPNS) and T_6: 50% K from PK-VC+50% K from CF +100% NPS from CF (non-IPNS). The treatment T_5 (4.8 t ha^{-1}) gave a significantly higher grain yield of T. aman rice followed by the treatment T_6 (4.7 t ha^{-1}). Hence, 100%P (9 kg P ha^{-1}) and 50%K (26 kg K ha^{-1}) could be met up with the application of PK-rich vermicompost @ 710 $kgha^{-1}$ with IPNS chemical fertilizers (NPS) which was sufficient for attaining the comparable grain yield of T. aman rice to the 100% NPKS.

Therefore 100%P (9 kg P ha^{-1}) and 50% K (26 kg K ha^{-1}) chemical fertilizer could be saved with the application of PK-rich vermicompost for the cultivation of T. aman rice.

Experiment No. 7: Effects of different doses of fertilizer and Vermicompost (VC) on Boro rice

A field experiment was conducted to investigate the effect of various doses of chemical fertilizers with the integrated use of vermicompost in Boro rice (Binadhan-14) at the BINA farm, Mymensingh during 2023-24. Six treatments were used in the experiment: T_1: Native soil fertility only, T_2: 100% NPKS, T_3: 75% NPKS, T_4: 125% NPKS, T_5: 150%N+ 100% PKS, T_6: 75% NPKS + 2 tha^{-1} VC. The treatment T_4 (4.2 t ha^{-1}) gave maximum grain yield of Boro rice (Binadhan-14) followed by the treatment T_2 (4.1 t ha^{-1}). The result indicated that the application of all kinds of fertilizers with increasing rates have tremendous influence on yield of Boro rice. The treatment T_1 gave a significant minimum grain yield (2 t ha^{-1}) of Boro rice. Recorded all the yield contributing characters were maximum in the treatment T_4 except straw yield, plant height and unfilled grain. Hence, 125% ($N_{161}P_{15}K_{79}S_{13}$ $kgha^{-1}$) NPKS chemical fertilizers gave greater grain yield of Boro rice (Binadhan-14) compare to the 100% ($N_{129}P_{12}K_{63}S_{10}$ $kgha^{-1}$) NPKS chemical fertilizers or 75% NPKS chemical fertilizer with 2 tha^{-1} vermicompost but these treatments were statistically identical. The result indicated that chemical fertilizer could be reduced by 25% with the integrated use of 75% CF + 2 tha^{-1} vermicompost for the cultivation of Boro rice.

Project No.4: Fertilizer management for relay/zero tillage cropping system

Experiment No. 8: Effects of different doses of fertilizers on relay cropping system in T.aman –Mustard (relay crop)-T.aus cropping system

Field experiments were conducted to investigate the effects of various fertilizer doses on mustard in relay cropping system as well as whole cropping pattern [T.aman-Mustard (relay crop) -T.aus] at BINA Sub-station, Gopalganj during 2023-24. Mustard was sown in preceding T. aman field before 15 days of harvesting of T. aman rice. After harvesting of T. aman rice the field was divided as treatment plan for mustard then imposed different treatments for mustard (Binasharisha-11). Six treatments combination were used for mustard and T. aus which were T_1: Native soil fertility only, T_2: 100% NPKS, T_3: 75% NPKS, T_4: 125% NPKS, T_5: 150%N+ 100% PKS, T_6: 75% NPKS + 2 tha^{-1} VC. After harvesting of mustard then T. aus was transplanted. In case of mustard, maximum seed yield (1.73 t ha^{-1}) was recorded with the treatment T_5 (150%N +100%PKS) which was significantly differed from other treatments. The result indicated that application of all kinds of fertilizers with increasing rates have tremendous influence on seed yield of mustard in relay cropping system. The treatment T_5 (4.5 t ha^{-1}) gave maximum grain yield of T. aus rice followed by the treatment T_3 (4.3 t ha^{-1}). The result also indicated that application of urea with increasing rates have tremendous influence on seed yield of T. aus rice.

Experiment No. 9: Effects of different doses of fertilizer on relay cropping pattern T. Aman-Mustard (relay crop) – Boro rice

An experiment was conducted to find out the effect of different doses of chemical fertilizers with the integrated use of vermicompost in 3 crops cropping pattern [T. aman-Mustard (relay crop) - Boro] and to find out optimum fertilizer doses of mustard under relay crop as well as the whole cropping system at the BINA Substation farm, Ishurdi during 2023 to 2024. Mustard was grown as relay crop. Six treatments were used in experiment which were T_1: 100% PKS, T_2: 100% NPKS from chemical fertilizer (CF), T_3: 100% P from VC+ 100% NKS from CF (IPNS), T_4:100%P from VC +100% NKS from CF (non-IPNS), T_5: 50% K from VC +50% K from CF +100NPS from CF (IPNS) and T_6: 50% K from VC +50% K from CF +100 NPS from CF(Non-IPNS) for T. aman rice (Binadhan-17) and T_1:Native soil fertility, T_2: 100% NPKS, T_3:75% NPKS, T_4:125% NPKS, T_5:150%N + 100% PKS and T_6: 75% NPKS+ 2 t/ha VC for Mustard (Binasharisha-11) and Boro rice (Binadhan-14). In the first crop of the cropping pattern, the treatment T_3 (6.5 t ha^{-1}) gave maximum grain yield of T. aman rice followed by the treatment T_5 (6.2 tha^{-1}) which indicated that 100% P from VC+ 100%NKS from CF (IPNS) reduced the application of 100% P fertilizer from CF. In the second (Mustard) and third crop (Boro rice), the treatment T_4 (125% NPKS) gave maximum seed yield of mustard (Binasharisha-11) and Boro rice (Binadhan-14) followed by the treatment T_2 (100%NPKS). The result indicated that increased amount of all fertilizers gave higher yields than the application of vermicompost or less amount of chemical fertilizers. Results revealed that relay cropping of mustard with T. aman was good option for minimizing the sowing time of mustard and also reduce the total length of T. aman-Mustard (relay crop) - Boro cropping pattern. The results also indicated that 125% NPKS fertilizer gave better yield of mustard and Boro rice to compare with the 100%NPKS.

Experiment No. 10: Improvement of carbon sequestration and crop production using chemical and organic fertilizers

A field experiment was conducted at BINA sub-station, Rangpur, to evaluate the effect of combined use of chemical and organic fertilizers, including chemical fertilizer alone and control, on yield and yield-attributing characteristics of mustard and rice. Five treatment combinations were: T_0 = control, T_1 = 100% RCF (recommended dose of chemical fertilizers), T_2 = 100% RCF + 1.5 t ha^{-1} VC (vermi-compost), T_3 = 80% RCF + 1.5 t ha^{-1} VC (vermi-compost), T_4 = 100% RCF + 3.5 t ha^{-1} VC, and T_5 = 80% RCF + 3.5 t ha^{-1} VC. The experiment was laid out in a randomized complete block design with three replications with a plot size of 12 m^2. For mustard and rice, the recommended doses of urea, TSP, MoP, gypsum, and zinc sulfate were used195, 135, 64, 83, & 9 and 326, 60, 110, 100, and 11 kg ha^{-1}, respectively. All the chemical fertilizers were used as basal doses except urea, which was applied at 10, 35, and 55 days after transplanting. According to the treatment combination, the entire amount of well-decomposed vermicompost was applied during final land preparation. In respect of mustard, results revealed that T_4 treatment produced the highest plant height, branch per plant, and pod per plant (115.33 cm, 3.53, 115.33), respectively. The highest seed yield was found in the T_2 and T_4 treatments, and the lowest seed yield was observed in the control treatment. The maximum straw weight was

obtained from the T_2 treatment. On the other hand, T_4 produced the highest grain yield of rice. The highest grain and straw yields were found in the T_4 treatment, and the lowest grain and straw yields were observed in the control treatment. In conclusion, 100% RCF + 3.5 t ha^{-1} VC is the effective dose for increasing mustard and rice production.

Experiment No. 11: Comparative studies of tillage practices on carbon emission, mineral nitrogen and yield and yield attributing characters of mustard

A field experiment was conducted at BINA Headquarters in Mymensingh to evaluate the effect of the combined use of chemical and organic fertilizers, including chemical fertilizer alone, on the yield and yield-attributing characteristics of mustard. Two treatment combinations were T = tillage and NT = no tillage. The experiment was laid out in a randomized complete block design with six replications. The plot size was 3 m × 4 m = 12 m^2. Initial soil characteristics were pH (6.2), organic carbon (1.78%), and total nitrogen (0.098%). Recommended doses of urea, TSP, MoP, gypsum, and zinc sulfate were used 195, 135, 80, 83, and 4.5 kg ha1, respectively. All the chemical fertilizers were used as basal doses except urea, which was applied at 10, 35, and 55 days after the sowing. Sowing date was 05-11-2023 for the no-tillage plot and 15-12-2023 for the tillage plot. For rice, sowing date was 24-01-2024 for no tillage plot and 25-02-2024 for tillage plot. Carbon dioxide emissions were estimated at six hours, 1, 2, 3, 4, 5, 6, 7, 8, & 9 days. Tillage practice produced higher carbon dioxide emission compared to no tillage practice. The maximum amount of carbon dioxide emission was observed in 2 days. After 2 days, carbon dioxide decreased up to 9 days. No-tillage practice emits less carbon dioxide than tillage practice. Tillage practice produced the highest NH_4-N and NO_3^-N from day 6 to day 5. The maximum plant height (121.47 cm), number of branches per plant (30.47), pod per plant (14.87), seed per pod (4.74), pod number (5.83), seed yield (0.76 ton ha^{-1}), and straw yield (1.90 t ha^{-1}).

Experiment No. 12: Effect of organic and inorganic fertilizers as supplement of micronutrients on rice based cropping pattern

Intensification of agricultural land use along with cultivation of new cultivars has substantially expanded in Bangladesh. This has consequently led to a decline in soil fertility and the establishment of both macro and micronutrient deficiencies in crops. In light of this, a study was conducted to determine the best combination of organic and inorganic fertilizers to supplement micronutrient application for maximizing yield for the T. Aman - Boro cropping pattern in AEZ 9. The study also aimed to assess the effects of organic and inorganic fertilizers on the growth, yield, and yield attributes of T. Aman and Boro rice. The findings indicate that, for Aman rice, 100% NPKS with Zn at 2 kg ha^{-1} and B application at 1 kg ha^{-1}, and again 100% NPKS with Zn at 4 kg ha^{-1} and B application @ 2 kg ha^{-1} to the Boro rice can give maximum grain yield in rice - rice cropping pattern. A good yield can be obtained in the Aman- Boro rice cropping pattern by applying 100% NPKS + 1 t ha^{-1} Vermicompost to the Aman rice and 75% NPKS + 2 t ha^{-1} vermicompost to the Boro rice.

Project No. 5: Assessment of different environmental pollutant in agricultural soil and crops using isotopic technique

Experiment No. 13: Effect of heavy metals on Water spinach (*Ipomoea aquatica*) cultivated in contaminated soil (pot experiment)

This study aimed to evaluate heavy metal contamination in food by assessing the soil and plant characteristics of water spinach *(Ipomoea aquatica)* grown in farm and industrial soils in Bangladesh. The study focused on determining the heavy metal concentrations (Fe, Zn, Cu, Pb, Cd, and Ni) in the soil, the transfer of these metals to spinach, and the potential health risks to humans through consumption. Farm (uncontaminated) soil from BINA HQs in Mymensingh and contaminated agricultural soils from various industrial areas in Bhaluka were used. The available concentrations of heavy metals in the contaminated soils significantly exceeded those in the farm soil, with industrial areas showing higher levels of Fe, Zn, Cu, Pb, and Ni. For example, Fe concentrations in industrial soils ranged from 509.76 to 829.04 mg/kg compared to 13.47 mg/kg in farm soil. The post-harvest soil analysis revealed minimal changes in heavy metal concentrations, although levels remained higher in contaminated soils than in the control. Water spinach accumulated heavy metals in both stems and leaves, with higher concentrations in plants grown in contaminated soils. The accumulation followed a pattern where Fe was the most absorbed metal, followed by Zn, Cu, Pb, Ni, and Cd in contaminated soils. The leaves generally accumulated more Fe, Zn, and Ni, while stems accumulated more Cu and Pb. Daily Metal Intake (DMI) and the Health Risk Index (HRI) were calculated to assess the potential health risks associated with consuming spinach grown in these soils. While the DMI values for Fe, Cu, Pb, and Zn were higher for contaminated soils, they remained within permissible levels. However, the HRI for Fe and Cu approached 1, indicating potential future health risks from consumption of spinach grown in contaminated soils. The transfer factor, which measures the ability of plants to absorb metals from soil, was highest for Zn, followed by Fe, Ni, Pb, Cu, and Cd. This suggests that Zn is more mobile in these soils, while Cd showed the least mobility. While water spinach grown in industrial contaminated soils shows significant uptake of heavy metals, particularly Fe, Zn, and Cu, the current health risk remains below the threshold. However, the elevated HRI values for Fe and Cu indicate a need for continuous monitoring and possibly stricter controls on heavy metal contamination in agricultural soils to ensure long-term food safety.

Experiment No. 14: Effects of liming and organic manure on crop production in acid soil

Soil acidity is one of the major yield-limiting factors for crop production worldwide. Different reports have indicated that there is significant soil acidity about 30% of capable land coverage in Bangladesh with acidity.Acidity is a well-known problem limiting crop production and productivity. As part of the solution to such problem in soils, combined application of dolomite as lime and VC as manure on rice has not been investigated in a pot experiment. Acid soil was collected from Madhupur upazila and pot experiment was conducted during Aus season in 2024 to evaluate the responses of acidic soil to the combined application of dolomite and vermicompost (VC). This experiment was laid out in the Completely Randomized Design (CRD) with six treatments and three replications. A number of 18 pots were used for this study. The treatments are;T_1:100%NPKS,T_2:100%NPKS+2t/ha dolomite, T_3:80%NPKS+2t/ha dolomite

T_4:100%NPKS+1t/ha dolomite, T_5:80%NPKS+2t/ha vermicompost, T_6:80%NPKS+1t/ha dolomite+1t/ha vermicompost. Among six treatments, T_6 has shown the best result that indicates combination of lime and organic manure can eliminate the adverse effect of soil acidity and save 20% of recommended chemical fertilizer.

Project No. 6: Improvement of carbon sequestration and crop production using chemical and organic fertilizers through ^{13}C tracer techniques

Experiment No. 15: Effect of biochar and vermicompost on soil carbon fractions and soil aggregation in rice based cropping pattern (T.aman-Mustard- Boro) of char land soil and increased crop production

A field experiment was conducted in charland soil to assess the effect of different organic amendments on soil organic carbon (SOC), aggregation, microbial biomass and crop yields. The experimental design was a split-split plot with three replications. Tillage systems were arranged in the main plots, five different manure and fertilizer treatments were assigned in the sub-plots viz. T_1: Native soil fertility (control); T_2: Recommended Chemical fertilizer (RCF); T_3: 2 tha^{-1} biochar + RCF (IPNS); T_4: 2 tha^{-1} vermi compost + RCF (IPNS); T_5: 3 tha^{-1} Rice straw+ RCF (IPNS). The results showed that biochar-based IPNS treatment (T_3) increased SOC accumulation, macro aggregate formation; enhanced soil MBC, TN concentration, decreased the soil bulk density in soil. All the IPNS treatments improved soil aggregate properties compared to control treatments. Therefore, minimum tillage with biochar (T_3: 2 tha^{-1} biochar + RCF) and vermi compost (2 tha^{-1} vermi compost + RCF) based IPNS could be recommended for the improvement of the charland soil and also it can reduce the usages of chemical fertilizer.

Project No.7: Enhancement the crop productivity and soil fertility in smart agriculture through nano-fertilizers

Experiment No. 16: Effects of nano-urea fertilizer on nitrogen uptake and yield of rice crop in pot culture

Nitrogen uptake, ammonia (NH_3) volatilization, chlorophyll content and others factors were quantified in Boro rice (Binadhan-14) by adopting combined use of nano nitrogen and conventional urea fertilizer. The objective was to increase nitrogen uptake, NUE, to reduce NH_3 volatilization or to reduce N loss and to increase crop yield. Six treatments were included such as T_1: Absolute Control; T_2: 100% Recommended Conventional urea with PKS; T_3: Full Nano urea; T_4: 50% Nano urea+ 50% conventional urea; T_5: 75% Nano urea+ 25% conventional urea; T_6: 25% Nano urea+ 75% conventional urea; T_7: 50% Nano urea+ 50% Vermicompost. The experimental design was RCBD with three replications. Combined use of nano and conventional urea (T_6: 25% Nano urea+ 75% conventional urea) increased crop yields, nitrogen uptake, and lower N volatilization was observed. Combination of nano and conventional urea can reduce ammonia volatilization losses 40% than conventional urea alone. Higher NUE and reduced NH_3 volatilization might be possible by adopting combined use of nano and conventional urea.

Experiment No. 17: Effect of alternate wetting and drying (AWD) on yield, water requirement, and methane gas emissions from Boro rice in synchronized cropping site

A field experiment was carried out at a synchronized cropping area of farmer's field, Nokla, Sherpur using Boro rice (SL8H Super Hybrid) to identify suitable water management options for water-saving, reduction of methane gas emissions, and sustainable yield. There were two treatments along with four replications in a Randomized Complete Block Design. The scheduled treatments were: T_1 = Irrigation following AWD [25 cm long plastic pipe (lower 15 cm was perforated) was inserted into rice field and water was added when water level inside the pipe dropped by 15 cm], and T_2 = Non-AWD [Normal irrigation/Farmer's practice, keeping continuous standing water in the field]. A rice transplanter was used to transplant the seedlings grown in trays. A 25- d old seedlings were transplanted. The fertilizers were applied based on the Khamari App: Urea @ 248 kg ha^{-1}, DAP @ 143 kg ha^{-1}, MoP @ 253 kg ha^{-1}, Gypsum @ 126 kg ha^{-1}, Zinc sulfate @ 6 kg ha^{-1}. The results indicated that a higher grain yield was observed in the AWD plot (6.61 t ha^{1}) compared to the Non-AWD plot (5.83 t ha^{-1}). Overall, yield was increased in the AWD plot by 13.4%, and irrigation water saved by 16%. Across the season, cumulative CH_4 emissions were higher under the Non-AWD irrigation compared to those recorded at the AWD irrigation. AWD irrigation reduced CH_4 emissions by 35% compared to the Non-AWD irrigation system, this was probably because of intermittent aeration makes the soil oxic, which results in the oxidation of CH_4 by methanotroph microbes and causes a drop in CH_4 emissions. Therefore, it is revealed that the alternate wetting and drying (AWD) implementation on the Boro rice provides a promising management strategy to effectively decrease CH_4 production and emissions from rice field, which will contribute to sustainable rice production.

Experiment No. 18: Effects of rice establishment methods, and N rates on soil N use efficiency and greenhouse gas emissions in rice-rice cropping pattern

A field experiment was carried out at BINA HQs farm, Mymensingh using the cropping pattern T. Aman – Fallow – Boro to identify the suitable rice establishment method, and N rate for maximizing crop yield and reducing greenhouse gas emissions. The treatments were rice establishment methods viz. SRI (System of rice intensification) and puddled transplanted rice (PTR) were used in the main plots. For the T. Aman and Boro rice, five N rates were used, viz. T_1=Native fertility, T_2= N @ 0 kg ha^{-1}, T_3= 75% N based on STB, T_4= 100% N, T_5= 125% N in the sub-plots. In SRI plots, one seedling (14-day-old seedlings) was transplanted in a field at a 25 × 25 cm spacing plot, and alternate wetting and drying (AWD) irrigation was practiced. Alternatively, in PTR plots, three seedlings (14-day-old seedlings) were transplanted in a field at 20 × 15 cm spacing plot, and continuous flooded irrigation was practiced. For the T. Aman rice,

the highest yield (4.56 t ha^{-1}) was found in the treatment T_5 (125% N based on STB) compared to the treatment T_2 (N @ 0 kg ha^{-1}). For the Boro rice (BINA Dhan-25), the results stated that the highest grain yield was observed in the SRI plot (4.79 t ha^{-1}) compared to the PTR plot (4.31 t ha^{-1}). Overall, yield was increased in the SRI plot by 11%, this was probably due to increased tiller per hill, increased microbial activity due to oxidation facility. The yield of Boro rice was significantly influenced by the different N rates. The highest grain yield (6.10 t ha^{-1}) was found in the treatment T_5 (125% N) while the lowest yield (2.93 t ha^{-1}) was observed in the T_1 (Native soil fertility) treatment. If, the interaction of the rice establishment method and N rates was not statistically significant; SRI with T_5 (125% N) was the combined approach that increased rice yield.

Experiment No. 19: Isolation and characterization of rhizobial strains from root nodules of mungbean, lentil, blackgram, chickpea, soybean, groundnut, cowpea, felon and french bean in laboratory

A Lab experiment was conducted in microbiology laboratory of Soil Science Division of BINA Head Quarters, Mymensingh from September, 2023 to March, 2024 to screening and selection of efficient *Rhizobium* /*Bradyrhizibium* strains for pulse crops. To determine the BNF potentials of strains and to investigate the effect of isolated rhizobial strains on crop yields (mungbean, groundnut and soybean), three pot experiments (filled with sterilized sand) were conducted at the glass house of Soil Science Division of BINA Head Quarters, Mymensingh. Healthy plants were collected from different areas of Mymensingh, Ishurdi and Rangpur districts and uprooted carefully and nodules were collected from the roots. After surface sterilized with 70% alcohol (Ethanol) and 3% H_2O_2 (Hydrogen peroxide), the nodules then cut with sterile surgical blade and with an inoculation loop a milky bacterial suspension was streaked on CRYEMA (Congo Red Yeast extract mannitol agar) plates and incubated for 5-7 days at 28°C to obtained bradyrhizobial bacterial colony. Then in microbiology laboratory of Soil Science Division pure culture of isolated *Bradyrhizobium* bacteria were subjected to BTB test (for alkali production), morphological, biochemical tests for characterization. For BTB test the isolated strains were grown in bromothymol blue media, while grown, all strains caused a color change from green to blue, indicating alkali production. Catalase activity test (for biochemical test), shows the ability of some microbes to degrade hydrogen peroxide by producing the catalase enzyme. On the basis of laboratory tests and pot experiments for nodulation test, the newly isolated *Bradyrhizobium* strains of mungbean (Str.-Iso-2 and Str.-Iso-3), groundnut (GNIsd.-Iso-2, isolated from Ishurdi) and soybean (Str.-Iso-2) could be used as biofertilizer for these crops.

Experiment No. 20: Isolation of salinity tolerant rhizobial strains from root nodules of groundnut and characterization in laboratory environment

A Lab experiment was conducted in Soil Science Division at BINA Head Quarters to isolate effective salinity tolerant rhizobial strains for groundnut cultivation and determine the nitrogen fixing, growth promoting ability of rhizobia strains on groundnut crops. To increase the groundnut production in increasing saline areas of large costal area of Bangladesh, healthy plants were collected from different areas of Satkhira districts and uprooted carefully and nodules were collected from the roots. After surface sterilized with 70% alcohol (Ethanol) and 3% H_2O_2 (Hydrogen peroxide), the nodules then cut with sterile surgical blade and with an inoculation loop a milky bacterial suspension was streaked on CRYEMA (Congo Red Yeast extract mannitol agar) plates and incubated for 5-7 days at 28°C to obtained bradyrhizobial bacterial colony. Then in microbiology laboratory of Soil Science Division pure culture of isolated *Bradyrhizobium* bacteria were subjected to authentication as congo red test, bromothymol blue test, morphological and biochemical characterization. For BTB test the isolated strains were grown in bromothymol blue media, while grown, all strains caused a color change from green to blue, indicating alkali production. Catalase activity test (for biochemical test), shows the ability of some microbes to degrade hydrogen peroxide by producing the catalase enzyme. To observe the effectiveness of the isolated *Bradyrhizobium* strain, biochemical test viz. salinity tolerant, pH (in laboratory condition) and nodulation tests will be done in pot condition filled with sterilized sand.

Experiment No. 21: Effect of *Bradyrhizobium* strains on nodulation and yield of mungbean varieties in field condition

A field experiment was conducted at BINA Sub-station farm, Ishurdi for evaluating effectiveness of inoculated *Bradyrhizobium* strains on nodulation and yield of BINA released mungbean varieties during March to June, 2024. There were six treatments viz. T_1: I_o (Control), T_2: I_1 (MBB-6), T_3: I_2 (MBB-7), T_4: I_3 (MB-8), T_5: I_4 (MB-9), T_6: N@ 20.0 kg ha^{-1}. The objectives were to determine the effectiveness of inoculated *Bradyrhizobium* strains on nodulation, nitrogen content and yield of BINA released mungbean variety namely Binamoog-5 (V_1) and Binamoog-8 (V_2). The experiment was laid out in Split-plot design with three replications. Unit plot size was 6 m^2 (2m × 3m) and line to line spacing was maintained 25 cm. Seeds were sown on 28 March 2024. Inoculation was done through seed treatment using carrier based inoculant at the rate of 50 g kg^{-1} seed at the time of sowing. The results of the experiment showed that the nodulation is higher in Binamoog-8 (27.00) than the Binamoog-5 (17.33). Binamoog-8 showed significantly highest plant height (69.00 cm) in treatment T_4 followed by the treatment T_5 (65.00 cm). For yield and yield attributing characters of two mungbean varieties, (interaction effect of Varieties and Inoculants) Binamoog-8 showed significantly highest dry weight $plant^{-1}$ in treatment T_2 (11.73 g) followed by treatment T_3 (11.28 gm) and T_4 (11.05 g) and in treatment T_6 seed yield (1.52 t ha^{-1}) and stover yield (1.72 t ha^{-1}) showed significantly higher than treatment T_4 (1.46 t ha^{-1} and 1.64 t ha^{-1}) compare with Binamoog-5 (1.41 t ha^{-1} and 1.61 t ha^{-1}) in treatment T_4 . From the result, it might be concluded that Binamoog-8 inoculated with *Bradyrhizobium* strains showed better results than Binamoog-5 inoculated with *Bradyrhizobium* strains and two new isolated strain performed better results compare with BINA biofertilizer strain MBB-6 and MBB-7.

Experiment No. 22: Effect of rhizobial inoculants in combination with vermicompost and Mo on soybean in pot condition

A pot experiment was conducted to see the effect of rhizobial inoculants in combination with vermicompost and Mo on soybean in glass house at Soil Science Division of BINA, Mymensingh. There were six treatments viz. T_1: I_0+VC_0, T_2: VC_5, T_3: VC_5+I_1, T_4: VC_5+I_1+ $Mo_{0.2,}$ T_5: I_1 and T_6: I_1+$Mo_{0.2}$. Here VC & I represents Vermicompost & Inoculant respectively. The experiment was conducted in a randomized complete block design with three replications in August, 2023. Plastic pot containing 10 kg soil was used. Nodulation data were recorded at vegetative stage. Yield attributing parameters were recorded after harvest of crop. Results showed significant increase in nodulation, plant height and yield with inoculated treatments over uninoculated control treatment. At 48 DAS, different growth parameters of soybean were collected. The highest no. of nodule plant^{-1}, and nodule fresh wt. plant^{-1} (0.82g) and no. of effective nodule plant^{-1} (26) were recorded in the treatment T_4. The treatment T_4 (3.01 t ha^{-1}) gave maximum yield followed by the treatment T_3 (2.74 t ha^{-1}) of the experiment. Among six treatments, T_4 (i.e.VC_5+I_1+$Mo_{0.2}$) showed overall good performance. There is no effective nodulation in the control uninoculated treatment. The result indicated that *Rhizobium* inoculation along with Mo and vermicompost enhanced soybean production.

Experiment No. 23: Integrated effects of rhizobial inoculant with vermicompost on groundnut in pot condition

An experiment was conducted to see the effects of rhizobial inoculant with vermicompost on groundnut in pot condition at BINA Headquarters, Mymensingh. There were five treatments viz. T_1: I_0 +VC_0, T_2: $N_{12}P_{12}K_{15}S_{12}$, T_3: I_1+ $P_{12}K_{15}S_{12}$, T_4: VC_2+$P_{12}K_{15}S_{12}$ and T_5: I_1+VC_2+$P_{12}K_{15}S_{12}$. Here VC & I represents vermicompost and Inoculant respectively. The experiment was conducted in a randomized complete block design with three replications in January, 2024. Plastic pot containing 5 kg sterilized sand was used. Sands were mixed with seedling solution of half strength @ 200 ml seedling solution per pot. Nodulation data were recorded at vegetative stage. Yield attributing parameters were recorded after harvest of crop. Results showed significant increase in nodulation, plant height and yield with inoculated treatments over uninoculated control treatment. At 62 DAS, different growth parameters of groundnut were collected. The highest effective nodule plant^{-1} (97) and nodule fresh wt. plant^{-1} (0.60 g) were recorded in the treatment T_5 whereas total plant height (28.5cm) was highest in the treatment T_4. No. of fruits plant^{-1} (11), yield (2.9 t ha^{-1}) were highest in the treatment T_5. Among five treatments the treatment T_5 (i.e I_1+VC_2+$P_{12}K_{15}S_{12}$) showed overall good performance. There is no effective nodulation in the control uninoculated treatment. The result indicated that *Rhizobium* inoculation along with vermicompost enhanced groundnut production.

Experiment No.24: Production and distribution of BINA biofertlizers in 2023-2024

An amount of 622.65 kg biofertilizers were produced for production of soybean (348.85 kg), mungbean (170.20 kg), lentil(19.60) groundnut (81.00 kg)) and french bean (3.00 kg). 622.65 kg were distributed to farmers, scientists, research students and other agricultural practitioners.

HORTICULTURE DIVISION

Research Highlights

Fruits

- Considering fruit characteristics of sweet orange i.e., taste, juiciness, sweetness, colour of pulp, fruit number, fewer incidences of insect, disease, yield potentiality and qualities MMD40 mutant was found promising.
- The CAD20P_1 mutant of lime was found promising considering fruit characteristics i.e., taste, juiciness, colour of pulp, fruit number in context of attractiveness, less incidence of insect, disease, considerable yield potentiality and edible qualities of fruit.
- Considering fruit characteristics of pomegranate i.e., taste, juiciness, fleshy pulp, sweetness, colour of pulp, no. of seed, softness of seed, fruit number in context of attractiveness, less incidence of insect, disease, considerable yield potentiality and edible qualities PG-2 (India-2) was found promising.
- Considering fruit characteristics of sapota, i. e., taste, juiciness, sweetness, colour of pulp, fruit number, less incidence of insect, disease, yield potentiality and qualities MAD20P9 mutant was found promising.
- The mutant SCD15P8 of jamun was found promising considering fruit characteristics i.e., taste, juiciness, sweetness, color of pulp, fruit number in context of attractiveness, less incidence of insect-disease, considerable yield potentiality and edible qualities of the fruit.
- Five germplasm of bel were included in the study. A wide variation was observed in case of different growth characters of the germplasm tested. AM - 001 was superior with bigger canopy size (8.7×7.6 m). The highest number of fruits (132) was found from AM - 003 with maximum yield (31.85 kg and 8.82 t/ha). There were variations among the quantitative fruit characters also. Maximum fruit weight was obtained from AM - 004 (550 g) with large sized fruit (11.2×10.4 cm). But AM - 001was superior with maximum TSS (40%), edible portion (63.76%).

- Five germplasm of pummelo viz. CG -001, CG -002, CG -003, CG -004 and CG -005 were evaluated at the laboratory of Horticulture Division, BINA, during 2023-2024. The highest edible portion was obtained (68.51%) in CG -003. TSS varied from 10-12%. The highest number of segment was found in CG -004 (16) and CG - 003(16). Fruits were either pyriform or oblate in shape. Fruits of CG -002 and CG -003 were very sweet and tasty. Considering fruit size, bearing and quality of fruits the lines CG - 002 and CG - 003 were found promising.

- Fruit characteristics of four custard apple germplasm were studied under the laboratory of Horticulture Division, BINA, during 2023-2024. The germplasm AS -005 showed better performances on the basis of fruit weight, number of seeds $fruit^{-1}$, TSS value and yield ($kg/plant^{-1}$).
- Three exotic longan germplasm namely EL- 003, EL - 005 and EL - 009 were studied at the BINA HQ's Farm, Mymensingh. Considering fruit size, bearing and quality of fruit the line EL- 003 was found promising.

Vegetables

- Binatomato-10 produced highest yield (76.46 t ha^{-1}) followed by CTL-1 (66.85 t ha^{-1}) and BARI Tomato-11 (49.36 t ha^{-1}).

- Highest yield was recorded in Bahbali which was 99.23 t ha^{-1} followed by Bijli-11 (94.78 t ha^{-1}), Durjoy (93.38 t ha^{-1}), Moon (89.73 t ha^{-1}), ACI summerking (88.50 t ha^{-1}), BARI Hybrid Tomato-8 (85.32 t ha^{-1}), Dipali (82.79 t ha^{-1}), BRAC 1710 (78.02 t ha^{-1}), Udayon plus (77.20 t ha^{-1}), Comet (76.10 t ha^{-1}), Megha (73.15 t ha^{-1}), Tidy plus (70.80 t ha^{-1}), Sawsan8323 (70.74 t ha^{-1}), Uttaran+ (68.90 t ha^{-1}), Shukhi (67.72 t ha^{-1}), Unnayan (62.01 t ha^{-1}), TM027 (61.63 t ha^{-1}), Red stone (59.04 t ha^{-1}), Ratan (54.96 t ha^{-1}), Sultan (53.43 t ha^{-1}), Lal bahadur (50.59 t ha^{-1}), Prottasha (48.33 t ha^{-1}), Extra profit (47.63 t ha^{-1}) and Raket 1040 (39.55 t ha^{-1}).
- Four tomato genotypes were collected from home & abroad which were irradiated with 200, 300, 400 and 500 Gy of gamma ray. 11 M_3 mutant generation of tomato seeds will harvest and preserve as breeding material for next season.
- CBM-3 produced highest yield (1.3 kg $plant^{-1}$) followed by CBM-4 (1.2 kg $plant^{-1}$) and parent (1 kg $plant^{-1}$).

- We just select 6 line (M_4 seed) on the basis of no. of branches $plant^{-1}$, no of fruits $plant^{-1}$, number of seed $fruit^{-1}$, fruit diameter (mm), fruit length (cm), fruit weight (g). M_4 seeds from each plant were collected to grow M_5 population.

- Six(6) mutant lines have been selected for further selection in subsequent generations.

- Harvested seventeen(17) M_3 mutation seeds were preserved as breeding material for next season.
- Selfed seeds of eight commercial hybrid varieties, one local variety and one mutant line have been collected, which will be selfed again in the next growing season.

Spices

- Two M_6 mutants (ACM - 026 and ACM - 030) of onion performed better, considering bulb yield and other yield contributing traits. Five M_5 onion mutants have been selected for future trail. In addition, various number of mutants $lines^{-1}$ at different generations were identified which will be evaluated in the next growing season.

- Two M_1V_3 mutants and eighteen(18) M_1V_1 mutants of garlic having high yield potentiality with moderate storage quality have selected for further trial.

Ginger

Twenty M_1V_1 mutants were selected for growing in next season.

Chilli

One exotic chilli genotypes and advanced mutants (CFG-43) were found promising through observation yield trial in respect of yield and pungency.

Turmeric

Two mutants of turmeric CLM-21-2-01 and CLM-21-5-02 were selected with high yield potentiality and tolerant leaf blotch disease for further selection in next season. To Create genetic variability, Rhizome of Turmeric local cultivar kukurmoni was irradiated with 10,15,20,25 30,35 & 40 Gy of Gamma rays .

Black Cumin

One M_6 mutants having high yield $BC_2M_6D_{150}$ (526.13 g) and short duration (121 days) have been selected for further yield trial in next season. This is also released as BINAkalojeera1 during 2024-25 season. M_2 generation is selected for further trial.

Sweet pepper

Based yield potentiality and number of fruits plant-1 seven genotypes have been selected for further selection in subsequent generations.

Flowers

Gladiolus

To develop gladiolus with various floret colours, long spikes with higher number of florets, and longer vase life the $M_1V_4D_{30}P_{1\text{-}30}$, and $M_1V_4D_{20}R_{1\text{-}30}$, with control were planted in RCBD design with three replications. $M_1V_4D_{30}P$ mutant produced maximum, attractive colour large flower (16.5) than the untreated control bulbs (13.0) respectively. In case of $M_1V_4D_0R$ mutants produced more variegated large red flower (19.0) than the untreated control bulbs (15.5) respectively. Longest shelf life (13.5 days) was found $M_1V_4D_{30}P$ and shortest shelf life (11.0 days) was found control pink flowers. Finally, the M_1V_6 corms from the survived plants were bulked and kept for growing of M_1V_6 generation in the next growing season.

To develop gladiolus with various floret colours, long spikes with higher number of florets, and longer vase life M_1V_2 gladiolus mutant were planted separately in rows and data were recorded. Finally, the M_1V_6 corms from the survived plants were bulked and kept for growing of M_1V_3 generation in the next growing season.

Rose

To develop rose variety with attractive flower colours, flower yield, longer stalk and longer vase life the $M_1V_2D_{20}RP_3$, $M_1V_1D_{20}RP_7$, $M_1V_1D_{20}RP_{10}$, $M_1V_1D_{20}RP_{14}$ rose mutant have been screened. $M_1V_1D_{20}RP_7$ produced maximum flower (16) and longer stalk length (32.5 cm) than control (9 flower/pl, 22.8 cm). $M_1V_2D_{20}RP_3$, $M_1V_1D_{20}RP_7$, $M_1V_1D_{20}RP_{10}$ and $M_1V_1D_{20}RP_{14}$ mutant produced different flour colour and shape.

Chrysanthemum and gerbera

To develop flower variety of chrysanthemum and gerbera were irradiated @ 0, 10, 20, 30, 40, and 50 Gy and planted separately and data were recorded. Among the radiation doses 20 Gy irradiated gerbera showed better performance (no. of leaf, flower number, flower colour and stalk length

than control. In case of chrysanthemum, 30 Gy irradiated sucker showed better performance (no. of leaf, flower number, flower colour and stalk length than control.

Postharvest technology

- 150 Gy irradiated potato (var. Diamant and Cardinal) showed minimum weight loss, inhibited sprouting and extend shelf life up to 3-4 months at ambient room temperature .

- The highest weight loss (86.5%) was found in non-irradiated wrapped control beans, whereas the lowest weight loss (6.3%) was observed in those beans irradiated with 200 Gy wrapped in LDPE bags at the 15 DAI. Longest shelf life (18 days) was found in country beans irradiated @ 200 Gy and wrapped in LDPE bags (25 µ). In contrast, the shortest shelf life (3.0 days) was found in the non-irradiated unwrapped country beans.

- The longest shelf life (66.3 days) and minimum weight loss (0.16%) was found when dragon fruits wrapped in LDPE bags (25 µ) and kept in at refrigerated condition without deteriorating quality and shortest shelf life (8.0 days) and maximum weight loss (22.07%) was found untreated control dragon fruits.

- Minimum weight loss (16.18%) was found 100 Gy irradiated Taherpuri onion at Mymensingh followed by Rangpur (22.0%) and maximum weight loss (50.0%) was found untreated control Lal Teel King Onion at Ishwadi, Pabna after 180 days storage. No Sprouting was found of irradiated Lal Teer King onion at Mymensingh after 180 days storage. Maximum sprouting (99.6%) was found at Ishwardi and Sathia, Pabna.

Tissue culture technique

- Light orange Oriental lilium outperformed in MS medium supplemented with 0.5 mg/l NAA with 1.0 mg/l BAP compared to Pink and orange genotypes and other treatments.
- Binatomato-11 outperformed after irradiation on callus at 4 Gy compared to other treatments, while the percent of shoot initiation was very poor in this treatment.

- The performance of IVRP 11.4, IVRP 11.6, IVRP 12.1, and IVRP 13.1 compared to their parent genotypes highlight the potential of somaclonal variation as a valuable tool for tomato improvement.

Variety/ Technology developed with salient features (during 2023-24)

Characteristics of BINA kalojira1:

- Medium plant height (60-65 cm).
- 15 days earlier than other varieties.
- The number of branches per plant is 12-15.
- The number of pods per plant is 35-45.
- Bold seeded: 1000 seed weight is 2.6-2.9 g.
- Yield per plant is 6-7 g.
- Average yield per hectare is 1.2 ton/ha.
- Duration-

Name of the project: Varietal improvement of Fruits

Collection and evaluation of major fruits germplasm

A total of 45 major fruits germplasm has been collected from the different parts of the country as well as outside the country and planted in the field. The germplasm were collected from farmers' home garden and nursery. The status of the sample was landraces. The samples were collected as scion from individual plant or population. Passport data like crop name, collector's number, local or cultivar name, sample status and source, date of collection, name of village, union, upazila and district were recorded. Collected germplasm were evaluated on the basis of morphological characters and yield.

Evaluation of mango germplasm

About 72 germplasms (Rani posondo, Neel uddin, Miyazaki, King chaka pat, Brunai King, Karate colombo, Nam Doc Mai, Kewsani, Taiwan red, Taiwan green, Rad, MARDI, Black stone, Honeydew etc) of mango have been planted and maintaining in the Germplasm Centre. Four genotypes of mango, namely MI -009, MI -019, MI - 052, and MI -076 were identified after screening. Between them, maximum number of fruits (30) plant^{-1} was produced by MI-009 and minimum number of fruits (24) plant^{-1} was produced from MI - 076. Maximum Total Soluble Solids (TSS) (21.57 %) was observed in MI - 076 and minimum (20.12 %) TSS was observed in MI - 009. The highest yield per tree (5.65 kg) was produced from MI - 009 and the lowest yield per tree (4.25 kg) was produced from MI - 076. Very good organoleptic taste was found in MI - 076.

Collection and evaluation of minor fruits germplasm

A total of 55 minor fruits germplasm has been collected from the different parts of the country as well as outside the country and planted in the field. The germplasm were collected from farmers' home garden and nursery. The status of the sample was landraces. The samples were collected as scion from individual plant or population. Passport data like crop name, collector's number, local or cultivar name, sample status and source, date of collection, name of village, union, upazila and district were recorded. Collected germplasm were evaluated on the basis of morphological characters and yield.

Evaluation of Custard apple germplasm at BINA HQ, Mymensingh

Fruit characteristics of four custard apple germplasm were studied under the laboratory of Horticulture Division, BINA, during 2023-2024. Two genotypes of custard apple, namely AS003 and AS005 were identified after screening. The result indicated that wide range of diversity existed in fruit weight, TSS content, yield plant^{-1} and fruit color etc. The weight of a matured fruit varied from 146.67 g to 443.00 g. The highest fruit weight (443 g) was observed in AS - 005 followed by AS - 003 (306.67 g) and the lowest fruit weight was noted in AS - 004 (146.67 g). TSS varied from 23.5 to 27.5. The germplasm AS - 005 showed better performance on the basis of fruit weight, number of seeds fruit-1, TSS value and yield (kg plant^{-1}).

Evaluation of exotic jamun germplasm

Fruit characteristics of four exotic jamun germplasm were studied under the laboratory of Horticulture Division, BINA, during 2023-2024. Two genotypes of jamun germplasm, namely SC007 and SC009 were identified after screening. Plant height, base girth and number of primary branches were 5.1 m, 67.8 cm and 4.0, respectively. Flowering started from 1st week of February and continued up to 1st week of March and fruit setting took place during April. Fruit weight was 5.67 g having 2.87 cm length and 2.15 cm diameter. Seed weight was 1.15 g and edible portion was 82.19%. Ripe fruit was black in color and TSS in fruit juice was 13.40%. The plant produced 5.23 kg fruit. Individual fruit weight was 5.57 g having TSS 13.00%. The growth condition of the plant, fruit quality as well as yield was quite satisfactory.

Evaluation of local pummelo germplasm

Five germplasm of pummelo viz. CG - 001, CG - 002, CG - 003, CG - 004 and CG - 005 were evaluated at the laboratory of Horticulture Division, BINA during 2023-2024. Fruit weight of the germplasm ranged from 705g (CG -004) to 825g (CG -001). The highest edible portion was obtained (68.51%) in CG -003. TSS varied from 10-12%. The highest number of segment was found in CG -004 (16) and CG - 003(16). Fruits were either pyriform or oblate in shape. Fruits of CG - 002 and CG - 003 were very sweet and tastes. Considering fruit size, bearing and quality of fruits the lines CG - 002 and CG -003 were found promising.

