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ANNUAL REPORT

2024-25

BANGLADESH INSTITUTE OF NUCLEAR AGRICULTURE

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

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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.*

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PLANT BREEDING DIVISION

Rice

Project-1: Varietal improvement of rice using mutation and other advanced breeding techniques

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

An experiment was conducted in Aman 2024 at BINA HQs, farmer's field in Magura and BINA sub-station farms in Jamalpur, Rangpur, and Nalitabari to evaluate a BLB-resistant rice line (BLB-P-19) against check varieties BRRI dhan75 and BINA dhan26. Across all locations, BLB-P-19 showed the highest mean yield (5.78 t/ha) compared to BRRI dhan75 (4.95 t/ha) and BINA dhan26 (5.74 t/ha), with similar growth duration. Molecular studies confirmed the presence of BLB resistance genes (*xa4, xa5, xa21*) in BLB-P-19, derived from a Tn-1 × IRBB60 cross. Grain quality tests showed long-slender kernels for BLB-P-19 and BINA dhan26, while BRRI dhan75 was medium. BLB-P-19 was resistant to BLB in all locations. After completion of two times DUS test the line is being submitted to SCA for field evaluation before release as a variety for Aman season.

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

An experiment was conducted during Boro 2024-25 at BINA HQs farm Mymensingh, BINA Sub-station farm Rangpur, Ishurdi, and farmer's fields of Netrokona and Kshorgonj to evaluate BLB-resistant rice line BLB-P-42 against check variety BRRI dhan58. BLB-P-42 showed the tallest plant height, higher effective tillers per hill and filled grains per. Average yield of BLB-P-42 was 7.15 t/ha, which is significantly higher than BRRI dhan58 (6.39 t/ha). BLB-P-42 line is long-slender grains and BLB resistance for all locations. This line will be sent to SCA for DUS test for releasing as a variety in the next Boro season.

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

On-farm and on-station trials were conducted during Boro 2024–25 at BINA HQs and BINA sub-station farm Rangpur, Ishurdi, and Magura to evaluate blast resistance rice lines (BN-P-114 and BN-P-120) against check variety BRRI dhan86. The line BN-P-114 showed the highest yields at all sites except Rangpur. Its maximum yield was recorded at BINA HQs (7.48 t/ha), followed by Magura (6.88 t/ha) with higher effective tillers per hill and higher filled grains per panicle. The line BN-P-114 possesses three blast resistance genes (*pi9, pish, pita*). After completion of DUS test the line will be sent to SCA for evaluation as Boro season.

On-farm and on-station yield trials of Brown Plant Hopper (BPH) resistant rice lines (Collaboration with Entomology Division)

An experiment was conducted during Aman season 2024-25 at BINA HQS (Mymensingh), sub-stations (Magura & Rangpur), and a farmer's field (Nalitabari) to evaluate the performance of rice line BPH-P-065 against check variety BRRI dhan75. Significant differences were observed for plant height, effective tillers, panicle length, filled grains, and grain yield across locations. Combined analysis showed BPH-P-065 produced higher yield (6.26 t/ha) than BRRI dhan75 (5.50 t/ha), with more effective tillers (10), filled grains (131), and longer panicle (23.02 cm). No

significant difference was found in maturity duration. Based on yield, grain quality, and BPH resistance, BPH-P-065 is recommended for DUS testing and further evaluation for varietal release.

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

An experiment was conducted during Aman 2024 at BINA HQs (Mymensingh), sub-stations (Jamalpur, Nalitabari, Rangpur), and a farmer's field in Rangpur to evaluate an iron and zinc enriched rice line, IZSD-26, against check variety BRRI dhan62. Significant differences were found across locations and in the combined analysis. IZSD-26 produced a longer panicle (24.56 cm), more filled grains (143), and higher grain yield (5.86 t/ha) than BRRI dhan62 (4.41 t/ha). BRRI dhan62 matured earlier (102 days) compared to IZSD-26 (115 days). IZSD-26 recorded higher Fe (20.3 mg/kg unpolished; 6.3 mg/kg polished) and Zn (52.3 mg/kg unpolished; 30.3 mg/kg polished) content than the check. With its red pericarp, enriched micronutrient profile, and superior yield, IZSD-26 shows strong potential for varietal release. The line has been submitted to the SCA for the 2nd DUS test and field evaluation to be released as Fe and Zn enriched variety as *Aman* season.