Evaluation of bael germplasm

Five germplasms of bael was included in the study. A wide variation was observed in case of different growth characters of the germplasm tested. The highest plant height was recorded in case of AM -004 but base girth was the highest from AM - 005 (132 m). AM - 001 was superior with bigger canopy size (8.7×7.6 m). The highest number of fruits (132) was found from AM -003 with maximum yield (31.85 kg and 8.82 t ha-^{1}). There were variations among the quantitative fruit characters also. Maximum fruit weight was obtained from AM -004 (550 g) with large sized fruit (11.2×10.4 cm). But AM - 001was superior with maximum TSS (40%), edible portion (63.76%).

Evaluation of pomegranate germplasm

An experiment was carried out at the laboratory of Horticulture Division, BINA, during 2023-2024 to evaluate thirty twenty five pomegranate germplasms. Wide range of variation was observed with respect to plant height, base girth, canopy spread in respect of E-W and N-S orientation and number of fruit. Plant height was maximum (280 m) in PG -002 and minimum (1.15 m) in PG -030 and the base girth was recorded maximum (25 cm) in PG -007, whereas it was noticed minimum (6 cm) in PG -02. Individual fruit weight was recorded maximum (180 g) in PG -039. The germplasm PG -001 contained maximum total soluble solids (14.6 %). Fruit colour of most of the germplasm was observed orange red, while aril color was noticed white to medium red. The fruits of all the germplasm were harvested between July and September 2024.

Collection and evaluation of exotic fruits germplasm

A total of 29 exotic fruits germplasm has been collected from the different parts of the country as well as outside the country and planted in the field. The germplasm was collected from farmers' home garden and nursery. The status of the sample was landraces. The samples were collected as scion from individual plant or population. Passport data like crop name, collector's number, local or cultivar name, sample status and source, date of collection, name of village, union, upazila and district were recorded. Collected germplasm were evaluated on the basis of morphological characters and yield.

Evaluation of exotic jackfruit germplasm

Two exotic jackfruit germplasm namely AH -001 and AH -002 were studied at the BINA HQ's Farm, Mymensingh. Plant height, base girth, plant spreading and male inflorescences were recorded. The average plant height was observed to be 4.55 m. Maximum plant height was recorded in AH -02 (5.66 m) and minimum plant height was recorded in AH -001 (4.46 m). All the germplasm were observed to produce male inflorescences and one of the germplasm was found to produce male inflorescences from the month of July 2024 which was the sign of off-season and year round behavior. Male inflorescences were observed from the first year of planting, but female inflorescences were not found. The exotic jackfruit germplasm (AH -02) and (AH -001) produced red and light pink colored pulp, respectively. Textures of pulp of both germplasm were firm. Experiment will be conducted in the next year for further evaluation.

Evaluation of exotic longan germplasm

Two exotic longan germplasm namely EL-003 and EL -005 were studied at the BINA HQ's Farm, Mymensingh. Fruit weight, Length of fruit, diameter of fruit, aril weight, rind weight, seed weight, TSS (%) and edible portion were recorded. Wide range of variability was observed among the genotypes under study in respect of different physical characteristics of fruits. Fruit weight of different genotype varied from 5.87g to 8.66g. The highest fruit weight was recorded in the genotypes EL- 003(8.96g. The lowest fruit weight was obtained from the genotypes EL-009 (5.87g). The highest rind weight was recorded in EL-0 09 (1.42g) whereas, the lowest in EL- 003 (0.65 g).The weight of aril was the highest in EL-0 03 (4.33g), while the lowest in EL-009 (4.07 g). The highest percentage of edible portion was recorded in the germplasm EL- 003 (75.02 %) while the lowest in EL-009 (61.45 %) (Table 3).The highest TSS was found in EL- 003 (22.23%)

.

Screening of M_1V_1 population of Sweet orange, Sapota, Jamun and Pomegranate suitable for drought and saline areas of Bangladesh

Twenty four M_1V_1 mutants of sweet orange, 31 M_1V_1 mutants of sapota, 20 M_1V_1 mutants of pomegranate and 29 M_1V_1 mutants of jamun having high yield potential has been evaluated. One jamun, one sapota and one pomegranate mutant have been selected as advanced lines. Individual experimental results are given below-

Growing of M_1V_1 population of sweet orange

The experiment was conducted with 3 M_1V_1 mutants derived from sweet orange and three check varieties ($WNMD_0P_1$, MMD_0P_1 and BARI D_0P_1) at the BINA HQ, Mymensingh to create genetic variability. Scions of sweet orange were irradiated with 20Gy, 40Gy, 60Gy, 80Gy and 100 Gy of gamma ray. Irradiated scions were graft on pummelo root stock. The experiment was laid out in row planting method with raw-to-raw 3m and plant to plant 3m spacing. Recommended production packages were followed to ensure normal plant growth and development. Urea, TSP, MoP, sulphur, zinc and cowdung were applied @ 100g, 100g, 100g, 50g, 50g and 20 kg pit^{-1}. Intercultural practices were followed as and when necessitated. Result from the experiment, it was found that the $MMD_{20}P_1$ mutant showed maximum number of fruits (174) per plant, accumulated higher TSS (11.00 %) and minimum number of seed $fruit^{-1}$ (6) whereas the minimum number of fruits (65) $plant^{-1}$ and maximum number of seeds $fruit^{-1}$ (13) were recorded in $WNMD_0P_1$**.** The maximum length of fruit (6.97 cm), breadth of fruit (6.99cm) and weight of individual fruit (194 g) as well as yield $plan^{-1}$ (23.33 kg $plant^{-1}$) were found in $MMD_{20}P_1$ mutant (Table 15). Considering fruit characteristics i.e., taste, juiciness, sweetness, color of pulp, fruit number, in context of attractiveness, less incidence of insect-disease, considerable yield potentiality and edible qualities of $MMD_{40}P_1$ mutant was found promising.

Growing of M_1V_1 population of lime

The experiment was conducted with 3 M_1V_1 populations of lime and a check variety (CAD_0P_1) at the BINA Horticulture farm, Mymensingh to create genetic variability. Scions of lime were irradiated with 20 Gy, 40 Gy, 60 Gy and 80 Gy of gamma ray. Irradiated scions were graft on lemon root stock. The experiment was laid out in row planting method with raw to raw 3m and plant to plant 3m spacing. Recommended production packages were followed to ensure normal plant growth and development. Urea, TSP, MoP, sulphur, zinc and cowdung were applied @ 100g, 100g, 100g, 50g, 50g and 20 kg pit^{-1}. Cultural and intercultural practices were followed as and when necessitated. Result from the experiment, there were differences among the mutants studied regarding plant height, number of fruits/plant, fruit length, fruit breadth, individual fruit weight and yield per plant. it was found that the $CAD_{20}P_1$ mutant showed the maximum number of fruits (165) per plant, weight of individual fruit (134g), accumulated higher TSS (7.0 %), minimum number of seeds $fruit^{-1}$ (5), length of fruit (5.07cm), breadth of fruit (4.67 cm) and yield (13.66 kg $plant^{-1}$) were recorded in $CAD_{40}P_1$. Whereas the minimum no. of fruit (92), length of fruit (4.66 cm), breadth of fruit (4.15 cm) and weight of individual fruit (105 g), maximum number of seed $fruit^{-1}$ (13) and minimum yield (7.04 kg/plant) were found in CAD_0P_1muta

Screening of pomegranate germplasm on growth, yield and quality attributes

The experiment was conducted with seven pomegranate genotypes at BINA headquarters farm, Mymensingh to select germplasm of desirable value with high yield, short duration, early fruit bearing, higher edible portion, best pickling quality, fleshy pulp, sweet, and juiciness, no. of seeds and longer shelf life. Seven Pomegranate germplasms PG-1(India-1), PG-2 (India-2), PG-3 (India-3), PG-4 (Indian Anar-1), PG-5 (Indian Anar-2), PG-6 (Indian Bedana-1), PG-7 (Indian Bedana-2) were collected from India. The experiment was laid out in randomized complete block design (RCDB) with three replications with raw to raw 3m and plant to plant 3m spacing. Recommended production packages were followed to ensure normal plant growth and development. Urea, TSP, MoP, sulphur, zinc and cowdung were applied @ 100g, 100g, 100g, 50g, 50g and 20 kg pit^{-1}. Cultural and intercultural practices were followed as and when necessitated. From the results, it was found that the germplasm PG-2 (India-2) showed the maximum number of fruits (65 fruits $plant^{-1}$), length and breadth of fruit were 5.5cm and 5.4cm, respectively whereas the minimum number of fruits (17fruits $plant^{-1}$), length and breadth (4.4cm and 4.5cm) of fruit were recorded in PG-7 (Indian Bedana-2). PG-2 (India-2) germplasm along with accumulated the highest TSS (18.50 %) and maximum weight of fruit $plant^{-1}$ (200 g) and yield /plant(12.44kg) whereas the lowest TSS (14.50 %), minimum weight of fruit $plant^{-1}$ (119 g) and yield/plant(2.00kg) were recorded in PG-7 (Indian Bedana-2).Considering fruit characteristics i.e., plant height, fruit number, weight of individual fruit, %TSS and yield potentiality of PG-2 (India-2) was found promising.

Growing of M_1 V_1 population of sapota

The experiment was conducted with four M_1V_1 populations (MAD20P5, MAD20P9, MAD40P2 and MAD40P6 1) of sapota and one check variety (MAD0P1) at the BINA HQs, Mymensingh to create genetic variability. Scions of sapota were irradiated with 20Gy, 40Gy and 60Gy of gamma ray. Irradiated scions were grafted on khirni root stock. The experiment was laid out in row planting method with raw to raw 3m and plant to plant 3m spacing. Recommended production packages were followed to ensure normal plant growth and development. Urea, TSP, MoP, sulphur, zinc and cowdung were applied @ 100g, 100g, 100g, 50g, 50g and 20 kg pit^{-1}. Cultural and intercultural practices were followed as and when necessitated. Result from the experiment, it was found that the MAD20P9 mutant showed the maximum number of fruits (35fruits $plant^{-1}$) per plant, accumulated higher TSS (23.0 %), length of fruit (6.9 cm), breadth of fruit (6.2 cm) and weight of individual fruit (325 g) as well as yield $plant^{-1}$ (11.20 kg/plant) were recorded. The minimum number of fruits (18) per plant, accumulated higher TSS (20.0 %), length of fruit (4.5 cm), breadth of fruit (4.4 cm) and weight of individual fruit (98 g) as well as yield $plant^{-1}$ (1.70 kg $plant^{-1}$) were recorded in MAD0P1. Considering fruit characteristics i.e., fruit number, individual fruit weight, %TSS and yield potentiality of MAD20P9 mutant was found promising.

Growing of M_1V_1 population of Jamun

The experiment was conducted with 5 M_1V_1 mutant (SCD5P5, SCD10P2, SCD10P6, SCD15P6 and SCD15P8) of sapota and one check variety (SCD0P1) at the BINA HQ, Mymensingh to create genetic variability. Scions of jamun were irradiated with 5Gy, 10Gy and 15Gy of gamma ray. Irradiated scions were grafted on jamun root stock. The experiment was laid out in row

planting method with raw to raw 3m and plant to plant 3m spacing. Recommended production packages were followed to ensure normal plant growth and development. Urea, TSP, MoP, sulphur, zinc and cowdung were applied @ 100g, 100g, 100g, 50g, 50g and 20 kg pit^{-1}. Cultural and intercultural practices were followed as and when necessitated. Result from the experiment, it was found that the SCD15P8 population showed the highest TSS (13.50 %), length of fruit (2.7 cm), breadth of fruit (2.3 cm) and weight of individual fruit (13.50 g) as well as yield $plant^{-1}$ (5.70 kg $plant^{-1}$) were recorded. The lowest TSS (10.50 %), length of fruit (2.0 cm), breadth of fruit (1.8cm) and weight of individual fruit (9.20 g) as well as yield $plant^{-1}$ (3.50 kg $plan^{-1}$t) were recorded in SCD0P1. Considering fruit characteristics i.e., fruit number, length and breadth of fruit, %TSS and yield potentiality of SCD15P8 mutant was found promising.

Name of the Project: Improvement of Vegetables

Regional yield trial of promising cherry tomato

A field experiment was conducted at horticulture research farm of Bangladesh Institute of Nuclear Agriculture. The experiment carried out using Randomized complete block design with three replications to evaluate the performance of CTL tomato line. In this experiment BARI Tomato-11 and Binatomato-10 were used as control. Fertilizer application was completed as per BARC fertilizer guideline. Irrigation and other intercultural operation were done when necessary. Data of plant height (cm), Days to 1st fruit set, No. of cluster $plant^{-1}$, Flower $cluster^{-1}$, fruit $cluster^{-1}$, no of fruit $plant^{-1}$, single fruit weight (g) and fruit yield t ha^{-1} were collected and analyzed with IRRI developed Statistical software 'STAR'. Maximum plant height was recorded in CTL (230.67 cm) which is statistically differing to Binatomato-10 (162.67 cm) and BARI Tomato-11 (125.67). In case of 1st fruit setting there no statistically different among three genotypes. Maximum days require for 1st fruit setting of BARI tomato-11 was 78.80 days followed by Binatomato-10 (77.83 days) and CTL (77.22 days). CTL produced maximum no. of cluster plant-1 (70.82) followed by Binatomato-10 (70.00) and BARI Tomato-11 (45.72). There is no significant difference among no. of flower cluster-1 but Binatomato-10 produced maximum flower $cluster^{-1}$ (13.85) followed by BARI Tomato-11 (12.80) and CTL (12.6). There is no significant difference among no. of fruit cluster-1 but Binatomato-10 produced maximum flower $cluster^{-1}$ (13.85) followed by BARI Tomato-11 (12.80) and CTL (12.60). CTL produced maximum no. of fruits $plant^{-1}$ (368.87) which is statistically identical to Binatomato-10 (353.03) and BARI Tomato-11 (207.84). Single fruit weight (g): Maximum single fruit weight was recorded in BARI Tomato-11 (11.89 g) that is statistically identical to Binatomato-10 (10.91 g). Both BARI Tomato-11 and Binatomato-10 are significantly different to CTL (9.07 g). Maximum fruit yield was recorded in Binatomato-10 (76.46 t ha^{-1}) which is significantly different to CTL (66.85 t ha^{-1}) and BARI Tomato-11 (49.36 t ha^{-1}).

Reverse breeding of commercial hybrid of tomato

A field experiment was conducted at Kashiar char farm of Bangladesh Institute of Nuclear Agriculture under Mymensingh district. The experiment carried out using complete randomized

design with non-replicated to evaluate the performance of 22 promising commercial hybrid tomato varieties. In this experiment Unnayan, Extra profit, Lal bahadur, BRAC 1701, Durjoy, ACI summerking, BARI Hybrid Tomato-8, TM027, Red stone, Sawsan8323, Shukhi, Megha, Udayon plus, Tidy plus, Moon, Bijli-11, Bahubali, Ratan (Marglove), Dipali, Sultan, Prottasha, Uttaran+, Raket 1040 and Comet were used treatment. Fertilizer application was completed as per BARC fertilizer guideline. Irrigation and other intercultural operation were done when necessary. Data of plant height (cm), Days to 1st fruit set, No. of cluster plant^{-1}, Flower cluster^{-1}, fruit cluster^{-1}, no of fruit plant^{-1}, single fruit weight (g) and fruit yield t ha^{-1} were collected and analyzed with IRRI developed Statistical software 'STAR'.

Preliminary yield trial with promosing country bean mutants

Three country bean mutants with parents were grown in at BINA HQs Farm, Mymensingh on 05 October 2023. The experiment was conducted in a RCBD design in a three replication. The Plant transplanted with 3m line to line and 3m plant to plant within a line. Recommended production packages i.e., application of fertilizers, irrigation, weeding etc. were followed to ensure normal plant growth and development. Data was recorded on no. of primary branch/plant, no. of bunch/plant, No. of fruit/bunch, days to first harvest, yield/plant from each selected plant from each pit presented in the Table 11. On an average, no. of primary branch/plant ranged from 4.7 to 8.7. CBM-4 having the lowest no. of primary branch/plant (4.7) and CBM-3 having the highest no. of primary branch/plant (8.7). No .of bunch/plant is one of the major yield contributing characters of country bean. Among the mutants, CBM-3 bearing highest no. of bunch/plant (27.0) and CBM-2 bearing lowest no. of bunch/plant (21.0). Considering yield contributing traits mutants CBM-2, CBM-3 and CBM-4 have been selected for future varietal evaluation. **:** Highest yield was recorded in Bahbali which was 99.23 t ha^{-1} followed by Bijli-11 (94.78 t ha^{-1}), Durjoy (93.38 t ha^{-1}), Moon (89.73 t ha^{-1}), ACI summerking (88.50 t ha^{-1}), BARI Hybrid Tomato-8 (85.32 t ha^{-1}), Dipali (82.79 t ha^{-1}), BRAC 1710 (78.02 t ha^{-1}), Udayon plus (77.20 t ha^{-1}), Comet (76.10 t ha^{-1}), Megha (73.15 t ha^{-1}), Tidy plus (70.80 t ha^{-1}), Sawsan8323 (70.74 t ha^{-1}), Uttaran+ (68.90 t ha^{-1}), Shukhi (67.72 t ha^{-1}), Unnayan (62.01 t ha^{-1}), TM027 (61.63 t ha^{-1}), Red stone (59.04 t ha^{-1}), Ratan (54.96 t ha^{-1}), Sultan (53.43 t ha^{-1}), Lal bahadur (50.59 t ha^{-1}), Prottasha (48.33 t ha^{-1}), Extra profit (47.63 t ha^{-1}) and Raket 1040 (39.55 t ha^{-1}).

Growing of M_3 generation of Tomato

Four tomato genotypes were collected from home & abroad which were irradiated with 200, 300, 400 and 500 Gy of gamma ray. The seeds were sown in the trays on 7th October 2023 at BINA HQs farm, Mymensingh. The parent was also sown in this experiment. The seedlings were transplanted (variety and dose wise) in the bed on 5 November 2023 separately. 11 M_3 mutant generation of tomato seeds will harvest and preserve as breeding material for next season.

Growing of M_3 generation of Okra

A large number of M_3 generation from two popular okra varieties BARIderosh-1 and BARIderosh-2 were irradiated with 300, 450 and 600Gy of gamma rays grown on 13 February 2023 in plant progeny rows at Horticulture research field, BINA, Mymensingh. The objective of this experiment was to select desirable mutants having higher fruits yield, seed yield, early maturing potentiality and yellow mosaic virus tolerance. Now we just select 6 line (M4 seed) on

the basis of no. of branches/plant, no of fruits/plant, number of seed/ fruit, fruit diameter (mm), fruit length (cm), fruit weight (g). M_3 seeds from each plant were collected to grow M_5 population.

Growing of M_3 generation of Egg plant

With view to develop fruit size, fruit shape, fruit weight, fruit colour, fruit texture, insect and disease infestation mutants, dry seeds of an Dub brinjal genotype were irradiated with 100,150, 200 & 250 Gy doses of gamma rays to create genetic variability in winter season. 6 M_3 mutant populations from M_2 generation were grown in plant-progeny-rows for selecting desirable mutants. Seeds were sown on 2th October, 2023 in seedbed. The germinated seedlings were transplanted in the main field on 6th November, 2023 at BINA HQ farm, Mymensingh in separate plots dose wise along with a control. Finally, a total of 6 mutant lines have been selected for further selection in subsequent generations.

Growing of M_3 generation of chilli

To create genetic variability, seeds of two exotic cultivar of Chili were irradiated with 100, 150, 200, 250, 300, 350, 400, 450 & 500 Gy of gamma rays. The seeds were sown in the trays on 2th November 2022 and seeds were sown at BINA HQs farm, Mymensingh. The parent was also sown in this experiment. The seedlings were transplanted (variety and dose wise) in the bed on 12th November 2023 separately. 17 M_3 mutant generation of chilli seeds will harvest and preserve as breeding material for next season.

Development of inbred line of bitter gourd

An experiment was conducted in the field of horticulture from March to June, 2024 to obtain selfed progeny. The experiment comprised 8 commercial hybrid varieties: Badsash (BT1), Bijoy, (BT2) Jhilik (BT3), Mala (BT4), Mithu (BT5), Sultan (BT6), Paliplus (BT9), Rider (BT10), alongside one local variety (Ranipukur, BT7), and one mutant (M2 of Ranipukur , BT8). Direct sowing was employed, with three seeds were sown per pit, spaced one meter apart. A total of 12 seeds from each germplasm were sown in the experiment. At flowering stage, male and female flowers from each plant were bagged at the day before anthesis. The following day, the female flowers were pollinated with the male flowers from the same plant. After fruit set, the fruits were bagged with net to protect them from insect infestation. Moreover, during the experiment, necessary pesticides, including Ridomild Gold and Emitaf, were applied to manage pest issues.

Finally, at the ripening stage, fully mature fruits were harvested, and the seeds from these fruits were collected and preserved for the next year.

Growing of M_3 generation of bitter gourd

All M_3 seeds were sown 07 March 2024 at BINA HQs farm, Mymensingh. The experiment was followed by non replicated design and sown separately (variety and dose wise). Recommended production packages were followed to ensure normal plant growth and development. Urea: 120g permada, TSP: 60g per mada, MoP: 60g per mada, Cowdung: 10 kg per mada were applied. Cultural and intercultural practices were followed as and when necessitated. From them, considering overall performance primarily a total of 10 mutants have been selected for further selection in subsequent generation.

Name of the project: Improvement of spices

Advanced yield trial of M_6 mutants of onion (seed to bulb)

The experiment was conducted at BINA HQs farm during November 2022 to April 2023 with a view to study the yield performances of selected winter onion mutants and to select promising mutants for further trial. Three M_6 mutants of onion (ACM-022, ACM-026 and ACM-030) with BARI Piaz-1 as a check variety were sown in the seed bed on 25 November 2023 for raising seedlings. The 40 days old seedlings were planted on 02 January, 2024. The unit plot size was 2.0 m x 1.0 m having plant spacing of 15 cm x 10 cm. The experiment was laid out in randomized complete block design with three replications. The crop was fertilized with recommended dose of cow dung 5 t/ha, N120, P50, K75 and S20 Kg/ha. Three weeding were done at 25, 45 & 65 days after planting. Irrigation was applied at 25, 45 and 65 days after planting. Fungicide (Rovral @ 2.5 g/L and Luna sensation @ 1ml/L) was alternately applied at 20 days interval starting from 30 days after transplanting. The crop was harvested on 21 April,2024. Data on plant height (cm), number of leaves/plant, neck diameter, bulb diameter (cm), Individual bulb weight (g), bulb yield ($kgplot^{-1}$), bulb yield (tha^{1}), and brix (%) were recorded. The bulbs were harvested and stored for studying keeping quality, rotting and sprouting behaviour as well as for seed production in the following year. Data on different morphological and yield contributing characters were analyzed using statistix 10 program and mean values were separated by DMRT. The yield and yield contributing characters of onion mutants varied significantly. Results showed that the mutants differed for yield and yield attributes from their parents. At BINA HQs farm, in case of three mutants of onion and a check variety, plant height was ranged from 40.5 cm to 47.1 cm. Highest number leaves was found in ACM-022 and ACM-030 mutants (9.0) which was followed by ACM-026 and BARI piaz-1 (8.5 & 6.9). The lowest neck diameter (0.40 cm) was found from ACM-026 and the highest (0.50 cm) was recorded from ACM-030. The maximum bulb diameter (3.7 cm) was observed from ACM-026 and the minimum (3.5 cm) was recorded from BARI Piaz-1. It was found that ACM-026 & ACM-026 gave the highest individual bulb weight (27.7 g). The lowest (23.9 g) was recorded from BARI Piaz-1. The highest bulb yield (8.3 kg/plot and 13.9 tha^{1}) was found from ACM-026 and the lowest (3.8 $kgplot^{-1}$ and 6.3 tha^{1}) was recorded from BARI Piaz-1. The highest brix (17.6%) was recorded from BARI Piaz-1 and the lowest (14.8%) was found from ACM-030.

Growing of M_5 generation of onion

Ten onion mutants with two parents of bulb were transplanted in plant progeny-rows at BINA HQs Farm, Mymensingh on 20 November 2023. The experiment was conducted in a non-replicated design with 15 cm line to line and 10 cm plant to plant distance. Recommended production packages i.e., application of fertilizers, irrigation, weeding, etc were followed to ensure normal plant growth and development.

Data was recorded on plant height, leaf length, leaf diameter and bolting time from five randomly selected plant from each plot. On an average, plant height ranged from 43.4cm to 53.0 cm. LK/50/M_4/P10 having the lowest plant height(43.4cm) on the other hand LK/50/M_4 /P11 having the highest plant height (53.0cm). Leaf length ranged from30.2cm to 38.6cm. LK/50/M_4/P11 and

LK/80/M_4/P20 having the highest leaf length 38.6 cm, and 38.4 cm respectively. Bolting time one of the major characters of onion. Bolting time ranged from 45 days to 61 days. LK/50/M_4 /P11 having highest bolting time (61 days) and LK/50/M_4/P10 having lowest bolting time (45 days). Considering the overall performance five mutants have been selected for future trial.

Growing of M_1V_3 generation of Garlic

M_1V_2 mutants garlic with parents were transplanted in plant progeny-rows at BINA HQs farm, Mymensingh on 16 November 2023. The experiment was conducted in a non-replicated design with 15cm line to line and 10 cm plant to plant within a line. Recommended production packages i.e., application of fertilizers, irrigation, weeding, etc. were followed to ensure normal plant growth and development. Data on plant height, no. of leaves plant^{1}, neck diameter, weight of individual bulb, no. of clove/bulb & clove length were taken in Table25.Considering the overall performance two treatments 3%EMS and 4%EMS derived mutants were selected for growing further generation.

Collection and Screening of Turmeric germplasm

Turmeric (*Curcuma longa* L.) the ancient spice of Indian subcontinent is known as the 'Golden Spice of life, and is one of the most essential spices used as an important ingredient in culinary all over the world. Bangladesh contributes 3% to global turmeric production. Bangladesh produces seventy thousand MT of dry turmeric in 26 thousand hectare land where the local demand for dry turmeric is 110 thousand MT. So it's very important to boost up our production. Rich morphological and genetic diversity is observed among the cultivated types of turmeric probably due to vegetative mutations accumulated over a period of time. Thereby this study was intended to select turmeric germplasm on the basis of high yield potentiality and tolerance to leaf blotch disease. This experiment was conducted at BINA HQs farm during 2023-2024. Twenty seven germplasm were used in this study to select the suitable germplasm on the basis of yield potentiality and tolerance to leaf blotch disease. The seed rhizome was sown in seed bed on 24th April, 2023. The unit plot size was 2 m x 1m having plant spacing of 60 cm x 25 cm. The crop was fertilized with recommended dose of cow dung 5t/ha, $N_{100}P_{36}K_{85}S_{20}Zn_2B_2$ Kg/ha. Irrigation and other intercultural operations were applied as and when necessary. Data were recorded during second week of November on plant height, number of leaves, no. of tillers hill^{-1}, number of fingers, weight of fingers, fresh yield hill^{-1}, disease infection etc. Data were analyzed using statistics 10 program.From the above data , among 27 germplasm of Turmeric CLG-011, CLG-012, CLG-015, CLG-016,CLG-020, CLG-021, CLG-022 and CLG-023 are selected for future breeding mateials.

Growing of M_1V_1 generation of Turmeric

To Create genetic variability, rhizome of turmeric local cultivar kukurmoni was irradiated with 10, 15, 20, 25 30, 35 & 40 Gy of Gamma rays. Rhizome were transplanted on 16 May 2023 at BINA HQs farm. The experiment was followed non-replicated design and sown separately (variety and dose wise). The experiment was conducted in a non-replicated design line to line and plant to plant distances were 30cm and 15 cm respectively.Recommended production packages i.e., application of fertilizers, irrigation, weeding, etc were followed to ensure normal plant growth and development. At maturity stage the survived plants producing rhizome were harvested separately for growing M_1V_2 population.

Growing of M_1V_4 generation of Turmeric

Turmeric (*Curcuma longa* L.) the ancient spice of Indian subcontinent is known as the 'Golden Spice of life, and is one of the most essential spices used as an important ingredient in culinary all over the world. Bangladesh contributes 3% to global turmeric production. Bangladesh produces seventy thousand MT of dry turmeric in 26 thousand hectare land where the local demand for dry turmeric is 110 thousand MT. So it's very important to boost up our production. Rich morphological and genetic diversity is observed among the cultivated types of turmeric probably due to vegetative mutations accumulated over a period of time. This experiment was conducted at Kashiar char farm during 2023-2024. Two mutant lines were used with a parent and check in this study to select the suitable mutants on the basis of yield potentiality and tolerance to leaf blotch disease. The seed rhizome was sown in seed bed on 4th April, 2023. The unit plot size was 3.4 m x 2m having plant spacing of 60 cm x 25 cm. The crop was fertilized with recommended dose of cow dung 5tha^{-1}, $N_{100}P_{36}K_{85}S_{20}Zn_2B_2$ Kgha^{-1}. Irrigation and other intercultural operations were applied as and when necessary. Data were recorded during second week of November on plant height, number of leaves, no. of tillers hill^{-1}, number of fingers, weight of fingers, fresh yield hill^{-1}, disease infection etc. The tallest plant (157 cm) was found in the CLM-21-2-02 mutant which was followed by CLM-21-5-01 (148. cm). The shortest plant was recorded from BARI halud- 4 (110cm) among the tested mutants. The highest fresh rhizome weight per hill (387.2 g) was observed in CLM-21-5-01 followed by CLM-21-2-02 (331.2 g) and BARIhalud-4(332) and the lowest (172 g) was recorded in BINAhalud-1. Considering yield and other attributing traits of five mutants and their parent, one mutants CLM-21-2-02 with parent BARI halud- 4 were selected for molecular study for further evaluation in next season.

Growing of M_1V_1 mutants of Zinger

Zinger is one of the major spices crop in Bangladesh, has got a wide range of cultivars in terms of yield and adaptability. Since ginger can be grown in a wide range of soils, so its evaluation and selection may be essential from available germplasm for boost up national production to reduce bulk import. Rich morphological and genetic diversity is observed among the cultivated types of ginger probably due to vegetative mutations accumulated over a period of time. In previous year, to create genetic variability of zinger through induced mutation techniques, a local germplasm (ZG-011) collected from Khagrachari hill tracts was treated with different irradiation doses (3Gy, 5Gy, 7Gy). This experiment was conducted BINA HQs farm during June 2023 to February 2024 to grow M_1V_1 generation of zinger. Rhizomes were sown on 1th week of June, 2023, maintaining 60 cm x 30 cm spacing in the unit plot size of 3.0 m x 1.6 m. In addition to 5 tha^{-1} of cow dung, the crop was fertilized with N_{140} P_{54} K_{117} S_{20} Zn_3B_1 kgha^{-1}. The entire quantity of cow dung, P, S, Zn, B and ½ of K was applied during final land preparation. One half N was applied at 50 DAP. The rest K and N was applied with two equal splits at 80 and 110 DAP. Three weeding were done at 50, 85 and 110 DAP. The crop was harvested on 20 February 2024. Considering different parameters such as Plant height, number of tillers hill^{-1}, no. of leaves hill^{-1}, weight of rhizome were varied significantly due to different irradiation doses. Finally, M_1V_1 rhizomes were harvested from the selected clump and kept separately to grow M_1V_2 population in next season.

Growing of M_1V_3 mutants of Zinger

Zinger is one of the major spices crop in Bangladesh, has got a wide range of cultivars in terms of yield and adaptability. Since ginger can be grown in a wide range of soils, so its evaluation and selection may be essential from available germplasm for boost up national production to reduce bulk import. Rich morphological and genetic diversity is observed among the cultivated types of ginger probably due to vegetative mutations accumulated over a period of time. In previous year, to create genetic variability of zinger through induced mutation techniques, a local germplasm (ZG-011) collected from Khagrachari hill tracts were imposed with different concentrations of EMS (0.5%, 0.75% & 1.0%). This experiment was conducted BINA HQs farm during May 2023 to February 2024 to grow M_1V_3 generation of zinger maintaining 60 cm x 30 cm spacing in the unit plot size of 3.0 m x 1.6 m. In addition to 5 t/ha of cow dung, the crop was fertilized with N_{140} P_{54} K_{117} S_{20} Zn_3B_1 kg/ha. The entire quantity of cow dung P, S, Zn, B and ½ of K was applied during final land preparation. One half N was applied at 50 DAP. The rest K and N was applied with two equal splits at 80 and 110 DAP. Three weeding were done at 50, 85 and 110 DAP. The crop was harvested on 12 March 2024. Data on different characters were collected and analyzed in. Plant height, number of tillers $hill^{-1}$, no. of leaves $hill^{-1}$, weight of rhizome were varied significantly due to different conc. of EMS. Finally, M_1V_3 rhizomes were harvested from the selected clump and kept separately to grow M_1V_4 population in next season.

Morphological screening of zinger genotypes collected from home and abroad

Zinger (*Zingiber officinale* Rosc.) is a monocotyledonous perennial herb in the family Zingiberaceae, grown mainly for its spicy and aromatic rhizomes. The production trend of ginger in most countries is low when compared with other export crops due to its inherent poor yields which can be attributed to lack of improved varieties. It is obvious that ginger production in Bangladesh is based on a very narrow gene pool and improvement of ginger is greatly challenged. The experiment was conducted at BINA HQs farm during May, 2023 to February, 2024 to characterize some plant and rhizome characters as well as to find out some promising lines in respect of yield, different yield contributing characters, dry matter (%) and disease. Fourteen ginger germplasm were collected from different parts of the country and abroad were considered in the trial. Each entry was planted on 6 April 2023 in two rows plot of 2.5 m x 1.0 m without following any design. The inter row and intra row spacing were 50 cm and 25 cm respectively. The land was fertilized with cowdung -5 t/ha, N140, P54, K117, S20 and Zn3 kg/ha. The entire quantity of cowdung, P, S, Zn and half of K were applied during land preparation. One half of N was applied at 50 DAP. The rest K and N were applied with two equal splits at 80 and 110 DAP. To control soft rot disease of ginger, seed treatment was done with Ridomil Gold (2g/l of water). To control the same disease foliar application of Ridomil Gold were done three times at 10 days interval starting from 75 DAP. Weeding was done at 50, 80 and 120 days after planting. The crop was harvested on 23 February, 2024. The rhizomes were evaluated by characterization in this year following guidelines for the conduct of test for distinctiveness, uniformity and stability on zinger. Data were recorded on plant growth habit, plant height (cm), number of leaves , tiller height (cm), rhizome shape and habit, finger thickness (cm) and length and clump weight (g). The germplasm ZG-011, ZG-013, ZG-015, ZG-018, ZG-017 and ZG-022 were showed satisfactory performances regarding yield and yield contributing characters. So, a secondary yield trial will be conducted in next season with said materials .

Growing of M_1V_1 generation of garlic

M_1V_2 mutants garlic were sowing in plant progeny-rows at BINA HQ farm, Mymensingh on 27 November 2023. The experiment was conducted in a non-replicated design with 15cm line to line and 10 cm plant to plant within a line. Recommended production packages i.e., application of fertilizers, irrigation, weeding, etc were followed to ensure normal plant growth and development. Data on plant height, no. of leaves plant^{-1}, neck diameter, weight of individual bulb, no. of clove bulb^{-1} & clove length were taken. Considering the overall performance twenty three mutants were selected and bulb harvested on 31 March for growing further generation.

Validation trial of Binarashun-1 with different released garlic varieties in Bangladesh

The experiment was conducted at BINA HQ farm, Mymensingh to observe the performance of the Binarashun-1 that compare with Patnai, China, Italy, local germplasm. Seeds(cloves) of the garlic were planted on 27 November 2023. The experiment was laid out in a non-replicated design with 15cm line to line and 10 cm plant to plant within a line. Recommended production packages i.e., application of fertilizers, irrigation, weeding, etc were followed to ensure normal plant growth and development. Data on plant height, no. of leaves plant^{-1}, neck diameter, weight of individual bulb, no. of clove bulb^{-1} & clove length were taken. Considering the overall performance twenty three mutants with control were selected and bulb harvested on 31 March 2024 for growing further generation. All the recorded data were analyzed with statistics 10. Results showed that the highest plant height (40.3cm) was found in China genotypes followed by patnai 38.4cm) and local(37.4). On the other hand , the lowest plant height was observed in Italy(33.4) followed by **Binarashun-1(33.9).** The highest **Bulb weight (0.0761)g)** was found in **Binarashun-1** followed by patnai(0.0175g). On the other hand , the lowest **Bulb weight (g)** was observed in China (0.021) and Italy followed by **Binarashun-1(33.9).**

Collection and evaluation of growth and yield of the genotypes of Chilli

Five promising chili lines/mutants were evaluated at BINA HQs farm, Mymensingh to see their yield and yield attributes. Seeds were sown in the seedbed for seedling on 12th November and 35 days aged seedlings were transplanted in 4th and 5th December 2023 at HQs farm. The experiment was followed non replicated design. Line to line spacing was 50 cm and plant to plant was 40 cm. Recommended production packages i.e., fertilizer application, irrigation, pesticides, weeding etc were followed to ensure normal plant growth and development. Recommended doses of fertilizers were applied and intercultural practices were followed as and when necessitated. Data on plant height, number of fruits plant^{-1}, fruit length, fruit breadth, single fruit weight were recorded from randomly selected 5 plants which was later. Among these genotypes, CFG-042 produced longer plant (90cm) and the shortest plant height was recorded Binamorich-1(48.6). The highest no of fruits plant^{-1}(51 plant^{-1}) was found from CFG-043 followed by the genotype Binamorich-2 (44 plant^{-1}) while the lowest yield per plant (8 plant^{-1}) was recorded from Binamorich-1. Highest numbers of fruits (96.2) was found from BARI Morich-1 which was followed by the mutants CL-020 (86.0). From the trial, CFG-041, CFG-042, CFG-043, CFG-22-02, Binamorich-1, Binamorich-2 were selected on the basis yield attributes and overall acceptability which will be further evaluated in next season.

Collection and evaluation of growth and yield of the genotypes of Capsicum

Sweet pepper (*Capsicum annuum* L.) is an important salad vegetables crop in Bangladesh, getting popularity towards urban and rural areas. Considering its high nutritive value and export potentials, it is imperative to take attempts for its successful cultivation in our country. In Bangladesh, sweet pepper varieties are being cultivated almost these are F_1, which are being imported from exotic source spending foreign currency. Seed costs of those hybrid varieties are very high. Seeds were sown on 10th October, 2023 in seedbed. The germinated seedlings were transplanted in the main field on 18th November, 2023 at BINA HQ farm, Mymensingh. Around seven (7) genotypes (Hybrid & OP) were collected and evaluated. The experiment was followed non replicated design. Line to line spacing was 50 cm and plant to plant was 40 cm. Recommended production packages i.e., fertilizer application, irrigation, pesticides, weeding etc were followed to ensure normal plant growth and development . Capsicum fruit harvest started on 1st week of March. Data on various characters such as plant height, No of branches , No. of fruits, Individual fruit weight(g) etc were considered for evaluation of the genotypes. Considering different growth and yield contributing characters, Indian hybrid variety (red) perform better than other genotypes.

Growing of M_1 generation of cumin

Cumin is an exotic and new spice crop in our country. It is a tropical plant can be grown in sub-tropical climate too. Cumin can be cultivated in all types of soils but well drained sandy loam and medium soils are suitable for the crop. Most of the demand has fulfilled through import cumin from India, Egypt, Libya, Pakistan and Mexico. Research on cumin in Bangladesh is very scanty or almost not done on cumin production. Recently, Spices Research Centre, Shibganj, Bogura, BARI has developed one variety adaptable to our agro-climate but still it's trial and error for yield and yield components. Last 3-4 years, Horticulture division try to adapt collected cumin germplasm in our climate but success is limited. Some germplasm was promising but they are not getting viable in subsequent generation. To create variability for short duration and tolerant to leaf blight disease,), BARI Zeera-1 was irradiated with different gamma irradiation doses (100 Gy, 150 Gy and 200 Gy). The experiment was set up at BINA HQs farm, Mymensingh and laid out in line sowing method with standard spacing of line to line (40 cm). Data on various characters such as plant height, days to 1st flowering, days to 1st fruiting, no. of pod plant^{-1} were recorded from randomly selected plant but at flowering stage all the plants were blighted due to infecting Alternaria blight diseases and after few days the whole plant will be die.

Growing of M_2 generation of Black cumin

Nigella sativa L. known as black cumin, belongs to the Ranunculaceae family and the order Ranales. The variability is created through recombination techniques in general, but it's difficult in black cumin, due to small flower size, lack of genetic variability and non availability of any type of sterility. There is immense need of high yielding varieties, which is not possible without generating variability in black cumin and also in other seeds species. Mutagenic effectiveness is a measure of the mutations induced per unit dose of a mutagen (time×concentration dose^{-1}), while mutagenic efficiency gives an idea of genetic damage (mutation) in relation to the total biological

damage caused in M_1 generation. To create variability for short duration and tolerant to leaf blight disease, BARI Kalozeera-1 was irradiated with different gamma irradiation doses (100 Gy, 150 Gy, 200 Gy, 250 Gy, 300 Gy, 350 Gy and 400 Gy). The experiment was set up at BINA HQs farm, Mymensingh on 26/11/2023 and laid out in line sowing method with standard spacing of line to line (40 cm). Data on various characters such as plant height, No of branches , No of pod plant^{-1} , Seed pod , Total seed weight plant^{-1}(g) were recorded from randomly selected plant. All the M_2 plant seeds were harvested on 25/03/24 and seeds stored for next season.

Growing and selection of promising coriander genotypes

Coriander (dhoney) a strong-smelling annual herb. Coriander is a wonderful taste maker to all the food or dishes. they are rich source of dietary fibers, vitamin c, vitamin k and other proteins. Therefore, we collected a cultivars from West Bengal India were grown on 23 november 2023 in plant progeny rows at Horticulture research field, BINA, Mymensingh for considering high yield (seed) and leafy. This experiment was followed non-replicated design and sown separately. Data on various characters such as plant height, No of branches , No of pod plant^{-1} , Seed pod , Total seed weight plant^{-1}(g) were recorded from randomly selected plant. All the selected plant seeds were harvested on 25/03/24 and seeds stored for next season

Screening of promising Fenugreek genotypes

The experiment was sown on 23 November 2023 at BINA HQs farm, Mymensingh to create genetic variability for desirable characters (duration, yield and tolerance to disease) . This experiment was followed non-replicated design and sown separately. Data on various characters such as plant height, No of branches , No of pod plant^{-1} , Seed pod , Total seed weight plant^{-1}(g) were recorded from randomly selected plant. All the selected plant seeds were harvested on 12/03/24 and seeds stored for next season

Name of the project: Improvement of flowers

Growing M_1V_6 generation of the selected gladiolus germplasm

Two field experiments were conducted in November 2023 to April 2024 at BINA HQs farm, Mymensingh and BINA Regional Research Station, Gazipur to develop gladiolus with various floret colours, long spikes with higher number of florets and longer vase life. The $M_1V_5D_{30}P$ and $M_1V_5D_{20}R$ gladiolus mutants with control (mother of pink and red gladiolus) were planted in RCBD design with three replications. Parameters investigated were days to first flowering, plant height (cm), inflorescence length, rachis length, number of flower per spikes, flower diameter, number of corms per plant, size and weight of corms. Results revealed that $M_1V_5D_{30}P$ mutants produced maximum, attractive colour large flower (16.5) than the untreated control bulbs (13.0). In case of $M_1V_5D_{20}R$ mutants produced more variegated large red flower (19.0) than the untreated control bulbs (15.5) respectively. Longest shelf life (13.5 days) was found $M_1V_5D_{30}P$ and shortest shelf life (11.0 days) was found control pink flowers. Finally, the M_1V_6 corms from the $M_1V_5D_{30}P$ and $M_1V_5D_{20}R$ with control survived plants were kept separately bulked in cold

storage for growing of M_1V_6 generation in the next growing season. The findings would greatly contribute in developed new gladiolus variety in Bangladesh under natural condition.