On-farm and on-station yield Trial of short duration rice lines for Haor areas

Two early-maturing Boro rice lines, BN-HR-26 and BN-HR-28, were evaluated along with the check variety BRRI dhan88 during Boro season 2024-25 at BINA HQs farm, farmer's fields in haor regions (Hason Nagar, Netrokona, B. Baria, Tahirpur) and BINA sub-station Sunamgonj. Significant variation was found among genotypes across locations. BN-HR-28 matured earlier (140 days) than BN-HR-26 (143 days) and check, BRRI dhan88 (145 days). BN-HR-26 recorded the highest grain yield (6.89 t/ha) followed by BN-HR-28 (6.86 t/ha). At farmer's fields, maximum yield was observed for BN-HR-26 at Netrokona (7.14 t/ha) followed by BN-HR-28 (6.64 t/ha). The shorter duration of BN-HR-26 and BN-HR-28 (140–143 days) compare to check suggests their potential to escape early flash floods damage. Further evaluation is needed for releasing as variey in haor areas.

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

Three International Low Land Rice Nursery (IRLON) lines were evaluated against two checks, BRRI dhan75 and BRRI dhan87, during Aman 2024 at BINA HQs, sub-stations (Nalitabari, Rangpur, Jamalpur), and farmers' fields (Rangpur, Netrokona). Growth duration ranged from 109 days (IRLON-19) to 117 days (IRLON-17), while BRRI dhan75 and BRRI dhan87 matured in 107 and 129 days, respectively. Plant height varied between 110 cm (BRRI dhan75) and 125 cm (IRLON-17). Significant variation was observed for yield and related traits. IRLON-19 produced the highest grain yield (5.84 t/ha), surpassing both checks (5.39 and 5.03 t/ha). Considering yield potential and maturity, IRLON-19 and IRLON-17 are recommended for on farm and on station trials, while IRLON-4 is suggested for regional yield trials.

Regional yield trial of nine advanced salt tolerant rice lines

A trial with seven advanced salt-tolerant rice lines and two checks (*Binadhan-10 and BRRI dhan99)* was conducted at BINA HQs farm (Mymensingh), BINA sub-station (Satkhira), and farmer's fields in Ashashuni and Harinkhola. The tested lines matured within 139–146 days,

with plant height ranging from 89 cm (IRSSTN-21) to 108 cm (*Binadhan-10*). Three lines produced higher yields (4.71–4.85 t/ha) than the check *Binadhan-10*. Based on yield and agronomic traits, SAL-52, SAL-44, IRSSTN-11, and IRSSTN-21 were selected. These lines will be further evaluated in the next Boro season.

Screening of Advanced Rice lines for salinity tolerance at seedling and reproductive stage

Seedling stage

The experiment was conducted during July–August 2024 in the glasshouse of the Plant Breeding Division, BINA, Mymensingh. Sixty-five mutant rice lines derived from *Nonabokra* and *Mondeshwar* along with three checks were screened for salinity tolerance at the seedling stage under EC 10 and 12 dS/m, following the IRRI standard protocol. After 21 days of salinization, plants were evaluated and scored. At EC 12 dS/m, nine mutant lines were identified as tolerant, 21 as moderately tolerant, and the remaining lines were susceptible.