Growing M_1V_2 generation of the collected gladiolus germplasm

A field experiment was conducted in November 2023 to April 2024 at BINA HQs farm to develop gladiolus with various floret colours, long spikes with higher number of florets, and longer vase life. The M_1V_2 gladiolus mutants (yellow, white, magenta and violet) were planted separately (colour and dose wise) in rows. Parameter investigated the days to first flowering, plant height (cm), number of flowers per spike, flower diameter, number of corms per plant, and weight and size of corms. Results revealed that irradiated corms (yellow, white, magenta and violet) showed the longest plant height, maximum number of flowers and maximum number of corms than control (mother). It was found that 20 Gy irradiated magenta flowers required the longest time (86.0 days) for first flower initiation and shortest time (74 days) required in 30 Gy irradiated white corms. The longest plant (158 cm) was found 10 Gy irradiated white gladiolus and the shortest plant found non irradiated (control) violet gladiolus. On the other hands, maximum number (18.5) flower/spikes was found 20 Gy irradiated white gladiolus and minimum number (8.5) of flowers spike^{-1} was found in non-irradiated control magenta flowers. Yellow and magenta flowers showed attractive variegated floret colours. Finally, the M_1V_3 corms from the survived plants were bulked as per dose and floret color and kept in refrigerator for M_1V_3 generation in the next growing season. The findings would greatly contribute in developed new gladiolus variety in Bangladesh under natural condition

Screening of M_1V_2 generation of rose

The experiment was conducted in July 2023 to June 2024 at BINA HQs farm to develop rose variety with attractive flower colours, flower yield and longer vase life. The M_1V_2 and control (mother) were planted separately in pots in rows. Parameter investigated plant height (cm), number of primary branches per plant, number of flowers per plant, flower diameter (cm), length of cut flower stalk, colour and shape, and vase life flower. Results showed that, the $M_1V_1D_{20}RP_7$ produced maximum flowers plant^{-1} (16) and longer stalk length (32.5 cm) than control (9 flowers plant^{-1}, 22.8 cm). $M_1V_2D_{20}RP_3$, $M_1V_1D_{20}RP_7$, $M_1V_1D_{20}RP_{10}$ and $M_1V_1D_{20}RP_{14}$ mutant produced different flower colour and shape. The findings would greatly contribute in developed new rose variety/varieties in Bangladesh under natural condition.

Growing of M_1V_2 generation of chrysanthemum and gerbera

A field experiment was conducted in November 2023 to May 2024 at BINA HQs farm to develop chrysanthemum and gerbera with various floret colours, long spikes with higher number of florets and longer vase life. The shoot tip of chrysanthemum and sucker of gerbera were treated @ 20, 30, 40, 50 and 60 Gy of gamma rays using ^{60}Co gamma irradiator with control. Among the radiation doses 20 Gy irradiated gerbera and 30 Gy irradiated chrysanthemum sucker showed better performance (no. of leaf, flower number, flower colour and stalk length) than control.

Name of the project: Postharvest Technology development of Horticultural crops

Enhancing postharvest storage life of Potato using gamma irradiation

To evaluate the effectiveness of gamma irradiation on extending the shelf life and quality of potato (vars. Diamant and Cardinal) under the ambient storage condition of Bangladesh, the research was carried out at the Postharvest Laboratory of Horticulture Division, BINA during the period from October 2023 to January 2024 following completely randomized design (CRD) with three replications. The potatoes were collected from commercial supplier at Mymensingh. Different doses of gamma irradiation (0, 50, 100 and 150 Gy) were applied from the Bangladesh Atomic Energy Commission, Savar, Dhaka along with a control treatment (untreated). Different parameters viz. size, colour, texture, TSS, weight loss, sprouting disease incidence (DI), disease severity (DS), pH, specific gravity and vitamin C content during the period of storage. Results revealed that 150 Gy irradiated showed minimum weight loss, DI and DS as compared to those of the untreated control potato. Minimum weight loss (27.10%) was found 150 Gy irradiated cardinal potato followed by 150 Gy irradiated diamant potato (29.9%) and maximum weight loss (47.2%) was found untreated control cardinal potato followed by untreated diamant potato (46.7%). After 120 days storage, 100 % sprouting were found non-irradiated Diamant and Cardinal potatoes and no sprouting found at 100 and 150 Gy irradiated potato. The findings would greatly contribute in reducing postharvest loss of potato and maintain their quality during marketing at ambient and cold storage condition.

Effects of gamma irradiation along MAP on shelf life of country beans without deteriorating quality

The experiment is aimed at identifying suitable dose of irradiation for longer-term storage of fresh country beans. The export quality country beans were collected from the commercial grower of Jamalpur District. The collected beans were gamma-irradiated using ^{60}Co gamma irradiator (CG-5000). The experiment comprised 6 treatments: T_0 = Control (None irradiated unwrapped); T_1 = Only LDPE Bags (25 µ); T_2 = 200 Gy + LDPE (25 µ); T_3 = 400 Gy + LDPE (25 µ) T_4 = 800 Gy + LDPE (25 µ); T_5 = 1200 Gy + LDPE (25 µ). The experiment will be laid out in CRD with 3 replications of 10 fruits wrapped in LDPE bags during the periods January-February-2023 at Post harvest laboratory, Horticulture Division, BINA. Data were collected on fruit morphological (shape, size, colour and texture of fruits); physical (weight loss, shrinkage, drying); pathological (disease incidence, disease severity) and shelf life. At the 15 DAI, the highest weight loss (86.5%) was found in non-irradiated unwrapped control beans, whereas the lowest weight loss (6.3%) was observed in those beans irradiated with 200 Gy wrapped in LDPE bags. The longest shelf life (18 days) was found in country beans irradiated @ 200 Gy and wrapped in LDPE bags (25 µ). In contrast, the shortest shelf life (only 3.0 days) was found in the non-irradiated unwrapped country beans bags. The findings would greatly contribute in reducing postharvest loss of beans and maintain their quality during marketing at ambient condition.

Extension of shelf life of Dragon fruit using gamma irradiation, chemical treatment and modified atmosphere packaging

To evaluate the effect of gamma irradiation and sanitizer on extending the shelf life of dragon fruits (red and White flesh) under the ambient room and refrigerated condition in Bangladesh, the research was carried out at the Postharvest Laboratory of Horticulture Division, BINA during the period from September to November 2023 following completely randomized design (CRD) with three replications. The dragon fruits were collected from commercial grower at Fulbaria Upazilla at Mymensingh district. The treatments were T_o= Control; T_1= wrapped in LDPE bags; T_2= Irradiated 1000 Gy and wrapped LDPE Bags; T_3= Treated 3% CaCl2 for 10 minutes wrapped LDPE Bags; and T_4 = Treated NaOCl for 10 minutes wrapped LDPE Bags; and T_5 =wrapped LDPE Bags and kept in refrigerator (4^0C). Parameters investigated size, colour, texture, weight loss, disease incidence (DI), disease severity (DS), moisture content , dry matter content, TSS, pH, Vitamin C, TA and Shelf life during the period of storage. Minimum weight loss (0.16%) was found at refrigerated condition with wrapped dragon fruits. At ambient room condition minimum weight loss (1.08%) was found dragon fruit (white flesh) treated 3% $CaCl_2$ for 10 minutes wrapped LDPE Bags and maximum weight loss (22.07%) was found untreated control dragon fruits (white flesh). Shelf life was calculated on basis of colour, shrinkage, DI and DS (≤10%) and longest shelf life (66.3 days) was found at refrigerated condition and shortest shelf life (8.0 days) was found untreated unwrapped dragon fruits respectively. The findings would greatly contribute in reducing postharvest loss of dragon fruits and maintain their quality during marketing at ambient and refrigerated condition.

Enhancing postharvest storage life of onion using gamma irradiation

To evaluate the effectiveness of gamma irradiation on extending the shelf life of onion (var. Taherpurit and Lal teer King) under the ambient storage condition in Bangladesh, the research was carried out at the Postharvest Laboratory of Horticulture Division, BINA; farmers house in Ishwardi, Pabna; Sathia Pabna and Rangpur during the period from July 2023 to January 2024 following completely randomized design (CRD) with three replications. The onions were collected from commercial grower at Sathia Upazilla at Pabna District. The collected onion were irradiated @ 100 Gy using ^{60}Cobalt gamma irradiator and store in ambient room condition with control (non- irradiation). Parameters investigated size, colour, texture, TSS, weight loss, sprouting disease incidence (DI) and disease severity (DS), during the period of storage. Minimum weight loss (16.18%) was found 100 Gy irradiated Taherpuri onion at Mymensingh followed by Rangpur (22.0%) and maximum weight loss (50.0%) was found untreated control Lal Teel King onion at Ishwardi, Pabna after 180 days storage (Figure 12) . No Sprouting was found of irradiated Lal Teer King onion at Mymensingh after 180 days storage. Maximum sprouting (99.6%) was found at Ishwardi and Sathia, Pabna. The findings would greatly contribute in reducing postharvest loss of onion and maintain their quality during marketing at ambient condition.

Effects of gamma irradiation and promising postharvest treatments on shelf life, quality and safety of fresh-cut pineapple (MoST project)

This study is aimed at evaluating the effects of gamma radiation and promising preservatives compounds in preservation, nutrient contents and safety aspects of fresh-cut pineapples. The objectives were to examine the efficacy of gamma irradation on extension of shelf life and qualitry of fresh- cut products; to standardize the types and concentration of edible presanitizers to reduce postharvest loss, extend shelf life and maintain quality and safety of fresh-cut; and to suggest postharvest technology pacakge(s) for improved shelf life of fresh-cut pineapple maintaining optimal quality and stafety standards. To achieve the objectives, one experiment was carried out following completely randomized designs at the Postharvest Laboratory of the Horticulture Division, Bangladesh Institute of Nuclear Agriculture (BINA), Mymensing during the period of Marchr-2024 to June 2024. Parameters investigated included Juice leakage, colour , texture, total soluble solids (TSS), Vitamin C, pathogen attack, dry matter, moisture content, sensory evaluation and shelf life. The edible coatings based on honey proved to be effective in maintaining the quality and extending the shelf life of the fresh-cut pineapples. Overall, the findings suggest that the 10% honey coating formulation proved to be the most effective in enhancing the shelf life of fresh-cut pineapple while maintaining its nutritive value. The findings would greatly contribute in enhance storage life of freshcut and value added pineapples and maintain their quality during marketing at ambient condition

Effects of gamma irradiation and promising postharvest treatments on shelf life, quality and safety of value-added pineapple products (MoST project)

This study is aimed at evaluating the effects of gamma radiation and promising preservatives compounds in preservation, nutrient contents and safety aspects of value-added (candy, jam, jelly) pineapples. The objectives were to examine the efficacy of gamma irradation on extension of shelf life and qualitry of value-added pineapple products; to standardize the types and concentration of edible presanitizers to reduce postharvest loss, extend shelf life and maintain quality and safety value- added pineapple products; and to suggest postharvest technology pacakge(s) for improved shelf life of value- added pineapple products maintaining optimal quality and stafety standards. To achieve the objectives, three experiments were carried out following completely randomized designs at the Postharvest Laboratory of the Horticulture Division, Bangladesh Institute of Nuclear Agriculture (BINA), Mymensingh during the period of Marchr-2024 to June 2024. Parameters investigated included colour, texture, total soluble solids (TSS), Vitamin C, pathogen attack, dry matter, moisture content, sensory evaluation and shelf life. In pineapples candy, jam and dehydrated pineapples, results showed the moisture content, drymatter content, TSS and Vitamin C varried among the treatments and it ranges from 11.1- 17.2% moisture content, 83.4- 88.9% dry matter conten, 28.0-33.7 % Brix TSS and Vitamin C 1.3-2.7 mg/100 gm and the candy prepared with 65% Brix sugar solution and irradiated with 2 KGy is most acceptability, 34.0- 390% moisture content, 61.0-67.0% dry matter conten, 21.5-23.5 % Brix TSS and Vitamin C 3.3-3.8 mg/100 gm and the candy prepared with Pulp:sugar = 100:75 sugar irradiated with 3KGy is most acceptability and 4.0- 10.0% moisture content, 90.0-96.0% dry matter conten, 20.5-23.5 % Brix TSS and Vitamin C 2.5-5.0 mg/100 gm and the longer period

drying dehydrated pineapples and irradiated with 3KGy is most acceptability in relation to colour, taste, texture and flavour. The findings would greatly contribute in enhance storage life of value added pineapples and maintain their quality during marketing at ambient condition

Name of the project: Tissue culture

Standardization of *in vitro* propagation procedure of oriental lilium using bulb scale

An experiment was conducted in 2023-24 to establish a protocol for increasing the number and size of lilium bulblets through in vitro propagation of three Oriental lilium genotypes: Pink (V_1), Light Orange (V_2), and Orange (V_3). Two plant growth regulator combinations were tested: 0.5 mg/L NAA + 1.0 mg/L BAP (T_1) and 0.5 mg/L NAA + 2.0 mg/L BAP (T_2), with a control group (T_3). Two plant growth regulator combinations were tested: 0.5 mg/L NAA + 1.0 mg/L BAP (T_1) and 0.5 mg/L NAA + 2.0 mg/L BAP (T_2), with a control group (T_3). Results showed that the Light Orange genotype (V_2) performed significantly better than Pink and Orange genotypes. The combination of 0.5 mg/L NAA + 2.0 mg/L BAP yielded the best results, while no regeneration occurred in the control group. Specifically, V_1 required the shortest time to initiate buds (3.57 days) under T_2, while V_3T_1 took the longest. Both V_1 and V_2 exhibited high bud initiation rates (7.67% and 7.63%, respectively) in T_2, with a maximum of 4.6 shoots per explant recorded in both V_2T_1 and V_2T_2 treatments. The longest shoots were observed in V_2T_2, indicating superior performance in shoot length and leaf number as well.

Effect of gamma irradiation on in vitro regenerated tomato plants for development of heat

tolerant variety

To create heat-tolerant tomato cultivars, the study looks into effect of gamma irradiation on two tomato genotypes, Binatomato-11 (V_1) and Binatomato-13 (V_2). To evaluate the ability to regenerate after irradiation, callus tissues were exposed to different dosages of gamma rays (0, 2, 4, and 6 Gy). The findings showed that V_1 performed better than V_2 in callus development, starting shoots faster (6.09 days) and yielding longer shoots (10.98 cm). Notably, the control group (0 Gy) had the greatest root length (10.30 cm) and shoot start percentage (57.55%). Significant variations were observed with irradiation, though; for example, for V_1, the longest shoots and largest shoot counts were recorded at 4 Gy. Different impacts on growth features were shown by the interaction between genotype and irradiation dose, with certain treatments leading to increases in growth instead of decreases. For instance, maximum shoot initiation (35.41%) was recorded in Binatomato-13 at 4Gy 32.88 % lower than control. However, the earliest shoot initiation was found in Binatomato-11 at 2 Gy (3.67 days) whereas, the longest shoot, maximum number of shoots and early root initiation were recorded in V_1T_2treatment. The maximum number of roots was in V_2T_3 and the longest root was in V_1T_2 treatment. Overall, Binatomato-11 showed improved regeneration ability after irradiation, especially at 4 Gy, indicating its potential for using mutagenesis to create genetic variability.

Evaluation of somaclonal variant from in vitro regenerated tomato plants in the field condition through agro morphological traits

Evaluating the R_1 population in field condition results showed that IVRP 11.6 was the tallest genotype with the most branches (89.57 cm; 6.50), while IVRP 11.4 was the shortest (54.71 cm; 1.50). IVRP 11.6 also had the highest yield per plant (32.16 kg), while IVRP 11.4 yielded the least (11.10 kg). Significant differences in flowering time and fruit shape were observed among genotypes compared to parent Binatomato-11. On the other hand, somaclones from Binatomato-12 showed no significant differences in morphological and fruit quality traits compared to the parent. However, IVRP 12.1 notably increased fruit number and yield per plant. In contrast, among somaclones from Binatomato-13, IVRP 13.2 had the tallest height (76.86 cm) but was shorter than the parent (80.11 cm). Despite this, IVRP 13.1 produced the highest total fruit weight (39.86 kg) and yield per plant, significantly surpassing Binatomato-13's yield (11.09 kg) despite having the lowest individual fruit weight (56.17 gm). All genotypes were similar in fruit dimensions and soluble sugar content. In conclusion, the performance of IVRP 11.4, IVRP 11.6, IVRP 12.1, and IVRP 13.1 compared to their parent genotypes highlights the potential of somaclonal variation as a valuable tool for tomato improvement. Further biochemical and molecular characterization of these genotypes will provide a more comprehensive understanding of the genetic basis of the observed variations.

AGRONOMY DIVISION

Determination of optimum transplanting date for maximizing yield of *Boro* rice mutants/variety in Mymensingh

A field experiment was conducted at BINA, HQ farm Mymensingh during the *Boro* season 2023-24 to determine the optimum transplanting date (December 30, January 20) for *Boro* rice mutants/variety namely MEF 27, RNDR-09-8-1, RM-16(N)-10-1, BNCR-14, BNCR-23 and BINA dhan25. The objective of the study was to find out the optimum transplanting date for maximizing the yield of *Boro* rice mutants/varieties. Thirty days old seedlings were transplanted in a split-plot design (RCBD) with three replications. The unit plot size was 3 m×2 m. Data on yield and yield components were recorded at harvest and analyzed statistically following the design used for the experiment and the means were compared with LSD. The results of the experiment showed that the grain yield was statistically higher on January 20 between the two transplanting dates. The grain yield had significant differences among the transplanting dates, tillering capacity and number of filled grains were higher among the different mutants/varieties. The mutant line RM-16(N)-10-1 showed a statistically higher grain yield (5.53 tha^{-1}) followed by RNDR-09-8-1 (5.44 tha^{-1}). Interaction between transplanting date and mutants/varieties mutant line RM-16(N)-10-1 showed the highest grain yield 5.80 t ha^{-1} when transplanted on January 20 followed by RNDR-09-8-1 when transplanted at January 20 (5.76 tha^{-1}).

Determination of optimum transplanting date for maximizing yield of *Aman* rice mutants/variety

A field experiment was conducted at BINA HQ farm, Mymensingh, during the aman season of 2023-24 to determine the optimum transplanting dates of July 30 and August 20 for aman rice mutants and varieties, specifically BLB-P-019 (V1), BLB-P-318 (V2), and BRRI dhan87 (V3). The study aimed to identify the transplanting date that maximizes yield for these rice mutants and varieties. Twenty two days old seedlings were transplanted using a split-plot design with three replications, and each unit plot measured 3 m × 2 m. Yield and yield component data were collected at harvest and analyzed statistically according to the split-plot two-factor design, with means compared using LSD. Results indicated that the highest grain yield of 6.31 t ha^{-1} occurred with the July 30 transplanting date. Among the varieties, BRRI dhan87 produced the highest yield of 6.05 t ha^{-1}, followed by BLB-P-318 at 5.93 t ha^{-1}. Notably, BRRI dhan87 achieved the maximum grain yield of 6.56 t ha^{-1} when transplanted on July 30, while BLB-P-318 yielded 6.34 t ha^{-1} on the same date. These findings suggest that transplanting on July 30 is optimal for maximizing the yield of aman rice mutants and varieties in Mymensingh.

Effect of sulfur on different ages of seedlings tillering dynamics for transplanting of T. aman rice variety Binadhan-17

A field experiment was conducted at BINA HQs, Mymensingh, during the Aman season of 2023-24 to evaluate the effect of seedling age (20 days and 30 days) and sulfur doses on the yield of the

Binadhan-17 rice variety. The objective was to identify the optimum sulfur dose for maximizing yield in this variety. The study utilized a split-plot design with three replications, and each unit plot measured 5 m × 5 m. Data on yield and yield components were collected at harvest and statistically analyzed according to the experimental design, with means compared using LSD. Results indicated that 30-day-old seedlings produced the highest grain yield of 5.26 t ha^{-1} compared to 20 day old seedlings. Among the sulfur doses, the application of 7.5 kg ha^{-1} (S3) resulted in the highest yield of 5.57 t ha^{-1}. Notably, the combination of 30 days old seedlings and a sulfur dose of 5.61 kg ha^{-1} (S2) yielded 5.64 t ha^{-1}. These findings suggest that both the age of the seedlings and sulfur application significantly influence the yield of Binadhan-17, with optimal results achieved at a seedling age of 30 days and appropriate sulfur dosage.

Effect of sea weed (*Caulerpa racemose*) on yield and yield contributing characters of boro rice in Mymensingh

A field experiment was conducted at BINA HQ farm during the Boro season of 2023-24 to evaluate the effects of various doses of seaweed (*Caulerpa racemose*) on the yield of BINA dhan25 rice. The study investigated two factors: basal doses of seaweed (control, 0.5 t/ha, 0.625 t/ha, 0.75 t/ha, 0.875 t/ha, and 1.00 t/ha) and seaweed extracts applied as a spray during the active tillering stage (control, 0.5 L/ha, 0.625 L/ha, 0.75 L/ha, 0.875 L/ha, 1.00 L/ha, and 1.25 L/ha). Seaweed was sourced from the Bay of Bengal, dried, and properly processed for application. The spraying was conducted by diluting the extracts in water and applying them near the hills at the tillering stage. The experiment utilized a randomized complete block design (RCBD) with three replications and unit plots measuring 2 m × 1 m. Data on yield and yield components were collected at harvest and analyzed statistically, with means compared using LSD. Results indicated that the basal application of 1.0 t/ha of seaweed produced the highest grain yield of 5.73 t/ha, closely followed by the 0.875 t/ha dose. For the seaweed extracts, the application of 1 L/ha resulted in a statistically significant yield of 5.38 t/ha, with 0.75 L/ha as the second most effective dose. These findings suggest that both the basal application and the timing of seaweed extracts play crucial roles in enhancing the yield of BINA dhan25 rice.

Effect of salicylic Acid on yield and yield contributing characters of rice in saline prone area

A field experiment was conducted at the farmer's field in Saronkhola, Bagerhat, during the Boro season of 2023-24 to investigate the effects of salicylic acid (SA) on the growth, yield, and yield-contributing characteristics of rice under saline prone area. The study employed a range of

salicylic acid concentrations: T0 (control), T1 (0.5 mM), T2 (1 mM), T3 (1.5 mM), T4 (2 mM), T5 (2.5 mM), T6 (3 mM), and T7 (3.5 mM). Salicylic acid was sprayed on the rice plants during the vegetative growth stage at 30 and 60 days after transplanting. The experiment followed a randomized complete block design (RCBD) with three replications and unit plots measuring 5 m × 4 m. Data on yield and yield components were recorded at harvest and analyzed statistically, with means compared using LSD. Results indicated that a 1.5 mM concentration of salicylic acid, applied twice during the active tillering stage and the reproductive stage, resulted in the highest statistically significant seed yield of 6.48 t ha^{-1}, followed by 2.5 mM SA, which yielded 6.27 t ha^{-1}. Additionally, the peak salinity level of the experimental field soil was recorded at 9.5 dS/m^2 on April 20. These findings suggest that salicylic acid can effectively enhance rice yield, particularly under saline conditions.

Assessing yield gap of BINA released boro rice varieties in Borishal

A field experiment was conducted at the farmer's fields in Babugonj, Borishal, and Nalcity, Jhalokati, under the supervision of the BINA substation Barishal during the Boro season of 2023-24. The objective was to identify yield limiting factors for BINA released boro rice varieties. The study focused on three popular varieties: Binadhan-10, Binadhan-24, and BINA dhan25. A randomized complete block design (RCBD) was employed, with three replications and unit plots measuring 4 m × 3 m. Data on yield and yield components were collected at harvest and statistically analyzed, with means compared using LSD. Results indicated that BINA dhan25 exhibited the highest yield gap of 2.02 t ha^{-1}. This gap was attributed to the excessive application of nitrogen fertilizer during top dressing. These findings highlight the need for optimized fertilizer management to minimize yield gaps in BINA boro rice varieties.

Yield maximization of boro rice varieties in Mustard- Boro-T. aman cropping patterns in Nalitabari

A field experiment was conducted at the farmer's field in Nalitabari under the supervision of the BINA substation Nalitabari during the Boro season of 2023-24 to identify the yield-limiting factors in Mustard (Binashorisha-11)-Boro (Binadhan-24/BINA dhan25)-T. aman (Binadhan-17) cropping patterns. The study focused on four popular BINA-released boro rice varieties: Binadhan-10, Binadhan-14, Binadhan-24, and BINA dhan25. Utilizing a randomized complete block design (RCBD) with three replications, the unit plot size was set at 4 m × 3 m. Data on

yield and yield components were collected at harvest and analyzed statistically, with means compared using LSD.

Results indicated that Binadhan-24 produced the highest statistically significant grain yield of 8.4 t ha^{-1}, followed by Binadhan-10, which yielded 7.63 t ha^{-1}. These findings underscore the performance of Binadhan-24 in maximizing yield within the cropping system.

Improved cropping pattern Mustard-Boro-T. aman cropping pattern with BINA released varieties uses for synchronized farming in Nalitabari

A field experiment was conducted at the farmer's field in Nalitabari under the supervision of the BINA substation Nalitabari during the Boro season of 2023-24 to identify yield-limiting factors in Boro rice cultivation under synchronized farming. The study evaluated four popular BINA-released boro rice varieties: Binadhan-10, Binadhan-14, Binadhan-24 and BINA dhan25. Utilizing a randomized complete block design (RCBD) with three replications, the unit plot size was 4 m × 3 m. Data on yield and yield components were recorded at harvest and analyzed statistically, with means compared using LSD. Results indicated that BINA dhan25 achieved the highest statistically significant grain yield of 6.98 t ha^{-1}, followed closely by Binadhan-10, which yielded 6.84 t ha^{-1}. These findings highlight the superior performance of BINA dhan25 in maximizing yield among the tested varieties in the region.

Yield maximization of boro rice varieties (Mustard-Boro-T. aman) cropping patterns in Chapainawabganj

A field experiment was conducted at the farmer's field in Gomostapur, Chapainawabganj, under the supervision of the BINA substation Chapainawabganj during the Boro season of 2023-24 to identify yield-limiting factors in (Mustard-Boro-T. aman) cropping patterns. The study focused on three popular BINA-released boro rice varieties: Binadhan-14, Binadhan-24, and BINA dhan25. The experiment employed a randomized complete block design (RCBD) with three replications, and each unit plot measured 4 m × 3 m. Data on yield and yield components were collected at harvest and analyzed statistically, with means compared using LSD. Results indicated that Binadhan-24 achieved the highest statistically significant grain yield of 7.13 t ha^{-1}, followed by BINA dhan25 at 6.7 t ha^{-1}. This superior yield in Binadhan-24 may be attributed to optimal seedling age and fertilizer management, including effective top dressing with nitrogen, which enhanced the number of effective tillers and filled grains per panicle. These findings suggest that Binadhan-24 perform better for Chapainawabganj during Boro season.

Yield maximization of boro rice varieties in different cropping systems in Noakhali

A field experiment was conducted at the farmer's field in Surbornochar, Noakhali, under the supervision of the BINA substation Noakhali during the Boro season of 2023-24 to identify yield-limiting factors in Boro rice cultivation. The study evaluated three popular BINA-released boro rice varieties: Binadhan-10, Binadhan-24, and BINA dhan25. The experiment utilized a randomized complete block design (RCBD) with three replications, and each unit plot measured 4 m × 3 m. Data on yield and yield components were collected at harvest and analyzed statistically, with means compared using LSD. Results indicated that BINA dhan25 achieved the highest statistically significant grain yield of 6.69 t ha^{-1}, followed by Binadhan-24 at 6.30 t ha^{-1}. The superior yield of BINA dhan25 can be attributed to the application of balanced fertilizers and the maintenance of seedling age at 30 days, which contributed to a higher number of filled grains per panicle. These findings highlight the critical role of agronomic practices in optimizing the yield of Boro rice varieties.

Yield maximization of BINA released boro rice varieties in Sunamganj

A field experiment was conducted at the BINA sub-station Sunamganj farm during the Boro season of 2023-24 to evaluate the yield potentials of three popular BINA-released boro rice varieties: Binadhan-10, Binadhan-24, and BINA dhan25. The study utilized a randomized complete block design (RCBD) with three replications, and each unit plot measured 3 m × 4 m. Data on yield and yield components were collected at harvest and statistically analyzed, with means compared using LSD. Results indicated that Binadhan-10 produced the highest grain yield of 7.58 t ha^{-1}, while Binadhan-24 yielded the lowest at 6.81 t ha^{-1}. Notably, Binadhan-24 exhibited statistically higher yield potential due to a greater number of effective tillers and higher thousand grain weight. These findings underscore the importance of variety selection and agronomic practices in maximizing the yield of Boro rice.

Effect of plant growth regulators on growth, yield and yield contributing characters of rapeseed

A field experiment was conducted at the farmers' field in Tarail, Kishoreganj, during the Rabi season of 2023-24 to investigate the effects of plant growth regulators on the growth, yield, and yield-contributing characters of rapeseed. Four common plant growth regulators were applied: Flora (Nitrobenzene 3 g/L), Power (Gibberellic acid 20%, 1 g/20 L), Bioferty (Auxin + Amino

acid 3 g/L), and Bumper (Chlorophenoxy acetic acid 3 g/L) using the popular BINA-released rapeseed varieties Binasharisa-9 and Binasorisha-11. The regulators were sprayed at the vegetative growth stage, 30 days after sowing. The experiment followed a randomized complete block design (RCBD) with three replications, and each unit plot measured 8 m × 5 m. Data on yield and yield components were collected at harvest and analyzed statistically, with means compared using LSD.

Results indicated that the application of Bumper (Chlorophenoxy acetic acid 3 g/L) resulted in the highest statistically significant seed yield of 1.89 t ha^{-1}, followed by Bioferty (Auxin + Amino acid 3 g/L). The Bumper treatment also produced the highest number of branches per plant (2.92) and siliqua per plant (52.12). These findings suggest that the use of specific plant growth regulators can significantly enhance the growth and yield of rapeseed.

Evaluation of late sowing potentials of Binasarisha-9 and Binasarisha-11 in Mymensingh

A field experiment was conducted at the farmer's fields in Fulbaria, Mymensingh, and Tarail, Kishoreganj during the Rabi season of 2022-23 to evaluate the effects of late sowing on the yield potentials of the mustard varieties Binasarisha-9 and Binasarisha-11. The two varieties were sown on two different dates: November 30 and December 10, 2023. Data on yield and yield components were collected at harvest. Results indicated that sowing mustard on November 30 produced a statistically higher seed yield, with Binasarisha-11 yielding 1.50 t ha^{-1}, followed by Binasarisha-9 at 1.38 t ha^{-1}. Additionally, yield-contributing characters such as the number of siliqua per plant, seeds per siliqua, and 1000-seed weight were all highest in Binasarisha-11. These findings suggest that timely sowing can significantly enhance the yield of mustard varieties, particularly Binasarisha-11.

Yield maximization of Boro rice BINA dhan25 in different cropping patterns

A field experiment was conducted at the farmer's fields in Gafargaon, Fulbaria, Sadar Mymensingh, and Tarail Kishoreganj during the Boro season of 2023-24 to evaluate the yield potentials of the BINA-released rice variety BINA dhan25 under different cropping systems. Thirty-five-day-old seedlings were transplanted, and recommended fertilizer doses were applied. Data on yield and yield components were collected at harvest. Results indicated that the highest yield for BINA dhan25 was observed at Chong Biroi, Gafargaon, Mymensingh, with a yield of 6.68 t ha^{-1}, followed by 6.48 t ha^{-1} at Boyra, Sadar Mymensingh. In the T. aman - Fallow - Boro cropping pattern, BINA dhan25 yielded the lowest at 6.26 t ha^{-1}. These findings highlight the

yield potential of BINA dhan25 in various cropping systems, emphasizing its adaptability and performance under specific conditions.

Yield maximization of Aus rice Binadhan-19 and Binadhan-21 in T. aman (Binadhan-17)-Aus (Binadha-19/Binadhan-21)- Boro (Binadhan-25) cropping patterns in Mymensingh

A field experiment was conducted at the farmer's fields in Fulbaria, Trishal, and Sadar Mymensingh during the Aus season of 2023-24 to evaluate the yield potentials of two BINA-released rice varieties: Binadhan-19 and Binadhan-21. Twenty-day-old seedlings were transplanted, and data on yield and yield components were collected at harvest. Results indicated that Binadhan-19 achieved the highest yield in the Aus season, with 3.92 t ha^{-1} in Sadar, Mymensingh, followed closely by 3.88 t ha^{-1} in Fulbaria, Mymensingh. Due to seedlings age exceed 20 to 25 days and weed management and top dressing of Nitrogen fertilizer delay application the yield was lower than potential yield. These findings suggest that Binadhan-19 demonstrates strong yield potential, particularly in the T. aman - Aus - Boro cropping patterns, highlighting its suitability for the region.

Assessing yield gap of mustard on Mustard (Binashorisha-11)-Boro (BINA dhan25)–T. aman (Binadhan-17) cropping pattern in Barishal

A field experiment was conducted at Rakudia, Vobanipur during the Rabi and Kharif seasons of 2023-24 to identify the yield-limiting factors of mustard, specifically focusing on the variety Binasarisha-9. The study employed a randomized complete block design (RCBD) with three replications, and each unit plot measured 4 m × 3 m. Data on yield and yield components were collected at harvest and analyzed statistically, with means compared using LSD. Results indicated that Binasarisha-11 produced a yield of 1.27 t ha^{-1}, followed closely by BARI shorisha-14, which yielded 1.22 t ha^{-1} at Vobanipur. These findings highlight the yield potential of mustard varieties and suggest that Binasarisha-11 is particularly effective under the conditions studied.

Improved cropping pattern with BINA released varieties uses for Synchronized farming in Borishal region

A field experiment was conducted in the 2023-24 season to evaluate the inclusion of BINA-released rice, mustard, and mungbean varieties under the supervision of the Barishal substation.

The study focused on the cropping pattern of Aman (Binadhan-23), Mustard (Binasarisha-9), and Mungbean (Binamoog-8). The experiment utilized a randomized complete block (RCB) design with three replications, and each unit plot measured 4 m × 3 m. Data on yield and yield components were collected at harvest and analyzed statistically, with means compared using LSD. Results indicated that the Aman-Mustard-Mungbean cropping pattern achieved a benefit-cost ratio (BCR) of 2.47 at Patuakhali Sadar. This finding demonstrates the economic viability of integrating these BINA-released varieties in a sequential cropping system, highlighting their potential for enhancing agricultural productivity in the region.

Evaluation of drought tolerant potentials of BINA released soybean varieties in Barishal

A field experiment was conducted at the farmers' field in Hizla, Barishal, under the supervision of the BINA substation during the Boro season of 2023-24 to evaluate the drought tolerance potentials of three BINA-released soybean varieties: Binasoybean-3, Binasoybean-5, and Binasoybean-6. The study employed a randomized complete block design (RCBD) with three replications, and each unit plot measured 4 m × 3 m. Data on yield and yield components were collected at harvest and analyzed statistically, with means compared using LSD. Results revealed that Binasoybean-5 achieved the highest seed yield of 2.42 t ha^{-1} under drought conditions, indicating its superior performance in water-limited environments. This finding suggests that Binasoybean-5 is a promising variety for cultivation in areas prone to drought, potentially enhancing soybean production in challenging conditions.

Evaluation of late sowing potentials of Binasarisha-9 and Binasarisha-11 in saline prone area Satkhira

A field experiment was conducted at the farmer’s field in Satkhira during the Rabi season of 2023-24 to evaluate the effects of late sowing on the yield potentials of two mustard varieties: Binasarisha-9 and Binasarisha-11. Both varieties were sown on November 30, 2023, and data on yield and yield components were recorded at harvest. Results indicated that Binasarisha-9 produced the highest seed yield of 1.75 t ha^{-1} in Shyamnagor, followed by 1.65 t ha^{-1} in Satkhira Sadar. These findings demonstrate that late sowing can still yield significant results, particularly with Binasarisha-9, suggesting its resilience and adaptability under varying sowing conditions.

Assessment of yield gap for pulse and oil seed crops in Satkhira

A field experiment was conducted at the farmer's field in Satkhira during the 2023-24 season to identify the yield gap limiting factors of BINA-released pulse and oilseed crops. The study focused on two pulse crops, Binamoog-8 and Binakhesari-1, and two oilseed crops, Binasarisha-4 and Binasarisha-9. Data on yield and yield components were collected at harvest. Results indicated that the highest yield gap for pulse crops was observed in Binamoog-8, with a gap of 0.22 t ha^{-1}, followed by Binakhesari-1 at 0.10 t ha^{-1}. Among the oilseed crops, Binasarisha-9 exhibited the largest yield gap of 0.26 t ha^{-1}, followed by Binasarisha-4 at 0.12 t ha^{-1}. These findings highlight the potential for improving yield performance in these crops through targeted interventions to address identified gaps.

Yield maximization of BINA released rice varieties (T. aus, T. aman and Boro) in Satkhira

A field experiment was conducted at the farmer's field in Satkhira during the 2023-24 season to assess the yield potentials of various BINA-released rice varieties across different cropping seasons. The study included three boro season varieties (Binadhan-10, Binadhan-24, and BINA dhan25), three aman season varieties (Binadhan-17, Binadhan-22, and Binadhan-23), and two aus season varieties (Binadhan-19 and Binadhan-21). Data on yield and yield components were collected at harvest. Results revealed that the highest yield in the boro season was achieved by Binadhan-10, with 7.8 t ha^{-1} recorded in both Tala and Kaliganj. Binadhan-24 followed closely with a yield of 7.5 t ha^{-1} in Kalaroa, while BINA dhan25 yielded 7.3 t ha^{-1} in Debhata. In the aman season, Binadhan-17 produced the highest yield of 6.6 t ha^{-1}, and Binadhan-22 yielded 6.35 t ha^{-1} in Tala. For Binadhan-23, the highest yield of 5.9 t ha^{-1} was recorded in Shyamnagor. In the aus season, Binadhan-19 led with a yield of 4.5 t ha^{-1}, closely followed by Binadhan-21 at 4.45 t ha^{-1} in Kalaroa. These findings underscore the potential of BINA-released varieties in maximizing rice yields across diverse environments.

Improved cropping pattern with BINA released varieties used for synchronized farming in Satkhira

A field experiment was conducted at the farmer's field in Haroddah, Satkhira Sadar, during the 2023-24 season to identify suitable cropping patterns using BINA-released varieties through

synchronized farming. The study involved three popular BINA varieties: Binadhan-10, Binadhan-17, and Binasarisha-9. The total experimental plot size was 33 decimals, and data on yield and yield components were recorded at harvest. Results indicated that Binadhan-10 achieved the highest grain yield of 6.75 t ha^{-1} in the late boro season, while Binadhan-17 produced a yield of 6.25 t ha^{-1} in the aman season. Additionally, Binasarisha-9 yielded 1.52 t ha^{-1} of seeds in the rabi season. The findings suggest that the Aman-Mustard-Boro cropping pattern may be a more suitable alternative to the existing Aman-Fallow-Boro system in the Satkhira region, promoting better resource utilization and increased productivity.

Yield maximization of BINA released aman rice varieties in Cumilla under Synchronize farming

A field experiment was conducted at the BINA substation farm in Cumilla during the Aman season of 2023-24 to assess the yield gap of aman rice. Six popular BINA-released boro rice varieties were evaluated: Binadhan-11, Binadhan-16, Binadhan-17, Binadhan-20, Binadhan-22, and BRRI dhan75. The study was designed using a randomized complete block design (RCBD) with three replications, and the unit plot size was 5 acres. Data on yield and yield components were collected at harvest and analyzed statistically, with means compared using LSD. Results indicated that Binadhan-17 achieved the highest grain yield of 5.14 t ha^{-1}, followed closely by Binadhan-16 with a yield of 5.05 t ha^{-1}. These findings highlight the potential of these varieties in maximizing yield in aman rice production under synchronize farming.

Assessment of yield gap of BINA released aman rice varieties at farmer's field Cumilla

A field experiment was conducted at a farmer's field in Cumilla under the supervision of the BINA substation during the boro season of 2023-24 to identify the yield-limiting factors of aman rice. Six popular BINA-released T. aman rice varieties were evaluated: Binadhan-11, Binadhan-16, Binadhan-17, Binadhan-20, and Binadhan-22. The study employed a randomized complete block design (RCBD) with three replications, and each unit plot measured 4m × 3m. Yield and yield component data were recorded at harvest and statistically analyzed, with means compared using LSD. Results indicated that Binadhan-17 produced the highest grain yield at 6.8 t ha^{-1}, followed by Binadhan-20, which yielded 5.8 t ha^{-1}. These findings emphasize the effectiveness of these varieties and highlight potential areas for improving yield in aman rice cultivation.

Determination the efficacy of different herbicide suppressing weed species in Aus rice

A field experiment was conducted at the Bangladesh Institute of Nuclear Agriculture (BINA) HQ farm during the Aus season of 2023-24 to identify efficient herbicides for aus rice. Seven classes of herbicides were evaluated: Control, Pretilachlo, Penoxsulam, Cyhalop-butyl, Bensulfuron methyl + Acetachlor, Pyrazosulfuron ethyl, Amchlor, and Triafemon, using the variety Binadhan-19. The study utilized a randomized complete block design (RCBD) with three replications, and each unit plot measured 4m × 3m. Yield and yield components were recorded at harvest and statistically analyzed, with means compared using LSD. Results revealed that the control plot exhibited the highest weed density (152.6 m^{-2}), fresh weight (382.53 g m^{-2}), dry weight (62.23 g m^{-2}), and a maximum number of weed species. The penoxsulam-treated plot achieved the highest grain yield at 5.02 t ha^{-1}, followed closely by Pyrazosulfuron ethyl at 4.96 t ha^{-1}. Additionally, the highest weed control efficiency was recorded in the Bensulfuron methyl + Acetachlor treatment at 84.63%. This study highlights the effectiveness of specific herbicides in enhancing rice yield while managing weed pressure.

Field trial of Novixid herbicide to suppress on different weed infestation in *boro* rice

A field experiment was conducted at the Bangladesh Institute of Nuclear Agriculture (BINA) HQ farm and Rangpur during the boro season of 2023-24 to evaluate the efficiency of the Novixid herbicide. Three treatments were tested: control, Novixid, and Penoxsulam (used as a positive control), with BINA dhan25 as the test crop. The study was designed using a randomized complete block design (RCBD) with three replications across two locations, and each unit plot measured 8m × 5m. Yield and yield components were recorded at harvest and analyzed statistically, with means compared using LSD. Results indicated that the control plot had the highest weed density (88.5 m^{-2}), fresh weight (243.8 g m^{-2}), dry weight (68.72 g m^{-2}), and maximum weed species. The Novixid-treated plot achieved a weed control efficiency of 83.45% and produced a grain yield of 5.16 t ha^{-1}, while the Penoxsulam-treated plot yielded the highest grain output at 5.36 t ha^{-1} across both locations. This study demonstrates the effectiveness of Novixid in managing weeds while supporting rice yield, although Penoxsulam remained the superior treatment for overall yield.

Field trial of KSB Bolt herbicide to suppress on different weed infestation in *boro* rice

A field experiment was conducted at the Bangladesh Institute of Nuclear Agriculture (BINA) HQ farm and Rangpur during the boro season of 2023-24 to evaluate the efficiency of the KSB Bolt herbicide. The

study utilized three treatments: a control, KSB Bolt, and Panida (used as a positive control), with BINA dhan25 as the test crop. The experiment followed a randomized complete block design (RCBD) with three replications across two locations, and each unit plot measured 8m × 5m. Yield and yield components were recorded at harvest and analyzed statistically, with means compared using LSD. Results showed that the control plot had the highest weed density (75.4 m^{-2}), fresh weight (257.42 g m^{-2}), dry weight (80.42 g m^{-2}), and a total of seven weed species. The Panida-treated plot exhibited the highest weed control efficiency at 81.58%, resulting in the highest grain yield of 5.37 t ha^{-1}, while the KSB Bolt-treated plot yielded 4.96 t ha^{-1}. This study indicates that both Panida and KSB Bolt can effectively manage weed populations, with Panida offering superior yield outcomes.

Field trial of Butachem herbicide to suppress different weed infestation in *boro* rice

A field experiment was conducted at the Bangladesh Institute of Nuclear Agriculture (BINA) HQ farm and Rangpur during the boro season of 2023-24 to evaluate the efficiency of Butachem herbicide. The study employed three treatments: a control, Butachem, and Amchlor (used as a positive control), with BINA dhan25 as the test crop. A randomized complete block design (RCBD) was implemented with three replications across two locations, and each unit plot measured 8m × 5m. Yield and yield components were recorded at harvest and analyzed statistically, with means compared using LSD. Results indicated that the control plot had the highest weed density (88.5 m^{-2}), along with fresh weight (217.4 g m^{-2}), dry weight (75.43 g m^{-2}), and a total of eight weed species. The highest weed control efficiency was observed in the Amchlor-treated plot at 81.06%, resulting in the highest grain yield of 5.40 t ha^{-1}, followed by the Butachem-treated plot, which yielded 5.11 t ha^{-1}. This study suggests that both Amchlor and Butachem effectively manage weed populations, with Amchlor.

Field trial of Rifit 500EC & Rifit Plus 37EW in Rice herbicide against grass and sedge of rice in boro season

A field experiment was conducted at the Bangladesh Institute of Nuclear Agriculture (BINA) HQ farm during the Aus season of 2023-24 to evaluate the efficiency of herbicides for Boro rice. Two herbicide formulations were tested: Rifit 500EC and Rifit Plus 37EW, using BINA dhan25 as the test crop. A randomized complete block design (RCBD) was employed with three replications across two locations (Mymensingh and Rangpur), and each unit plot measured 4m × 3m. Data on yield and yield components were collected at harvest and analyzed statistically, with means compared using LSD. Results indicated that the control plot exhibited the highest weed dry weight at 1736 g. The average weed control efficiency for the selected weed species, achieved through the application of Rifit 500EC and Rifit Plus 37EW, exceeded 84% across both locations.

This study demonstrates the effectiveness of these herbicides in managing grass and sedge weeds in Boro rice cultivation.

Yield improvement of rapeseed through seed treatment and foliar application of Nano-Particles under saline prone area

A field experiment was conducted at a farmer's field in Shyamnagar, Satkhira during the rabi season of 2023-24 to assess the effects of nanoparticles (NP) on mustard yield in saline areas. The treatments included seed treatment with Fe_2O_3 NP at concentrations of control (0 mg L^{-1}), (50 mg L^{-1}), and (100 mg L^{-1}), along with foliar applications: (Control), (1.5 g L^{-1} ZnO), (1.5 g L^{-1} Fe_2O_3), and (1.5 g L^{-1} Fe-Zn oxide). Binasarisha-9 was utilized as the test crop. A split-plot design was employed with three replications, and each unit plot measured 4 m × 3 m. Data on yield and yield components were recorded at harvest and analyzed statistically, with means compared using LSD. Results indicated that the highest seed yield (1.71 t/ha) was achieved with seed soaking in Fe_2O_3 NP at 100 mg L^{-1} combined with foliar application of 1.5 g L^{-1} Fe-Zn oxide. Conversely, the lowest seed yield (1.18 t/ha) was recorded in the control plot. This study highlights the potential of nanoparticles to enhance mustard yield in saline conditions.

Effect of seed soaking and foliar application with Zinc Oxide (ZnO) nano-fertilizer on growth and yield of wheat under drought prone area

A field experiment was conducted at a farmer's field in Nachol, Chapainawabganj during the rabi season of 2023-24 to investigate the effects of ZnO nanoparticles (NP) on wheat yield in drought-prone areas. The treatments included (control, no ZnO), (recommended $ZnSO_4$ fertilizer at 6 kg/ha), (seed soaking with 150 mg L^{-1} ZnO NP), (foliar application of 150 mg L^{-1} ZnO NP), and (seed soaking plus foliar application of 150 mg L^{-1} ZnO NP). Binagom-1 was utilized as the test crop. A randomized complete block design (RCBD) with three replications was employed, with each plot measuring 4 m × 3 m. Data on yield and yield components were recorded at harvest and analyzed statistically, with means compared using LSD. Results indicated that the highest grain yield (3.81 t ha^{-1}) was achieved with the combined treatment of seed soaking and foliar application of ZnO NP. The lowest grain yield (3.44 t ha^{-1}) was recorded in the control plot. Yield-attributing parameters mirrored this trend, suggesting that ZnO NP application can significantly enhance wheat performance in drought conditions.

Evaluation of yield performance of intercropping combinations between sesame and mungbean in hill tracts

A field experiment was conducted at a farmer's field in Khagrachari during the rabi season of 2023-24 to identify the optimal intercropping combinations for sesame and mungbean in hill tracts. The study involved five treatments: solo mungbean, solo sesame, and three intercropping ratios (sesame) of 4:6, 2:4, and 3:3. The experiment was organized using a randomized complete block (RCB) design with three replications, and each unit plot measured 4 m × 4 m. Data on yield and yield components were recorded at 30, 60, and 90 days after sowing, with final yields noted at harvest. Statistical analysis of the data was performed, and means were compared using LSD. Results showed that the highest yield for solo mungbean was 1.21 t ha^{-1}, while solo sesame yielded 1.17 t ha^{-1}. In the intercropping treatments, the sesame (4:6) ratio yielded 1.05 t ha^{-1} for sesame and 1.1 t ha^{-1} for mungbean; the (2:4) ratio yielded 1.34 t/ha for sesame and 1.09 t/ha for mungbean; and the (3:3) ratio yielded 1.28 t ha^{-1} for sesame and 1.32 t ha^{-1} for mungbean. These findings suggest that intercropping can enhance overall productivity, with varying combinations yielding different results for sesame and mungbean.

Improved multilayer cropping system on hill slope in Khagrachari

A field experiment was conducted at a farmer's field in Khagrachari during the 2023-24 season to evaluate suitable multilayer cropping combinations involving aonla, pineapple, and Binalebu-1 in hill tracts. The cropping pattern consisted of two rows of pineapple with a single row of Binalebu-1 and a single row of aonla. Each unit plot measured 8 m × 5 m. Data on yield and yield components were recorded at 90 and 180 days after transplanting, with final yields assessed at harvest. Statistical analysis was performed, and means were compared using LSD. Results indicated that the pineapple plants produced a substantial number of bearing fruits, averaging 2078 fruits per hectare. The Binalebu-1 variety yielded 213 fruits per plant, with four harvests noted throughout the season. In contrast, the aonla plants were in an active growth stage but did not bear fruit during the study period. These findings highlight the potential of multilayer cropping systems in hill tracts, particularly for maximizing fruit yield from pineapple and Binalebu-1.

Effect of herbicide on weed management in *Aus* rice cultivation on the hill slope of Khagrachari

A field experiment was conducted at a farmer’s field in Khagrachari during the aus season of 2023-24 to evaluate suitable weed management techniques. Seven different treatments were assessed: Control, Pre-emergence herbicide, Pre-emergence herbicide + Hand weeding, Post-emergence herbicide, Post-emergence herbicide + Hand weeding, Hand weeding (2 times), and a

combination of Pre-emergence and Post-emergence herbicides, with Binadhan-21 as the test crop. The experiment utilized a randomized complete block design (RCBD) with three replications, and each unit plot measured 5 m × 4 m. Data on yield and yield components were collected at harvest and statistically analyzed, comparing means using LSD. Results indicated that the combination of pre-emergence herbicide and hand weeding achieved the highest weed control efficiency (WCE) at 80.79%, closely followed by the pre-emergence herbicide alone at 79.64%. The highest grain yield of 3.59 t ha^{-1} was obtained with the pre-emergence herbicide combined with hand weeding, while the post-emergence herbicide treatment yielded 3.40 t ha^{-1}. These findings suggest that integrated weed management strategies can significantly enhance rice yields in aus season cropping systems.

CROP PHYSIOLOGY DIVISION

Effect of high temperature and quality at flowering stage of Aman rice lines/ genotypes.

A pot experiment was conducted at the pot yard and a temperature-controlled chamber of Bangladesh Institute of Nuclear Agriculture (BINA), Head Quarters, Mymensingh, Bangladesh. Twelve rice genotypes viz., Kasalat, RL-4, N-22, RL-5, Binadhan-17, NP-1, RL-1, NP-3, RL-2, NP-8, RL-3 andNP-N-I-2 were set in CRD with three replications during Aman seasons 2023. Temperature were treated as control and 37^0C. Plants were grown in ambient temperature and during flowering stage pots were kept in temperature-controlled cabinet for 3 days. Then transfer the pot in pot yard allowed to continue up to maturity. High temperature actually affects the final yield of Aman rice varieties at flowering stage except NP-N-1-2, NP-8,N-22, Kasalat and RL-4 showed better yield under high temperature stress.

Molecular characterization of some cold tolerance of rice genotypes.

A pot experiment was conducted at the pot yard and a temperature-controlled chamber of Bangladesh Institute of Nuclear Agriculture (BINA), Head Quarters, Mymensingh, Bangladesh to identify cold stress tolerant rice genotypes. In this experiment 65 rice genotypes were grown and screened by phenotypic selection. Among them 21 selected rice genotypes viz., Y-1281**,** BNCR-20, BNDR-18, BNCR-45, BNCR-35, NP540, RD3072, RD3027, PNR166, BNDR 48, BNDR -57, IR 67, NP121**,** NP71, NP143, IN 650, IN 550, VT69, VT1204,512 and IR171. IR-171 was as a check genotype. The experiment was set in CRD with three replications in during Boro season 2023. RM-474 showed polymorphism among the rice genotypes. Genetic diversity observed in Y-1081, BNDR-18, BNCR-45, NP-540, RD-3072, BNDR-57, and IR-67 and IN -550 genotypes. Further research should be done for finding cold tolerant rice genotypes.

Effect of cold stress on growth and development of Boro rice genotypes at field condition

A field experiment was carried out to assess the natural cold stress on growth and development of rice plant and to identify cold stress tolerant rice genotypes. The experiment was set in a two factorial RCBD with three replications. The first factor was rice genotypes (BNCR-20, BNCR-35, BNCR-45, BNDR 18, BNDR-48, BNDR-57 and BRRI dhan67) and the second factor was date of transplanting: D/T1: 30/11/23, D/T2: 12/12/23 and D/T3: 28/12/23. In terms of different physiological growth and development analysis BNCR-20, BNCR-45, BNDR-57, BNDR-18 and BNDR-48 perform better under cold stress. The transplanting date 28/12/23 showed better physiological growth and development than other dates may be due very low temperature at this time. The highest seed yield (t ha^{-1}) was recorded in BNDR-18 at D/T3: 28/12/23. From this experiment BNCR-20, BNDR-18 and BNDR-48 can be used for cold tolerant rice breeding program.

Polyethylene glycol induced drought stress affects morphological traits and antioxidant enzymatic activities in rice genotypes

The study examined the effects of PEG-induced drought stress on nine rice genotypes in a hydroponic setting at the Bangladesh Institute of Nuclear Agriculture. Two checks were included:

Binadhan-17 (tolerant) and Binadhan-7 (susceptible). Three levels of drought stress were applied: control (nutrient solution), 10%, and 15% PEG. Seven days post-treatment, various growth parameters were measured, including shoot and root lengths, fresh and dry weights. Antioxidant enzyme activities—catalase (CAT), ascorbate peroxidase (APX), and peroxidase (POD)—were also assessed. Results showed significant variations among genotypes under drought stress, with advanced lines BRM-5, BRM-7, and BRM-8 outperforming others in growth metrics compared to the susceptible check. All measured parameters declined with increasing PEG concentration; however, no significant differences were observed between the 10% and 15% treatments. Binadhan-17 exhibited the highest CAT activity under 15% PEG stress, while BRM-4 had the lowest. In terms of APX and POD activities, BRM-6 and Binadhan-17 showed the highest levels, respectively. Overall, tolerant genotypes demonstrated superior enzymatic activity compared to susceptible ones under both control and high-stress conditions.

Physiological and biochemical responses of rapeseed genotypes for salinity tolerance at seedling and reproductive stage

The study investigated the effects of salinity stress on seven advanced mustard genotypes under hydroponic conditions at BINA. Conducted in a randomized complete block design with three replications, the experiment measured growth parameters at the seedling and flowering stages, and yield parameters at harvest. Key physiological metrics, including chlorophyll content and antioxidant enzyme activity (CAT, POD, and APX), were assessed alongside proline and MDA levels. Results indicated significant differences in growth and yield across genotypes and salinity treatments. Increased salinity negatively impacted growth, with RM-28 achieving the highest seed yield, while RM-14 recorded the lowest. Proline content nearly doubled under stress conditions compared to controls, and chlorophyll levels decreased with rising salinity. Antioxidant enzyme activities were generally higher at the flowering stage than at the seedling stage. All mustard genotypes demonstrated salt tolerance up to 10 dSm^{-1}. Notably, RM-38 and RT-38 exhibited superior tolerance compared to other genotypes based on growth and biochemical responses.

Identification of sesame genotypes for water logging tolerance based on physiological criteria

A pot experiment was conducted with four sesame genotypes viz.BARItil-4, BINAtil-5, BARItil-5 and Binatil-2 at BINA farm, Mymensingh during March to June 2024. The present study was undertaken to investigate to find out the water logging tolerance genotypes on the basis of morphological, physiological, yield and yield contributing characters of sesame genotypes. Three water logging treatments viz., control and water logging periods of 48hrs and 60 hours were imposed at flowering stage and high temperature was about $38\text{-}40^0C$. After seedling establishment one seedling was allowed to grow in each pot. The experiment was laid out in completely randomized design with three replications. Results revealed that all the genotypes were severely affected and all the genotypes died with heat stress and water logging stress.

Evaluation of chili (*Capsicum annuum L.*) genotypes for water logging tolerance at seedling stage based on physiological criteria

An experiment was conducted with nine chili genotypes *viz*. RCL-1, BCL-1, YCL-1, Binamorich-1, Binamorich-2, FC-025, Bindu morich, B-M-1-2 and Maguramorich at pot yard of Bangladesh Institute of Nuclear Agriculture (BINA) during March- September, 2023. The experiment was set in a two factorial RCBD with three replications. The first factor was chili genotypes and the second factor was two water logging conditions: Control (no water logging) and Water logging (for 72 hrs). Water logging period was applied (water height was 3–5cm above the soil surface) for three (36–38 DAE) days, and subsequent withdrawal of water logging, i.e., 39–45 DAE was designated as the recovery period. There was no water logging tolerant chili genotype found.

Identification of mustard (Rape seed) genotypes for water logging tolerance based on physiological criteria.

This study investigated the impact of waterlogging during the seedling stage on the growth and development of nine mustard genotypes—Agrani, Binasorisa-4, Binasorisa-7, Binasorisa-9, Binasorisa-11, Binasorisa-12, BARIsarisa-14, BARIsarisa-17, and BARIsarisa-18—conducted at BINA pot yard in Mymensingh from November to February 2024. The experiment employed three waterlogging treatments: control, 48 hours, and 72 hours, applied at 30 days after seeding. Morphological traits, yield components, and reactive oxygen species expression were measured. Results showed that genotypes Binasorisa-7, Binasorisa-9, Binasorisa-12, BARIsarisa-14, and BARIsarisa-17 demonstrated better recovery and yield after experiencing waterlogging for both durations. In contrast, Agrani, Binasorisa-4, and BARIsarisa-18 exhibited lower yields, indicating their sensitivity to waterlogging conditions.

Screening of advanced lentil lines for drought tolerance based on physiological criteria

A pot experiment was carried out to assess the effects of water stress on total dry mass production, seed yield and yield attributes of lentil mutants. Control (100% FC) and two water stresses such as 40% and 60% FC were imposed at flowering start phase and continued until physiological maturity on five lentil mutants/varieties viz., LM-01, LM-02, LM-03, LM-o4 and Binamasur-8. The experiment was laid out in a two factorial Complete Randomized Design with four replications. The first factor was lentil genotypes and the second factor was two levels of water stress 40, 60% and control (not water stress). LM-02 showed better performance in terms of physiological and biochemical parameters in water stress condition. The highest seed weight plant^{-1} was observed in LM-02 followed by LM-01 and LM-04. So, LM-01, LM-02 and LM-04 mutants could be used as breeding material to develop high yielding lentil variety that can tolerate drought condition.

Evaluation of soybean genotypes for salinity tolerance based on physiological criteria

A pot experiment was carried out to assess the effect of salinity stress on growth and yield of soybean mutants/varieties and to identify salinity stress tolerant soybean mutants. A total of five soybean genotypes, namely SCM-5, SCM-11, SBM-15, SBM-22 and Binasoybean-6 were used as plant materials in the experiment. The experiment was accomplished following Completely Randomized Design (CRD) under controlled condition at the Glass House Laboratory of Plant Breeding Division, BINA. The genotypes were screened at different salinity levels viz.6, 9, 12 and 0 (control) dSm^{-1} at seedling stage using standard hydroponic culture with three replications

for each treatment. Salinity treatments were imposed at 40 days after emergence (DAE). SCM-5, SCM-11 and SBM-22 mutants showed better performance in terms of morpho-physiological characters and chlorophyll content. At 6 dSm^{-1} salinity SCM-5 and SBM-22 found to be a salinity tolerant genotype on the other hand at 9 dSm^{-1}salinity only SBM-15 found to be a salinity susceptible genotype. So, in breeding program SCM-5, SCM-11 and SBM-22 mutants could be used to develop salinity tolerant soybean variety.

Evaluation of Aman rice lines to drought stress based on physiological criteria

This study examined the morpho-physiological differences in drought tolerance among five rice genotypes and one check variety (Binadhan-17) in a pot experiment conducted at BINA during Aman 2023. The experiment utilized a randomized complete block design with three replications and included two drought treatments: T1 (60% field capacity) and T2 (45% field capacity), alongside a control (100% field capacity). The tolerant genotypes, notably Binadhan-17 and RL-15, produced lower levels of hydrogen peroxide (H2O2) compared to sensitive lines like RL-07 and RL-08. All genotypes exhibited increased enzymatic activity under water deficit conditions, with RL-15 outperforming the check variety Binadhan-17.

Screening of advanced lines of grass pea for drought tolerance based on physiological parameters

This study evaluated the physiological characteristics of three advanced grass pea genotypes (GM-02, GM-03, and GM-04) alongside two check varieties (Binakheshari-2 and BARI Kheshari-2) in a pot experiment conducted at HQ, BINA during Robi 2023 with RCBD design. The objective was to screen for drought tolerance under controlled conditions with two drought treatments: T1 (60% field capacity) and T2 (40% field capacity), compared to a control (100% field capacity). Despite grass pea's inherent drought resilience, significant yield losses were observed under severe drought stress, affecting all measured parameters. GM-04 demonstrated the best performance across all yield and yield-contributing traits under water scarcity. Additionally, proline and soluble sugar contents increased in all genotypes, with GM-04 and GM-02 showing the highest osmoprotectant production.

Evaluation of five soybean genotypes based on morpho-physiological characters under water stress condition

A pot experiment was carried out to assess the effects of water stress on morphological, physiological and yield attributes of soybean genotypes. Control (100% FC) and two water stresses such as 40% and 60% FC were imposed at pre flowering stage and continued until physiological maturity on five soybean mutants/variety viz., Binasoybean-7, SBM-15, SBM-22, SCM-5 and SCM-11. The experiment was laid out in a Complete Randomized Design with three replications. Data on chlorophyll and nitrate reductase (NR) activity was measured at reproductive stage, flowers counts were recorded from each plant of each replication and yield and yield attributes were also recorded at maturity. Binasoybean-7 showed better performance regarding yield and yield attributes against water stress up to 40% FC.

Estimation of Physico-chemical properties of different grain, pulse and oilseed crops mutants/ varieties.

The experiment involved analyzing 53 grain samples in the grain quality lab of the Crop Physiology Division. The goal was to assess various physical and biochemical properties of the grains. For the physical properties, data was collected on grain/seed size, shape, and color. The biochemical parameters that were determined included protein content, amylose content, and gel consistency. Rice grain samples (53) were analyzed to assess various physical and biochemical properties of the grains. Highest protein content was found in Binadhan-20 and Binadhan-26. Binadhan-25 looks fine, long and slender type. Binadhan-13 showed strong aroma.

ENTOMOLOGY DIVISION

Eco-friendly management approaches against fall armyworm (*Spodoptera frugiperda*) of maize

A field experiment was conducted to evaluate the effectiveness of three bio-rational and one synthetic insecticide against fall armyworm (FAW), *Spodoptera frugiperda* of maize. The experiment was laid out at BINA farm, Mymensingh during khaif-I season of 2023 following a randomized complete block design with three replications. Biorational insecticides were Cyantraniliprole (Fortenza), SfNPV (*Spodoptera frugiperda* Nuclear Polyhedrosis Virus), SNPV (Spodoptera Nuclear Polyhedrosis Virus) and the synthetic insecticide was Chlorantraniliprole **(**Coragen). Seeds were treated with Cyantraniliprole before sowing. Insecticides were sprayed at 22, 33 and 43 days after sowing at the recommended dose. An untreated plot was used as a control. Data on Spodoptera infestation were taken on total infested plants in the plot at 10 days after treatment application. Data on per cent FAW infested plants were transformed and then analyzed using Statistix 10 software. Chlorantraniliprole had a significant effect in reducing 78.69% and 97.25% of FAW infestation of plants over untreated control at 10 days after 1st and 2nd application of treatment, respectively. Although SfNPV did not have a significant role after 1st spray in reducing FAW infestation, an alternate 2nd spray of Chlorantraniliprole significantly reduced 84.03 percent of FAW infestation. Chlorantraniliprole had also a significant effect in reducing 68.32% of FAW infestation of cob over untreated control at 10 days after 3rd application of treatment. The highest yield of 13.3kg/plot of maize was found in the Chlorantraniliprole treated plot.

Evaluation of different management approaches against mite and thrips complex of chili (*Capsicum frutescens* L.)

A field experiment was conducted to find out suitable management approach against mite (*Lorryia formosa*) and thrips (*Scirtothrips dorsalis*) complex of chili during rabi season of 2023-24 at BINA farm, Mymensingh. The experiment was laid out in a randomized complete block design with 3 replications. There were seven treatments where one was control and other six were Matrin (Biotrin 0.5%) @1.4ml/L water, alternate spraying of K-mite 0.5% @1ml/L water and Matrin (Biotrin 0.5%) @1.4ml/L water, alternate spraying of Imidacloprid 20SL (Admire 20SL) @1ml/L water and Abamectin (Vertimec18EC) @1.25ml/L water, Spinosad 44.03% W/W (Tracer 45SC) @1ml/L water, alternate spraying of Spinosad 44.03% W/W (Tracer 45SC) @1ml/L water and Abamectin (Vertimec18EC) @1.25ml/L water, alternate spraying of K-mite 0.5% @1ml/L water and Spinosad 44.03% W/W (Tracer 45SC) @1ml/L water. Spray were applied 2 times starting from the first appearance of thrips or mite infestation at 10 days interval. Data on number of thrips were recorded from 12cm upper twig per plant from randomly selected 5 plants per plot. Mite infestation data were taken on number of infested leaves from 5 randomly selected plants at 10 day after 2nd dose of treatment application. From the results, it was evident that after lst treatment application, the lowest number of thrips (0.40) was recorded in Spinosad+K-mite treated plots with population reduction of 71.44 percent which was statistically identical with that of Spinosad treated plots with population reduction of 66.43 percent. It was also evident that on the 10th day after 2nd treatment

application, the lowest number of mite infested leaves/plant (3.27) was recorded in Spinosad+K-mite treated plots with population reduction of 74.71 percent which was statistically similar to Imidacloprid+Abamectin treated plots. The highest number of mite infested leaves/plant (12.93) was observed in untreated control. From the above result, it may be concluded that alternate spraying of Spinosad and K-mite twice starting from the first appearance of thrips or mite infestation at 10 days interval was most effective against thrips and mite complex of chili in respect of reducing pest infestation.

Evaluation of different IPM components for management of cotton jassid and bollworm

A field experiment was conducted to find out suitable management approach against cotton jassid and bollworm during kharif-2 season of 2023-24 at BINA regional station, Gazipur. The experiment was laid out in a randomized complete block design with 3 replications. There were seven treatments where one was control and other six were Matrin (Biotrin 0.5%) @1.4ml/L water, Azadirachtin 0.1% (Fytomax) @10ml/L water, Diafenthiuron 50% (Pegasus 50SC)@1 ml/L water, alternate spraying of Diafenthiuron 50% (Pegasus 50SC) @1 ml/L water and Azadirachtin 0.1% (Fytomax) @10ml/L water, alternate spraying of Matrin (Biotrin 0.5%) @1.4ml\L water and Azadirachtin 0.1% (Fytomax) @10ml/L water, alternate spraying of Imidacloprid 20SL (Admire 20SL) @1ml/L water and *Celastrus angulatus* 1% (Bio-chamak) @1.20ml/L water. Three sprays were applied on 10 days interval. Data on number of jassid were recorded from randomly selected 3 plants per plot at 7 day after last treatment application. Bollworm infestation data were taken on the number of infested bolls from 3 randomly selected plants. Effectiveness of various treatments against cotton jassid after 3rd spray was that the lowest number of jassid/plant was (1.66) recorded in Diafenthiuron+Azadirachtin treated plots with population reduction of 84.44 percent while thee highest infestation (10.67) was observed in untreated control and it was statistically similar to Biotrin treated plots. The highest yield (703.33 g/plot) was obtained from Diafenthiuron+Azadirachtin which was statistically similar to Imidacloprid+*Celastrus angulatus* 1%. From the above result, it may be concluded that alternate spraying of Diafenthiuron 50% (Pegasus 50SC) @1 ml/L water and Azadirachtin 0.1% (Fytomax) @10ml/L water at 10 days interval three times was most effective against jassid and bollworm of cotton in respect of reducing insect pest's infestation with higher yield.

Evaluation of some bio-pesticides and new generation insecticides against papaya mealybug ((*Paracoccus marginatus)*

A field experiment was conducted to find out appropriate management approach against papaya mealybug (*Paracoccus marginatus).* The experiment was laid out at BINA farm, Mymensingh during kharif-2, 2023 with randomized complete block design with three replications. The test variety was Top lady (BU papaya-1) and 31 days old seedlings were transplanted. Among the 6 treatments two were bio-pesticides e.g Bio-clean @ 1ml/L, Fytoclean @ 1ml/L and three were new generation insecticides e.g Imixam 70WDG @ 0.4 g/L, Saka 25 SC @ 1.0 ml/L,and Ravjum 14.5 SC @ 1.0.ml/L. The untreated plot was used as control. There was very little infestation or the infestation of the insect was below economic threshold level that's why no

treatment was applied. Moreover, the annual research program workshop 2023-24 of BARC, the expert members commented a technology is already developed by BARI to control papaya mealybug so there is no need for duplication. That's why the experiment would not be continued in Annual Research program 2024-25.

Development of bio-rational pest management approach against cucurbit fruit fly of bitter gourd

A field experiment was conducted to find out suitable management approach against cucurbit fruit fly (*Bactrocera cucurbitae*) of bitter gourd during kharif-1 season of 2023-24 at BINA farm, Mymensingh. The experiment was laid out in a randomized complete block design with 3 replications. Botanical insecticides were Azadirachtin (Fytomax), Spinosad (Libsen) and synthetic insecticide was Emamectin benzoate (Suspend 5G). The treatments consisted of Pheromone (Individual), Pheromone+Azadirachtin (Fytomax), Pheromone+Spinosad (Libsen), Pheromone+Emamectin benzoate (Suspend 5 SG), Pheromone impregnated yellow sticky trap and untreated control. Insecticides were sprayed at 65 days after sowing at recommended dose by producer. After 7 days of each treatment application, data were collected by observing all the fruits present per plot through naked eye. Numbers of fruit flies trapped in pheromone were recorded at 2 days interval. Data were collected on the following parameters: i) total and infested number of fruits, ii) number of healthy marketable fruits, iii) weight of healthy or marketable fruits. Data were analyzed by CropStat7.2 and harvesting damage and percent infestation of fruits was calculated on both number and weight basis. From the results, it is evident that Azadirachtin had significant effect in reducing harvesting damage (17.79%) over untreated control and Spinosad also had significant role of 18.46% reduction of damage over control. It is also evident that total marketable fruit percent was highly increased by Spinosad (67.89%) followed by Azadirachtin (66.15%) and Emamectin benzoate (63.96%). The lowest infestation of fruit fly was recorded in Spinosad and highest number was recorded in untreated control. Percent of marketable fruit weight was highest in Spinosad which was 70.26% followed by Azadirachtin (66.78%) and pheromone+yellow sticky trap (65.73%). Number of trapped fruit fly was lower at early weeks after sowing and gradually increased at 8 weeks after sowing. Abundance of fruit fly slightly increased in 9^{th} week after sowing and highest number was trapped in 11^{th} week and then gradually decreased after 11^{th} week.

Effect of gamma irradiation on sterility of cucurbit fruit fly (*Bactrocera cucurbitae*)

An experiment was conducted during March 2024-May 2024 to confirm the previous year's results on investigation of the effect of gamma radiation doses on adult emergence, mortality and sterility of cucurbit fruit fly (*Bactrocera cucurbitae*) where the pupae of cucurbit fruit fly were irradiated @ 0, 30 and 40 Gy. Experiment was carried out in the growth room of Entomology Division, BINA under controlled environment of 25^{o}C. In this year, 3 replications were used for each dose and during the experimentation 100 pupae were irradiated for each of the replication Larvae only emerged at 0 Gy in F_1 generation. There

were no larval emergences at 30 and 40 Gy which revealed that 30 Gy of radiation to pupae found to induce sterility of cucurbit fruit fly.

Determination of radiation dose to control pulse beetle (*Callosobruchus chinensis*) in storage

An experiment was conducted to find out lethal dose against pulse beetle (*Callosobruchus chinensis*) during 2023-24 at Entomology laboratory, BINA, Mymensingh. The experiment was laid out in a complete block design with three replications. There were four doses of radiation treatments namely, 150, 200, 250 and 300 Gy and untreated control. A total of 750g mungbean seed containing egg and larval stage and 450 adult pulse beetles were separated from stock culture and they were distributed into three replications of four doses and untreated control. Each replicated treatment contains 50g of seed and 30 adult beetles which were irradiated. With all stages of beetles, radiation was applied from gamma source of BINA. Alive pulse beetles were counted after 2, 4 and 7days after irradiation. From the result, it is evident that after 2 days of irradiation, number of alive beetle was lowest at 300 Gy (10.00) which was statistically identical to that of 250 Gy. The untreated control exhibited significantly highest number of beetle (32.33). After 4 days of irradiation, number of live beetle was highest (37.00) in untreated control treatment. There was no existence of live beetle at 300 Gy after 4 days of gamma radiation which means all the stages of pulse beetle were being killed at 300 Gy after 4 days of irradiation. As mungbean seeds contained egg and larval stage also with supplied 30 adults, the number of adults were increased by come out of new adult from unirradiated replication of control treatment. After 7 days of irradiation, all of the adult and stages of beetle were found to be dead with 100% mortality at 250 and 300 Gy of irradiation which was statistically similar to that of 200 Gy. The untreated control exhibited significantly highest beetles population at 7 days after treatment application. To control pulse beetle for reducing damage of pulses in storage, it is need to kill all the existing stages of beetles instantly after irradiation. This experiment revealed that 300 Gy of gamma radiation can kill all the stages of pulse beetle after 4 days of irradiation.

Determination of radiation dose to control rice weevil in storage

An experiment was carried out to determine the radiation dose to control rice weevil, *Sitophilus oryzae* during 2023-24 at Entomology laboratory, BINA, Mymensingh. Mixed stages (egg, larvae, pupae, and adult) of rice weevil were exposed to different doses of gamma radiation. The experiment was designed in CRD with five replications and nine treatments. For each treatment, 50g of sample from the mixed colony of rice weevil were exposed to the different doses viz., (0, 40, 70, 100, 130, 160, 190, 220 and 250 Gy) of gamma radiation. The data analyzed by analysis of variance procedure and least significant differences was utilized to test for significance of the means at the 5% level. There were no significant differences between untreated control and dose levels in the four days after irradiation. The highest number of alive adult weevils was found at 0 Gy (52.33) and the lowest at 250 Gy (38.83) after 10 days of irradiation. The number of adult weevils from all the treatments was increasing at different rates and the rate was comparatively higher at 0 Gy and very low at 220 and 250 Gy after 10 days of irradiation. The number of

adults from all irradiated populations were significantly reduced as compared with the number of the control population after 15 days of irradiation. The number of adult weevil was decreased with the increase of the irradiation dose levels. The adult weevil population became zero after 18 days of irradiation at the doses of 220 and 250 Gy which were significantly different from other treatments. The population was also decreasing in all the irradiated samples except the control. All the adults from the treatments 130, 160, and 190 Gy were zero after 22 days of irradiation. On the other hand, same results were observed in the treatments 70 and 100 Gy in after 25 days of irradiation. The number of adults was increasing day by day in the control but it became almost stable in the 40 Gy up to the observed period (63 days).

Determination of radiation dose to control red flour beetle in storage

An experiment was carried out to determine the radiation dose to control the red flour beetle, *Tribolium castaneum* during 2023-24 at Entomology laboratory, BINA, Mymensingh. Mixed stages (egg, larvae, pupae and adult) of red flour beetle were exposed to different doses of gamma radiation. The experiment was designed in CRD with three replications and nine treatments. For each treatment, 50g of sample of cashew nut from the mixed colony of red flour beetle were exposed to the different doses viz., (0, 50, 100, 150, 200, 250, 300, 350, and 400 Gy) of gamma radiation. The data were analyzed by analysis of variance procedure and least significant differences was utilized to test for the significance of the means at the 5% level. After 10 days of irradiation, the highest number of alive adult red flour beetle was observed in 0 Gy (54.33) which was statistically similar to that of 50 Gy (50.67). 100 Gy shows a significant result (34.67) in comparison to control (0 Gy). There were no significant differences between 150 Gy and 200 Gy considering the number of alive beetles. 250, 300, 350 and 400 Gy showes almost similar results 18.68, 18.00, 18.00 and 18.00 respectively and there were no significant differences among the treatments. After 15 days of irradiation, the effects of irradiation were clearly visible, number of adult beetles decreased with the increased dose level. 50, 100 and 150 Gy showed statistically significant results (50.66, 28.0 and 14.67) compared to untreated control (55.0). After 20 days of irradiation 0, 50, 100 and 150 Gy show different results (57.33, 51.0, 20.33 and 10.33) which is statistically significant with each other. A total number of adult beetle was observed 5 and 3 in 200 and 250 Gy respectively, which was statistically similar to each other. The population of adult beetle were zero both in 350 and 400 Gy, a statistically similar result is also observed in 300 Gy (0.67). After 24 days of irradiation, the trend of population increase was unchanged in the untreated control (0 Gy). 0, 50, 100 and 150 Gy show statistically significant results (59.67, 50.00, 20.33 and 5.67) compared to each other's but 150 Gy was statistically non-significant with 200 Gy (2.33).

Screening of BINA released popular/new rice varieties against Brown Plant Hopper

The experiment was conducted to find out genes responsible for resistance in rice varieties against Brown Plant Hopper (*Nilaparvata lugens* Stãl) during. Before going to molecular study, the experiment was carried to find out reactions of rice varieties against Brown Plant Hopper under artificial infested condition during the T. aman 2023 and Boro 2023-2024 at the net house of Entomology division, BINA,

Mymensingh. BINA released six popular rice varieties, viz. Binadhan-10, Binadhan-16, Binadhan-17, Binadhan-22, Binadhan-24 and BINA dhan25 were evaluated along with one susceptible check variety TN1. The screening procedures standardized at IRRI were followed in this study. The seedlings were infested at the one to two leaf stage (about 7 days after seeding) by uniformly scattering a large number of 2^{nd} and 3^{rd} instar BPH nymphs on them. The seed boxes were covered with fine-meshed nylon net after infestation. An average of 5-7 nymphs per seedling constituted an optimum population to differentiate the resistant level of tested varieties. The damage rating was done when about 90% of the plants of the susceptible check were killed. The varieties were rated using the standard evaluation system for rice (IRRI, 2013). Among the six BINA released popular rice varieties, most of the varieties were susceptible to BPH and only one variety Binadhan-22 was moderately susceptible under artificial infested condition.

Screening of BINA developed advanced rice lines/mutants against Brown Plant Hopper

The experiment was conducted to find out the genes responsible for resistance in BINA developed advanced rice lines and mutants against Brown Plant Hopper (*Nilaparvata lugens* Stãl). Before going to molecular study, the experiment was carried to find out reactions of rice varieties against Brown Plant Hopper under artificial infested condition during the reporting year 2023-2024 at the net house of Entomology division, BINA, Mymensingh. Fifteen BINA developed advanced rice tested lines/mutants viz. BNDR-9, BNDR-26, BNDR-48, BNDR-55, BPHP-034, BPHP-043, BPHP-065, BNCR-8, BNCR-14, BNCR-35, BNCR-44, BNCR-120, BNCR-121, BNCR-122 and BNCR-123 were evaluated along with one susceptible check variety TN1. The screening procedures standardized at IRRI were followed in this study. An average of 5-7 nymphs per seedling constituted an optimum population to differentiate the resistant level of tested lines. The damage rating was done when about 90% of the plants of the susceptible check were killed. The varieties were rated using the standard evaluation system for rice (IRRI, 2013). Among the 15 BINA released advanced rice lines/mutants, most of them were susceptible, one (BNDR-48) was moderately resistant and one (BNCR-120) was moderately susceptible to BPH under artificial infested condition.

Screening of rice lines against stem borer in the field (In collaboration with Plant Breeding Division)

The experiment was conducted to observe the reaction of advanced rice lines against stem borer. The experiment was set up by plant breeding division in a randomized complete block design with three replications during Boro season of 2023-24 at BINA Farm Mymensingh. Two varieties of rice, BRRI dhan89 and BRRI dhan92, nine advanced lines N_4-17-5, N_4-17-4, I-18-5, B17-17-8, N_4-17-6, I-18-16, I-18-13, N_4-17-3 and I-18-12 were tested along with one susceptible check, TN1 against stem borer under field condition. No protective measure was taken to control the insect pests. In general, % of dead heart data is recorded at 45 days after transplanting and white head data at 10 days before harvesting. All the essential data were recorded accordingly and presented in. No dead heart symptoms were found during the

tillering stage and very small differences ranges from (0.185% to 0.67%) were observed among the twelve tested variety/lines and one check variety of rice with respect to stem borer infestation, and all the infestation were below the economic threshold level (ETL: 10-15% dead hearts, 5% white head). In set-1, total number of entries was 120. No white head was found in 86 entries, percent white head (0.73 to 2.0) were observed in 11 entries, (2.1 to 4.47) were observed in 23 entries. Among the entries highest % white head was observed in 81 no. entries (4.47). In set-2, total number of entries was 120. No white head was found in 88 entries, percent white head (1.12 to 2.0) were observed in 21 entries, (2.1 to 3.5) were observed in 22 entries. Among the entries highest % white head was observed in 194 no. entries (4.43).

Screening of advanced groundnut mutant/lines against some major insect pests

An experiment was conducted to find out the performance of advanced groundnut mutant lines against major insect pests in field conditions. The experiment was laid out in a randomized complete block design with three replications during Rabi season of 2023-24 at BINA farm, Mymensingh. Seven advanced mutant/lines of groundnut BCB-3, BCB 3-4-5, BCB-4, BCB 3-1-2, BCB 3-4-1, BCB 4-2-2, BCB 3-4-3 were tested along with one check variety Binachinabadam-4 against jassid, thrips, cutworm, leaf roller under field condition. No protective measure was taken to control the insect pests. The data shows overall infestation was very little in all the treatments. The lowest number of jassid/plant (0.13) was observed in advanced mutant/line BCB-4-2-2 and check variety Binachinabadam-4, which are statistically similar to BCB 3-4-1, BCB-3, BCB-4 and BCB 3-4-5. No infestations were observed in advanced line BCB 3-1-2 and BCB 3-4-3. No infestation was observed among all the advanced lines/mutants and variety except BCB-3 (no. of thrips/plant 0.7). The number of infested leaves by cutworm (0.07, 0.07 and 0.13) were observed in advanced mutant/line/variety Binachinabadam-4, BCB 3-4-3 and BCB-4 and the rest of the advanced mutants/lines were free from cutworm infestation. For leaf roller infestation, the lowest number (0.08) was found in advanced mutant/line BCB 3-1-2 and the highest number (0.60) in Binachinabadam-4 and there are not statistical differences between the treatments. No infestation was observed in advanced mutant/line BCB 3-4-5.

Screening of advanced mungbean mutant line against pod borer and other major insect pests

One advanced mutant (MBM-656-51-2) and one check variety (BARI Mung-6) of mungbean were assessed for their performance against jassid, whitefly, hairy caterpillar, leaf roller, cutworm and pod borer at BINA substation, Ishurdi in kharif-I season of 2024 under natural infested condition. The experiment was laid out in a randomized complete block design with three replications. The incidence of jassid, whitefly, hairy caterpillar, leaf roller, cutworm and pod borer were recorded from vegetative stage to harvesting. From the result, it is evident that mean infestation of jassid per cage was higher (5.13) in BARI Mung-6 than that of MBM-656-51-2 (3.27). There was no significant difference in whitefly and percent

leaf infestation by leaf roller infestation. Significant difference was observed in percentage of hairy caterpillar infestation in MBM-656-51-2 and BARI Mung-6. Infestation was comparatively higher in MBM-656-51-2 (9.27%). The mutant MBM-656-51-2 significantly differed and performed better than check variety (BARI Mung-6) in respect of percent leaf infested by cutworm (10.07) and percent pod infested by pod borer (9.47).

PLANT PATHOLOGY DIVISION

Research Highlights (2023-24)

- Five mutants and 2 lines of mustard were found to be moderately susceptible to alternaria blight.
- Three advanced lines of groundnut (BCB-3-4-1, BCB-3-4-3 and BCB-3-4-5) showed moderately resistant and two lines (BCB-3-1-2 and BCB-4-2-4) showed moderately susceptible reaction to foot and root rot and cercospora leaf spot diseases.
- In the evaluation of five mutants of soybean, all the mutants showed moderately susceptible reaction to collar rot disease. In case of yellow mosaic disease, four mutants (SCM-5, SCM-11, SBM-22 and SBM-23) showed moderately resistant reaction.
- One black gram mutant (BM-4) out of three showed moderately resistant reaction whereas other two mutants were moderately susceptible to cercospora leaf spot disease. All the mutants showed moderately resistant reaction to powdery mildew disease.
- In the evaluation of four mutants of grasspea, all the mutants showed tolerant and susceptible reaction against root rot and yellow mosaic diseases.
- Application of solid formulation in pot soil, brocoli and cabbage seedlings had the highest (65.7%) disease reduction over control following by tomato, brinjal seedlings (43.8%) and chilli seedlings (35.7%). Seed treatment with powder formulation increased the germination over control from 31-46% and decreased the incidence of seed associated fungi (*Fusarium* sp., *Carvularia* sp., *Aspergillus* sp.) in the vegetables.
- In the molecular characterization of *Trichoderma* isolates, six were identified as *T. asperellum*, two as *T. viride* and an isolate BINA_Tri_iso_011 was found to contain a mixture of *T. harzianum* and *T. asperellum*. Additionally, isolate BINA_Tri_iso_012 exhibited a combination of *T. harzianum* and *T. viride*.
- The chemical fungicide Rovral 80 WP showed the best performance, significantly reducing stemphylium blight incidence in lentil to 17.06% in Ishwardi and 15.33% in Magura, and yielding 1.79 t/ha and 1.76 t/ha, respectively. Among biological treatments, Dynamic performed the best in reducing disease incidence to 47.14% in Ishwardi and 33.14% in Magura, with corresponding yield of 1.23 t/ha and 1.31 t/ha.
- In a study to evaluate the influence of *Trichoderma asperellum* on tomato growth and the expression of defense-related genes in response to *F. oxysporum*, high expression of PR10 and PR4 genes was observed which indicated that *T. asperellum* can trigger systemic resistance in tomato plants enhancing their resilience to pathogenic attacks.
- For the molecular identification of *Fusarium* spp. associated with bakanae disease of rice in Bangladesh, 15 isolates were characterized morphologically.
- Thirty endophytic bacteria were isolated from twelve indigenous rice varieties and among them, only six were active in dual culture assay against *Magnaporthe oryzae*.
- For morpho-molecular study of *Alternaria*, 31 isolates were collected form three location (Mymensingh=12, Jamalpur=8 and Joypurhat =11). Morphological study was done for Mymensingh isolates and among them, isolate 1, 5, 3 and 2 were fast growing and isolate 10, 11 were slow growing. Color of culture for all isolates varied from ashy black to black.
- Two advanced mutants of lentil (LM-118-9 and LM-2) showed most genetically diverse, indicating their potentiality in stress breeding programs for developing Stemphylium-resistant lentil cultivars.
- Aflatoxin concentration in groundnut and cashewnut samples were found to be 1.5-2 times higher than the highest standard concentration. Both raw and roasted samples were analyzed using ELISA, revealing higher

aflatoxin levels were present in nuts. The study highlighted the need for stringent aflatoxin control measures in nuts to ensure safe consumption.