Reproductive stage

The experiment was conducted during July–November 2024 at the Pot Yard of the Plant Breeding Division, BINA, Mymensingh, to evaluate salt tolerance rice genotypes under salinity levels of 8, 10, and 12 dS/m. At 8 dS/m. Among 17 genotypes 11 were tolerant and 7 were moderately tolerant. At 10 dS/m, five genotypes IRSSTN-1, IRSSTN-11, IRSSTN-21, BRRI dhan97 and Binadhan-10 showed tolerance, while seven became moderately tolerant. At 12 dS/m, only four genotypes (IRSSTN-1, IRSSTN -11, BRRI dhan97 and Binadhan-10) retained tolerance, while most others were moderately tolerant or susceptible. These findings highlight the consistent performance under increasing salinity stress. Such resilient lines hold strong potential for breeding salt-tolerant rice to ensure productivity in salt-affected regions.

Growing M_3 Generation of premium quality line EFSD-59

An aromatic rice mutant, EFSD-59, was irradiated with 250 Gy gamma rays after optimizing the irradiation dose to develop a high yielding, fine-grained, short-duration aromatic rice variety. The resultant M_2 populations were grown under physical isolation without applying any selection pressure. A total of 63 putative mutants were identified based on fine grain type, number of filled grains, yield-contributing traits, and crop duration.

Project-2: Promoting sustainable agricultural food productivity in the association of South-east Asian nations region (IAEA/RAS/5094)

Growing of M_2 Generation of rice landraces Nonabokra and Mondeshwar

Two local salt tolerant rice landraces, *Moneshwar* and *Nonabokra* were irradiated with 350 Gy and 400 Gy gamma rays, respectively, after optimizing the irradiation dose. The resultant M_1 populations were grown under physical isolation, and M_2 seeds were harvested and bulked for rising the M_2 generation. A total of 65 putative mutants were identified based on fine grain type, number of filled grains, yield-contributing traits, and lodging tolerance.

Growing of M_3 Generation of salt tolerant rice variety Binadhan-10

One salt tolerant rice variety, Binadhan-10 was irradiated with 200 Gy gamma rays after optimizing the irradiation dose to develop a salt-tolerant, fine-grained, short-duration variety. The M_2 populations were grown under physical isolation without selection, while selection was initiated at the M_3 generation. From this generation, 34 putative mutants were identified based on fine grain type, number of filled grains, yield-contributing traits, and crop duration. These mutants represent promising genetic resources for further evaluation and advancement in developing improved salt-tolerant rice variety.

Detection of induced noble mutation in drought tolerant rice mutants through whole genome sequencing

Functional genomic study of mutant along with parent

In this study, NERICA-4 was irradiated with gamma rays, and one advanced drought-tolerant mutant line, **N4/M7/P-14(3)**, was selected. Whole genome sequencing revealed 340.23–343.17 Mbp mapped bases with 117.86–145.13 M mapped reads. Comparative genomic analysis between NERICA-4 and its mutant identified 6.43 M SNPs, 1.3 M short InDels, and several large structural variations including 2109 DEL, 134 DUP, 184 INS, 168 INV, 5102 BND, and 1028 CNVs, with transitions (73.21%) being more frequent than transversions. In the mitochondrial genome, 20 SBSs and 4 InDels were detected as unique induced mutations, while no unique variants were found in the chloroplast genome. The mutant showed strong variation in agronomic and grain traits, indicating potential for cultivation in drought-prone areas and providing valuable genomic resources for functional genomics and breeding of drought-tolerant rice.

Evaluation of rice lines against blast

To evaluate the resistance of rice genotypes against the pathogen *Magnaporthe oryzae*, a controlled experiment was conducted at the BINA HQs farm in a protected blast screening house. Four introgressed BINA-BR rice lines, along with two check varieties; BRRI dhan74 (moderately resistant) and USV2 (universal susceptible), were tested against four different *M. oryzae* isolates (9, 10, 11, and 12). The experiment followed a randomized complete block design (RCBD) with three replications, each comprising four plants per genotype, totaling 288 plants across all isolate-specific plots. Inoculation, sporulation, and disease scoring were conducted following the JIRCAS protocol. Disease severity was assessed over 7-, 14-, and 21-days post-inoculation, with final resistance scoring on day 21 using a 1–5 scale (1–2 = Resistant, 3 = Moderately Resistant, 4–5 = Susceptible). Results indicated significant variation in resistance among the genotypes. BINA-BR-4-10-12 consistently showed the highest resistance across all isolates, scoring 2 (Resistant) in every case. BINA-BR-4-10-15 and BINA-BR-4-10-19 also demonstrated strong resistance, with scores in the Resistant to Moderately Resistant range. In contrast, USV2 was the most susceptible, scoring 4 (Susceptible) against all isolates, while BRRI dhan74 and BINA-BR-4-10-18 exhibited moderate to high susceptibility depending on the isolate. Disease severity data corroborated the scoring results, showing a progressive increase in severity over time, with BINA-BR-4-10-12 and BINA-BR-4-10-15 maintaining the lowest severity levels. These findings highlight

BINA-BR-4-10-12 as a highly promising genotype for developing blast-resistant rice varieties.

Regional yield trial of blast resistant rice line with grain aroma

An agronomic evaluation was conducted to assess the yield potential, grain quality, and disease-pest resistance of a blast-resistant, aromatic rice line, BINA-BR-4-10-12, in comparison to the check variety BRRI dhan50 during the Boro season. The trial was implemented across six locations under the supervision of BINA HQs and its sub-stations using a Randomized Complete Block Design (RCBD) with three replications. Each unit plot measured 4.0 m × 5.0 m, and standard cultivation practices and fertilizer recommendations were followed. Agronomic data including yield were recorded. Grain yield was measured from a 20 m² area and converted to tons per hectare. Statistical analyses were conducted to assess genotype performance. BINA-BR-4-10-12 consistently outperformed the check variety in all measured parameters. It exhibited a higher average grain yield (7.62 t/ha), taller plant height (104.94 cm), and longer maturity duration (153 days) compared to BRRI dhan50. The highest yield (8.08 t/ha) was recorded at Mymensingh HQ Farm also found superior grain quality, featuring medium-slender kernel type, bright golden grain color, and a strong aroma during drying, milling, and cooking. Disease and pest resistance were evaluated using the IRRI Standard Evaluation System (SES) across locations. BINA-BR-4-10-12 showed notable resistance to major diseases and pests, including blast, bacterial blight, sheath blight, stem borer, and brown plant hopper. Based on above profile, BINA-BR-4-10-12 performed strong potential for future varietal release.

Advanced yield trial of some selected blast resistant rice lines

A multi-location field experiment was conducted during the Boro season to evaluate the agronomic performance, grain quality, and disease-pest resistance of five blast-resistant rice lines—BINA-BR-2-10-3(2), BINA-BR-2-10-3, BINA-BR-2-15, BINA-BR-4-10-15, BINA-BR-23-1-5—and one aromatic line, BINA-BR-3-6-7, against the check variety Binadhan-17. The trials were conducted at five locations at BINA HQs and its sub-stations, following a Randomized Complete Block Design (RCBD) with three replications. Grain yield was recorded from a 6 m² area and converted to t/ha. BINA-BR-2-10-3(2) produced higher average yield of 7.68 t/ha and highest was observed 8.15 t/ha at Mymensingh HQ Farm. BINA-BR-2-15 performed well with stable yields and superior grain appearance, featuring a bright golden color. BINA-BR-3-6-7 was noted for its strong aroma during drying, milling, and cooking, surpassing the check. Kernel analysis revealed all lines had medium-slender grain shape, while the check was long-slender. Disease and pest resistance were evaluated using the IRRI Standard Evaluation System (SES) showed BINA-BR-4-10-15 and BINA-BR-2-10-3(2) were resistant to major stresses including blast, bacterial blight, sheath blight, stem borer, and brown plant hopper. Based on high yield, grain quality, aroma, and resistance, BINA-BR-2-10-3(2), BINA-BR-3-6-7, and BINA-BR-2-15 are recommended for further evaluation for varietal release program.