- AI-powered software, successfully developed in April 2024 demonstrated high accuracy in diagnosing diseases in rice and brinjal. It included a bilingual interface, image uploading and disease detection Solutions.
- Gamma irradiation at 2.5 kGy rendered *Ralstonia solanacearum* undetectable by damaging its DNA and cellular structure. Direct irradiation of pathogen showed DNA bands up to 2 kGy but not at 2.5 kGy. Potato tubers exposed up to 7 kGy showed the pathogen's DNA band up to 5.0 kGy, disappearing at 5.5 kGy. This indicated that 5.5 kGy could effectively eradicate the pathogen, ensuring safe storage and consumption of potatoes.
- The study on mitigating bacterial wilt of potatoes with gamma irradiation, Cardinal and Asterix showed superior yield. Higher doses (30-40 Gy) effectively reduced wilt incidence across regions. PCR techniques confirmed *R. solanacearum* presence, aiding diagnostics. These findings offer practical strategies for enhancing yield and managing bacterial wilt.
- Among 148 isolates of *R. solanacearum*, 26 were detected via species-specific PCR. Samples from Thakurgaon had the highest soil bacterial concentration and samples from Lalmonirhat had the lowest. Biovar characterization identified all isolates within specific biovars. PCR analysis found Race 3 and biovar 2 in multiple districts.
- Direct irradiation caused greenish hue changes in potato skins, but polythene bags prevented this, preserving quality. Ascorbic acid was the highest in Asterix, Cumbica, and Santana (11.48-22.47 mg/100g). Anthocyanin content remained stable (0.07-1.02 g/kg), while carotenoids decreased with higher doses (1.26-6.68 mg/kg). Total Soluble Solids (TSS) was unaffected (3.60-9.170 Brix). Higher radiation doses were negatively correlated with ascorbic acid and carotenoid levels.
- Seventy-nine (79) rice genotypes were screened for blast resistance, there were 54 with *Pi9*, 44 with *Pita*, 23 with *Pish*, and 3 with *Pita-2* genes. Advanced line BN-P-102, carrying all four resistance genes, showed the highest resistance. Early control measures are recommended based on AUDPC results showing rapid disease spread.
- In a pathogenicity test, seventy-nine (79) rice genotypes were screened for BLB resistance, among 40 germplasms, 1 was highly resistant, 5 resistant, 10 moderately resistant, 1 moderately susceptible, 12 susceptible and 11 highly susceptible to BLB disease. Molecular analysis revealed that 27 carried Xa4, 18 carried xa5, and 1 carried xa13. Germplasm BLB-P-003, with all three genes, was most effective against BLB. AUDPC results indicated rapid disease progression, highlighting the need for early control measures.
- The study of gene expression in US-2 and BRRI dhan89 rice plant post-pathogen inoculation, showed that seed priming induced a stronger and quicker activation of defense-related genes than seedling priming, enhancing disease resistance in BRRI dhan89.

Evaluation of mustard-rapeseed mutants/lines against alternaria blight disease

Five mustard mutants, 3 lines and a check variety were tested against alternaria blight (*Alternaria brassicae*) under natural field condition at BINA farm, Mymensingh during the rabi season of 2023-24. The experiment was conducted in a randomized complete block design with three replications. The unit plot size was 3m × 2m. Seeds were sown on 13 November 2023. The recommended doses of fertilizer were applied and normal cultural practices were followed. The severity scale 0-9 was followed for

assessing the disease at early pod maturity stage. The disease incidence of alternaria blight ranged from 55.2-93.9%. The lowest disease incidence was recorded in the line RMT-14 and the check variety Tori-7 had the highest one. All the mutants and lines of mustard showed moderately susceptible reaction, except RT-39 and the check variety was highly susceptible to alternaria blight.

Field evaluation of advanced lines of groundnut against foot and root rot and cercospora leaf spot

Five advanced lines of groundnut along with two varieties (Binachinabadam-4 and BARI Badam-9) were evaluated for their resistance to foot and root rot (*Sclerotium rolfsii*) and cercospora leaf spot (*Cercospora achidicola*) diseases under field condition at Mymensingh in 2024. The experiment was conducted in a randomized complete block design with three replications. The unit plot size was 2.0m x 2.0m. Spacing between rows and plants within rows were 40 cm and 15 cm, respectively. Seeds were sown on 8 February 2024. The disease incidence and severity was assessed following the scale developed by Chester (1950) and Mehta and Mandal (1978) for foot and root rot and cercospora leaf spot, respectively. Mean foot and root rot incidences ranged from 5.7 to 14.6. Mean cercospora leaf spot incidences and severities ranged from 45 to 58.3% and 2.5 to 3.6. Three lines (BCB-3-4-1, BCB-3-4-3 and BCB-3-4-5) showed moderately resistant and two lines (BCB-3-1-2 and BCB-4-2-4) showed moderately susceptible reaction to both the disease. The check varieties showed moderately susceptible reaction to both the diseases.

Evaluation of soybean mutants against foot and root rot and yellow mosaic disease

Five mutants (SCM-5, SCM-11, SCM-17, SBM-22 and SBM-23) along with two check varieties (Binasoybean-5 and Binasoybean-6) were tested against foot and root rot (*Sclerotium rolfsii*) and yellow mosaic disease under natural field condition. The unit plot size was 2.0 m × 1.50 m. The experiment was conducted in randomized complete block design with three replications at BINA farm, Mymensingh. Seeds were sown on 21 December 2023 maintaining row to row distance 75 cm and line to line distance 30 cm. The fertilizer was applied at recommended doses. With appearance of visible symptoms, observation on disease parameter was made following (0-9) scale (Nene *et al*., 1981) for collar rot and the severity of yellow mosaic was recorded on a (0-8) scale (Malik, 1992). The mean incidence of collar rot ranged from 10.66 to 16.41%. All the mutants showed moderately susceptible reaction to collar rot disease. The mean incidence and severity of yellow mosaic ranged from 43.3 to 65% and 4.1 to 5.7, respectively. In case of yellow mosaic disease, four mutants (SCM-5, SCM-11, SBM-22 and SBM-23) and Binasoybean-6 showed moderately resistant reaction.

Evaluation of black gram mutants against cercospora leaf spot, powdery mildew and yellow mosaic

Three advanced mutants (BM-4, BM-42 and BM-63) and one check variety (BARI Mash-3) of black gram were assessed for their resistance to cercospora leaf spot (*Cercospora sp.*), powdery mildew (*Erysiphe polygoni*) and yellow mosaic (YMV) at BINA substation farm and farmers field, Magura in kharif-2 season of 2023 under natural field condition. The experiment was conducted in a randomized complete block design with three replications. The seeds were sown on 8 October 2023 in both locations and the unit plot size was 4.0 m x 2 m. The recommended dose of fertilizer was applied and normal cultural practices were followed. The incidence and severities of CLS, YMV and powdery mildew were recorded from flowering to maturity stage. In Magura substation field, the mean incidence of cercospora leaf spot ranged from 9.40 to 18.51%. One mutant (BM-4) showed moderately resistant reaction whereas other two mutants were found moderately susceptible to cercospora leaf spot disease. The mean incidence of powdery mildew disease of black gram ranged from 12.33 to 16.67 %. All the mutants showed moderately resistant reaction to powdery mildew disease.

Evaluation of grass pea mutants against root rot, downy mildew, powdery mildew and yellow mosaic

Four mutants (GM-1, GM-2, GM-3 & GM-4) and two check varieties (Binakheshari-1 and BARI Khesari-2) of grasspea were evaluated against root rot, downy mildew, powdery mildew and Yellow Mosaic Virus at BINA sub- station farm and farmers field, Magura during the winter season of 2023-24 under natural field condition. The experiment was conducted in randomized complete block design with three replications. The seeds were sown in rows on last week of November, 2023 in both locations. Distances between rows and seeds were maintained 40 cm and 5 cm, respectively. The mean incidence of root rot and yellow mosaic virus ranged from 10.33 to 20.33% and 3.33 to 6.33 % in Magura sub- stations field respectively. All the mutants and two varieties showed susceptible reaction against yellow mosaic virus.

Evaluation of different formulation of *Trichoderma* based biofungicide

Two types of formulation of *Trichoderma* based biofungicide were prepared: (i) Solid formulation and (ii) Powder formulation. Solid formulation grown in chickpea bran was applied in pot soil @ 10g/pot. The pathogen *Fusarium oxysporum* was inoculated in pot soil after three days of *Trichoderma* application. After two days of pathogen inoculation, seeds of vegetables (brocoli, cabbage, tomato, brinjal and chilli) were sown @ 10 seeds/pot. Data on disease incidence was recorded in time. Seeds of different vegetables (brocolli, cabbage, olcopi, tomato, cucumber and bottle gourd) were coated with dry powder formulation of *Trichoderma* (incorporated in talc powder, MgCO3) @ 4g of formulation per kg seed. Seeds were examined by following Blotter method where seeds were placed on moist filter paper in petri plates. Data on seed germination (%) were collected. The seeds were observed under stereo microscope and the

presence of seed associated fungi was recorded. Application of solid formulation in pot soil, brocoli and cabbage seedlings had the highest (65.7%) disease reduction over control following by tomato, brinjal seedlings (43.8%) and chilli seedlings (35.7%). Seed treatment with powder formulation increased the germination over control from 31-46% and decreased the incidence of seed associated fungi (*Fusarium* sp., *Carvularia* sp., *Aspergillus* sp.) in the vegetables.

Antagonostic activity of *Trichoderma asperellum* against *Fusarium oxysporum* in rhizospere of tomato triggers the expression of host defense genes

This study was aimed to assess how different *Trichoderma* species affect tomato plant growth and their defense responses against Fusarium wilt disease, as well as analyzing changes in the expression profiles of various defense-related genes (*actin, PAL1, PAL3, CH5, CH4, CH1, PR10, PRSTH-21, PR4*) through RT-PCR. The treatments applied in this study consist of: T_0= control, T_1= only *T. asperellum*, T_2= *T. asperellum* combined with *F. oxysporum* and T_3= only *F. oxysporum* to evaluate their respective impacts on plant health and gene expression. The antagonistic activity of *T. asperellum* was assessed through *in vitro* dual culture assays against *F. oxysporum*. Tomato plants were inoculated with the selected treatments and leaf samples were collected at 0, 24, 48 and 72-hour intervals post-inoculation. Defense-related gene expression was evaluated through RT-PCR using specific primers for nine genes. Total RNA was extracted from leaf tissue using a commercial RNA isolation kit, followed by cDNA synthesis. In the expression of defense-related genes in response to *F. oxysporum*, high expression of PR10 and PR4 genes was observed which indicated that *T. asperellum* can trigger systemic resistance in tomato plants enhancing their resilience to pathogenic attacks.

Characterization of different isolates of *Trichoderma*

Trichoderma isolates were obtained from soil samples using the dilution plate technique and subsequently purified. Molecular characterization was performed on the isolates by analyzing the ribosomal DNA (rDNA) regions ITS1 and ITS2. DNA extraction was conducted following the protocol outlined in the Wizard genomic extraction kit (Promega). Among the ten *Trichoderma* isolates examined, six were identified as *T. asperellum*, two as *T. viride* and isolate BINA_Tri_iso_011 was found to contain a mixture of *T. harzianum* and *T. asperellum*. Additionally, isolate BINA_Tri_iso_012 exhibited a combination of *T. harzianum* and *T. viride*. This study successfully characterized various isolates of *Trichoderma*, highlighting their potential roles in agriculture as biocontrol agents. The molecular techniques provided valuable insights into the diversity and relationships among different *Trichoderma* species, paving the way for future research on their applications in sustainable agriculture practices.

Management of stemphylium blight disease in lentil

This experiment was conducted during the Rabi season of 2023-24 at BINA sub-stations in Ishwardi and Magura to manage stemphylium blight disease in lentil. The trial involved four chemical fungicides (Amister top 325SC, Filia 525 SE, Rovral 80 WP, Curzate M-45) and five bio-control agents (*Trichoderma asperellum*, Bioderma, Dynamic, *Bacillus subtilis*, and *Pseudomonas fluorescens*). The study followed a randomized complete block design (RCBD) with three replications, and disease severity was assessed on a 0-5 scale. In Ishwardi, Rovral 80 WP was the most effective treatment, reducing disease incidence to 17.06% and increasing yield to 1.79 t/ha. Dynamic performed best result among the bio-control treatments. In Magura, similar results were observed with Rovral 80 WP lowering disease incidence to 15.33% and producing the highest yield of 1.76 t/ha.

Genetic diversity analysis of stemphylium blight disease in lentil using SSR markers

Nine Simple Sequence Repeat (SSR) markers were used to assess the diversity among seven mutants line (LM-1, LM-2, LM-3, LM-4, LM-20-4, LM-99-8, LM-118-9) from BINA and two released varieties Binamasur-8 and Barimoosur-1. Polymorphic Information Content (PIC) of SSR primers ranged from 0.33 (SSR156) to 0.10 (SSR19). The maximum Jaccard's similarity was recorded between LM-3 and LM-4 (approximately 100%) whereas minimum was between LM-118-9 and LM-1. Out of 9 SSRs, 8 markers were found to be polymorphic. Based on the polymorphism pattern, UPGMA dendogram was constructed using NtSyspc V.2.02 software. Highest number of bands was observed in case of SSR113 which amplified 9 bands. The range of size of bands amplified were 80-290bp. Diversity study among them revealed that LM-118-9 and LM-2 mutants are least similar showing maximum diversity that could be used in stress breeding programme for developing stemphylium resistant lentil cultivars in future.

Detection and management of aflatoxins in groundnut and cashew nut using gamma Irradiation

A study was conducted to detect aflatoxins in groundnuts and cashew nuts collected from local markets in Mymensingh. Fourteen raw and roasted samples of groundnut and cashew nut were analyzed for aflatoxin concentration using Enzyme-linked Immunosorbent Assay (ELISA). The total aflatoxin concentration in all samples exceeded the FDA's acceptable limit of 4 ppb for direct human consumption. Groundnut samples showed concentrations between 3.54 and 4.68 ppb, while cashew nut samples ranged from 2.62 to 3.95 ppb. These levels were 1.5-2 times higher than the standard concentration. The experiment used absorbance data to determine aflatoxin levels in nuts. The results highlighted the importance of monitoring aflatoxins in stored nuts to ensure food safety.

Molecular identification of *Fusarium* spp. associated with bakanae disease of rice in Bangladesh and assessment of their pathogenicity

Bakanae disease, caused by *Fusarium* spp., is a significant threat to rice production in Bangladesh. This study aimed to identify the variability of *Fusarium* isolates associated with bakanae disease and assess their pathogenicity on a susceptible rice cultivar. Rice plants displaying bakanae symptoms were collected from five locations across Bangladesh. The pathogens were isolated from infected stems and roots, cultured on Potato Dextrose Agar (PDA) medium, and incubated for characterization. Fifteen pure isolates of *Fusarium* spp. were obtained and showed notable variability in colony color, mycelial development, conidial shape, and size. Fungal DNA was extracted from these isolates, and the elongation factor 1-alpha (TEF-1α) gene was amplified using PCR, producing a 660-bp fragment. Sequencing was performed, and the results were analyzed using DNA BASER and compared to the NCBI and FUSARIUM-ID databases for confirmation. This study provides critical insights into the morphological and molecular diversity of *Fusarium* spp. in Bangladesh, contributing to better disease management strategies in rice cultivation.

Characterization of endophytic bacteria isolated from indigenous rice seeds in Bangladesh: their potential as biocontrol agents and plant growth promoters

This study was aimed to isolate and characterize endophytic bacteria from indigenous rice seeds in Bangladesh and assess their potential as biocontrol agents and plant growth promoters. Seeds from 25 rice cultivars were collected, and bacteria were isolated through serial dilution. A total of 30 bacterial isolates were obtained and screened for antagonistic activity against three fungal pathogens: *Magnaporthe oryzae*, *Rhizoctonia solani*, and *Sclerotium rolfsii*. Six bacterial isolates showed significant antagonism against *M. oryzae*, while no isolates demonstrated activity against *R. solani* and *S. rolfsii*. *In vitro* tests revealed that these bacterial isolates inhibited the mycelial growth of *M. oryzae* in dual culture assays, with one isolate (isolate 2) showing the most pronounced inhibitory effect. Further biochemical tests, including indole-3-acetic acid (IAA) production and phosphate solubilization, will be conducted to explore the plant growth-promoting traits of the bacterial isolates. This study highlighted the potential of endophytic bacteria from indigenous rice as biocontrol agents and growth promoters, contributing to sustainable rice cultivation.

Morphological characterization of *Alternaria* isolates collected from different mustard growing areas in Bangladesh

An experiment was conducted for the morphological study and experimental design was CRD with three replication in the laboratory of Plant Pathology Division, BINA. Alternaria isolates were collected from three location viz. Mymensingh sadar, Jamalpur sadar and Kalai upazila of Joypurhat district. Among the locations, 12 isolates of Alternaria was collated from Mymensingh and morphological study was done this year and the other isolates collected from different location is ongoing. In this study, the protocol for isolation and pure culture preparation of Alternaria sp. also was developed. Among the 12 isolates from

Mymensingh, isolate 1 (8.61cm), 5 (8.55cm), 3 (8.40cm) and 2 (8.38cm) were fast growing and isolate 10 (7.20cm), 11 (7.33cm) were slow growing. Color of culture for all isolates varied from ashy black to black.

Diagnosis of plant diseases using AI-based software in Bangladesh

This project addressed the critical challenge of plant diseases in Bangladesh's agriculture, particularly affecting rice and brinjal (eggplant). Traditional diagnostic methods are often slow and require specialized knowledge, hindering timely intervention. To overcome these barriers, an AI-powered software was developed with a bilingual interface (Bangla and English) to facilitate user accessibility. The software integrates advanced AI algorithms for accurate disease identification and offers practical management solutions while maintaining a history of detections for farmers. Developed through systematic phases including requirement analysis, design, AI integration, and deployment, the software demonstrated high accuracy by April 2024. Accompanied by training materials and technical support from Medina Tech, it empowers farmers with essential tools for effective disease management. The project aimed to modernize agricultural practices in Bangladesh, with plans for future expansion to include additional crops, enhancing the overall productivity and sustainability of the agricultural sector.

Management of brown rot (*Ralstonia solanacearum)* disease of potato with gamma radiation

This study investigated the efficacy of gamma radiation in managing brown rot disease caused by *Ralstonia solanacearum* in potatoes. Experiments revealed that exposure to a gamma radiation dose of 2.5 kGy rendered the pathogen undetectable, as evidenced by the absence of a DNA band at 553 base pairs, indicating significant damage to its genomic structure. Further tests on potato tubers showed that doses up to 5.5 kGy allowed for the detection of the pathogen, but at 6 kGy, the DNA band disappeared, confirming the effective inhibition of *R. solanacearum*. These findings suggested that gamma irradiation is a viable method for controlling brown rot in potatoes, ensuring their safety for consumption and storage by effectively eradicating the pathogen from infected tubers. This approach could enhance potato preservation and mitigate economic losses associated with this destructive disease.

Status and analysis of genetic variation of brown rot (*Ralstonia solanacearum*) disease of potato in Bangladesh

Potato crop is severely affected by *Ralstonia solanacearum* causing brown rot disease. This quarantine pathogen affects the exportation of potato also. A study was carried out in 2022-23, to find out the status and identification of brown rot of potato in different potato growing areas in Bangladesh and management of this pathogen using gamma irradiation. In total, 168 isolates of *R. solanacearum* were collected from both potato tubers and soil samples across 12 major potato-growing regions of Bangladesh. Based on the morphological parameter, 148 isolates were confirmed through the presence of pink or light red colonies on TTC medium and further representatives 26 (14 potato tuber and 12 soil) isolates were detected having

R. solanacearum using species-specific PCR primers (759/760 and PS-1/PS-2) and produced specific DNA fragments of 281 bp and 553 bp respectively. The soil bacterial concentration measured in colony-forming units (CFU), varied significantly across regions, with Thakurgaon showing the highest count (7.4×10^8 CFU/g) and Lalmonirhat the lowest (1.8×10^6 CFU/g). Biovar characterization tests involving the utilization of disaccharides and sugar alcohols revealed that all isolates belonged to a specific biovar. Subsequent PCR analysis using primers designed for detecting Race 3 and biovar 2 identified specific DNA fragments (306 base pairs) in isolates of Munshiganj, Chandpur, Cumilla, and Mymensingh districts, indicating the presence of these particular strains in these regions. To ensure the safety of potatoes for consumption and storage, virulent and pathogenic culture of this pathogen was directly exposed to irradiation doses ranging from 0 kGy to 6 kGy. Remarkably, exposure to 2.5 kGy effectively damaged the bacterium's DNA and cellular components, preventing the onset of brown rot disease. Higher doses (2.5 kGy to 6 kGy) eliminated *R. solanacearum* entirely, providing a promising method for disease prevention in stored potatoes.

Gamma irradiation induced resistance in potato cultivars against bacterial wilt (*Ralstonia solanacearum*) for improved crop productivity in Bangladesh

Bacterial wilt caused by *Ralstonia solanacearum* significantly threatens potato crops in Bangladesh leading to significant yield losses and affecting production and export. This study, conducted in Mymensingh, Rangpur, and Cumilla, aimed to evaluate the effect of gamma irradiation in developing resistant potato genotypes among eight cultivars (Asterix, Granola, Musica, Cumbia, Cardinal, Diamond, Santana, and Sunshine). Dry tubers were exposed to gamma rays at doses of 20, 30, and 40 Gy, and the M1V1 generation was planted for analysis. Tubers and soil samples collected from the regions underwent molecular identification of *R. solanacearum* using species-specific primers (PS-1/PS-2), consistently revealing a 553 bp DNA fragment. The results showed that gamma irradiation had variable effects on tuber production. Notably, Cardinal and Asterix exhibited enhanced yields at 20 Gy, outperforming other cultivars in tuber number and weight across treatments and regions. Additionally, higher radiation doses (30 Gy and 40 Gy) effectively reduced bacterial wilt incidence in all cultivars and regions. This study not only demonstrated the potentiality of gamma irradiation in developing resistant potato genotypes but also highlighted its role in improving yield.

Effect of gamma radiation on genetic variation of *Ralstonia solanacearum* and physiochemical-nutritional status of export oriented potatoes

Eleven commercially important potato varieties, including Asterix, Cardinal, Cumbica, Diamond, Granola, Musica, Santana, Sunshine, Carriage, 747 and Lady Rosetta were collected from 12 major potato-growing regions in Bangladesh. A total of 42 isolates of *R. solanacearum* were identified based on distinct colony characteristics. Species-specific confirmatory test of *R. solanacearum* was also performed by PS-1/PS-2 primer and all the tested isolates produced 553 bp fragment length. Eight isolates of *R. solanacearum*

underwent 16S rRNA sequencing, with one isolate successfully identified as *R. solanacearum*, exhibiting a close genetic relationship with various strains, primarily from India and China, demonstrating approximately 98% genetic similarity with these strains. Phylotype determination using the Pmx-PCR method revealed 213 bp fragments, confirming the presence of Phylotype IV (Indonesian). Potato tubers exposed to a substantial irradiation dose of 6 kGy experienced effective inactivation of *R. solanacearum*, preventing the development of brown rot. The radiation had an impact on the *mut*S gene in *R. solanacearum* isolates. 'Sunshine' exhibited the highest weight loss 90.5%, while 'Santana' and 'Diamont' displayed the lowest weight loss at 66.7% and 79.2%. Direct radiation exposure induced color changes, particularly a greenish hue, in potato skin pigments, while employing polythene bags effectively shielded the tubers from such changes, maintaining their desired quality and appearance. Ascorbic acid content was the highest in Asterix, Cumbica and Santana across different doses ranging from 22.47 to 11.48 mg/100g. The total anthocyanine content remained relatively stable, with values ranging from 0.07 to 1.02 g/kg of fresh weight. The research identified a consistent decrease in Carotenoid content with increasing irradiation doses, spanning from 1.26 to 6.68 mg/kg of fresh weight. This study consistently found that Total Soluble Solids (TSS) content remained unaffected by different gamma radiation doses, with values ranging from 3.60 to 9.170 Brix. Findings of the study revealed a negative correlation between radiation dose and the levels of ascorbic acid and total carotenoids in potato tubers, with higher doses resulting in lower content. However, the content of anthocyanine and total soluble solids (TSS) were not significantly affected due to different doses of gamma radiation during the period of investigation. The trace element (%Ca, %Mg, %P, %S, %K, %B) was increased with the increase the dose of irradiation.

Detection of blast resistance gene(s) in in BINA germplasm and advanced lines by using gene based molecular marker

Seventy nine (79) rice genotypes were screened for four major blast-resistant genes (*Pi9, Pita, Pish, and Pita-2*) using gene-based molecular markers (RM276, RM403, RM302, and RM155) at the Plant Pathology Division, BINA. Out of 79 studied rice genotypes, 54 were identified as carriers of the *Pi9* gene, while 44 genotypes possessed the *Pita* gene and 23 carried the *Pish* gene. Notably, only 3 genotypes were found to contain the *Pita-2* genes, indicating their rarity within the sample. The genetic frequencies of 2 blast resistant genes ranged from 6.12% to 77.5%. The resistant gene *Pi9* was widely distributed (77.5%) among the selected genotypes. Based on the phenotypic resistance screening, 1 genotype showed resistant, 3 genotypes were shown as highly susceptible, while 16 genotypes were moderately susceptible, 11 genotypes were moderately resistant, 16 genotypes were susceptible. Advanced line BN-P-102, which combined four resistance genes (*Pita, Pi9, Pish,* and *Pita-2*), showed resistance to blast disease compared to genotypes with a single resistance gene. The study using the area under disease progress curve (AUDPC) method demonstrated a rapid progression of blast disease in the studied rice genotypes with resistant genes over 21 days, with symptoms appearing in 7.67% of plants by 7 days after inoculation (DAI), nearly twelve (11.75%) affected by 14 DAI, and 11.92% plants affected by 21 DAI, showing an

initial rapid spread followed by a slower rate of progression. It could be concluded that advanced line BN-P-102 and indigenous cultivar Sete Pajam-2 would be promising candidates for developing the resistant variety against blast disease of rice. In addition, the AUDPC result indicated that control measures should be taken as soon as disease occurs in the field.

Detection of bacterial blight resistant gene(s) in BINA germplasm and advanced lines by using gene based molecular markers

Forty IRRI-provided advanced lines were screened to evaluate their disease reaction against a highly virulent strain of *Xanthomonas oryzae* pv. *oryzae (Xoo).* Subsequently, it was intended to identify the possible candidate resistant (*R*) genes responsible for the resistant reaction using five Sequence Tagged Site (STS) markers corresponding to *Xa4, xa5, xa13, Xa21* and *Xa23* genes. Based on the pathogenicity test, only 1 germplasm was found as highly resistant while five germplasm were resistant, ten were moderately resistant, one was moderately susceptible, 12 were susceptible and 11 were highly susceptible. Further molecular study on this 40-germplasm divulged that 27 germplasm carried *Xa4* gene, 18 carried *xa5* gene and only 1 germplasm carried *xa13* gene. Interestingly, we found a wide range of gene combinations ranging from 2 to 3 genes among the germplasm, where 1 germplasm carried 3 genes, 15 germplasm carried 2 genes of various combinations. Notably, BLB-P-003 germplasm (highly resistant) having *Xa4*, *xa5* and *xa13* gene combinations being the most effective against the *Xoo* strain. The outcome of this study would enrich and diversify the rice gene pool and would be promising candidates for developing the durable resistant variety against BLB disease of rice in Bangladesh. The study using the area under disease progress curve (AUDPC) method demonstrated a rapid progression of BLB disease in the studied rice germplasms and the result indicated that control measures should be taken as soon as disease symptoms appears in the field.

Antagonistic mechanism of *Pseudomonas mosselii* against rice blast disease defense-related gene expression

This study examined gene expression patterns in US-2 and BRRI dhan89 rice plants following inoculation with *Pseudomonas mosselii*, focusing on the effects of seed and seedling priming treatments. Rice plants were grown until the three-leaf stage and subjected to either seed priming or seedling priming before pathogen inoculation. Leaf samples were collected at 0, 24, 48, and 72 hours post-inoculation for RNA extraction and quantitative real-time PCR (qRT-PCR) analysis, normalized using OsActin as an internal reference. The expression of defense genes associated with systemic acquired resistance and the salicylic acid signaling pathway was analyzed. Results indicated that seed priming led to a stronger and quicker activation of defense-related genes compared to seedling priming, with peak expression at 48 hours post-inoculation. This study highlights the potential of seed priming to enhance disease resistance in rice crops, warranting further investigation into its underlying mechanisms and applications in sustainable agriculture.

AGRICULTURAL ENGINEERING DIVISION

Development and performance evaluation of biochar production machine

Biochar is a carbonized biomass obtained from thermo-chemical conversion of biomass in an oxygen-limited environment, which help to retain water and nutrients in the soil.Appropriate dimensions of a biochar machine for fabrication are crucial for optimum production of biochar. A biochar production machine has been developed with this study. Rice straw, jute sticks, and mustard plants were used as a suitable biochar feed stock. The maximum biochar output was found 54.7% from rice straw feedstock at 300^0C. Maximum percentage of carbon was found 41.1% from jute stick biochar at 500^0C. The developed machine was found suitable for biochar production from feedstocks.

Effect of alternate wetting and drying (AWD) on yield, water requirement, and methane gas emissions from boro rice in synchronized cropping site in nokla, sherpur

Rice production practices, such as the rice establishment method, increasing use of N fertilizer, irrigation water management (continuous flooded, alternate wetting and drying-AWD irrigation), etc. may impact soil C and N cycle. Therefore, it is essential to have a clear understanding of the effects of AWD on yield, water requirement, and greenhouse gas emission from Boro rice in the synchronized cropping site. A field experiment was carried out at a synchronized cropping area farmer's field, Nokla, Sherpur using Boro rice (SL8H Super Hybrid) to quantifywater-saving and reduction of methane gas emission. There were two treatments (AWD and Non-AWD) along with four replications in Randomized Complete Block Design.AWD method saved water by 15.9%, and Rice yield increased by 13.4%, compared to the Non-AWD irrigation method. The results revealed that AWD method saved water by 15.9%, increased rice yield by 13.4% compared to the Non-AWD irrigation method.

Irrigation management for hybrid maize for higher yield and water productivity

Field experiments were conducted in three locations, namely Natore, Jamalpur, and Sherpur, during Rabi season to find out the best irrigation management practice for higher yield and profitability of hybrid maize. The irrigation treatments were: Farmer's irrigation practice (T_1); Irrigation at 30-55-80-110 days after sowing (4 irrigations with twin line) (T_2); Irrigation at 30- 75 -110 days after sowing (3 irrigations) (T_3); Irrigation at 30- 75 -110 days after sowing plus additional management (with twin-line and 30% excess fertilizer of recommended dose); Irrigation at 70% depletion of available soil moisture (ASM) (T_5); No Irrigation (T_6). The Cultivars were BARI hybrid maize17 (V_1), and locally cultivated hybrid maize DURJOY (V_2) and Five Star (V_3). Overall, the highest yield (12.78 t ha^{-1}) was obtained with the application of 3 irrigations (Irrigation at 30- 75 -110 days after sowing plus additional management with twin-line) and 30% more fertilizer than recommended dose. The cultivar 'DURJOY' showed the highest result.

Development of efficient irrigation practice for citrus crops and other crops for hilly area

The experiment was carried out at farmer's field in hill of Jadurampara, Khagrachari to ensure efficient use of Jhiri-water and maximize water productivity for citrus crops and develop efficient irrigation practice for

lemon production in hill slopes. The imposed treatments were: T_1= Control/ Farmers practice (water carrying by labor) /no irrigation; T_2 = Drip Irrigation using power sprayer. The tested cultivar was local cultivar Kagji. Drip irrigation system was settled in the slope of hill for applying irrigation on 30 lemon trees whereas no irrigation was applied in another 10 trees (as control). Irrigation was applied for 5 times in the dry months (December-March). Single dripper was used for each tree. Water source for irrigation was Jhiri of hill which is located on the underneath of the hill. A water pump including 6 Hp engine (which is locally used for spraying chemicals at orchards) was used for uplifting the waters from the jhiri to the tank (1000ltr) which is placed on the top of the hill (around 120-150 ft). Dripper were placed on the base of each tree and connected with the water tank using water conveying pipes. The highest average yield was obtained in the treatment T_2. The treatment T_1 produced the lowest yield of lemon. On average, 308 lemons were harvested in each tree where drip irrigation was applied and around 185 lemon was produced in non-irrigated lemon trees (sold @ 5-7 tk/piece). Additionally green amaranth, brinjal and turmeric are also cultivated by supplying irrigation (sprinkler and flood) on the top of the hill. From the last three years study, it was found that application of developed irrigation system found suitable for farmers for the hill area for cultivation in the hill.

Development and evaluation of a pineapple leaf fiber extraction machine

Pineapple leaf is a reasonable source of high textile-grade commercial fiber. A pineapple leaf fiber extraction machine was designed and developed by considering the local context and demand for optimum fiber extraction in a short period of time. In the developed pineapple leaf fiber extraction machine, using only roller cutting blade at 1400 rpm at 2 horsepower motor, the fibre quality was found pretty good and suitable.

Development of a portable grain dryer

Dryer reduces the time and energy required for drying the grains. The study was undertaken to design and develop a portable and low-cost grain dryer. The Fabrication of the proposed dryer is ongoing on a local engineering workshop. The capacity of the proposed dryer is 300 kg. The dryer can dry rice, wheat, maize and other cereals and pulses and oil seeds 300kg per batch.

Future climate scenario and its impact on hydrologic components

The objectives were to predict climate change using Global Climate Model, and to estimate the change in hydrologic components due to climate change. At first global climate models were calibrated with the existing data of Bangladesh Meteorological Department. The best performing model was used to predict climatic parameter, water balance components and drought indices using SSP4.5 and SSP8.5 scenarios. The results showed that, there is a distinct increasing trend of monthly temperature at different decadal time scales (average of the decade) compared to that of base-year. In all cases, the predicted temperatures are higher than the base-temperature. Furthermore, relatively more water deficit was found during dry

period, and more water surplus during monsoon period. The results indicated that need for appropriate planning and preparedness for remedial measures.

Impact of climate change on future water demand in crop production

Crop water demand is a function of climatic factor and crop factor. Reference crop evapotranspiration (ET0) and crop evapotranspiration (ETp) were calculated under future climatic scenario. The results revealed that, the ETo demand are increasing with time-scale, which corresponds to the monthly forecasted temperature. The monthly crop water demand (ETp) also showed increasing trend in most of the months.

Monitoring of groundwater table fluctuation at bina hqs and its substations

The experiment was conducted to know the temporal and spatial pattern, trend ofwater table and ground water drought. The weekly water table data were collected from Bangladesh Water Development Board (BWDB). The patterns, trend and drought index were examined by graphical methods.The long-term (1981–2013) hydrograph of yearly maximum and minimum WT depth under different Upazilas of shows that the WT depth was beyond the suction limit for 22 wells out of 33 wells in the area. In case of long-term minimum water table depth was also beyond the suction limit for about 10 wells out of 33 wells in the area.The patterns of long termmaximum and minimum water table depth at Chapainawabganj indicated that was decreased over time, meaning that the withdrawal rate is higher than recharge. The time series of SWI shows many similar broad scale structures across most of the wells. There are some exceptions in well number GT1020006, GT1033009, GT1067015 and GT1081016 which may due to the Padma and mohananda rivers of Bangladesh flows through Shibganj and chapainawabganj sadar Upazila or less extraction of groundwater for irrigation. The mild to moderate groundwater drought (SWI> 1.0) occurred frequently. The severe drought intensity (SWI> 1.5) shows in many of the observation well during the dry season. The extreme drought (SWI >2.0) identified in some wells in some specific years.

ADAPTIVE RESEARCH AND EXTENSION DIVISION

RESEARCH SUMMARY

During 2023-2024, 6,367 block farming demonstrations using BINA-developed crop varieties were conducted in collaboration with the Department of Agricultural Extension (DAE). Key rice varieties include Binadhan-11, which produced 5.18 t/ha with a 117-day maturity period and submergence tolerance, Binadhan-17 yielding 6.183 t/ha, and Binadhan-23, a variety tolerant to both saline and tidal submergence. Mutant rice varieties, such as BLB-P-19 and BN-P-318, exceeded the yields of standard varieties with outputs of 6.01 t/ha and 6.39 t/ha, respectively.

For Boro rice, Binadhan-5 yielded 5.60 t/ha, while Binadhan-10 produced 6.54 t/ha, both showing strong yield performance. Groundnut varieties like Binachinabadam-4, Binachinabadam-6, Binachinabadam-8 and Binachinabadam-10 produced 2.278 t/ha, 2.37 t/ha, 2.18 t/ha and 2.55 t/ha respectively, while Binatil-2 standing out for waterlogging resistance, producing 1.358 t/ha. Binamoog-8, a mung bean variety, performed particularly well in Gopalganj with yields of 1.60 t/ha and a maturity period of 71 days.

To advance BINA technologies, 217 block farming projects were established near BINA headquarters, with cropping patterns like "Binadhan-11/17-Binasarisha-9/11–Binadhan-24/25" being highly profitable in Mymensingh. Additionally, 98 training programs were held, educating 4,565 farmers. To further promote BINA varieties, 87 field days and six workshops were organized, focusing on popularizing BINA-developed crop technologies across Bangladesh to ensure sustainable agricultural practices.

Rice

Exp 01: Block farming performance of Aman rice variety, Binadhan-7 at different locations

During Aman season of 2023, block farming with Binadhan-7 was conducted at the farmer's fields in different locations in collaborations with DAE. The main objectives were to evaluate the performance of this variety at different flood prone and normal areas for widening its adoption by the farmers. Area of each plot was 0.33 acre. Spacing between line-to-line and plant-to-plant was 20 cm × 15 cm. All fertilizers were applied by farmers as per recommendation. Transplanting dates ranged from July 20 to August 15, 2023 and age of seedlings were 20 to 28 days. Based on the available reports, Binadhan-7 performed well in two locations. The grain yield was 5.36 t ha^{-1} with maturity period of 110 days. Farmers were found keen to cultivate Binadhan-7 in upcoming years.

Exp 02: Block farming performance of submergence tolerant Aman rice variety, Binadhan-11 at different locations

During Aman season of 2023, block farming with Binadhan-11 was conducted at the farmer's fields in two locations in collaborations with DAE. The main objectives were to evaluate the performance of this variety at different flood prone and normal areas for widening its adoption by the farmers. Area of each plot was 0.33 acre. Spacing between line-to-line and plant-to-plant was 20 cm×15 cm. All fertilizers were applied by farmers as per recommendation. Transplanting dates ranged from July 20 to August 20, 2023 and age of seedlings were 20 to 25 days. Based on the available reports, Binadhan-11 is a flood tolerant variety. The average grain yield was 5.18 t ha^{-1}

with maturity period of 117 days. Farmers of Ishwardi and Cumilla districts were keener to cultivate Binadhan-11 in upcoming years.

Exp 03: Block farming performance of submergence tolerant Aman rice variety, Binadhan-12 at different locations

During Aman season of 2023, block farming with Binadhan-12 was conducted at the farmer's fields in different locations collaborations with DAE. The main objective was to evaluate the performance of this variety at different flood prone and normal areas for widening its adoption by the farmers. Area of each plot was 0.33 acre. Spacing between line-to-line and plant-to-plant was 20 cm × 15 cm. All fertilizers were applied by farmers as per recommendation. Transplanting dates ranged from July 20 to August 15, 2023 and age of seedlings were 20 to 30 days. Binadhan-12 is a flood tolerant variety. The average grain yield of Binadhan-12 was 4.52 t ha^{-1} with mean maturity period of 120 days. Farmers were found keen to cultivate Binadhan-12 in upcoming years especially farmers of Khagrachari district highly accepted this variety.

Exp 04: Block farming performance of Aman rice variety, Binadhan-16 at different locations

During Aman season of 2023, block farming with Binadhan-16 was conducted at the farmer's fields in different locations in collaborations with DAE. The main objective was to evaluate the performance of this variety at different areas for widening its adoption by the farmers. Area of each plot was 0.33 acre. Spacing between line-to-line and plant-to-plant was 20 cm × 15 cm. All fertilizers were applied by farmers as per recommendation. Transplanting dates ranged from 16 July to 10 August, 2023 and age of seedlings were 20 to 25 days. The results revealed that Binadhan-16 performed well in all locations. The average grain yield of Binadhan-16 was 5.06 t ha^{-1} with maturity period of 103 days. Anyway, Binadhan-16 is a short duration variety and after harvest of Binadhan-16, farmers can easily cultivate early winter crops. Sunamgonj, Cumilla, Gopalganj districts performed better than other districts. Farmers of most districts were found keen to cultivate Binadhan-16 in upcoming years.

Exp 05: Block farming performance of Aman rice variety, Binadhan-17 at different locations

During Aman season of 2023, block farming with Binadhan-17was conducted at the farmer's fields in different locations in collaborations with DAE. The main objective was to evaluate the performance of this variety at different areas for widening its adoption by the farmers. Area of each plot was 0.33 acre. Spacing between line-to-line and plant-to-plant was 20 cm×15 cm. All fertilizers were applied by farmers as per recommendation. Transplanting dates ranged from 16 July to 10 August, 2023 and age of seedlings were 20 to 25 days. The results revealed that Binadhan-17 performed well Kishoreganj, Gopalgonj, Magura, Noakhali districts. Farmers of those districts were found keen to cultivate Binadhan-17 in upcoming years. The average grain yield of Binadhan-17 was 6.183 t ha^{-1} with maturity period of 114 days.

Exp 06: Block farming performance of Zn enrich Aman rice variety, Binadhan-20 in different locations

During Aman season of 2023, block farming with Binadhan-20 was conducted at the farmer's fields in different locations in collaborations with DAE. The main objective was to evaluate the performance of Binadhan-20 at areas for widening its adoption by the farmers. Area of each plot was 0.33 acre. Spacing between line-to-line and plant-to-plant was 20 cm×15 cm. All fertilizers were applied by farmers as per recommendation. Transplanting dates ranged from July 20 to August 15, 2023 and age of seedlings were 25 to 30 days. Based on the available reports, Binadhan-20 performed well in all locations. Binadhan-20 is Zn and Fe fortified variety and market price is high. Farmers are interested to cultivate Binadhan-20 in most cases. Binadhan-20 preformed high yield potential in Gopalganj, Satkhira, Jamalpur, Barishal and Cumilla districts. The average grain yield of Binadhan-20 was 4.95 t ha^{-1} with maturity period of 127 days. Farmers of most districts were found keen to cultivate Binadhan-20 in upcoming years.

Exp 07: Block farming performance of early maturing Aman rice variety, Binadhan-22 in different locations

During Aman season of 2023, block farming with Binadhan-22was conducted at the farmer's fields in different locations in collaborations with DAE. The main objective was to evaluate the performance of this variety at different areas for widening its adoption by the farmers. Area of each plot was 0.33 acre. Spacing between line-to-line and plant-to-plant was 20 cm × 15 cm. All fertilizers were applied by farmers as per recommendation. Transplanting dates ranged from 16 July to 10 August, 2023 and age of seedlings were 20 to 25 days.

The average grain yield of Binadhan-22 was 5.73 t ha^{-1} with maturity period of 116 days. Binadhan-22 was accepted by the farmers of North-west and south-west of Bangladesh. Anyway, Binadhan-22 is a short duration variety and after harvest of Binadhan-22, farmers can easily cultivate early winter crops.

Exp 08: Block farming performance of dual tolerant Aman rice variety, Binadhan-23 in different locations

During Aman season of 2023, block farming with Binadhan-23was conducted at the farmer's fields in southern area of Bangladesh. The main objectives were to evaluate the performance of this variety at different areas for widening its adoption by the farmers. Area of each plot was 0.33 acre. Spacing between line-to-line and plant-to-plant was 20 cm × 15 cm. All fertilizers were applied by farmers as per recommendation. Transplanting dates ranged from 16 July to 10 August, 2023 and age of seedlings were 20 to 25 days. The results revealed that Binadhan-23 performed well in gopalgonj and Satkhira over other district. The average grain yield of Binadhan-23 was 5.24 t ha^{-1} with maturity period of 120 days. However, Binadhan-23 is a short duration variety and after harvest of Binadhan-23, farmers can easily cultivate winter crops.

Exp 09: Adaptive trial with mutants BLB-P-19 of Aman rice at different locations

During Aman season of 2023-24, adaptive trials with Aman rice mutants BLB-P-19 was conducted at farmers' field at two districts of Manikganj and Chapainawabganj districts. The objectives were to evaluate the performance of mutant lines at different locations and to provide the feedback information to the concerned lines about bacterial leaf blight. The experiment was setup in RCB design with three replications. The unit plot size was 5m × 6m at all locations. Seed were sown during 2nd week of July, 2023. Recommended doses of nitrogen, phosphorus, potassium, sulphur and zinc were applied in the form of Urea, TSP, MoP, Gypsum and Zinc Sulphate. Proper cultural practices were followed as and when necessary for normal plant growth and development. Data on morphological and yield attributes were recorded at harvest from 10 randomly selected plants in each plot. Grain yield was recorded from whole plot and converted into t ha^{-1}. The recorded data were finally subjected to proper statistical analysis and results indicated that the mutant line was longer than the check variety, BRRI dhan75. The maturity period of the mutant line took 4-5 days less than the check variety and moderately blight resistant. The mutant BLB-P-19 showed the highest grain yield (6.01 t ha^{-1}) and showed higher grain yield than the check variety, BRRI dhan75 (5.15 t ha^{-1}). Farmers of both districts were found keen to cultivate that mutant.