Growing of BC_1F_2 population of rice

For the development of blast resistant rice variety, the F_1 generations derived from 3 cross combinations between Binadhan-17(recurrent) x blast resistant Pongso Seribu2 (*Pi9*) and Binadhan-17 (recurrent) x blast resistant line (*Pish*) and Binadhan-17 (recurrent) x blast resistant

line (*Pb1*) were evaluated for hybridity using the *Pi9* and *Pish* linked molecular markers RM6836, RM212 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, RM212 and RM206 respectively. Rest of the plants was discarded. Highest recurrent parent genome recovery was found 94.1% in plant no. 11 derived from Binadhan-17(recurrent) x blast resistant Pongso Seribu2 (*Pi9*), 96.3% in plant no. 3 derived from Binadhan-17(recurrent) x blast resistant line (*Pish*) and 89.2% in plant no. 6 derived from Binadhan-17(recurrent) x blast resistant line (*Pb1*) at BC_1F_1Population. Then BC_1F_1 population was advanced for BC_1F_2 population through selfing. A total of 21 BC_1F_2 family's seeds were collected including 7 families derived from Binadhan-17(recurrent) x blast resistant Pongso Seribu2 (*Pi9*), 8 families derived from Binadhan-17(recurrent) x blast resistant line (*Pish*) and 6 families derived from Binadhan-17(recurrent) x blast resistant line (*Pb1*).

Growing F_3 population of rice

A field experiment of plant progeny-row was conducted during Aman season 2024 at BINA HQs, Mymensingh, to evaluate F_3 populations derived from three rice cross combinations involving high-yielding and aromatic parental lines. A total of 37 F_3 families were assessed, including 10 families from the cross BRRI dhan89 × Fatema-3, 12 families from Fatema-3 × Binadhan-17, and 15 families from Binadhan-17 × Fatema-3. The primary objective was to identify promising segregating lines for desirable agronomic and quality traits, particularly plant architecture, grain characteristics, and aroma. F_3 populations were grown under standard agronomic practices and evaluated for key phenotypic traits such as plant height, flag leaf orientation, number of filled grains per panicle, grain type (shape and size), and grain aroma. Lines will be selected for further evaluation in subsequent generations to develop high-yielding, aromatic rice varieties suited for farmers and consumers preference.

Growing of M_2 generation using eBeam irradiation and gamma irradiation

A study was conducted to evaluate and compare the mutagenic effectiveness of electron beam (eBeam) irradiation with traditional gamma irradiation in inducing genetic variability in rice. The M_2 generation, derived from bulked seeds treated with both eBeam and gamma rays at doses ranging from 100 to 600 Gy, was grown during Boro season in 2025-26 at BINA HQ Farm, Mymensingh. The experiment aimed to assess and compare morphological and molecular mutations induced by both irradiation types, with a focus on identifying the most effective dose and method for mutation breeding. Seedlings were transplanted to the field at 30 days after sowing with standard spacing (15 cm × 20 cm), and a total of 680 gamma-irradiated and 476 eBeam-treated plants were established. Morphological traits such as flag leaf blade attitude, penultimate leaf structure, ligule shape, heading time, culm and panicle length, panicle exertion, maturity time, leaf senescence, and biotic stress responses were observed and recorded. The eBeam-treated populations, particularly at the 100 Gy and 200 Gy doses, exhibited a higher frequency and wider range of morphological mutations than gamma-irradiated plants. The highest morphological variation (75%) in culm length was observed at 100 Gy in the eBeam treatment, followed by 60% at 200 Gy, whereas the highest in gamma rays was 45% at 300 Gy. Similarly, molecular marker analysis revealed greater polymorphism in eBeam-treated plants, with the highest molecular variation (70%) again noted at 100 Gy. These results indicate that

eBeam irradiation, especially at lower doses (100–200 Gy), is more effective and efficient than gamma irradiation for inducing useful mutations. The findings support the use of eBeam technology as a promising tool in rice mutation breeding programs due to its broader applicability and higher trait-specific mutation efficiency.

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

A comprehensive study was initiated to collect and preserve *Magnaporthe oryzae*, the causal agent of rice blast disease, with a particular focus on neck blast, from hotspot areas across Bangladesh. A total of 50 infected samples were collected, ensuring representation from all administrative divisions of the country to capture the diversity of the pathogen. The primary objective was to isolate single-spore cultures suitable for subsequent morphological, molecular, and pathogenicity analyses. Single conidia were isolated from symptomatic leaves and panicles using the moist chamber incubation method as described by Hayashi et al. (2009). Infected plant tissues were placed on moist filter paper in petri dishes and incubated at room temperature for 24 hours to induce sporulation. Germinated single spores were then cultured on water agar medium for 5 to 7 days to promote colony development. Colonies derived from individual spores were subsequently transferred to sterile filter paper placed on water agar to facilitate long-term storage. To preserve the integrity of the isolates for future research, five representative isolates were carefully selected and aseptically stored on dried filter paper at −20°C. This method allows repeated access to genetically uniform and viable fungal material for extended analysis. The collected and preserved isolates will serve as a valuable resource for ongoing and future studies on the morphological diversity, molecular characterization, and pathogenic behavior of *M. oryzae* populations in Bangladesh.

On-station and on-farm yield trial with high yielding and early maturing rice lines

Seeds of three mutant lines derived from the irradiations of Indian Zirashail rice with 200 Gy dose of gamma rays were sown on 1st week of January, 2025 and seedlings were transplanted on 1st week of February, 2025 along with the check variety BRRI dhan96 at BINA Sub-station farm Magura, Cumilla and Sunamganj and farmer's field of Magura. The experiment was followed by Randomized Complete Block design. Significant variation among mutant lines and the check for most of the characters were showed in combined and individual locations. In combined locations, it was observed that height of the check variety (102.05 cm) was more than mutants (91.95 cm to 92.47 cm). Number of effective tillers (17.12) was highest in ZM-231 mutant and the lowest number was observed in the check variety (14.10). Panicle length was higher in the check variety BRRI dhan96 (23.28 cm) than in mutants (ranging from 20.63- 20.93 cm). The mutant ZM-611 showed higher filled grain (164) which is statistically significant than the check variety (145). Maximum number of unfilled grain was observed in ZM-231 mutant (34) comparing to the check variety (22). Mutant ZM-611 (8.19 t ha^{1}) produced the higher yield than the check variety BRRI dhan96 (8.05 t ha^{1}) and mutant ZM-231 (7.68 t ha^{1}) combined over location. Considering the yield performances of the mutant ZM-611 will be put into the next trial for releasing as a variety.

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

The objectives of this study were to investigate the genetic variability and mutation patterns of *M. oryzae* isolates across Bangladesh and to perform phylogenetic analyses to understand their evolutionary relationships. A total of 43 isolates were collected from different parts of Bangladesh. The identity of all isolates was confirmed as *M. oryzae* through internal transcribed spacer (ITS) region sequencing. Phylogenetic analysis revealed substantial genetic diversity among the isolates, resulting in the formation of 9–11 distinct clusters based on color-coded branching and topology. Cluster 1 (greenish-brown) contained the majority of isolates, indicating a closely related lineage with a shared common ancestor. Other clusters, such as Cluster 2 (pink), Cluster 4 (green-blue), and Cluster 5 (light brown), formed well-supported groups with distinct genetic backgrounds. Notably, Clusters 3 (purple), 8 (dark blue), 9 (pink variant), and 10 (outgroup) represented singleton or highly divergent isolates, suggesting the presence of unique or potentially novel genetic lineages. The observed clustering may represent distinct races of *M. oryzae*, pending further pathogenicity testing on monogenic lines to confirm their virulence profiles. The high degree of genetic variation among the isolates highlights the dynamic nature of the pathogen population in Bangladesh and suggests ongoing mutation and adaptation. This study provides valuable insights into the population structure of *M. oryzae* and emphasizes the importance of continuous monitoring and characterization. The findings will support the development of effective resistance breeding strategies and contribute to improved management of rice blast disease through better understanding of host-pathogen interactions.