Exp 10: Adaptive trial with mutant BN-P-318 of Aman rice at different locations

During Aman season of 2023-24, adaptive trials with Aman rice mutants BN-P-318 was conducted at farmers' field at two districts of Manikganj and Chapainawabganj districts. The objectives were to evaluate the performance of mutant lines at different locations and to provide the feedback information to the concerned lines about blast resistance. The experiment was setup in RCB design with three replications. The unit plot size was 5m × 6m at all locations. Seed were sown during 2nd week of July, 2023. Recommended doses of nitrogen, phosphorus, potassium, sulphur and zinc were applied in the form of Urea, TSP, MoP, Gypsum and Zinc Sulphate. Proper cultural practices were followed as and when necessary for normal plant growth and development. Data on morphological and yield attributes were recorded at harvest from 10 randomly selected plants in each plot. Grain yield was recorded from whole plot and converted into t ha^{-1}. The recorded data were finally subjected to proper statistical analysis and results indicated that the mutant line was longer than the check variety, BRRI dhan87. The maturity period of the mutant line took 4-5 days less than the check variety and moderately blast resistant. The mutant BN-P-318 showed the highest grain yield (6.39 t ha^{-1}) and showed higher grain yield than the check variety, BRRI dhan87 (5.40 t ha^{-1}). Farmers of both districts were found keen to cultivate that mutant in future.

Boro rice

Exp 11: Adaptive trial with two mutants RM-16(N)-8-1 and RM-16(N)-10-1 of Boro rice at different locations

During Boro season of 2023-2024, adaptive trials with two Boro rice mutants RM-16(N)-8-1 and RM-16(N)-10-1were conducted at farmers' field at two districts of Pabna and Kustia districts. The objectives were to evaluate the performance of mutant lines at different locations and to provide the feedback information about the concerned lines. The experiment was setup in RCB design with three replications. The unit plot size was 5m × 6m at all locations. Seed were sown during middle to end of December 2022 and transplanting was completed within last week of January to 1st week of February, 2023. Recommended doses of nitrogen, phosphorus, potassium, sulphur and zinc were applied in the form of Urea, TSP, MoP, Gypsum and Zinc Sulphate. Proper cultural practices were followed as and when necessary for normal plant growth and development. Data on morphological and yield attributes were recorded at harvest from 10 randomly selected plants in each plot. Grain yield was recorded from whole plot and converted into t ha^{-1}. The recorded data were finally subjected to proper statistical analysis and results indicated that the mutant lines were shorter than the check variety, BRRI dhan58 (92.40 cm). The maturity period of the two mutant lines took 4-5 days more than the check variety, BRRI dhan58 (149 days) with being the longest in RM-16(N)-10-1(154 days). Grain yield was greater in Kustia district. The mutant RM-16(N)-10-1 showed the highest grain yield (7.04 t ha^{-1}) at 2 locations and showed 6.00% higher grain yield than the check variety, BRRI dhan58 (6.65 t ha^{-1}). On the other hand, the mutant RM-16(N)-8-1 showed apparently lower grain yield than the check variety, BRRI dhan58 at 2 locations. However, BRRI dhan58 showed lodging tendency. Considering farmers' observation, though the mutant RM-16(N)-10-1 had higher grain yield over the check, BRRI dhan58 but the farmers were reluctant to cultivate the mutant RM-16(N)-8-1 in future due to longer duration and coarse grain size.

Exp 12: Block farming performance of Boro rice variety, Binadhan-5 at different locations

During Boro season of 2023, block farming with Binadhan-5 was conducted at the farmer's fields in different locations in collaborations with DAE. The main objectives were to evaluate the performance of this variety at different flood prone and normal areas for widening its adoption by the farmers. Area of each plot was 0.33 acre. Spacing between line-to-line and plant-to-plant was 20 cm × 15 cm. All fertilizers were applied by farmers as per recommendation. Transplanting dates ranged from 20 December, 2023 to 15, January 2024 and age of seedlings were 20 to 28 days. Based on the available reports, revealed that Binadhan-5 performed well . The average grain yield was 5.60 t ha^{-1} with maturity period of 135 days. Farmers were found keen to cultivate Binadhan-5 in upcoming years.

Exp 13: Block farming performance of salt tolerant Boro rice variety, Binadhan-10 at different locations

During Boro season of 2023-24, block farming with Binadhan-10 was conducted at the farmer's fields in different locations in collaborations with DAE. The main objective was to evaluate the performance of Binadhan-10 coastal areas and also normal areas in Boro for widening its adoption by the farmers. Area of each plot was 0.33 acre. Spacing between line-to-line and plant-to-plant was 20 cm × 20 cm. All fertilizers were applied by farmers as per recommendation. Transplanting dates ranged from 20 to 31 January 2024 and age of seedlings were 30 to 35 days. Based on the available reports, revealed that Binadhan-10 performed better under non-saline soil than saline soil. However, under saline condition, Binadhan-10 also performed well regarding grain yield. Binadhan-10 performed the best in Rangpur district. Under saline condition, the average grain yield was 6.54 t ha^{-1} with maturity period of 133 days. Farmers of Rangpur, Satkhira, Gopalgonj districts were found keen to cultivate Binadhan-10.

Exp 14: Block farming performance of Boro rice variety, Binadhan-14 at different locations

During Boro season of 2023-24, block farming with Binadhan-14 was conducted at the farmer's fields in different locations in collaborations with DAE. The main objectives were to evaluate the performance of this variety in Boro season for widening its adoption by the farmers. The main objective was to evaluate the performance of this variety in Boro season. Area of each plot was 0.33 acre. Spacing between line-to-line and plant-to-plant was 20 cm × 20 cm. All fertilizers were applied by farmers as per recommendation. Transplanting dates ranged from 15 to 28 February 2024 and age of seedlings were 20 to 25 days. Binadhan-14 performed better Jamalpur district. The grain yield was 6.165 t ha^{-1} with maturity period of 116 days. Farmers were found keen to cultivate Binadhan-14.

Exp 15: Block farming performance of Boro rice variety, Binadhan-24 at different locations

During Boro season of 2023-24, block farming with Binadhan-24 was conducted at the farmer's fields in different locations in collaborations with DAE. The main objectives were to evaluate the performance of this variety in Boro season for widening its adoption by the farmers. The main objective was to evaluate the performance of this variety in Boro season. Area of each plot was 0.33 acre. Spacing between line-to-line and plant-to-plant was 20 cm×20 cm. All fertilizers were applied by farmers as per recommendation. Transplanting dates ranged from 20 to 31 January 2024 and age of seedlings were 35 to 40 days. The average grain yield was 6.57 t ha^{-1} with maturity period of 143 days. Farmers of all districts were found keen to cultivate Binadhan-24.

Exp 16: Block farming performance of Boro rice variety, BINA dhan25 at different locations

During Boro season of 2023-24, block farming with BINA dhan25 was conducted at the farmer's fields in different locations in collaboration with DAE. The main objectives were to evaluate the performance of this variety in Boro season for widening its adoption by the farmers. The main objective was to evaluate the performance of this variety in Boro season. Area of each plot was 0.33 acre. Spacing between line-to-line and plant-to-plant was 20 cm×20 cm. All fertilizers were applied by farmers as per recommendation. Transplanting dates ranged from 20 to 31 January

2024 and age of seedlings were 35 to 40 days. The results revealed that BINA dhan25 performed well in all locations. The average grain yield was 6.85 t ha^{-1} with maturity period of 141 days. Farmers of Mymensingh, kishoregonj, chapainawabgonj, Magura, Ishwardi districts was more keen to cultivate BINA dhan25.

Exp 17: Block farming performance of Aus rice variety, Binadhan-19 at different locations

During Aus season of 2024, block farming with Binadhan-19 was conducted at the farmer's fields in at different locations in collaborations with DAE. The main objective was to evaluate the performance of this variety at different areas for widening its adoption by the farmers. Area of each plot was 0.33 acre. Spacing between line-to-line and plant-to-plant was 20 cm×15 cm. All fertilizers were applied by farmers as per recommendation. Transplanting dates ranged from 26 April to 16 May, 2024 and age of seedlings were 20 to 22 days. The results showed that Binadhan-19 performed well in most of the locations. The average grain yield of Binadhan-19 was 4.31 t ha^{-1} with maturity period of 103 days. Farmers of Satkhira, Chapainawabgonj, Nalitabari districts were found keen to cultivate Binadhan-19 in upcoming years.

Exp 18: Block farming performance of Aus rice variety, Binadhan-21 in different locations

During Aus season of 2024, block farming with Binadhan-21 was conducted at the farmer's fields in different locations in collaborations with DAE. The main objective was to evaluate the performance of this variety at different areas for widening its adoption by the farmers. Area of each plot was 0.33 acre. Spacing between line-to-line and plant-to-plant was 20 cm × 15 cm. All fertilizers were applied by farmers as per recommendation. Transplanting dates ranged from 26 April to 16 May, 2024 and age of seedlings were 20 to 22 days.

The results revealed that Binadhan-21 performed well in most of the locations except Barishaln and Jamalpur . The average grain yield of Binadhan-21 was 4.29 t ha^{-1} with maturity period of 104 days. Binadhan-21 is a short duration variety and after harvest of Boro rice, farmers can easily cultivate next crop, Aman rice. Khagrachori and Chapainawabgonj ,Cumilla districts performed better than other districts. Farmers of most districts were found keen to cultivate Binadhan-21 in upcoming years.

Oilseed crops

Exp 19: Block farming performance of rapeseed variety, Binasarisha-4 in different locations

During winter season of 2023-24, block farming with Binasarisha-4 was conducted at the farmer's fields in different locations in collaborations with DAE. The main objective was to evaluate the performance of this variety in winter season for widening its adoption by the farmers. Area of each plot was 0.33-5 acre. All fertilizers were applied by farmers as per recommendation. Sowing dates ranged from 1st week to 31 last week of November 2023.

The results revealed that Binasarisha-4 performed well in most of the locations. Binasarisha-4 performed inferior in these districts due to lately sowing. But farmers are happy for giving some seed yield of Binasarisha-4, because the land is fallow after harvest of Aman. On the other hand, there is no seed yield of other rapeseed variety in lately sowing but Binasarisha-4 gave some seed yield under late sowing condition (last week of Novemver to 1st week of December). Results

further indicated that seed yield is positively related with maturity duration. For example, north-west and south-west part of Bangladesh took longer duration for maturity. The average grain yield was 1.53 t ha^{-1} with maturity period of 89 days. Farmers of most districts were found keen to cultivate Binasarisha-4.

Exp 20: Block farming performance of rapeseed variety, Binasarisha-9 in different locations

During winter season of 2023-24, block farming with Binasarisha-9 was conducted at the farmer's fields in different locations in collaborations with DAE. The main objective was to evaluate the performance of this variety in winter season for widening its adoption by the farmers. Area of each plot was 0.33-5 acre. All fertilizers were applied by farmers as per recommendation. Sowing dates ranged from 1st week to 31 last week of November 2023.

The results revealed that Binasarisha-9 performed well in most of the locations except Noakhali, Chattagram, Feni districts. Binasarisha-9 performed inferior in these districts due to lately sowing. But farmers are happy for giving some seed yield of Binasarisha-9, because the land is fallow after harvest of Aman. On the other hand, there is no seed yield of other rapeseed variety in lately sowing but Binasarisha-9 gave some seed yield under late sowing condition (last week of Novemver to 1st week of December). Results further indicated that seed yield is positively related with maturity duration. The average grain yield was 1.634 t ha^{-1} with maturity period of 85 days. Farmers of most districts were found keen to cultivate Binasarisha-9.

Exp 21: Block farming performance of rapeseed variety, Binasarisha-10 at different locations

During winter season of 2023-24, block farming with Binasarisha-10 was conducted at the farmer's fields in **Khagrachari** district in collaborations with DAE. The main objective was to evaluate the performance of this variety in winter season for widening its adoption by the farmers. Area of each plot was 0.33-5 acre. All fertilizers were applied by farmers as per recommendation. Sowing dates ranged from 1st week to 31 last week of November 2023.

The results revealed that Binasarisha-10 performed well in most of the locations. The average grain yield was 1.43 t ha^{-1} with maturity period of 95 days. Farmers of Khagrachari district was found keen to cultivate Binasarisha-10.

Exp 22 : Block farming performance of rapeseed variety, Binasarisha-11 at different locations

During winter season of 2023-24, block farming with Binasarisha-11was conducted at the farmer's fields in at different locations in collaborations with DAE. The main objective was to evaluate the performance of this variety in winter season for widening its adoption by the farmers. Area of each plot was 0.33-5 acre. All fertilizers were applied by farmers as per recommendation. Sowing dates ranged from 1st week to 31 last week of November 2023. The results revealed that Binasarisha-11 performed well in most of the locations. Binasarisha-11 performed inferior in these districts due to lately sowing. But farmers are happy for giving some seed yield of Binasarisha-11, because the land is fallow after harvest of Aman. On the other hand, there is no seed yield of other rapeseed variety in lately sowing but Binasarisha-11 gave some seed yield

under late sowing condition (last week of November to 1st week of December). Results further indicated that seed yield is positively related with maturity duration. The average grain yield was 1.76 t ha^{-1} with maturity period of 85 days. Farmers of Barishal, Ishwardi, Chapainawabgonj, Sunamgonj districts were found keen to cultivate Binasarisha-11.

Exp 23: Block farming performance of rapeseed variety, Binasarisha-12 at different locations

During winter season of 2023-24, block farming with Binasarisha-12 was conducted at the farmer's fields in Satkhira in collaborations with DAE. The main objective was to evaluate the performance of this variety in winter season for widening its adoption by the farmers. Area of each plot was 0.33-5 acre. All fertilizers were applied by farmers as per recommendation. Sowing dates ranged from 1st week to 31 last week of November 2023. The results revealed that Binasarisha-12 performed well in most of the locations. Binasarisha-12 performed inferior in these districts due to lately sowing. But farmers are happy for giving some seed yield of Binasarisha-12, because the land is fallow after harvest of Aman. On the other hand, there is no seed yield of other rapeseed variety in lately sowing but Binasarisha-12 gave some seed yield under late sowing condition (last week of November to 1st week of December). Results further indicated that seed yield is positively related with maturity duration. The average grain yield was 1.575 t ha^{-1} with maturity period of 85 days. Farmers of all districts were found keen to cultivate Binasarisha-12.

Exp 24: Block farming performance of sesame variety, Binatil-2, 3 & 4 at different locations

During Kharif-1season of 2024, block farming with Binatil-2 was conducted at the farmer's fields at **different locations** district in collaborations with DAE. The main objective was to evaluate the performance of Binatil in Kharif-1 season for widening its adoption by the farmers. Area of each plot was 0.33 acre. All fertilizers were applied by farmers as per recommendation. Sowing dates ranged from 1st week to last week of March 2024. Based on the available reports, results from block farming plots revealed that Binatil-2 performed well in Kishoreganj. The average seed yield of Binatil-2 was 1.358 t ha^{-1} with maturity period of 94 days. Farmers of Goplagonj, Magura districts were found keen to cultivate Binatil-2. The average seed yield of Binatil-3 was 1.15 t ha^{-1} with maturity period of 96 days. Farmers of Magura district was found keen to cultivate Binatil-2.

The results revealed that average seed yield of Binatil-4 was 1.25 t ha^{-1} with maturity period of 89 days at selected locations. At pabna district yield was maximum, 1.50 t ha^{-1}.

Exp 25: Block farming performance of groundnut varieties, Binachinabadam-4, Binachinabadam-6 and Binachinabadam-8 at different locations

During winter season of 2023-24, block farming with Binachinabadam-4, Binachinabadam-6 and Binachinabadam-8 were conducted at the farmer's fields in different locations in collaborations with DAE. The main objective was to evaluate the performance of Binachinabadam-4, Binachinabadam-6 and Binachinabadam-8 for widening its adoption by the farmers. Area of each plot was 0.33-1.0 acre. All fertilizers were applied by farmers as per recommendation. Sowing dates ranged from 1st week to 3rdweek of January 2024.

The results revealed that Binachinabadam-4 performed well in Rangpur districts. The average pod yield of Binachinabadam-4 was 2.278 t ha^{-1} with maturity period of 139 days. Farmers of most districts were found keen to cultivate Binachinabadam-4. In case of Binachinabadam-6, performed best in Gopalgonj district. Binachinabadam-8 is becoming a popular variety in Noakhali and Ishwardi districts.

Exp 26: Block farming performance of soybean varieties, Binasoyabean-2, Binasoybean-3, Binasoybean-5 and Binasoybean-6,7 at different locations

During winter season of 2023-24, block farming with Binasoybean-3, Binasoybean-5 and Binasoybean-6was conducted at the farmer's fields in different locations in collaborations with DAE. The main objective was to evaluate the performance of Binasoyabean-2, Binasoybean-3, Binasoybean-5 and Binasoybean-6 for widening its adoption by the farmers. Area of each plot was 0.33acre. All fertilizers were applied by farmers as per recommendation. Sowing dates ranged from 1st week to 3rd week of November 2023.

The results revealed that Binasoybean-2 performed well in Noakhali. Binasoybean-3 performed well in Noakhali, Lakshmipur districts. The average seed yield of Binasoybean-3 was 1.845 t ha^{-1} with maturity period of 106 days. Most farmers were found keen to cultivate Binasoybean-3. Binasoybean-5 performed better in Luximpur than Noakhali district. Most farmers were found keen to cultivate Binasoybean-5. In lakshmipur district, farmers were keen to cultivate Binasoybean-6,7.

Pulse crops

Exp 27: Block farming of black gram variety Binamash-2 at different locations in collaboration with DAE

During the rabi season of 2023-24, block farming was conducted with Binamash-2 in Mymensingh and Kishoreganj districts in collaboration with the DAE. The main objectives were to demonstrate the performance of Binamash-2 to evaluate their location specific suitability and widen adoption by the farmers. Unit plot size of block farming was 0.33 acre at all the locations. Seeds were sown during 3rd week of August to 2nd week of September 2023. All fertilizers were applied as per recommendation. Data were recorded on crop duration, seed yield, reactions from farmers' and extension personnel. The results revealed that Binamash-2 produced average yield of 1.23 ha^{-1} with duration of 78. Farmers were interested to cultivate the variety in future.

Exp 28: Block farming performance of mungbean variety, Binamoog-8 at different locations

During Kharif-1 season of 2023, block farming with Binamoog-8 was conducted at the farmer's fields in different locations in collaborations with DAE. The main objective was to evaluate the performance of Binamoog-8 for widening its adoption by the farmers. Area of each plot was 0.33 acre. All fertilizers were applied by farmers as per recommendation. Sowing dates ranged from 1st week, February to last week of March, 2024.

The results showed that Binamoog-8 performed better in Gopalganj districts than greater Barishal and Ishwardi districts. The average seed yield of Binamoog-8 was 1.60 t ha^{-1} with maturity period of 71 days. Most farmers were found keen to cultivate Binamoog-8 in future.

Exp 29: Block farming performance of lentil variety, Binamasur-5, Binamasur-8, Binamasur-9, in different locations

During winter season of 2023-24, block farming with Binamasur-8 was conducted at the farmer's fields in different locations in collaborations with DAE. The main objective was to evaluate the performance of Binamasur-8 for widening its adoption by the farmers. Area of each plot was 0.33 acre. All fertilizers were applied by farmers as per recommendation. Sowing dates ranged from 1st week to 3rd week of November 2023.

The results revealed that Binamasur-5 performed well in Gopalganj district than Chapainawabgonj. The average seed yield of Binamasur-5 was1.84 t ha^{-1} with maturity period of 101 days. Most farmers were found keen to cultivate Binamasur-5 in future.

The results revealed that Binamasur-8 performed well in Gopalganj district than Magura . The average seed yield of Binamasur-8 was1.9 t ha^{-1} with maturity period of 100 days. Most farmers were found keen to cultivate Binamasur-8 in future

The results revealed that Binamasur-9 performed well in Gopalganj district than Magura. The average seed yield of Binamasur-9 was1.85 t ha^{-1} with maturity period of 103 days. Most farmers were found keen to cultivate Binamasur-9 in future.

Exp 30: Block farming performance of grasspea variety, Binakhasari-1 at different locations

During winter season of 2023-24, block farming with Binakhasari-1was conducted at the farmer's fields at different locations in collaborations with DAE. The main objective was to evaluate the performance of Binakhasari-1 for widening its adoption by the farmers. Area of each plot was 0.33 acre. All fertilizers were applied by farmers as per recommendation. Sowing dates ranged from 1st week to last week of November, 2023.

The results revealed that Binakhasari-1 performed good in Gopalganj district. The average seed yield of Binakhasari-1 was 2.00 t ha^{-1} with maturity period of 113 days. Most farmers were found keen to cultivate Binakhasari-1 in future.

Exp 31: Block farming performance of chickpea variety, Binasola-4 at different locations

During winter season of 2023-24, block farming with Binasola-4 was conducted at the farmer's fields at different locations in collaborations with DAE. The main objective was to evaluate the performance of Binasola for widening its adoption by the farmers. Area of each plot was 0.33 acre. All fertilizers were applied by farmers as per recommendation. Sowing dates ranged from 1st week to last week of November, 2023. The results revealed that the average seed yield of Binasola-4 was 1.39 t ha^{-1} respectively with maturity period of 126 in Chapainawabgonj.

Horticultural crops

Exp 32: Performance of lemon variety, Binalebu-1 at Rangpur district

During the season of 2023, block farming with Binalebu-1 was conducted at Rangpur district. The main objective was to evaluate the performance of Binalebu-1 for widening its adoption by the farmers. Area of each plot was 0.20 acre. All fertilizers were applied by farmers as per

recommendation. Transplanting dates was last week of January 2023. The results revealed that average yield of Binalebu-1 was 23.7 t ha^{-1}.

Exp 33: Block farming performance of turmeric variety, Binahalud-1 at different locations

During the Kharif-1season of 2023, block farming with Binahalud-1was conducted at the farmer's fields at different locations. The main objective was to evaluate the performance of Binahalud-1for widening its adoption by the farmers. Area of each plot was 0.33 acre. All fertilizers were applied by farmers as per recommendation. Sowing dates ranged from last week of April to 2nd week of May, 2023.

The results revealed that Binahalud-1 performed better in Ishurdi. The average rhizome yield of Binahalud-1was 33.0 t ha-1. The maturity period of Binahalud-1 was 330 days. Farmers preferred Binahalud-1 for its good yield performance.

Exp 34 : Establishment of BINA-Technology Pilot Area (BINA-Village)

During Aman season of 2023-24, block farming with T. aman (Binadhan-11, Binadhan-17) at different district for widening its adoption by the farmers. Area of each plot was 0.33 acre. Results depicted that rice varieties of Binadhan-11, Binadhan-17 produced average grain yield of 4.45 and 5.10 t ha-1 with average maturity period of 117, 116 days, respectively.

During Boro season of 2023-24, block farming with Sarisha (Binasarisha-09, Binasarisha-11) at Mymensingh district for widening its adoption by the farmers. Area of each plot was 0.33 acre. Binasarisha-09, Binasarisha-11 yielded 1.76 and 1.85 t/ha respectively.

Exp 35: Promotional Activities:

To advance BINA technologies, 217 block farming projects were established near BINA headquarters, with cropping patterns like "Binadhan-11/17-Binasarisha-9/11–Binadhan-24/25" being highly profitable in Mymensingh. Additionally, 98 training programs were held, educating 4,565 farmers. To further promote BINA varieties, 87 field days (7,929 participants) and six workshops (595 participants) were organized, focusing on popularizing BINA-developed crop technologies across Bangladesh to ensure sustainable agricultural practices.

AGRICULTURAL ECONOMICS DIVISION

Yield gap analysis of Binadhan-11 in some selected areas of Bangladesh

The yield gap study of Binadhan-11 was covered 250 farmers of five major districts. The highest yield of actual farmers level was obtained from Kurigram (4.19 t ha^{-1}) followed by Rangpur (4.10 t ha^{-1}), Jamalpur (3.98 t ha^{-1}), Lalmonirhat (3.92 t ha^{-1}) and Mymensingh (3.84 t ha^{-1}) district, respectively. The average yield of actual farmers of Binadhan-11 was 4.01 t ha^{-1}. The estimated average yield gap-I was 0.50 t ha^{-1} (9.28%) and average yield gap-II was 0.93 t ha^{-1} (18.82%). The lowest total yield gap was 1.31 t ha^{-1} (25.12%) observed in Kurigram district and it was the highest 1.54 t ha^{-1} (30.85%) in Mymensingh district. The average yield gap was 1.43 t ha^{-1} (28.10 %) due to not consider the recommended doses of inputs. The average seed rate was 33.11 Kg ha^{-1}, Urea 164.02 Kg ha^{-1}, MoP 60.92 Kg ha^{-1}, TSP 80.28 Kg h^{-1}, Zypsum 13.50 Kg ha^{-1} and Zinc 6.82 Kg ha^{-1}, respectively. In average 50.77 % farmers used power tiller three times or more than three times, 67.03 % weeded their lands 2 times, 79.10 % farmers no irrigation their land and 84.59 % spray pesticide and insecticide to control disease and insect. The regression coefficients for Power tiller, Urea, TSP and Human labour were found positively significant at 1% level. But MoP and Insecticide cost were found positively significant at 5% level. Seed and Zypsum were found positively significant at 10% level. The positive sign indicated that using more of these inputs in Binadhan-11 production could increase the yield to some extent. The values of R^2 were 0.941 means that around 94% of the variations in gross return for Binadhan-11 rice were explained by the independent variables. The F-values of all areas were 9.171 which were highly significant at 1% level of probability implying that all the explanatory variables were important for explaining the variations in gross returns of the Binadhan-11. The return to scale was 1.084 in case of Binadhan-11 meaning increasing returns to scale. This means that, 1 percent increase in all inputs simultaneously would result on average 1.084% increase in gross return of Binadhan-11. The first ranked constraint was inadequate supply of quality seeds (66%). Other constraints were lack of knowledge about recommended production technology (41.78%), non-availability of sufficient labour in time (36.52%) and others (33.06%). In order to decrease the yield gap at farm level, the Government should ensure timely adequate supply of quality or adulteration free inputs. Frequent interaction was needed among farmers, extension personnel and farmers. Hand-on training on production and crop management practices for the Binadhan-11 growing farmers is also important. Ensuring labour facilities during harvesting time influence farmers to a greater extent to reduce yield gap. The study found that in Bangladesh, we are losing 1.43 t ha^{-1} (28.10%) yield of Binadhan-11 in *Aman* season. If we could reduce these gaps, our total production per year will be increased which will support in achieving food security.

Financial profitability of Binadhan-17 in some selected areas of Bangladesh

In total, 250 farmers were interviewed for the profitability of Binadhan-17 study. The average costs of Binadhan-17 cultivation were Tk. 79770 and Tk. 51904 per hectare on full cost and cash cost basis, respectively. The highest production cost was for human labour (55.4%), followed by land use cost (11%), power tiller (9.3%), and irrigation (5.1%). The cost of Binadhan-17 cultivation was found highest in Mymensingh (Tk. 81180 ha^{-1}) followed by that in Bogura (Tk. 80221 ha^{-1}), Rangpur (Tk. 78911 ha^{-1}), Gaibandha (Tk. 78317 ha^{-1} and Kurigram (Tk. 76297 ha^{-1}), respectively. The average yield of Binadhan-17 was 5552 kg ha^{-1}. The yield was highest at

Rangpur (5743 kg ha^{-1}) followed by Kurigram (5660 kg ha^{-1}), Gaibandha (5514 kg ha^{-1}), Mymensingh (5441 kg ha^{-1}) and Bogura (5401 kg ha^{-1}). The average gross margin was found Tk. 71051 ha^{-1} on variable cost basis. Gross margin was highest in Rangpur (Tk. 81700 ha^{-1}) followed by Kurigram (Tk. 76940 ha^{-1}), Gaibandha (Tk. 72409 ha^{-1}), Mymensingh (Tk. 62979 ha^{-1}) and Bogura (Tk. 61228 ha^{-1}), respectively. The net return was highest in Rangpur (Tk. 53285 ha^{-1}) followed by Kurigram (Tk. 48123 ha^{-1}), Gaibandha (Tk. 43631 ha^{-1}), Mymensingh (Tk. 34568 ha^{-1}) and Bogura (Tk. 34364 ha^{-1}), respectively. BCR was estimated at 1.54 and 2.41 on full cost and variable cost basis implying that the Binadhan-17 cultivation at farm level was profitable. The regression coefficients for human labor for Binadhan-17 under all areas were positive and significant. The coefficient for human labor of Mymensingh, Gaibandha and Bogura districts were significant at 5% level and Rangpur and Kurigram district were significant at 1% level. The coefficient of power tiller cost in Rangpur, Kurigram and Gaibandhan districts were found to be significant at 5% level. On the contrary, the coefficient of power tiller cost under Mymensingh and Bogura district was positive but not significant. Coefficients for fertilizers and irrigation were found to be positively significant at 10% level. Coefficient of insecticides and weeding out cost were positively significant at 5% level under all areas. The coefficient of seedling cost of the Binadhan-17 production was statistically significant at 5% level of significance for Rangpur and Kurigram district and was statistically significant at 10% level of significance for Mymensingh, Gaibandha and Bogura districts. The value of R^2 under all areas were 0.781, 0.832, 0.771, 0.810 and 0.795 for Mymensingh, Rangpur, Kurigram, Gaibandha and Bogura districts, respectively. This means that around 78, 83, 77, 81 and 80 percent of the variations in gross return for Binadhan-17, respectively were explained by the independent variables included in the model. The average return to scale was 1.0608 meaning increasing returns to scale. The average F-value was 9.639 which was highly significant at 1% level. The first ranked constraint was unavailability of Binadhan-17 varieties' seeds in all areas (90%). Other constraints were lack of proper training (74%), lack of capital (54%), lack of technical know-how (37%) and lack of storage facility (21%).

Production and marketing system of Binasarisha-11 in some selected areas of Bangladesh

A total of 180 sample taking 60 from each district and among the 60 samples 30 farmers and 30 traders/intermediaries were selected from each district. The average costs of Binasarisha-11 cultivation were Tk. 55290 ha^{-1} and Tk. 36670 ha^{-1} on full cost and cash cost basis, respectively. The highest production cost was for hired labour (20.9%) followed by family labour (18.1%), land preparation (15.8 %) and land use cost (15.5%). The cost of Binasarisha-11 cultivation was found highest in Magura (Tk. 57568 ha^{-1}) followed by that in Jamalpur (Tk. 54541 ha^{-1}) and Rangpur (Tk. 53763 ha^{-1}), respectively. The average yield of Binasarisha-11 was 1576 kg ha^{-1}. The yield was highest in Rangpur (1715 kg ha^{-1}) followed by Jamalpur (1692 kg/ha) and Magura (1320 kg ha^{-1}). The average gross margin was found Tk. 69912 ha^{-1} on variable cost basis. Gross margin was highest in Rangpur (Tk. 81846 ha^{-1}) followed by Jamalpur (Tk. 78061 ha^{-1}) and Magura (Tk. 49827 ha^{-1}), respectively. The average net return was Tk. 51291 ha^{-1}. The net return was highest in Rangpur (Tk. 62857 ha^{-1}) followed by Jamalpur (Tk. 58823 ha^{-1}) and Magura (Tk. 32192 ha^{-1}), respectively. BCR was assessed at 1.94 and 2.93 on full cost and variable cost basis implying that

the Binasarisha-11 cultivation at farm level was profitable. The per quintal marketing cost of Binasarisha-11 of different actors like Faria for Tk. 188, Bepari for Tk. 277, Arathdar for Tk. 258, Stockist for Tk. 1123, Paiker for Tk. 430 and Retailer for Tk. 253. The major marketing chain was found in the study areas:

Chain-I: Farmer>Faria>Arathdar>Paiker>Stockist>Millier>Consumer.

Chain-II:Retailer>Consumer.Chain-IV:Farmer>Paiker>Retailer>Consumer.Chain-V:Farmer>Retailer>Consumer. Chain-I incurred the highest marketing cost (Tk. 1330/100 kg) followed by Chain-II (Tk. 1188/100 kg), Chain-III (Tk. 1123 and Chain-IV (Tk. 675/100 kg). Lowest marketing cost was found in Chain-V (Tk. 440/100 kg). Highest numbers of intermediaries were involved in Chain-I which was the main reasons for higher marketing cost. The net margin of the actors like Faria for Tk. 112, Bepari for Tk. 213, Arathdar for Tk. 232, Stockist for Tk. 1027, Paiker for Tk. 191 and Retailer for Tk. 367 per 100 kg. Among the intermediaries the stockiest added highest margin followed by Retailer, Arathdar, Bepari, Paiker and Faria. Farmers' share in consumer prices of Binasarisha-11 was the highest in Chain-V followed by Chain-IV, Chain-III and Chain-II and was lowest in Chain-I. It indicated that if farmers' would sell their mustard through Farmer>Retailer>Consumer, they would be most benefited. The Chain-I of Binasarisha-11 marketing has incurred highest marketing cost whereas the lowest in case of Chain-v. It reveals if farmers' sell their mustard through Farmer>Faria>Arathdar>Paiker>Stockist>Millier>Consumer, the marketing cost becomes high (Chain-I). If farmer sell their product through Chain-V (Farmer>Retailer>Consumer) then the marketing cost is the lowest. It was found that the highest marketing margin in Chain-II and the lowest in Chain-V. The first ranked problem was unavailability of seeds (89%). Other problems were lack of training (78%), high price of fertilizer (51%), lack of capital (32%) and lack of technical know-how (20%). The intermediaries were faces different marketing problems and 87% percent farmers were suffered unstable price during their business but 76% farmers had to paid high charge for transportation followed by lack of market facilities (68%) and lack of capital (51%).

Costs and return analysis of Binahalud-1 in some selected areas of Bangladesh

A total of 150 farmers were randomly selected for the study area, 50 from each district for costs and return analysis of Binahalud-1. The average costs of Binahalud-1 cultivation were Tk. 153715 and Tk. 103169 ha^{-1} on full cost and cash cost basis, respectively. The highest production cost per hectare was for human labour Tk. 114185, followed by seed Tk. 13421, land use cost Tk. 8012 and power tiller Tk. 4202. The cost of Binahalud-1 cultivation was found highest in Mymensingh (Tk. 159458 ha^{-1}) followed by that in Tangail (Tk. 155860 ha^{-1}) and Khagrachari (Tk. 145826 ha^{-1}), respectively. The average yield of Binadhan-22 was 5133 kg ha^{-1}. The yield was highest in Rangpur (5259 kg ha^{-1}) followed by Bogura (5162 kg ha^{-1}), Mymensingh (5101 kg ha^{-1}) and Naogaon (5011 kg ha^{-1}). The average gross margin was found Tk. 232034 ha^{-1} on variable cost basis. Gross margin was highest in Mymensingh (Tk. 255261 ha^{-1}) followed by Khagrachari (Tk. 237672 ha^{-1}) and Tangail (Tk. 203170 ha^{-1}), respectively. The average net return was Tk. 181488 ha^{-1}. The net return was highest in Mymensingh (Tk. 204682 ha^{-1}) followed by Khagrachari (Tk. 184741 ha^{-1}) and Tangail (Tk. 155043 ha^{-1}), respectively. BCR was estimated at 2.18 and 3.16 on full cost and variable cost basis implying that the Binahalud-1 cultivation at farm level was

profitable. The first ranked constraint was inadequate finance in all areas. Other constraints were insect, pest and disease attack (78%), non-availability of transport (40%) and lack of technical know-how (15%).

Area coverage of BINA developed rice, pulse, oilseed and horticultural varieties in Bangladesh

From area coverage study, it was observed that the overall area coverage of BINA developed rice varieties were 9.97%. Among the three seasons; Aus, Aman and Boro the highest area coverage was found in Aman season that was 15.49% followed by Aus 11.15%, and Boro 3.12% respectively. In Aman season, the highest coverage was 8.78% for Binadhan-17 and the lowest was 0.0002% for Binadhan-13. In Boro season, the highest coverage was 1.27% for Binadhan-10 and the lowest was 0.01% for Binadhan-5. In Aus season, the highest coverage was 8.70% for Binadhan-19 and the lowest was 0.01% for Iratom-24. The overall area coverage of BINA developed pulse varieties were 8.85%. The highest area as well as coverage was found 15.36 % for Binamoog-8, respectively and lowest was seen 0.001% in case of Binasola-4 and among the 14 regions the highest area coverage for pulses was found Barishal region 54.51% (Reg-6) and the lowest was found Rangamati region 0.001% (Reg-4), respectively. The overall area coverage of BINA developed oilseed varieties were 22.35%. The highest area coverage was found 22.38% for Binachinabadam-4 and the lowest 0.001% was seen in case of BINA Sarisha12 and among the 14 regions the highest area coverage for oilseed was found in Jashore region 12.53% (Reg-13) and the lowest was found in Rangamati region 0.73% (Reg-4). Area coverage of BINA developed horticultural crop varieties were 0.17%. The highest area coverage was found 4.58% for Binalebu-1 and the lowest was found 0.06% for Binalebu-2 and among the 14 regions the highest area coverage for horticultural crop was found 495.00ha (49.48%) in Rangamati agricultural region (region-4) and the lowest was found 0.001% in Dhaka region (region-11). For more expansion of the variety, it is necessary to ensure the seed demand at proper time. Besides, more training and demonstration should be emphasized. It is essential to promote collaboration among research, DAE, BADC, NGOs and private sector to more dissemination of the varieties.

REGIONAL STATION AND SUB-STATIONS

BINA Regional Research Center, Gazipur

Regional yield trial of Bottle gourd mutant line at farmer's field

Two advanced mutant lines of bottle gourd were evaluated at BINA Regional Research Center, Gazipur; BINA substation Khagrachari, Sunamganj and Ishurdi during rabi season 2023-2024 to evaluate the performance of promising mutant lines of bottle gourd. The experiment was conducted at BINA Regional Research Center, Gazipur; BINA substation Khagrachari, Sunamganj and Ishurdi during rabi season 2023-2024 to evaluate the performance of promising mutant lines of bottle gourd. The seeds of these selected mutants were sown on the pit on November 9th, 2023. The experiment was laid out in a Randomized Complete Block design with three replications. The unit plot size was 10.0 x 2.0m maintaining 2.0 x 2.5m spacing between two adjacent block and 0.5m drain between two adjacent plots. The land was fertilized with cow dung, N, P, K, S, B and Zn @ 100, 80, 45, 88, 25, 1.8 and 4.5 kg/ha, respectively. Results showed that at BINA Regional Research Center, Gazipur, the mutant line BL-4$M_7D_{150}P_{3-3}$ produced maximum in individual fruits plant^{-1} (16.67), fruit weight (4.57 kg) and the yield (84.29 tha^{-1}) which is dark green with whitish spot. In the other hand minimum fruits plant^{-1} (9.67), fruit weight (2.93 kg) and the yield (50.87 tha^{-1}) were produced by BARI Lau-4 followed by BL-4$M_7D_{300}P_{4-2}$. At Khagrachari, the mutant line BL-4$M_7D_{150}P_{3-3}$ also produced maximum fruits plant^{-1} (16), fruit weight (4.50 kg) and the yield (82.98 t ha^{-1}) which is dark green with whitish spot in colour and the minimum fruits plant^{-1} (11.00), fruit weight (3.06 kg) and the yield (55.37 t ha^{-1}) was recorded by BARI Lau-4. At Sunamganj, the mutant line BL-4$M_7D_{150}P_{3-3}$ also produced maximum fruits plant^{-1} (15.67), fruit weight (4.55 kg) and the yield (84.35 t ha^{-1}) which is dark green with whitish spot in colour and the minimum fruits plant^{-1} (9.33), fruit weight (3.21 kg) and the yield (50.95 t ha^{-1}) was recorded by BARI Lau-4. At Ishurdi, the mutant line BL-4$M_7D_{150}P_{3-3}$ also produced maximum fruits plant^{-1} (16.33), fruit weight (4.47 kg) and the yield (83.25 t ha^{-1}) which is dark green with whitish spot in colour and the minimum fruits plant^{-1} (10.00), fruit weight (3.23 kg) and the yield (51.48 t ha^{-1}) was recorded by BARI Lau-4. Considering yield potentiality, fruit color, acceptable fruit shape (bottle) and taste two advanced mutant lines viz., BL-$_4M_7D_{150}P_{3-3}$ (proposed BINAlau-1) and BL-$_4M_7D_{300}P_{4-2}$were found promising which may be selected for further nutritional analysis.

Up-scaling of BINA developed crop varieties in Gazipur region

A total of 508 demonstrations (33 decimal/demonstration) of BINA developed aman rice, mustard, sesame, boro rice, aus rice, turmeric and groundnut varieties to observe the yield performance and spreading its adoption by the farmers in Dhaka, Gazipur, Tangail, Narsingdi, Munshiganj and Manikganj district were conducted at the farmer's fields during 2023-24 in Gazipur region through BRRC, Gazipur and DAE. The main objective of these demonstrations was to observe the yield performance and widening its adoption by the farmers in this region. The demonstration plot was 33 decimals with recommended spacing. Application of fertilizer and intercultural operations were done following the BINA recommendations. Based on the collected reports from DAE and crop cutting data of demonstration plots BINA developed aman rice varieties Binadhan-16, Binadhan-17, Binadhan-20 and Binadhan-22 produced higher yield in farmers field and becoming popular in Gazipur, Manikganj, Narsingdi, Dhaka and Tangail as they

get enough time to cultivate oil crops. In case of mustard varieties Binasarisha-11 and Binasarisha-9 produced higher yield in farmers field. Binatil-2, Binatil-4, Binadhan-14, Binadhan-24, BINA Dhan25, Binadhan-19, Binadhan-21, Binachinabadam-8 and Binachinabadam-9 produced higher yield and becoming popular in Gazipur, Dhaka, Munshiganj, Narsindi, Manikganj and Tangail.

Validation trial of mustard varities with zero tillage and optimum tillage in Tangail, Gazipur and Manikganj district

To popularize the conservation agriculture and reduce production cost and time; two modern varieties of mustard viz. Binasarisha-9 and BARI Sarisha-14 were evaluated following a RCB design with four dispersed locations Horirampur, Mirzapur, Kalihati and Kaliganj during rabi season of 2023-24. Unit plot size was 1 bigha for each variety. The seeds were broadcasted after harvesting of aman rice @ 1 kg/bigha on 22th November 2023. All sorts of fertilizer were applied as per FRG'2018 using medium soil analysis interpretation level. Yield and yield attributes were taken after final harvesting of the crop plants. Findings disclosed that, the highest seed yield was obtained from Binasarisha-9 (1.38 tha^{-1}) and the lowest seed yield was obtained from BARI Sarisha-14 (1.1 t ha^{-1}). The shorter life cycle was seen with BARI Sarisha-14 (78.2 days) and Binasarisha-9 (85.4 days) . The yield under optimum tillage was 13.77% higher than zero tillage condition and the expenditure was double compare to zero tillage. Now, farmers were very much interested towards the zero-tillage cultivation technique of mustard as it lets them time to prepare for next crops (boro rice). But they needed some proven technology for the agronomic management of the crops i.e. time of weeding, thinning considerations, pesticide spray, fertilizer management etc. to gain the potential yield of the mustard cultivars.

In addition, BINA Regional Research Center, Gazipur is trying to develop a new cropping pattern fallow – mustard (Binasarisha-9 in zero tillage) – Boro (Binadhan-24) instead of (fallow–fallow–boro) pattern using BINA released technology.

Evaluation of improve cropping pattern in Gazipur region

Determination of profitable cropping pattern in farmers' fields at Gazipur region different proposed cropping pattern were conducted along with existing cropping pattern during 2023-2024 at Gazipur.

Existing Cropping Pattern: Aman – Fallow - Boro rice
Improved Cropping pattern: Aman (Binadhan-17) – Mustard (Binasarisha-11) – Boro (Binadhan-24)
Time period: Year round 2023-24.
Experiments were conducted in the different locations of Shreepur and Kapasia upazila in Gazipur. Land size of the proposed patterns on which experiment was done was 1 bigha (33 decimal) for each pattern. For land preparation, planting method, plating time, weeding, pest control, irrigation, fertilization, rouguing, harvesting, etc. farmers local practice was used.

From the above studied cropping patterns Aman (Binadhan-17) – Mustard (Binasarisha-11) – Boro (Binadhan-24) rice (improved cropping pattern) was found more profitable compared to Aman (Ranjit) – Fallow – Boro (BRRI Dhan-28/29) rice (existing cropping pattern). Hence, further research work is needed to justify this in greater area/region to get the more accuracy in

case of above statement. Farmers expressed their reactions to execute such type of cropping patterns again for the consecutive years.