On-farm yield trial of IRBBN rice lines

A multi-location on-farm yield trial was conducted during the Boro 2024-25 season to evaluate the agronomic performance and yield stability of five rice genotypes (IRBBN-6, IRBBN-9, IRBBN-18, IRBBN-31, and the check variety BRRI dhan101) across four diverse locations in Bangladesh (Mymensingh, Rangpur, Cumilla, Sunamganj). The experiment was laid out in a Randomized Complete Block Design with three replications. Significant genotypic and environmental variations were observed for all traits. The check variety BRRI dhan101 recorded the highest mean grain yield (7.00 t ha^{-1}), tallest plants (111.89 cm), and highest number of filled grains (151.60). Among the test lines, IRBBN-18 and IRBBN-31 yielded competitively (6.95 and 6.85 t ha^{-1}, respectively). IRBBN-31 exhibited outstanding tillering ability (13.13 effective tillers $hill^{-1}$), while IRBBN-6 demonstrated the highest 1000-grain weight (25.92g) and earliest maturity (140 days). Sunamganj was the highest-yielding location (7.97 t ha^{-1}). The results indicate that IRBBN-31, with its superior tillering, and IRBBN-6, with its early maturity and grain weight, are promising candidates for further evaluation.

On-farm yield trial of IRBN rice lines

This study assessed the yield performance of three improved rice genotypes (IRBN-11, IRBN-14, IRBN-18) against the check variety BRRI dhan74 across five locations (BINA Substation Cumilla, Magura, Sunamganj, Rangpur and BINA HQ Mymensingh) in Boro 2024-25 season. The experiment followed a Randomized Complete Block Design with three replications. Analysis revealed significant differences attributable to both genotype and location. IRBN-18 was the tallest genotype (112.20 cm), while BRRI dhan74 produced the most effective tillers

(11.15). IRBN-14 recorded the highest number of filled grains per panicle (155.61) but also the most unfilled grains (43.92), indicating environmental sensitivity. For grain yield, IRBN-14 (7.47 t ha^{-1}) and IRBN-18 (7.38 t ha^{-1}) significantly outperformed the check variety (6.91 t ha^{-1}). IRBN-11 yielded the least (6.56 t ha^{-1}). The locations of Sunamganj and BINA HQ Mymensingh were the most favorable environments. The trial concluded that IRBN-18 demonstrated the most stable and balanced performance across locations, combining high yield with desirable agronomic traits, making it a strong candidate for recommendation and further evaluation.

On-farm yield trial of IRBPHN rice lines

The yield performance of four rice genotypes (IRBPHN-5, IRBPHN-9, IRBPHN-44, and the check Binadhan-24) was evaluated across four locations (BINA Sub-station Camilla, Magura, Nalitabari and BINA HQ Mymensingh) during Boro 2024-25 seasons using a Randomized Complete Block Design with three replications. Results showed that IRBPHN-44 was the tallest (115.00 cm) and had the highest tillering capacity (12.27 tillers hill^{-1}). IRBPHN-5 registered the highest number of filled grains per panicle (156.43), whereas IRBPHN-9 had the fewest unfilled grains (24.67). The check variety, Binadhan-24, had the bold grains (28.50g 1000-grain weight) among genotypes. For the key trait of grain yield, IRBPHN-9 produced the highest mean yield (7.34 t ha^{-1}), followed by IRBPHN-44 (6.98 t ha^{-1}); both outperformed the check Binadhan-24 (6.57 t ha^{-1}). The Cumilla sub-station was the highest-yielding location (7.23 t ha^{-1}). The study demonstrates that IRBPHN-9, with its high yield, favorable panicle traits, and lower sterility, is a superior genotype. Both IRBPHN-9 and IRBPHN-44 are recommended for further evaluation as high-yielding adaptable candidates.