Current Status, Challenges and Potentiality of Binasarisha-11

During Rabi season of 2023-24, an experiment with Binasarisha-11 was conducted at farmers' fields in different locations of Gazipur and Tangail district. The main objective was to find out the performance of this variety during Rabi season for expanding it's cultivated area. Area of each plot was 0.33 acre. The result revealed that Binasarisha-11 performed well in most of the selected location. Even some late sowing incidence showed better yield compared to the check variety. Farmers could utilize the fallow land after Aman season. Some farmers cultivated this mustard variety after BINA developed short duration Aman variety to harvest the highest advantage. Farmers opined that having good quality seed and determining sowing time to avoid cold injury are greater challenges for them. Result indicated that Binasarisha-11 has done impressive having the highest yield potential in this area. The average grain yield was 1.73 t/ha with maturity period of 85 days. Greater potentials are there for area coverage extension. Binasarisha-11 is one of the best suited mustard variety in Gazipur and Tangail district. Sowing date and germination rate should be checked for greater result.

Head-to-head adaptive trial (one bigha/trial) of existing potential variety and BINA released improved varieties

Three head-to-head adaptive trials were conducted by the BINA Regional Research Center, Gazipur. Treatment was existing potential variety and improved BINA released variety. BINA Dhan25 performed best than Binadhan-24 and BRRI dhan89 in all aspects. Binasarisha-11variety had shown high demand for early maturity and higher yield.

Breeder and TLS seed production

Breeder and truthfully labeled seed (TLS) were produced at the regional research center farm of Gazipur according to the requisition from different division of BINA head quarter. The regional research center also produced few amounts of seeds on the basis of land availability after producing demanding seed by the divisions of head quarter. Seeds of BINA released crop varieties popular in Gazipur, Dhaka, Manikganj, Narsingdi, Munshiganj and Tangail region were produced at the regional research center farms and also in the farmer's fields of different locations and part of those seeds were purchased during 2023-24. A total of 2141kg seeds were produced where 50 kg were breeder seeds and 2091 kg were TLS at BINA regional research center, Gazipur during 2023-24.

Workshop (2023-24)

During the year 2023-24, one workshop programs were organized where 150 different level officers of DAE, DG's and scientists from different NARS institutes, Officers from SCA, BADC, NGO and other stakeholders were present in the workshop and gave their valuable comments and suggestions.

Farmer's training (2023-24)

During the year 2023-24 one workshop, eight farmer's and SAAO's training programs, six field day programs were organized where 380 farmers and 42 Sub Assistant Agriculture Officers (SAAO) were trained.

Field Days (2023-24)

In field day programs, **600** farmers and **18** Sub Assistant Agriculture Officers (SAAO) were present and informed about BINA's popular high yielding varieties.

Germplasm collection

Furthermore, twelve germplasm of different fruits and spices were collected from Gazipur region and conserved as future breeding materials to see their inherent characteristics for further irradiation process.

BINA Sub Station, Rangpur

1. A large number of M_2 variants developed from different irradiated materials with two checks BARI Kawn-2 and BARI Kawn-4. A total of 38 true breeding mutants were selected primarily for evaluation in respective advanced generation based on their agronomic and field performance.
2. Twenty-one aromatic rice germplasm were collected from greater Dinajpur and grown with aim to characterize these germplasms.
3. A comparative evaluation trial was done and found that Binadhan-17 and BRRI dhan75 mature earlier compared to other varieties. Binadhan-16 took the lowest duration though it was very low yielder. The highest grain yield was recorded in BRRI dhan103 whereas the lowest in Binadhan-16. Regarding the location wise comparison, all the test varieties gave the highest seed yield in BRRI regional station, Rangpur followed by BINA Rangpur and BWMRI, Dinajpur.
4. Four crops based cropping pattern in char land ecosystem instead of three crops had the larger BCR which will enhance the farmers income.
5. Total of 17 block demonstrations were conducted with BINA released rice, mustard and groundnut varieties in Rangpur and Dinajpur region during 2023-24.
6. A total of 473 demonstrations and 4 head to head trials were conducted with BINA released rice, mustard, sesame, lemon and groundnut varieties in Rangpur and Dinajpur region during 2023-24.
7. Conducted 13 training/workshop and 05 field day at different location on different topic and crops during 2023-24.

Bina Sub-station, Ishurdi

Experiment-1: Comparative performance of Binamoog-8, Binamoog-9 and BARI mung-6.

The objectives of this experiment were to evaluate the overall performance of these varieties. The experiment was conducted with three mungbean varieties (Binamoog-8, Binamoog-9 and BARI mung-6) during kharif-1 season of 2024 at BINA substation farm, Ishurdi. Data on days to maturity, plant height, pod plant^{-1}, pod length, seeds plant^{-1} and yield were recorded from five randomly selected plants from each plot. Mean values were used for statistical analysis. It was observed from the result that Binamoog-9 had shorter plant height than other varieties. The highest number of pod plant^{-1}, pod length, seed pod^{-1} and seed yield were produced Binamoog-9 (1.56 tha^{-1}) than Binamoog-8 (1.45 tha^{-1}) and BARI mung-6 (1.33 tha^{-1}). Based on the present findings Binamoog-9 can ensure better yield with the highest economic return for the farmers.

Experiment-2: Yield Performance of Binasola-7, Binasola-11 and BARI Chola-10

The experiment was conducted with three chickpea varieties (Binasola-7, Binasola-11 and BARI Chola-10) during the Rabi season 2023-24 at BINA Sub-station Farm, Ishurdi, Pabna to study yield performance.

Variety exerted significant effect on total number of branches plant^{-1}. Among the three varieties, the highest number of branches was recorded in Binasola-11 (2.80) while the lowest number of branches plant^{-1} recorded in BARI Chola-10 (2.33). The number of pods ranged from 31.80 to 48.67. The highest pod number (85.67) was obtained from Binasola-11 followed by Binasola-7 (81.47) and BARI Chola-10 (51.20). The highest number of seeds pod^{-1} was recorded in the variety Binasola-11 (1.70) and the lowest number of seeds pod^{-1} (1.06) was found in Binasola-7. The highest yield (2.35 tha^{-1}) was obtained from the variety Binasola-11 followed by Binasola-7 and BARI Chola-10. Based on the present findings Binasola-11 can ensure better yield with the highest economic return for the farmers.

Experiment-3: Study on the performance of cropping pattern

The experiments were conducted at farmers field i. Esta, Ishurdi, Pabna ii. Lalpur, Natore during the year 2023-2024 to develop an economically profitable cropping pattern against the existing. . In the improved cropping pattern BINA released

varieties (Binadhan-17, Binasarisha-11 and BINA dhan25 in CP-1 and Binadhan-17, Binamasur-8 and Binatil-2 in CP-2) were cultivated.

In CP_1 T. Aman-Mustard-Boro was cultivated under improved cropping pattern whereas T. Aman-Fallow-Boro was cultivated under existing cropping pattern. In CP_2 T. Aman-Lentil-Sesame was cultivated under improved cropping pattern whereas T. Aman-Lentil-Fallow was cultivated under existing cropping pattern. In the study the BCR (1.41) were same in both the cropping patterns but the REV was highest in CP_1 (17.95) than the CP_2 (15.57).

BINA Sub-Station, Magura

Report on BINA Sub-Station Magura Research Activities in Jashore Region (2023-24)

Highlights

The Bangladesh Institute of Nuclear Agriculture (BINA) Sub-Station, Magura, conducted 50 experiments in collaboration with BINA Headquarters during the 2023-24 reporting year. These trials, held at the Magura farm and farmer fields in the Jashore region, included yield performance assessments of mutant rice lines ZM-611 and ZM-231 for future release. Additionally, M2 populations of irradiated red rice were harvested for M3 generation trials, and local rice germplasm Rod Miniket was collected. Prominent findings included the yield performance of Binadhan-17, producing 7.69 t/ha during the Boro season under AWD irrigation, and BARI Sarisha-14, which achieved the highest seed yield of 1.53 t/ha under waterlogged conditions. Binasarisha-9, Binadhan-17, and BINA dhan25 demonstrated favorable yields across different seasons. Block demonstrations were conducted on lentil, mustard, groundnut, rice, and sesame varieties, with Binamasur-8, Binachinabadam-6, and Binatil-2 achieving notable results. A total of 359 demonstration trials were conducted with BINA-released crop varieties across the Jashore region during the Aman, Rabi, Boro, Kharif-I, and Aus seasons in 2023-24. During the reporting year, a total of 33.00 tons of seeds from various popular BINA-released varieties were produced at the BINA Sub-Station in Magura, as well as by contract growers. BINA also provided training to 625 farmers, seed dealers, and SAAOs in the Jashore region to promote best practices for crop production and seed management. These comprehensive efforts contributed to advancing crop productivity and agricultural practices in the Jashore region.

Experiment 01. Advanced yield trial with high yielding and early maturing rice lines

A field experiment was conducted to evaluate the performance of three mutant lines (ZM-231, ZM-421, and ZM-611) of Indian Zirashail rice, developed through gamma irradiation (200 Gy), in comparison to the check variety BRRI dhan96. The study was carried out at BINA Sub-station farms in Magura, Cumilla, and Sunamganj, as well as a farmer's field in Magura, using a Randomized Complete Block design. Data on plant height, tiller number, panicle length, grain filling, and yield were collected. Results showed significant variations among the mutant lines and the check variety. Mutants ZM-611 and ZM-421 had significantly higher filled grain numbers (204), while ZM-611 produced the highest yield (7.02 t ha^{1}) across locations, followed by ZM-421 (6.93 t ha^{1}) and ZM-231 (6.73 t ha^{1}), outperforming the check (6.41 t ha^{1}). Based on yield performance, ZM-611 and ZM-231 are recommended for further trials.

Experiment 02. Growing M_2 generation of rice for earliness and higher yield

In an effort to create genetic variability, seeds of an exotic red rice variety were irradiated with gamma rays at doses of 100, 200, 250, 300, and 350 Gy. The seeds were sown on 24th December 2023 and transplanted on 10th January 2024 at BINA Sub-Station farm, Magura, alongside the parent variety. The experiment was conducted using a non-replicated design, with the seeds sown

separately according to dose and variety. Basal fertilizers were applied, and intercultural practices were carried out as needed. The irradiated rice plants that survived and produced seeds were harvested in bulk for developing the M3 population.

Experiment 03. Collection and evaluation of Germplasm of different crops

An experiment was conducted to assess the yield potential and morpho-physiological attributes of the local rice cultivar, Rod Miniket, across different seasons during 2023-24 at BINA Sub-Station farm, Magura. The experiment followed a non-replicated design with seeds sown separately based on the variety. Basal fertilizers were applied, and necessary intercultural practices were followed. Data on plant height, duration, and seed yield were recorded at harvest. The results provide insights into the seasonal performance of Rod Miniket in terms of growth and productivity.

Experiment 04. Effect of different durations of water-logging at different growth stages on seed yield of Binasarisha-9, Binasarisha-11 and BARI Sarisha14

The experiment aimed to assess the water tolerance of conventional mustard varieties by studying the effects of varying durations of water-logging on seed yield. Conducted at BINA Sub-Station, Magura, during Rabi 2023-24, the experiment tested three varieties: Binasarisha-9, Binasarisha-11, and BARI Sarisha-14, using a randomized complete block design with split plots and three replications. Water-logging treatments were applied at different growth stages, and plant height, branch number, siliquae per plant, and seed yield were recorded. BARI Sarisha-14 produced the highest seed yield (1.53 t/ha) under 2-day water-logging at seed sowing, while Binasarisha-9 showed better performance under prolonged water-logging. Minor variations in maturity duration were observed. The study will be repeated to confirm these findings.

Experiment 05. Evaluation of Binadhan-17, Binadhan-24 & BINA dhan25 under different 'soil moisture stress/drought tolerance level' in Boro season

An experiment was conducted at BINA Sub-Station, Magura during the Boro season of 2023-24 to evaluate the performance of three rice varieties—Binadhan-17, Binadhan-24, and BINA dhan25—under different irrigation regimes. The experiment followed a randomized complete block design with split plots and three replications. Three irrigation treatments were applied: normal irrigation (3 days AWD), irrigation at 7 days AWD, and irrigation at 15 days AWD. Data on plant height, panicle length, tiller number, grain count, unfilled grains, 1000-seed weight, and yield were collected. Results showed that Binadhan-17 with irrigation at 7 days AWD produced the highest seed yield (7.69 t/ha), followed closely by Binadhan-24 under 15 days AWD (7.65 t/ha). The lowest yield (5.09 t/ha) was observed for BINA dhan25 under 7 days AWD. The study suggests that Binadhan-17, a popular T. aman variety, performs well in the Boro season with low water demand. The experiment will be repeated for further validation.

Dissemination of BINA varieties/Technologies

Experiment 06. Block farming with BINA varieties/technologies

A total of five block demonstrations were conducted during the Rabi season of 2023-24 in Jashore (Magura and Chuadanga) region to evaluate the performance of three BINA-developed lentil varieties—Binamasur-8, Binamasur-9, and Binamasur-10—against the check variety, BARI Masur-6. The experiment covered 2.00 acres per block, with proper seed treatment, balanced fertilizers, and intercultural practices applied. Results showed that all three BINA varieties outperformed the check variety in both yield and maturity duration. Binamasur-8 matured 8 days earlier than the check and produced a 23.51% higher yield (1.84 t/ha vs. 1.49 t/ha). Similarly, Binamasur-9 and Binamasur-10 showed yield increases of 20.48% and 10.24%, respectively, over the check. The study concludes that these BINA-developed varieties are more productive and should be cultivated widely in the Jashore region for higher yields.

Experiment 07. Dissemination of BINA varieties/Technologies

A total of 359 block demonstrations were conducted across multiple seasons in 2023-24 to assess the performance of various BINA-developed crop varieties. The varieties tested included rice (Binadhan-17, BINA dhan25, Binadhan-21), mustard (Binasarisha-9, Binasarisha-11), lentils (Binamasur-8, Binamasur-9, Binamasur-10), groundnut (Binachinabadam-4, Binachinabadam-6), and sesame (Binatil-1, Binatil-2, Binatil-3, Binatil-4). Results revealed that BINA dhan25 performed best in Boro season with a yield of 7.21 t/ha, while Binachinabadam-6 had the highest groundnut yield of 2.41 t/ha. Among the mustard varieties, Binasarisha-9 achieved the highest yield (1.50 t/ha). Binamasur-8, Binamasur-9, and Binamasur-10 showed promising performance in lentil production, with yields up to 1.68 t/ha. These results highlight the superior yield and performance of BINA-developed varieties across different crop seasons and regions.

Development of suitable and profitable cropping patterns with BINA released varieties/technologies

Pattern Experiment 01. Development of a 3-crop based cropping pattern at 6 districts of Jashore region with BINA developed crop varieties

The experiment was conducted across six districts in the Jashore region (Magura, Jashore, Jhenaidah, Chuadanga, Meherpur, and Kushtia) during 2023-24 to assess the impact of BINA-developed varieties in a three-crop-based pattern. The cropping pattern included T. Aman (Binadhan-11, Binadhan-17, Binadhan-22), mustard (Binasarisha-11), and Boro (BINA dhan25). The study followed a randomized complete block design (RCBD) with three dispersed replications across different locations. The cropping cycle took 346 days to complete, increasing the cropping intensity from 200% to 300% by introducing mustard between T. Aman and Boro rice. Data were collected on crop duration and seed yield, demonstrating the effectiveness of the sequence in enhancing land use and productivity.

Pattern Experiment 02. Development of a 4-crop based cropping pattern at Sadar, Jhenaidah with BINA developed crop varieties

The experiment was conducted at Sadar upazila of Jhenaidah district during 2023-24 to evaluate a four-crop-based cropping pattern using BINA-developed varieties. Existing cropping pattern was T. Aman, Mustard and Boro. The cropping pattern included T. Aman (Binadhan-17), mustard (Binasarisha-9), sesame (Binatil-2), and T. Aus (Binadhan-19). The study followed a randomized complete block design (RCBD) with three dispersed replications across different locations. Fertilizer application and intercultural operations were performed as recommended. The entire cropping cycle, excluding seedling age for T. Aman and T. Aus, took 358 days to complete. Data were collected on crop duration and seed yield (t/ha). This cropping pattern aims to optimize land use and productivity through a year-round rotation of crops.

Pattern Experiment 3. Development of a 4-crop based cropping pattern at Kaliganj, Jhenaidah with BINA developed crop varieties

The experiment was conducted at Kaliganj, Jhenaidah during 2023-24 to assess a four-crop-based cropping pattern using BINA-developed varieties, excluding Boro rice. The pattern included T. Aman (Binadhan-17), mustard (Binasarisha-9), mung bean (Binamoog-8), and T. Aus (Binadhan-19). The study followed a randomized complete block design (RCBD) with three dispersed replications. Fertilizer was applied as recommended, and necessary intercultural operations were carried out. Data were collected on crop duration and seed yield (t/ha) throughout the growing seasons. This pattern aims to enhance cropping intensity and maximize productivity through diversified crop rotations.

Pattern Experiment 4. Development of a 3-crop based cropping pattern at Mohammadpur, Magura with BINA developed crop varieties

The experiment was conducted in Mohammadpur upazila, Magura district, during 2023-24, focusing on a three-crop-based cropping pattern to enhance agricultural productivity. The study commenced in the Kharif-II (T. Aman) season and concluded in Kharif-I season of 2024, utilizing BINA-developed varieties. A randomized complete block design (RCBD) with three dispersed replications was implemented across three locations, with recommended fertilizer doses and necessary intercultural operations applied. The short-duration T. Aman variety Binadhan-11 was selected due to its adaptability to waterlogged conditions often found in the area. Following T. Aman, mustard variety Binasarisha-9 was planted in the Rabi season, and sesame variety Binatil-2 was included in Kharif-I. The total cycle duration for the cropping pattern T. Aman–Mustard–Sesame was 307 days. Results indicated an increase in cropping intensity from 200% to 300%, demonstrating the effectiveness of integrating these crops in the region.

Development of BINA-technology village

Performance of BINA developed crop varieties at Moghi union during 2023-24

The establishment of a BINA Technology Village in Moghi in Sadar, Magura district, demonstrates excellent potential for cultivating rice, pulses, oilseeds, and vegetables. In the T. Aman season, the short-duration variety Binadhan-17 achieved the highest grain yield of 6.25 t/ha, capturing the interest of local farmers. For the Rabi season, farmers showed a preference for BINA-released oilseed varieties, such as Binasarisha-4, 9, and 11, as well as pulse varieties like Binamasur-8 and 10, due to their short duration and high yield potential. Notably, mustard variety Binasarisha-9 and lentil variety Binamasur-8 exhibited remarkable yields and quick maturation. In the Boro season, BINA dhan25 achieved the highest yield of 7.60 t/ha.

Seed production of BINA released crop varieties

The production of various crop varieties in the current season has yielded a total of 33.00 tons of seeds, encompassing both breeder and TLS (Truthfully Labeled Seed) types. Among the rice varieties, Binadhan-17 stands out with a significant production of 10.000 tons as TLS, alongside contributions from other varieties such as Binadhan-7, Binadhan-20, Binadhan-21, Binadhan-22, BINA dhan25, and BINA dhan26. Mustard variety Binasarisha-11 produced 2.750 tons as TLS. Additionally, grass pea variety Binakheshari-1 and Binakheshari-2, black gram varieties BINA Mash2 and BINA Mash3 contributed to the overall seed production with 0.400 tons and 1.150 tons, respectively. Sesame varieties, including Binatil-1, Binatil-2, Binatil-3, and Binatil-4, collectively added 0.880 tons. This diverse production highlights the successful cultivation and variety selection within the region, supporting agricultural sustainability and seed availability.

Training on the use of BINA developed varieties/technologies

To promote the adoption of BINA-developed varieties and technologies, a series of nine training sessions were conducted at various locations, including BINA Sub-station in Magura, and the Department of Agricultural Extension (DAE) in Jashore, Jenaidha and Kushtia. These sessions targeted farmers, both male and female, along with Sub-Assistant Agriculture Officers (SAAOs). Throughout the reporting year 2023-24, a total of 625 participants, including farmers and seed dealers, received training. This initiative aims to enhance agricultural practices and improve the livelihoods of local communities through the effective dissemination of advanced agricultural technologies.

Field Day(s)

To encourage farmers to adopt BINA-developed varieties and technologies, six field days were organized featuring the following crops: Binamasur-8, BINA Mash2, Binatil-2, Binatil-4, Binamoog-8, and Binachinabdam-6. These field days successfully engaged a total of 740 participants, including farmers and agricultural professionals facilitating hands-on learning and direct interaction between farmers and agricultural experts, fostering awareness and encouraging the adoption of these high-yield varieties. Additionally, the field days provided an opportunity for participants to observe the crops' performance and engage in discussions about best practices for cultivation, pest management, and sustainable farming techniques.

BINA Sub-station, Satkhira

Short duration Aman rice varieties seedling age impact on yield and yield attributes

This experiment was conducted at the BINA sub-station farm, Satkhira during the Aman season in 2023 to observe the effect of different seedling ages on the grain yield of BINA-developed Aman rice varieties in the Khulna region. There were eight rice varieties and the seedling age were 15, 25, 35, 45 and 55 days.

Different seedling ages had a significant effect on different parameters among the studied rice varieties. The rice plant produced the highest grain yield in 25 days of seedling followed by 15 days of seedlings and then gradually decreased with the increased seedling age.

In case of varieties, all the tested varieties showed significant differences in different yield contributing characters. The highest grain yield was observed in Binadhan-23 followed by Binadhan-22, Binadhan-20, and Binadhan-17, and the lowest was recorded in Binadhan-16.

Considering the interaction (seeding age × variety) effect on different agronomical traits was found statistically significant. Binadhan-17 produced the highest grain yield in 25 days seedlings followed by Binadhan-22 in 25 days seedlings and Binadhan-23 in 25 days seedlings. Besides, the lowest grain yield was recorded in 55 days of seedling in all the tested varieties and the gradual increase was noticed with decreasing seedling age.

Screening of different Mungbean cultivars in saline prone areas

The experiment was conducted at the BINA sub-station farm, Satkhira during the Kharif-1 in 2024 to find suitable mungbean cultivars for developing new varieties for saline-prone areas in Bangladesh. Nineteen mungbean cultivars were assessed to identify the morphological superiority for grain yield production.

Days to flowering were minimal in Local Harodda and Binamoog-10. The tallest plant was recorded in Binamoog-7, and the shortest plant was found in BARI moog7 cultivars. In addition, the highest number of branches per plant was identified in Binamoog-10 and the lowest number of branches was noted in BARI moog5. Besides, the variety BARI moog5 and BARI moog6 also displayed the longest pod, and the shortest pod was recorded in BARI moog1. The highest number of pods per plant was exhibited by Local tillmoog and BU moog5 produced the lowest number of pods per plant. In contrast, the maximum number of seeds per pod was counted in BARI moog1 but the minimum number of seeds per pod was obtained from BARI moog7. Binamoog-10 showed the highest yield followed by Binamoog-8 and BARI moog6 while BARI moog7 showed the minimum yield.

Growing of M_3 mutant lines of summer mungbean

Mungbean is a major pulse crop in Asia due to its short duration, and adaptation to various cropping systems; it increases tenant farmers' income and improves soil fertility by fixing atmospheric nitrogen through nodulation in roots but the low yield and asynchronous pods formation is a big challenge for cultivation. Therefore, it is important to develop higher-yielding synchronized pod-bearing mungbean varieties.

The experiment was executed at the BINA sub-station farm, Satkhira during the Kharif-1 season in 2024 to find out the genetic variation for synchronous pod maturity with high yielding. The M3 population of Binamoog-8 (300 Gy, 350 Gy, 400 Gy, 450 Gy, and 500 Gy) was grown in line for target selection. In the M3 populations, 13 plants were selected based on plant height, growth duration, pods per plant, and yield per plant. The parent was also included in this experiment. The M4 seeds were collected and stored for future cultivation.

Role of Gypsum application for overcoming salinity stress and maximizing growth and yield of Boro rice

This experiment was conducted at Farmers field in Harinkhola, Tala, Satkhira during Boro season in 2023-24 to evaluate the effect of Gypsum on salinity stress and growth and yield of rice.

Application of Gypsum had a significant effect on growth and yield parameters. The results showed that an application of gypsum 45kg ha^{-1} might be necessary to ensure a satisfactory yield of rice in saline prone area. All the tested varieties showed significant difference in different yield contributing characters but there is no significant variation in number of effective tillers, number of ineffective tillers and grain yield. The interaction effect of the yield and yield-contributing characteristics of two rice varieties subjected to different doses of gypsum. The data shows that gypsum dose has a different impact on various growth and yield parameters across treatments. In case of variety V_1 and V_2, treatment T_2 showed the highest grain yield (6.29-6.39 t/ha) and the filled grains per panicle (146.44-157.44), while treatment T5 showed the lowest yield (4.60 t/ha) and the highest number of unfilled grains per panicle (50.00). So, implementing gypsum treatment, particularly at the proper dose, can significantly mitigate salinity stress and improve rice cultivation outcomes in saline affected regions.

Up-scaling of BINA developed crop varieties in Khulna region

Dissemination of BINA varieties/technologies

A total of 459 demonstrations were conducted at the farmer's fields during 2023-24 in different districts of Khulna region using BINA-developed crop varieties. The main objective of these demonstrations was to observe the yield performance and its adoption by the farmers. Data was collected from DAE personnel and farmer's cultivated different crops.

There were 120 demonstrations distributed throughout the Khulna region at the farmer's field using Aman rice varieties namely, Binadhan-11, Binadhan-17, Binadhan-20, Binadhan-22, and Binadhan-23. Data suggested that Binadhan-17 and Binadhan-22 produced the highest grain yield and became a popular variety in the Khulna region.

About 225 demonstrations were conducted in the Rabi season using BINA-developed mustard, Boro rice, and grass pea varieties. The performance of Binadhan-10, Binadhan-14, Binadhan-24, Binadhan-25, Binasarisha-4, Binasarisha-9, Binasarisha-11 and Binakhesari-1 were promising for Khulna region.

In the kharif-1 season, about 114 demonstrations were distributed in Satkhira, Khulna, and Bagerhat districts using Binamoog-8, Binachinabadam-8, Binatil-2, and Binatil-4. Crop duration and average yield of different cultivated varieties showed that these varieties might be promising for this region.

Recently, BINA sub-station Satkhira introduced some new crop varieties namely BINA dhan25, Binatil-4, and Binachinabadam-8 in the Khulna region, and received a good response from the farmers.

Head-to-head adaptive trial (one bigha/trial) of Existing potential variety and BINA released improved variety

There were three head-to-head adaptive trials were conducted by the BINA substation, Satkhira. Treatment was existing potential variety and improved BINA released variety. Binadhan-17 performed better than BRRI dhan75 in all aspects. BINA sarisha12 variety had shown high

demand for early maturity and higher yield. BINA dhan-10 variety had shown high demand due to high salt tolerance, early maturity and higher yield.

Year-wise (2023-24) TLS production and Distribution

There were about 61 tons of seeds of different BINA-developed crop varieties produced and purchased in the BINA substation farm, Satkhira during 2023-24.

Farmers' training including SAAO

To accelerate the adoption of BINA-developed technologies in the Khulna region, about 375 farmers and 30 Sub-assistant Agriculture Officers (SAAO) were trained on the cultivation procedure of BINA-developed crop varieties in changing climatic conditions.

Field days conducted by BINA substation Satkhira

Besides, there were 08 field days for Binadhan-17, Binadhan-10, BINA dhan25, Binaholud-1, Binachinabadam-8 and Binamoog-8 organized to motivate the farmers in Khulna region.

Workshop conducted by BINA substation Satkhira

There was 01 workshop conducted by BINA substation Satkhira and its location was the Training room, BINA substation Satkhira. Thirty-five Stakeholders from different sectors were present in that workshop.

BINA Sub-station, Barishal

Screening and evaluation of rice lines against two widely grown rice cultivar in boro season at Barishal region

An experiment was carried out at the BINA sub-station, Rahmatpur, Barishal, during the period from December 2023 to April to investigate the suitable Boro rice lines for Barishal region. The experimental site belongs to the Ganges Tidal Floodplain (AEZ 13), having dark grey soil (47) and located at 24º75´ N latitude and 90º50´ E longitude having an altitude of 18m above the mean sea level. Active Ganges Floodplain (3,334 sq km) this region occupies unstable alluvial land and adjoins the Ganges River. Complex mixtures of calcareous sandy, silty and clayey alluvium are found in this area. Soils are low in organic matter and slightly alkaline in reaction. The experimental field was medium high land with moderate drained conditions. The land was sandy loam in texture, having a soil pH value of 6.5, low in organic matter content. Experiment was carried out in a randomized Complete Block Design with 9 cultivars combinations and three replications. The unit plot size was 2m x80 cm. Row and hill spacing was 20 cmx15 cm. The cultivars were used IR99853-72-4-2-1, IR15C1008, IR16F1097, IR16T1405, IR17A3006, IR18A1075, IR17A1633, Binadhan-10 and Binadhan-24. Parameter including days to maturity, plant height, panicle length, number of effective tiller, filled grain per panicle, thousand grain weight and grain yield were recorded.

The line IR17A1633 was observed to be having higher total yielding than the other cultivars in Barishal region. Therefore, line IR17A1633 is recommended for further evaluation at different region of Bangladesh against popular grown cultivar of that region.

Collection and morphomoloecular characterization of T. Aman rice landraces cultivated in Barishal region.

An experiment was conducted at the BINA sub-station, Rahmatpur, Barishal, during the period from June 2023 to Novembere 2024 to investigate the genetic divergence of local rice landraces and to select the source of gene for tidal submergence tolerant for Barishal region. The experiment was carried out in a Randomized Complete Block Design with 15 landraces and three replications. The landraces were used Lalvojon, Skkhorkhora, Vushihara, Chaulamani, Kauathuti, Holdemota, Motadhan, Dudhsona, Dudhkalam, Chinigura, Moulota, Bashfulchikon, BRRI Dhan76, and Sadamota

Variation in grain filling may have occurred due to genetic variation of the varieties. Among the 15 cultivars studied Dudhsona (34.33 gm) and Motadhan (34.33) showed significantly highest thousand seed weight followed by Kauathuti (30 gm) and BRRI dhan77 (27gm). Landraces Motadhan recorded the highest grain yield and second highest yield was produced from Chaulamani. Almost similar grain yield were recorded at BRRI dhan76 and BRRI dhan77. Plant landraces represent heterogenous, local adaptations of domesticated species and thereby provide genetic resources that meet current and new challenges for farming in stressful environment. The landraces Motadhan was observed to be having higher yield than the other local randraces. So, we can use as well as Motadhan and another landraces Sadamota, Holdemota, Dudhsona as a genetic resources or parent material for further evaluation at different place of Barishal districts.

Establishment of BINA technology in Barishal region through block demonstration and quality seed dissemination

A total of 315 demonstrations were conducted at the farmer's fields during 2023-24 in Barishal region using BINA developed different crop varieties. The main objective of these demonstrations was to observe the yield performance and increase its adoption by the farmers in Barishal region. Each demonstration plot was 33 decimals with recommended spacing based on crop varieties. Application of fertilizer and intercultural operations were done following the BINA recommendation.

From BINA substation Barishal total 29740 kg Aman rice, Boro rice, mustard, soybean, groundnut, Binamoog-8, sesame and Binadhan-19 seeds were distributed to the farmers through DAE. Total 800 lemon sapling (Binalabu-1) was distributed to nearest Horticultural center and DAE for distributing to the farmers.

For the dissemination of BINA developed technology in Barishal, 6 farmers training were conducted where 340 farmers (female and male) and 15 Sub-assistant Agriculture Officers (SAAO) were trained on the cultivation procedure of BINA developed Aman rice varieties, and seed storage techniques and production technology of BINA released oil crops varieties. Besides, nine farmers field days were organized on Binadhan-20, Binadhan-10, Binasarisha-4, Binasarisha-9 and Binamoog-8 to motivate the farmers in Barishal region for cultivation.

BINA Sub-station, Cumilla

Experiment 1: Comparative study of some Boro rice cultivars for different transplanting time in Cumilla region

The study aimed to determine the optimal transplanting time for maximizing the yield of six Boro rice cultivars (Binadhan-14, Binadhan-16, Binadhan-17, Binadhan-24, BRRI dhan84, and BINA dhan25) in the Cumilla region, Bangladesh. The experiment was conducted at BINA Substation Cumilla farm using a split-plot design with three replications. Cultivars were transplanted on two dates (December 31, 2023, and January 16, 2024) and evaluated for various agronomic traits, including days to maturity, plant height, panicle length, tiller number, grain yield, and grain quality. Results indicated that transplanting on December 31 significantly increased grain yield compared to January 16. Binadhan-17, BINA dhan25, and Binadhan-24 matured earlier than the other cultivars. Binadhan-24 produced the highest grain yield (7.93 t/ha), followed by Binadhan-17 and BINA dhan25. An interaction effect between transplanting date and cultivar was observed, with Binadhan-16, Binadhan-14, and BRRI dhan84 maturing earlier when transplanted on January 16. BINA dhan25 exhibited the highest yield when transplanted on December 31 but yielded significantly less when transplanted late. Overall, this study suggests that transplanting Boro rice cultivars in the Cumilla region on December 31 can enhance grain yield. Among the evaluated cultivars, Binadhan-24 and Binadhan-17 demonstrated promising performance in terms of both yield and early maturity. These findings provide valuable insights for farmers and agricultural extension workers in optimizing Boro rice production in the region.

Experiment 2: Effect of seedling age & transplanting time on the yield and shattering of Binadhan-14 in Cumilla region

The study aimed to determine the optimal sowing time and seedling age for the late boro variety Binadhan-14. A split-plot design experiment was conducted at BINA Substation, Cumilla, Bangladesh, during 2023-24. Three different seedlings ages (20, 25, and 30 days) were sown at three different times (March 1, 8, and 22, 2024). Various agronomic parameters, including days to maturity, plant height, panicle length, tiller number, grain yield, and shattering, were evaluated. The results revealed that the earliest transplanting date (March 1) produced the highest yield (5.60 t/ha) and the shortest days to maturity (105.89). However, it also exhibited the highest shattering percentage (13.81). The seedling age of 30 days yielded the maximum grain yield (5.60 t/ha) but did not significantly differ from the other ages. The interaction between transplanting date and seedling age indicated that the combination of March 1 transplanting and 20-day seedlings resulted in the highest yield and the lowest shattering. Yield reduces drastically with delayed transplanting. Overall, this study provides valuable insights into the optimal sowing time and seedling age for the late boro variety Binadhan-14 in the Cumilla region. The findings can contribute to improving rice production practices and enhancing farmer income.

Experiment 3: Estimation of appropriate time saving cultivation practice for mustard

The study aimed to investigate time-saving mustard cultivation practices in Cumilla, Bangladesh. A randomized complete block design (RCBD) experiment was conducted at the BINA Substation during the 2023-24 season. Five cultivation practices (relay cropping with aman, zero tillage, zero tillage with mulch, conventional practice with mulch, and conventional practice) and three mustard varieties (Binasarisha-4, Binasarisha-9, and BARI sarisha14) were evaluated. Data on plant growth parameters and seed yield were collected. The results indicated that the conventional practice with mulch produced the highest yield (1.63 t/ha), followed by the conventional practice and relay cropping with aman. Among the varieties, Binasarisha-4 yielded the most (1.44 t/ha). The interaction analysis revealed that BARI Sarisha-14 performed best in the conventional practice with mulch but was not significantly different from

Binasarisha-4 or Binasarisha-9. Relay cropping with aman, particularly using Binasarisha-4, emerged as a promising time-saving practice, increasing cropping intensity and improving yield. Overall, this study concluded that conventional practice with mulching is the most effective method for mustard cultivation in Cumilla, while relay cropping offers a viable alternative for time-constrained farmers.

Experiment 4: Development of profitable four crops-based cropping pattern including oil crop at upland of Cumilla district

The study aimed to develop a profitable four-crop cropping pattern (CP) incorporating oil crops to enhance farmers' income in Muradnagar upazila of Cumilla, Bangladesh. A comparative analysis was conducted between the existing (Aman-Fallow-Boro-Fallow) and proposed (Aman-mustard-Nabi Boro-Aus) cropping patterns. The study was implemented on one bigha (33 decimal) of high and medium-high land under Agro-Ecological Zone 19 from July 2023 to June 2024. Yield data and benefit-cost ratio (BCR) were calculated for both patterns. The proposed CP exhibited a higher total input cost (60%) due to increased cropping intensity. However, it also yielded a significantly higher gross return (91.2%) and net return (182.3%) compared to the existing CP. The BCR for the proposed CP was 1.65, surpassing the existing CP's BCR of 1.32. These findings suggest that the proposed four-crop cropping pattern, incorporating oil crops, offers a promising strategy for improving farmers' income in the study area. By diversifying crop production and optimizing resource utilization, this pattern can contribute to the sustainable development of agriculture in the region.

Experiment 5: Development of profitable four crops-based cropping pattern including oil crop at medium high and high land of Cumilla region

The study aimed to evaluate the economic viability of integrating oil crops (mustard and sesame) into cropping systems in Cumilla, Bangladesh. A proposed cropping pattern (Aman-Mustard-Sesame-Aus) was compared to the existing pattern (Aman-Fallow-Boro). The study was conducted on farmers' fields in Burichang and Chouddogram. Economic parameters such as gross return, net return, and benefit-cost ratio (BCR) were calculated for both patterns. The proposed cropping pattern demonstrated a significantly higher gross return (Tk 6,46,404.4/ha) compared to the existing pattern (Tk 3,915,502.5/ha). The net return was also substantially higher for the proposed pattern (Tk 3,19,965.4/ha) compared to the existing pattern (Tk 1,37,522.5/ha). The BCR for the proposed pattern was 1.98, indicating a more profitable investment compared to the existing pattern with a BCR of 1.54. The findings suggest that integrating oil crops into cropping systems can enhance economic returns for farmers in Cumilla. This approach can contribute to both economic growth and improved health outcomes by promoting the production of nutritious oil crops.

BINA Sub-Station, Gopalganj

Experiment-1: Characterization of local rice variety

In Bangladesh, rice is the main staple food, deeply integrated into the socioeconomic and cultural fabric of the country. Farmers cultivate over 1,000 indigenous rice landraces, valued for their resilience to environmental stresses and adaptability. This preference leads farmers to choose these varieties for fallow fields. A study was conducted in Gopalganj during the 2023 Aman season to evaluate the performance of eleven local rice varieties using a Randomized Complete Block Design. The research assessed various traits, including plant height, effective tillers, panicle length, filled and unfilled grains, 1000-seed weight, and grain yield. Results indicated that the tallest plant height was in the Jabra variety (161.15 cm), while the shortest was in Rangadigha (136.97 cm). Rangadigha also had the highest effective tillers (17.00), while Debmoni had the lowest (9.15). Jabra demonstrated the longest panicle (25.00 cm) and the highest 1000-seed weight (45.10 g). The best grain yield was recorded in Sishumaty (5.70 t ha^{-1}), whereas Kachkalam yielded the least (2.10 t ha^{-1}). This research underscores the importance of assessing indigenous rice varieties for breeding and conservation strategies.

Experiment-2: Comparison between BINA and BARI released mustard varieties

This experiment was carried out to assess yield and agronomic attributes of some mustard varieties in rabi season 2023-24. Seeds of 5 varieties namely, BINA Sarisha12, Binasarisha-11, BARI Sarisha- 14, BARI Sarisha- 17 and BARI Sarisha-18 were sown on 11 November, 2023 at BINA Substation farm, Gopalganj following RCB design with 3 replications. A unit plot size was 2.0 m × 1.0 m for all varieties. Recommended doses of farm yard manure and fertilizers were applied during final land preparation. Results showed that BARI Sarisha-18 was the tallest, while Binasarisha-11 had the highest number of siliqua per plant, indicating strong fruit-bearing capacity. BARI Sarisha-17 produced the most branches. Blooming occurred earlier for all varieties except BARI Sarisha-18. Seed size was largest in BINA Sarisha-12 and BARI Sarisha-18, based on 1000-seed weight. Notably, Binasarisha-11 yielded the highest overall seed yield, benefiting from a greater number of siliqua and seeds per siliqua. The findings indicate significant differences among varieties, suggesting that selection should consider both yield and agronomic traits for optimal mustard cultivation. Further research could examine environmental influences on these varieties.

Experiment-3: Effect of seedling age on growth and yield contributing characters of BINA released *Aman* rice varieties cultivated in Gopalganj region

An experiment was conducted to find out the appropriate time of transplanting and avoid the disease and insect infestation during maturity period of Binadhan-16 and Binadhan-17 at the BINA sub-station, Gopalganj during the Aman season 2023. The trial was laid out in RCBD with 3 replications. Unit plot 3m × 2m having the spacing of 15 cm × 20 cm as plant to plant and row to row respectively. The experiment was conducted at different seedling age (T_1= 15 days, T_2= 20 days, T_3= 25 days, T_4= 30 days). Recommended doses of fertilizer and irrigation was done as per required. Data on plant height, effective tillers, panicle length, filled grains, unfilled grains and seed yield were collected from five randomly selected plants from the field. Finally, the grain yield was converted into t ha^{-1}. The recorded data were finally subjected to proper statistical

analysis. Highest yield (6.22 t ha^{-1}) was recorded in T_1 treatment for Binadhan-16 and highest yield (6.77 t ha^{-1}) was recorded in T_2 treatment for Binadhan-17 and lowest yield was recorded in T_3 in both cases. Therefore, T_1 treatment is appropriate age of seedlings for transplanting of Binadhan-16 and T_2 treatment is appropriate age of seedlings for transplanting of Binadhan-17.

Experiment-4: Development of a profitable Cropping Pattern in Gopalganj Region

An experiment was carried out at the BINA sub-station in Gopalganj to determine a profitable cropping pattern throughout the year across different growing seasons with various crops. The current cropping pattern included T. aman, fallow, and Boro, while the proposed pattern featured T. aman (Binadhan-16), mustard (Binasarisha-9), mungbean (Binamung-8), and T. aus (Binadhan-21). The study was designed using a Randomized Complete Block Design (RCBD) with three replications, and each experimental plot measured 3m × 2m. Intercultural operations were performed as necessary, and phenotypic data were collected from five randomly selected plants in each plot. Yields were measured per ten square meters and converted to tons per hectare (t ha-1). All crops demonstrated improved performance in terms of yield and yield-related characteristics. The yields recorded were 5.4 t ha^{-1} for Binadhan-16, 1.75 t ha^{-1} for Binasarisha-9, 1.78 t ha^{-1} for Binamung-8 and 4.8 t ha^{-1} for Binadhan-21.

Experiment-5: Demonstration results of different BINA varieties over the year (2023-2024) at various locations in Faridpur-Gopalganj region

A total of 540 demonstrations were conducted at the farmer's fields during 2023-24 in Faridpur-Gopalganj region using BINA developed different crop varieties. The main objective of these demonstrations was to observe the yield performance and extend the adoption by the farmers in Faridpur-Gopalganj region. The demonstration plot was 33 decimals with recommended spacing based on crop varieties. Application of fertilizer and intercultural operations were done following the BINA recommendation.

Quality seed production of potential BINA released crops

Seeds of demanding and promising crop varieties of BINA were produced in BINA Sub-station, Gopalganj farm and also in the farmer's field at different locations at the BINA Sub-station, Gopalganj farm in 2023-2024. A total of 3.24 tons of TLS seeds of different BINA varieties were produced in station with proper inspection and finally distributed to all stakeholders.

Training on the use of BINA developed technologies

During 2023-24, in order to disseminate BINA varieties, several trainings were conducted at BINA sub-station and at different UAO office. For performing these training programs UAOs, SAAOs and farmers from different Upazillas were trained up and it was covered the number of 100 SAAOs and 450 Farmers (Male & Female).

Field days

For field motivation of the farmers and technology adoption, Farmers Field Day on BINA developed varieties/technologies were carried out. A total of eight field days on different crop varieties (Binadhan-17, Binasarisha-11, Binamosur-8, Binakhesari-1, Binatil-2, Binachinabadam-6, Binachinabadam-10, and Binadhan-10) were organized in Faridpur-Gopalganj region.

BINA Technology Village

BINA technology village was established at Fukhra, kashiani, Gopalganj. BINA Substation, Gopalganj continuously distributing promising mutant varieties among the farmers for developing existing cropping pattern.

BINA Sub Station, Nalitabari, Sherpur

The combined effect of organic and inorganic fertilizers on the growth and yield of T. Aman rice (Binadhan-17) and mustard (Binasharisha-9 in the T. aman-Mustard-Boro cropping pattern

Combined effect of organic and inorganic fertilizer at the rate of 85% chemical fertilizer with 2 t ha^{-1} Vermicompost resulted in more number of tiller $plant^{-1}$, highest panicle length, more number of filled grain $plant^{-1}$, 1000 seed weight which resulted in greater grain yield as compared to control treatment in T Aman. In case of mustard crop, combined effect of organic and inorganic fertilizer at the rate of 70% chemical fertilizer with 5 t ha^{-1} cowdung resulted in highest plant height, highest number of pod $plant^{-1}$, highest seed pod^{-1} and 1000 seed weight which resulted in greater grain yield as compared to control treatment

Growing of M_3 Population of Pajam and chinishail in Aman season

To select lodging resistant population with shorter duration and high yield but keeping the grain colour and quality same as the parent, seeds of M2 generation of pajam and chinishail were grown at Nalitabari substation following plant-progeny-row method. A total of 39 plants have been selected primarily based on shorter plant height, panicle compactness and higher filled grains for future selection in M_4 generation in two local cultivar pajam and chinishail

Technology Transfer

Block demonstration with different BINA released crop varieties in Sherpur and Netrokona Districts

Fifty demonstration of T. Aman rice varieties Binadhan-11, Binadhan-17, Binadhan-20 and Binadhan-22 produced average grain yield as 4.77, 5.63, 4.15 and 5.61 t ha^{-1} respectively at Sherpur and Netrokona districts. The average maturity period of Binadhan-11 was 120 days, Binadhan-17 was 119 days, Binadhan-20 was 124 days and Binadhan-22 was116 days.

Fifty demonstrations of Aus rice varieties Binadhan-19 and Binadhan-21 produced average grain yield as 4.01 and 3.95 t ha^{-1} respectively. The average maturity period was 98.4 and 103 days respectively.

Fifty five demonstrations of Mustard varieties Binasharisha-11 produced average grain yield of 1.51 t ha^{-1}. The average maturity period was 81 days.

Production of quality seed of BINA released popular crop varieties in Sherpur district

Total 23.5 t of TLS seed of different crops were produced during 2023-24 under Bangladesh Institute of Nuclear Agriculture Sub-station, Nalitabari, Sherpur sub-station, Nalitabari Sherpur.

Training on the use of BINA developed technologies

Six farrmer's training, one SAAO training, one workshop and four field days were conducted at Sherpur and Netrokona districts during 2023-24 year.

BINASub-station, Khagrachari

Research Highlights

- A total number of **06** experiments from BINA Head quarter and **05** experiments of BINA Sub-Station, Khagrachai were conducted and maintained at BINA Sub-Station farm and the farmers' field. Monitoring, data collection, data analyses and reporting were done by respective PI with the help of BINA Sub-Station, Khagrachari.
- Under the validation program, **farmer's observation trial (FOT)** was conducted in 3 locations of Khagrachari. For T. Aman Binadhan-12 performed better in respect of yield (4.8 t/ha) and yield contributing characters than Sylheti Pajam.
- In another **FOT** of T. Aus rice which was conducted also in 3 areas of Khagrachari, Binadhan-19 performed better than Binadhan-21 and a local variety named Gelon in respect of yield (4.6 t/ha) and other yield contributing characters.
- An **observational trial** of mustard resulted better for Binasarisha-9 (2.1 t/ha) than, Binasarisha-11 (1.8 t/ha), BARI sarisha-14 (1.68 t/ha) and Binasarisa-10 (1.65 t/ha) in respect of yield but BARI sarisha-14 (88.7 days) was matured earlier than other varieties of Binasarisha-9,10 and 11.
- **03 cropping pattern** experiments showed better BCR in comparison with existing pattern in 3 different locations of CHT (Chittagong hill tracts).
- A total number of **2** block demonstrations were conducted with BINA dhan25 in Khagrachari sadar and Manikchari upazila during Boro season of the reporting year 2023-24 in which BINA dhan25 performed better than BRRI dhan 50 with average yield of 6.5 t/ha and also short in duration (143 days).
- A total of **268** demonstrations were conducted with BINA released high yielding crop varieties at different crop growing areas of Khagrachari, Rangamati and Bandarban during Aman, Rabi, Boro, Kharif-I & Aus season of the reporting year 2023-24.
- In T. Aman season, a total of **44** demonstrations were conducted with Binadhan-12, Binadhan-16, Binadhan-17, Binadhan-20 and Binadhan-22 were produced average yield of 4.38 t/ha, 4.71 t/ha, 4.55 t/ha, 4.02 t/ha and 5.00 t/ha respectively.
- In Boro season 2023-24, a total of **51** demonstrations were conducted with Binadhan-5, Binadhan-10, Binadhan-14, Binadhan-24 & BINA dhan25 with average yield of 6.16 t/ha, 6.34 t/ha, 5.5 t/ha, 6.40 t/ha and 7.63 t/ha respectively.
- In Rabi season 2023-24 a total of **78** demonstrations were conducted with Binasarisha-9, Binasarisha-9, Binasarisha-10, Binasarisha-11 and Binachinabadam-8 produced average yield of 1.45, 1.15, 1.47 & 2.24 t/ha, respectively.
- In Kharif-I season 2023-24, a total of **70** demonstrations were conducted with Binatil-2 and Binamoog-8 with average yield of 1.12 t/ha, & 1.10 t/ha, respectively.
- In T.Aus season 2023-24, a total of **25** demonstrations were conducted with Binadhan-19 & Binadhan-21 with average yield of 4.8 & 5.0 t/ha respectively.
- A total of **33.06** tons seed of different popular BINA released varieties were produced in BINA Sub-Station, Khagrachari farm as well as contract growers.
- A total of **832** farmers, seed dealers and SAAO were trained up during the reporting year 2023-24.
- A total of **04** field days were conducted with BINA dhan25 & Binatil-2 during the reporting year 2023-24.
- A total of **30 DAE** personnel participated in a workshop arranged in BINA sub-station, Khagrachari during the reporting year 2023-24.

Name of the Program : Validation Trials of BINA Developed Crop Varieties
Experiment 1 : Farmers observation trials with T. Aman rice

BINA developed aman rice varieties are taking place of local varieties in respect of duration, production and quality. The experiment was conducted at Farmers Field, Khagrachari during aman season 2023-24 with the objectives to demonstrate the performance of Binadhan-12 in farmer's field of different areas of CHT and identify suitable areas for expensive promotional work and encourage the farmers for cultivation of Binadhan-12. The varieties for the selected treatments were Binadhan-12 and Sylheti Pajam. The experiment was laid out in a randomized complete block design (RCBD) with three replications. Seedlings were transplanted on 22 July 2023. Spacing was 25cm line to line. Recommended cultural operations viz. application of fertilizers, weeding, thinning, irrigation, application of esticides was followed to ensure normal plant growth and development.

It was observed from results that Plant height of Sylheti Pajam was 130.0 cm which was higher than Binadhan-12 (111.2cm). Number of effective tiller in Binadhan-12 was higher than the check variety: Sylheti Pajam (15). Binadhan-12 produced highest yield (4.8 t/ha) compared to check variety.

The study showed us that plant height, grain yield and straw yield were significantly different between the two varieties though number of tillers/plant and number of effective tillers/plant showed no significant pairwise differences between two varieties. Binadhan-12 performed better than Sylheti Pajam. Due to the earliness, comparatively better yield and fine grain quality, farmers find Binadhan-12 as a good variety to cultivate in the respective area.

Experiment 2 : Farmers observation trials with Aus rice

BINA developed rice varieties are taking place of local varieties in respect of duration, production and quality. The experiment was conducted at Farmers Field, Khagrachari during aus season 2023-24 with the objectives to demonstrate the performance of Binadhan-19 and Binadhan-21, identify suitable areas for expensive promotional work and encourage the farmers for cultivation of Binadhan-19 and Binadhan-21**.** The varieties for the selected treatments were Binadhan-19, Binadhan-21 with the Check variety: Gelon. The experiment was laid out in a randomized complete block design with three replications. Seedlings were transplanted on 20 May, 2024. Line to line spacing was 25cm. Recommended cultural operations viz. application of fertilizers, weeding, thinning, irrigation, application of pesticides was followed to ensure normal plant growth and development.

The result of the experiment showed that Plant height of Gelon was higher (125 cm) than Binadhan-19 (95.2 cm) and Binadhan-21 (87.7cm). Number of effective tillers in Binadhan-21 was highest (22.5) among other varieties. Binadhan-19 produced highest yield (4.6 t/ha) compared to Binadhan-21 (4.4 t/ha) and check variety Gelon (3.1 t/ha). Highest straw yield was found in Gelon (9.7 t/ha), followed by Binadhan-19 (7.4 t/ha) and Binadhan-21 (7.1 t/ha).

The study showed us that plant height and straw yield is significantly different from one another between the selected three Aus rice varieties. For yield of grain Binadhan-19 and Binadhan-21 is significantly higher from Gelon. For number of tillers/plant and number of effective tillers/plant Binadhan-19 is significantly higher than Bindhan-21 and Gelon. Due to the earliness, less water requirement, comparatively better yield and good grain quality, farmers find Binadhan-19 as a good variety to cultivate in the respective area.

Experiment 3 : Observational trials of four mustard varieties

To observe the performance, identify the promising characters and encourage the farmers for cultivation

the experiment was conducted at BINA Sub-station Farm, Khagrachari during rabi season 2023-24. The varieties for the selected treatments were a) Binasarisha-9, b) Binasarisha-10 c) Binasarisha-11 and d) check variety: BARI sarisha14. The experiment was laid out in a randomized complete block design with three replications. Seeds were sown on 09 November, 2023. Recommended cultural operations viz. application of fertilizers, weeding, thinning, irrigation, application of pesticides was followed to ensure normal plant growth and development.

The result of the experiment showed that BARI sharisha14 matured earlier than the other varieties (85.7 days). Binasarisha-10 had highest number of siliquae per plant (112), followed by BARI sarisha-14 (97), Binasarisha-9 (94), and Binasarisha-11 (91). Binasarisha-9 highest yield (2.1 t/ha) compared to Binasarisha-11 (1.8 t/ha) and BARI sarisha-14 (1.68 t/ha) and Binasarisha-10 produced the lowest yield (1.65t/ha).

Among the considered 4 varieties of mustard Binasarisha-9 performed better than other 3 varieties. Except BARI sarisha-14 matured earlier than others and produced 1.68 t/ha. So, for hills where climate is a big factor both Binasarisha-9 and BARI sarisha-14 can be recommended in Rabi season.

Name of the Program : Development of a profitable cropping pattern for Chittagong Hill Tracts

Experiment 4 : Development of improved cropping pattern in Chittagong Hill Tracts

To increase the cropping intensity (%), develop a profitable cropping pattern, increase the land use efficiency and conserve soil health with the BINA released different varieties in the farmer's field , the xperiment was conducted in aman/ kharif-II season, rabi/ boro season and aus/ kharif-I season during the year 2023-24 Area of experiment plots was 33 decimals. Recommended cultural operations viz. application of fertilizers, weeding, thinning, irrigation, application of pesticides was followed to ensure normal plant growth and development.

The details of crop sequence of different crops under proposed and existing cropping pattern are

shown in the table

Result of proposed cropping pattern in Sadar, Khagrachari during 2023-24

Location	Existing pattern	Proposed pattern	Total duration (Days)	Rice Equivalent Yield (t/ha)	BCR
Sadar, Khagrachari	Aman-Mustard-fallow	Binadhan- 12- Binasarisha-9- Binadhan-21	316 days	11.03	1.56
Dighinala, Khagrachari	Aman-Mustard-fallow	Binadhan- 12- Binasarisha-9- Binadhan-19	311 days	10.79	1.56
Panchari, Khagrachari	Aman-Fellow-Aus	Binadhan- 12- Binasarisha-9- Binadhan-19	310 days	10.16	1.49

Name of the Program : Technology transfer

Experiment 5 : Block farming of BINA developed varieties

To demonstrate the performance of BINA released different varieties to the farmer's field and increase production and income of the farmers, the experiment was conducted in boro season

in the year of 2023-24. A demonstration was conducted with BINA dhan25 in Sadar and Matiranga of Khagrachari. The check was a local variety: BRRI dhan50. The main objectives were to demonstrate the performance of BINA dhan25 and widening their adaptability by the farmers. Area of demonstration plots was 10 bigha. Seeds were sown during December 2023. Seedlings were transplanted after 30 days to sowing and harvested in 143 days. Fertilizers viz. Urea (20 kg), TSP (15 kg), MOP (10 kg), Gypsum (10 kg), Zinc Sulphate (1 kg) were applied in the demonstration plots. All fertilizers (except urea) were applied during land preparation Urea was split into three does. Urea was applied 7, 30 and 55 days after seedling transplanting. Pesticides were sprayed as and when necessary to control pests. Data were recorded on crop duration and grain yield.

Performance of BINA dhan25 in block farming in Khagrachari during 2023-24

Location	No. of demonstration(s)	Durations		Yield (t/ha)		% increase of yield over check
		BINA dhan25	Check (BRRI dhan 50)	BINA dhan25	Check (BRRI dhan 50)	
Sadar, Khagrachari	1	143	154	6.5	5.8	10.76
Matiranga, Khagrachari	1	132	154	6.1	5.8	4.91

Experiment 6 : Up-scaling of BINA developed varieties of different crops in hill tracts

There are so many local, high yielding and hybrid varieties available in the market as well as in farmer'sfield. Every variety differs from each other. Demonstrations are needed to be done to specify suitablevariety for particular area based on agro-climatic condition. The Experiments were conducted in aman/ kharif-II season, rabi/ boro season and aus/ kharif-I season round the year' 2023-24. The objectives were to demonstrate the performance of BINA released different varieties in the farmer's field and increase production and income of the farmers. Area of demonstration of each plot was 33 decimals

Variety name	Demonstration (no.)	Districts	Duration (days)	Yield (t/ha)
Binadhan- 12	05	Khagrachari	129	4.38
Binadhan- 16	08	Khagrachari, Rangamati	105	4.71
Binadhan- 17	21	Khagrachari, Rangamati	121.5	4.55
Binadhan- 20	05	Khagrachari	119.5	4.02
Binadhan- 22	05	Khagrachari	117.21	5.00
Binadhan- 5	03	Khagrachari	135.8	6.16
Binadhan- 10	11	Khagrachari	138	6.34
Binadhan- 14	03	Khagrachari	123.8	5.36
Binadhan- 24	09	Khagrachari	142.5	6.4
BINA dhan25	25	Khagrachari	143.5	7.63
Binadhan- 19	5	Khagrachari	99.8	4.8
Binadhan- 21	20	Khagrachari, Rangamati	102.5	5.0
Binasarisha- 9	9	Khagrachari, Rangamati	82.5	1.45
Binasarisha- 10	05	Khagrachari	83.6	1.15
Binasarisha- 11	34	Khagrachari	85.8	1.47
Binachinabadam-8	30	Khagrachari	146.8	2.24
Binatil- 2	40	Khagrachari, Rangamati, Bandarban	93.72	1.12
Binamoog-8	30	Khagrachari, Rangamati, Bandarban	76.4	1.10

Experiment 9 : Quality seed production of promising BINA released varieties for hill tracts

The program was conducted in Farmers' field and BINA Sub-station farm of Khagrachari during aman/kharif-II, rabi/boro, aus/kharif-I season of the fiscal year 2023-24. The objectives of the program were to supply quality seeds to the farmers and DAE for extension of BINA technologies, to meet the local demand of seed and supply during season for demonstration and research purposes and to sustain the cultivation of BINA released crop varieties. Seeds of different crop varieties which were produced and purchased from the farmer's field during 2023-24 are presented in. For buying seeds from the farmer's government rate were followed. Farmers were provided with partial inputs, subsidies and free seeds or only with free seeds. During the 2023-24 period a total of 33.06 tons seeds of different crop varieties of BINA were produced and procured. Among them rice were about 25.73 tons, mustard = 5.83 tons and lentil = 0.016 tons, and sesame = 1.480 tons.

Farmer's training, Workshop and Field day

A total of six (13) trainings and one (01) workshop were organized on the cultivation techniques, seed production and farmer's motivation for BINA developed varieties. A total of five (04) Field days were organized to motivate farmers to adopt BINA developed crop varieties/technologies during 2023-24.

BINA Sub Station, Jamalpur

Experiment 1. Compatibility and interaction between bio-pesticides with chemical insecticides

An experiment was conducted to find out the effectiveness and interaction of different insecticides against brinjal fruit and shoot borer. The lowest cumulative shoot infestation (1.07) was found in treatment T_6 (Virtako + Ambush 1.8EC) i.e combination of two different chemical insecticides and the highest cumulative shoot infestation (7.72) was found in treatment T_1 [Naptune (Nitenpyram 20% + Pymetrozine 60%)]. The lowest cumulative fruit infestation (3.55) found in treatment T_7 (Virtako40WDG) i.e combination of two different chemical insecticides and highest cumulative shoot infestation (6.88) found in treatment T_9 [Ambush 1.8EC + Naptune]. Synergistic effects were found in all cases of insecticides used in combination.

Experiment 2. Effect of different organic amendments on soil fertility and increase crop production

An experiment was conducted to observe the effect of different organic amendments on soil fertility and crop production. Mustard crop production was significantly influenced by application of organic matter with chemical fertilizer: The experiment's results showed that there was no significant difference between T_5 (CF + 4 t ha^{-1} cow dung) and T_4 (CF + 3 t ha^{-1} poultry manure) on seed yield of Binasarisha-9. But the highest yield 2.00 t ha^{-1} was observed in T_5 followed by T_4 (1.81 t ha^{-1}). The lowest mean seed yield (1.43 t ha^{-1}) was observed in the control plot.

Experiment 3. Demonstration results of different BINA varieties over the year (2023-24) at different locations in Jamalpur and Tangail, Kurigram (Roumari and Rajibpur Upazila) regions

A total of 260 demonstrations were conducted at farmers field using BINA promising varieties (Binadhan-11, 14, 16, 17, 19, 20, 21; Binasharisha-4, 9, 11 & 12; Binachinabadam-6 & 8; Binatil-2 & 4) showed better yield performance. These varieties are getting popular day by day in Jamalpur and Tangail regions.

Seeds produced/purchased, (Breeder/TLS) during 2023-24

In respect of seed production1.8 tons breeder seeds and 35.768 tons TLS produced in Jamalpur Sub-Station.

Training on the use of BINA developed technologies

Four farmer’s training and five field day programmes were organized by BINA Sub-Station, Jamalpur where 235 farmers along with 26 Sub-assistant Agriculture Officers were trained.

Sub-Station, Noakhali

Collection and characterization of local germplasm

Landraces are the valuable sources of different gene pool that enrich biodiversity. In Chattogram region different local landraces of various crops were being found cultivating in different locations like saline area, hilly area, flood prone area or others. The area coverage of these landraces was very minimal and generally cultivated by some marginal farmers. The yield of these local landraces was very poor compare to the HYV or hybrid variety. Nevertheless, these landraces are more tolerant to disease, pest and problematic soil. So, a study was conducted on collection of popular local landraces having good character that helps to select potential landrace for future breeding program. The field study was conducted at the Subarnachar upazila of Noakhali during 2023-2024 for finding special traits and use in breeding program these landraces need close supervision and grown in next season. Five (05) local rice landraces and four (4) groundnut landraces were collected from farmers' fields of Noakhali and some preliminary data were recorded on seed size, 1000 seed weight and seed color.

Growing and evaluation of f_1 population of groundnut

A field study was conducted in natural saline soil condition at the BINA substation, Noakhali during Rabi season of 2023-2024 with 10 F_1 derived from crossing among 5 parents in half diallel combinations. The main focus of the study was to introduce 3-4 seeded groundnut's variety with high saline tolerance ability. Of the parents all were two seeds but some had wide adaptability in slat condition. The experiment followed Randomized Complete Block Design (RCBD) with 3 replications. A unit plot comprised a row of twelve plants. Recommended fertilizer dose, cultural and intercultural operations were also followed. The results from all of the crosses had heterosis/heterobeltiosis for at least one trait which confirms them as F_1s. Therefore, these F_1s will be evaluated and selected in F_2 generation based on large seed, salt tolerant capacity and higher shelling percentage in the next Rabi season.

Growth and yield performance of high yielding and hybrid rice varieties in saline area of noakhali, Bangladesh

Three mutant rice lines and two check varieties were evaluated in a RCBD design during Boro season 2023-24 at the BINA substation Noakhali. The aim was to assess their growth performance, yield potential, and resilience under local conditions. Observations were recorded on key agronomic traits, including plant height, panicle length, and grain yield. The RCBD facilitated a robust comparison among the mutant lines and check varieties, providing valuable insights into their adaptability and productivity. In this study evaluating the performance of five rice treatments, BINA dhan25 and ACI Shera emerged as the top performers in terms of yield, effective tiller number, and panicle length. Both varieties demonstrated superior agronomic traits leading to higher yields of 826.66 g/plot and 876.66 g/plot respectively compared to the other treatments. BINA dhan25 and ACI Shera consistently produced a greater number of effective tillers that is 13.66 and 13.00 respectively and longer panicles i.e. 26.00 cm and 25.00 cm respectively, which are the key indicators of rice productivity. But in terms of regional acceptance in Southern belt, ISL-8 has to be taken into concern as it showed highest 1000 grain weight which is 28.8 g. These results suggested that BINA dhan25 and ACI Shera are promising options for enhancing rice production, but for offering potential benefits for agricultural practices in southern belts ISL-8 or similar bold seeded rice varieties might come in handy.

Development of a suitable cropping pattern in the farmer's field of noakhali

The field experiment was conducted at the Subarnachar upazila under Noakhali district during 2023-2024. The existing cropping pattern of this area is CP_1: T. Aman (Binadhan-17)- Groundnut (Binachinabadam-4)- Fallow and proposed cropping pattern CP_2: T. Aman (Binadhan-17)- Groundnut (Binachinabadam-4) - T. Aus (Binadhan-19). The experiment was laid out in a RCBD with 3 replications. The unit plot size was 1 bigha. As per treatment T. Aman (Binadhan-17) was grown during the Aman season and it was the 1st crop of the proposed crop sequence. Twenty days old seedlings of Binadhan-17 were transplanted with 20 cm × 15 cm spacing on 16 July, 2023 and harvested on 20 October, 2023. Groundnut seeds were sown on 01 November, 2023 as 2nd sequential crop and harvested on 15 March, 2024. Binadhan-19 was the 3rd crop of the crop sequence. Seeds were sown on 18 March, 2024 by dribbling method with 20 cm × 15 cm spacing. Grain and straw of yields of Binadhan-19 were harvested on 28 June, 2024. Results revealed that in CP_1, the harvested grain and straw yields of Binadhan-17 were 5.61 and 5.30 t ha^{-1} and Binachinabadam-4 were 2.00 and 4.30 t ha^{-1} respectively. In CP_2 the harvested grain and straw yields of Binadhan-17 were 5.80 and 5.11 t ha^{-1}, Binachinabadam-4 were 2.20 and 4.10 t ha^{-1} and Binadhan-19 were 3.70 and 4.30 t ha^{-1} respectively. Total productivity of two cropping pattern was determined by rice equivalent yield (REY) which was calculated from yield component of crops. Rice equivalent yield was different in different cropping sequences. The highest REY (19.58 t ha^{-1}) was recorded from the proposed cropping pattern CP_2 and the lowest REY (14.81 t ha^{-1}) was obtained from the existing cropping pattern CP_1. From the study it may be concluded that three crop based cropping pattern such as CP_2: Aman-Groundnut-Aus (Binadhan-17- Binachinabadam-4- Binadhan-19) is more productive compared to the existing cropping pattern viz. Aman-Groundnut-Fallow. The experiment was conducted in an economic year. For final conclusion this experiment needs to be conducted for next two or three years.

Block farming of aman rice at subarnachar uapzila under noakhali district in 2023-24

A study on variety-wise rice block farming was conducted at Subarnachar upazila in Noakhali district during Aman season of 2023-2024. BINA released 3 popular rice varieties (Binadhan-16, Binadhan-17 and Binadhan-23) and 01 check (BRRIdhan95) variety were demonstrated. This demonstration was surrounded in 32 Bigha of land. The seeds were sown at 10 July, 2023 and harvested on 30 October 2023. Fertilizer management and intercultural operations like weeding, fertilizer application, irrigation etc. were done according to recommended dose and when necessary. Results revealed that the grain yield of Binadhan-16, Binadhan-17 and Binadhan-23 were 5.1, 6.7 and 5.6 t ha^{-1} respectively where the check variety (BRRI dhan95) yielded 5.3 t ha^{-1}. The duration of the Binadhan-16, Binadhan-17 and Binadhan-23 were 106, 112 and 121 days respectively, where the check showed 125 days. From the results of the study, it may be concluded that block farming with BINA released Binadhan-17 and Binadhan-23 showed better yield with short duration. This may help the farmer to catch-up next season for same crop or another crop.

Demonstration and performance of bina released varieties/technologies in chattogram region

A total of four hundred (400) demonstrations for BINA released varieties of rice (Aus, Aman and Boro), oilseed, pulse crops were successfully carried out at different locations of Chattogram region during all around the year of 2023-24. Among them 184, 188 and 28 demonstrations were of rice, oilseed and pulse crops. Among the varieties i.e. Binadhan-17, Binadhan-22, Binadhan-23 cultivated in Aman season where Binadhan-17 showed highest yield performance (6.60 t ha^{-1}) with farmer's

satisfaction. In Boro season, BINA dhan25, Binadhan-24 and Binadhan-10 showed average yield of 6.80, 5.60 and 5.35 t ha^{-1} respectively. The yield performance of Binadhan-10 in saline area was quite good with farmer's satisfaction. In Aus season Binadhan-19 and Binadhan-21 showed almost same average yield as 4.20 and 4.10 t ha^{-1} respectively. In Rabi season Binasarisha-9 showed satisfactory yield in some areas with average yield of 1.32 t ha^{-1}. The yield of Binasoybean-2, Binasoybean-3 and Binasoybean-5 was satisfactory in both Kharif-2 and Rabi season as 1.60, 1.78 and 1.70 t ha^{-1} respectively. The yield of Binatil-2 and Binatil-4 was also satisfactory in both Kharif-2 and Rabi season (1.30 and 1.25 t ha^{-1} respectively). Groundnut varieties Binachinabadam-4, Binachinabadam-6 and Binachinabadam-9 showed 2.30, 2.10 and 2.38 t ha^{-1} yield respectively. Farmers are highly interested with those BINA released varieties in Chattogram region.

Training on bina developed technologies

Some farmers' trainings on BINA developed latest technologies for better crop production were arranged by BINA Substation, Noakhali. The total number of participated farmer (both male and female) was four hundred and twenty-five (425). Total eight (8) trainings were conducted on five (5) different locations.

Field days

In order to motivate the farmer and evaluate the yield of BINA developed varieties at farmers' field, five (05) field days were arranged by BINA Substation, Noakhali. In Rabi season 3 field days of Binasarisha-11, Binasoybean-6 & Binachinabadam-8 and Binadhan-10 while in Aman season 2 field days of Binadhan-17 and Binadhan-23 each one each respectively were arranged. The participants were farmer (both male and female) and SAAO and UAOs.

BINA Sub-station, Sunamganj

Research Highlights

Agronomical satisfactory in F4 population of BARI Hybrid Tomato-4, BARI Hybrid Tomato-8, Lal bahadur and ACI summer king.

In case of Barshati mistikumra 100 Gy treatments, the seedling height and plant length were shorter and had high yield potential.

In Dhanimorich. 150 Gy treatments, shorter seedling height, high pungency and high yield potential were found.

Groundnut production experiment was carried out without any nitrogenous fertilizer and instead of nitrogenous fertilizer, we used BINA Biofertilizer for groundnut. Maximum yield was obtained in Groundnut husk treatment and shelling percentage was 69.72 in egg shell treatment.

The number of filled grains per panicle, number of unfilled grains per panicle, and yield of BINA dhan25 significantly differed due to the effect of different herbicide treatments. It was revealed that the highest weed control index (82.23%) was in the Carfentrazone-ethyl 24 EC treatment

Adoption of new cropping pattern with BINA released mustard and short duration aman rice varietie for aman season:

The highest REY (11.66 t ha^{-1}) was recorded from the cropping pattern of Aman-mustard – Fallow and the lowest REY (5.7 t ha^{-1}) was obtained from the cropping sequence of Aman-Fallow-Fallow.

The highest REY (11.66 t ha^{-1}) was recorded from the cropping pattern of Aman-mustard – Fallow and the lowest REY (5.7 t ha^{-1}) was obtained from the cropping sequence of Aman-Fallow-Fallow.

The highest REY (16.01 t ha-1) was recorded from the cropping pattern of T. Aman (Binadhan-17)-sarisha (Binasarisha-11)-Boro (Binadhan-14). The lowest REY (10.59 t ha-1) was obtained from the cropping sequence of T. Aman (Binadhan-7) -Fallow-Boro (Binadhan-24).

The highest REY (16.43 t ha^{-1}) was recorded from the cropping pattern of T. Aman-Sesame-T. Aus. The lowest REY (10.66 t ha^{-1}) was obtained from the cropping sequence of T. Aman-Fallow-T. Aus.

The highest REY (19.61 t ha^{-1}) was recorded from the cropping pattern of T. Aman-groundnut-T. Aus. The lowest REY (8.83 t ha^{-1}) was obtained from the cropping sequence of T. Aman-Fallow-T. Aus.

The highest REY (21.03 t ha^{-1}) was recorded from the cropping pattern of T. Aman-groundnut-T. Aus. The lowest REY (4.65 t ha^{-1}) was obtained from the cropping sequence of T. Aman-Fallow-Fallow.

We executed seven farmers' and SAAO/other officials training, five field days and one workshop during last 2023-2024 fiscal year from BINA Sub-station, Sunamganj. Here, 457 demonstrations were implemented during 2023-2024 with BINA varieties.

Experiment title: Effect of different sources of organic and inorganic material as a source of calcium in groundnut production

The experiment was conducted in an RCBD with four replications. Total plots were (5×4): 20 and treatments were T_0: control, T_1: 40g gypsum m^{-2}, T_2: 30 g egg shell m^{-2}, T_3: 98g dolo chun m^{-2}, T_4: 50g groundnut husk m^{-2}. Treatment T_4 gave maximum pod per plant, pod per plot (47.75), (2.06kg). In groundnut production Shelling % is a very important factor and the treatment T_2 that means 30 g egg shell /m^2 gave maximum shelling percentage (69.72). In case of yield 3.44 ton/ha. was obtained from T_4 treatment.

Experiment title: Role of different herbicides on growth, yield and weed control capacity of boro rice

The experiment consisted of 4 treatments viz., T_1: Control, T_2 : Pretilachlor 500 EC, T_3 : Carfentrazone-ethyl 24 EC, T_4 : Pyrazosulfuron Ethyl 10 WP. The test rice variety was BINA dhan25. Experiment results showed that the highest number of filled grain per panicle (154.6). Highest yield (6.27 ton/ha.) was observed in Carfentrazone-ethyl 24 EC treatment and lowest yield (4.53 ton/ha.) was observed in control plot. The weed control index is a standard parameter to judge the effectiveness of herbicides.From table 3 it is revealed that highest weed control index (82.23%) in the Carfentrazone-ethyl 24 EC treatment.

There were **457** demonstration was conducted during 2023-2024 with BINA released varieties like; Binadhan-16, Binadhan-17(Aman) Binadhan-17(Boro), Binadhan-22, Binadhan-24, Bina dhan25, Binacinabadam-6, Binacinabadam-8, Binacinabadam-10 Binasorisha-9, Binasorisha-11, Binasorisha-12 Binatil-2 in Sylhet division. About **6** tons seeds of BINA released different varieties were produced at BINA Sub-station, Sunamganj research farm and about **30.9** tons seeds of BINA released different varieties were distributed.

We executed **seven** farmers' and SAAO/other officials training, **five** field days and **one** workshop during last 2023-2024 fiscal year from BINA Sub-station, Sunamganj.

BINA Sub-station, Chapainababganj

Research highlights

A total of 50 demonstrations with short duration T. aman rice varieties Binadhan-16, Binadhan-17, Binadhan-20 and Binadhan-22 were conducted respectively which produced average grain yields of 4.71 t ha^{-1}, 6.25 t ha^{-1}, 6.00 t ha^{-1} and 6.20 t ha^{-1} respectively.
A total of 37 demonstrations were conducted with short duration high yielding Binasarisha-4 and Binasarisha-9 which produced better yield with less maturing time than the check variety of BARI sarisha-14.
A total of 20 demonstrations were carried out with short duration high yielding Binamasur ,Binachola which produced better yield with less maturity period than the check variety of local cultivar.
A total of 25 demonstrations were carried with high yielding sesame variety which produced better yield than the check varieties of local cultivars.
A total of 30 demonstrations were carried with short duration high yielding Binadhan-19 and Binadhan-21 which produced better yield with less duration than check variety of BRRI dhan-48.
A total of 44 demonstrations were carried with short duration high yielding boro rice variety Binadhan-14, BINA dhan24 and BINA dhan25 which produced better yield with less maturity period than the check variety of local cultivars.

Experiment 1: Influence of organic residue with alternate wetting and drying irrigation on rice yield, water productivity and soil physicochemical properties

The experiment utilized a split-plot design, with main field treatments comprising alternate wetting and drying (AWD) and continuous flooding irrigation, and sub-plot treatments involving rice straw, legume straw, and a control without residue addition (RFD).

Treatment I_1 (Continuous flooding,7.27a t ha^{-1}) which is significantly higher than the treatment I_2 (AWD, 7.16b t ha^{-1}). The significant differences in water required for 1kg rice, where I_2 required lesser amount of water (3207.78 L) to produce 1 kg of rice . From the main effect of OR and (CF) combination it was observed that, yield contributing characters such as plant height (ranged from 111.50 to 114.00 cm) and panicle length (ranged from 25.33 cm to 26.33 cm) did not vary significantly . In comparison number of effective tillers significantly influenced by the combination of OR and CF, where T_2 and T_3 exhibited statistically identical (12.83) but higher tiller number compared to T_1 (10.16). Similarly, T_2 an T_3 showed similar and remarkably greater number of grains per panicle (151.33 and 152.67, respectively) over T_1 (146.00). Maximum amount of grain was produced by the treatment T_3 (7.51 t ha^{-1}) which is significantly higher than the treatment T_2 (7.30 t ha^{-1}) and the minimum amount was found in T_1 (6.84 t ha^{-1}). Moreover, there was no significant variation in straw yield (ranged from 8.34 t ha^{-1} to 8.59 t ha^{-1}) due to the combination of OR and CF.

Experiment 2: Assessing rice crop performance through combined application of conventional urea and nano urea sprays

A field experiment was carried out in the research field of Bangladesh Institute of Nuclear Agriculture (BINA), sub-station, Chapainawabganj to evaluate the effect of combinations of conventional urea and nano urea sprays on the growth and production of rice. Randomized block design was used where six treatments were undertaken viz. Recommended P, K (no-N) (T1), Recommended P, K and 100% of recommended N (T2), Recommended P, K, 75% of recommended N and 2 nano-urea sprays (T3), Recommended P, K, 50% of recommended N and 2 nano-urea sprays (T4), Recommended P, K, 25% of recommended N and 2 nano-urea sprays (T5) and Recommended P, K (no-N) and 2 nano-urea sprays (T6)

Out of all the treatments, T3 exhibited the highest response in all parameters studied. Grain yield being a crucial determinant of agricultural success, T3 again emerged as the best, producing significantly highest grain yield of 5000.00 kg ha-1. The evident outcome was that, by using the proper combination of conventional urea (most preferably 75% of N) and nano urea as foliar spray during the active growth stages, a substantial increase in rice grain yield could be achieved.

Demonstrations with BINA developed high yielding and short duration T. Aman rice variety in Greater Rajshahi region

During Aman season of 2023-24, 50 demonstrations with Binadhan-16, Binadhan-17, Binadhan-20 and Binadhan-22 were conducted at the farmer's fields in Rajshahi region. The main objectives were to demonstrate the yield performance of these varieties and widening their adoption by the farmers. Area of demonstration plots was 33 decimals. Spacing between line-to-line and plant-to-plant was 20 cm × 15 cm. All fertilizers were applied as per recommendation. Transplanting dates ranged from mid July to 1st week of August 2022, and age of seedlings was 18 to 20 days.

Binadhan-16 produced average grain yield of 4.71 t ha^{-1}, which was 9 percent lower compared to check variety. Average maturity period of Binadhan-16 was 102 days. Binadhan-17 produced average grain yield of 6.25 t ha^{-1}, which was 12.8% higher compared to check variety. Average maturity period of Binadhan-17 was 112 days. Farmers are interested to cultivate Binadhan-17 during T. Aman season in Rajshahi region. Binadhan-22 produced average grain yield of 6.20 t ha^{-1}, which was 14.1% higher compared to check variety. Average maturity period of Binadhan-22 was 115 days. Farmers are interested to cultivate Binadhan-22 during T. Aman season in Rajshahi region.

Block demonstrations with BINA developed high yielding and short duration mustard variety in Rajshahi region

During the Rabi season of 2023-24, total 37 demonstrations were conducted with Binasarisha-4, Binasarisha-9 and Binasarisha-11 in Rajshahi region. The main objectives were to demonstrate the performance as well as widening their adoption by the farmers. Area of demonstration plots was 33 decimals. Seeds were sown during end of October to

November 2022 at the rate of 7.5 kg ha^{-1}. The check variety was BARI sarisha-14. All fertilizers were applied as per recommendation and 1-2 irrigation was applied in the demonstration plots.

Binasarisha-4 produced average seed yield of 1.8 t ha^{-1}, which was 5.55% percent higher than the cheek variety BARI sarisha-14. Average maturity period of Binasarisha-4 was 86 days. Farmers were found interested to cultivate Binasarisha-4 in upcoming years. Binasarisha-9 and BARI sarisha-14 produced same average seed yield of 1.70 t ha^{-1} with average maturity period of 82 and 83 days respectively. Farmers were found interested to cultivate both varieties Binasarisha-9 and BARI sarisha-14 in upcoming years. Binasarisha-11 and BARI sarisha-14 produced same average seed yield of 1.81 t ha^{-1} with average maturity period of 85 and 83 days respectively. Farmers were found interested to cultivate both varieties Binasarisha-11 and BARI sarisha-14 in upcoming years.

Block demonstrations with BINA developed high yielding and short duration lentil variety in Rajshahi region

During the Rabi season of 2023-24, total 10 demonstrations were conducted with Binamasur-5, in Rajshahi region. The main objectives were to demonstrate the performance as well as widening their adoption by the farmers. Area of demonstration plots was 33 decimals. Seeds were sown during end of October to November 2021 at the rate of 30 kg ha^{-1}. The check variety was a local cultivar. All fertilizers were applied as per recommendation and some of places one or two supplemental irrigation was applied in the demonstration plots where necessary. Pesticides were sprayed as and when necessary to control pests. Data were recorded on crop duration and seed yield.

Results revealed that Binamasur-5 produced average grain yield of 1.65 t ha^{-1}, which was 14.1% higher compared to check variety. Average maturity period of Binamasur-5 was 105 days. Farmers were found interested to cultivate Binamasur-5 in Rajshahi region.

Block demonstrations with BINA developed high yielding and short duration Chickpea variety in Rajshahi region

During the Rabi season of 2023-24, total 10 demonstrations were conducted with Binachola-4 in Rajshahi region. The main objectives were to demonstrate the performance of Binachola-4 as well as widening their adoption by the farmers. Area of demonstration plots was 33 decimals. Seeds were sown during end of October to November 2022 at the rate of 30 kg ha^{-1}. The check variety was local cultivar. All fertilizers were applied as per recommendation in the demonstration plots. Pesticides were sprayed as and when necessary to control pests. Data were recorded on crop duration and seed yield.

Results revealed that Binachola-4 produced average grain yield of 1.39 t ha^{-1}, which was 18.7% higher compared to check variety. Average maturity period of Binachola-4 was 126 days. Farmers were found interested to cultivate Binachola-4 in Rajshahi region.

Block demonstrations with BINA developed high yielding and short duration Mungbean variety in Rajshahi region

During the Kharif-1 season of 2023-24, total 5 demonstrations were conducted with Binamoog-8 in Rajshahi region. The main objectives were to demonstrate the performance of Binamoog-8 as well as widening their adoption by the farmers. Area of demonstration plots was 33 decimals. Seeds were sown during mid February to mid March 2023 at the rate of 30 kg ha^{-1}. The check variety was BARI mug-6. All fertilizers were applied as per recommendation in the demonstration plots. Pesticides were sprayed as and when necessary to control pests. Data were recorded on crop duration and seed yield.

Binamoog-8 produced average grain yield of 1.21 t ha^{-1}, which was 0.85% higher compared to check variety. Average maturity period of Binamoog-8 was 69 days. Due to excessive heat, the yield of mungbean was lower than previous year.

Block demonstrations with BINA developed high yielding and short duration Sesame variety in Chapainawabganj region

During the Kharif-1 season of 2023-24, total 30 demonstrations were conducted with Binatil-3 in Chapainawabganj district. The main objectives were to demonstrate the performance of Binatil-3 as well as widening their adoption by the farmers. Area of demonstration plots was 33 decimals. Seeds were sown during mid February to mid March 2022 at the rate of 7.5 kg ha^{-1}. The check variety was a local cultivar. All fertilizers were applied as per recommendation in the demonstration plots. Pesticides were sprayed as and when necessary to control pests. Data were recorded on crop duration and seed yield.

Binatil-3 produced average grain yield of 1.11 t ha^{-1}, which was 2% higher compared to check variety . Average maturity period of Binatil-3 was 92 days. Some demonstration plots were damaged due to excessive heat. Farmers were found interested to cultivate Binatil-3 as a drought tolerant variety in Chapainawabganj area.

Block demonstrations with BINA developed high yielding and short duration Boro Rice variety in Rajshahi region

A total of 44 demonstrations were carried with short duration high yielding boro rice variety Binadhan-14, BINA dhan24 and BINA dhan25 which produced better yield with less maturity period than the check variety of local cultivars. Area of demonstration plots was 33 decimals. The check variety was a local cultivar known as 76, BRRI dhan-89, BRRI dhan-58. All fertilizers were applied as per recommendation in the demonstration plots. Pesticides were sprayed as and when necessary to control pests. Data were recorded on crop duration and grain yield.

Binadhan-14 produced average grain yield of 6.13 t ha^{-1}. Average maturity period of Binadhan-14 was 122 days. Farmers were found interested to cultivate Binadhan-14 as a late Boro rice variety in Rajshahi region. BINA dhan25 produced average grain yield of 7.90 t ha^{-1}. Average maturity period of BINA dhan25 was 131 days. Farmers were found interested to cultivate BINA dhan25 as a premium early maturing Boro rice variety in Rajshahi region.

Block demonstrations with BINA developed high yielding and short duration Aus Rice variety in Rajshahi region

During the Aus season of 2023-24, total 38 demonstrations were conducted with Binadhan-19 and Binadhan-21 in Rajshahi region. The main objectives were to demonstrate the performance of Binadhan-19 and Binadhan-21 as well as widening their adoption by the farmers. Area of demonstration plots was 33 decimals. Seeds were sown during mid April to the end, at the rate of 30 kg ha^{-1}. The check variety was BRRI Dhan 48. All fertilizers were applied as per recommendation in the demonstration plots.

Binadhan-19 produced average grain yield of 4.75 t ha^{-1}, which was 6.10 percent higher compared to check variety. Average maturity period of Binadhan-19 was 103 days. Because of excess heat during vegetative growing stage affected by stem borer in both of Aus rice varieties. Farmers were found interested to cultivate Binadhan-19 as an Aus variety in Rajshahi region. Binadhan-21 produced average grain yield of 5.11 t ha^{-1}, which was 2.8 percent lower compared to check variety. Average maturity period of Binadhan-21 was 105 days. Because of excess rainfall during vegetative growing stage affected by stem borer in both of Aus rice varieties. Farmers were found interested to cultivate Binadhan-21 as an Aus variety in Chapainawabganj district.

Establishment of BINA Technology village, in surrounding area of BINA Sub-station, Chapainawabganj

In order to establish BINA-Technology village demonstrations and other extension work were considered at the farmer's fields done in surrounding area of BINA-substation, Chapainawabganj. Results of overall promotional activities related to BINA-Technology village establishment at, Rajabari Godagari are presented below:

Table 20: Demonstration plan of BINA developed varieties at Rajabari during 2023-24

Crop	variety	Demo area
Aman rice	Binadhan-17	15 x 33 decimals
Mustard	Binashorisha-11	15 x 33 decimals
Boro rice	BINA dhan25	15 x 33 decimals

Field days and crop cutting:

Eight field days and crop cutting were organized on BINA developed different varieties in Rajshahi region.