Zonal yield trial of salt tolerant rice lines with higher yield and premium quality

A zonal trial was conducted to evaluate seven advanced salt-tolerant mutant lines against the check Binadhan-10 across five coastal and saline-prone locations with BINA Farm, Mymensingh, Sub-station Cumilla, Noakhali, Satkhira, and the farmers' field of Noakhali in Boro 2024-25 seasons. The experiment was set in a Randomized Complete Block Design with three replications. The mutant lines showed considerable variation. IRSSTN-14 and IRSSTN-1 were the tallest genotypes, while IRSSTN-13 and IRSSTN-7(2) showed the highest effective tillering. IRSSTN-1 recorded the highest filled grains per panicle (131.34). Notably, the check Binadhan-10 exhibited superior grain filling stability with the fewest unfilled grains (9.03). For grain yield, the mutant lines IRSSTN-1 (7.95 t ha^{-1}), IRSSTN-7(1) (7.73 t ha^{-1}), and IRSSTN-7(2) (7.16 t ha^{-1}) surpassed the yield of the check Binadhan-10 (6.80 t ha^{-1}). IRSSTN-1 also benefited from an earlier maturity (139 days). Satkhira and Cumilla were the highest-yielding locations. The results confirm the high yield potential and adaptability of IRSSTN-1, IRSSTN-7(1), and IRSSTN-7(2) under diverse environments, marking them as promising salt-tolerant candidates for advanced evaluation.

Advanced yield trial of IRTON rice lines

An advanced yield trial was conducted to compare three IRTON lines with the check variety BINA dhan25 across multiple locations (five locations: BINA Farm, Mymensingh, Sub-station Cumilla, Sunamgonj, and the farmers' field of Cumilla, Sunamgonj) in Boro 2024-25 season, using a Randomized Complete Block Design with three replications. Significant genotype-by-

environment interaction was observed. The check variety, BINA dhan25, had the longest panicles (28.02 cm) and most filled grains (153.25) but also the highest number of unfilled grains (54.61), which limited its yield stability. Among the test genotypes, IRTON-13 achieved the highest combined mean yield (7.01 t ha^{-1}), demonstrating superior adaptability, particularly at the Cumilla sub-station (8.07 t ha^{-1}). IRTON-11 and IRTON-5 yielded 6.49 and 6.42 t ha^{-1}, respectively. IRTON-5 performed the best at the Sunamganj sub-station (8.45 t ha^{-1}). Cumilla was the most favorable location overall (7.88 t ha^{-1}). The study concludes that IRTON-13 is the most promising genotype due to its high and stable yield performance. IRTON-5 and IRTON-11 are also recommended for further evaluation for specific, high-potential environments.

On-farm and on-station yield trial of IRBN rice lines

This study evaluated the performance of two lines (IRBN-11, IRBN-18) and two check varieties (Binadhan-17, BRRI dhan87) across three locations during Aman 2024-25 seasons, using a Randomized Complete Block Design. IRBN-18 emerged as the top performer, yielding the highest at both Rangpur (7.08 t ha^{-1}) and Sunamganj (7.05 t ha^{-1}) sub-stations, resulting in the highest combined mean yield (6.54 t ha^{-1}). IRBN-11 produced the bold grains (28.77g 1000-grain weight) but yielded less (5.86 t ha^{-1}) due to fewer filled grains. The check variety Binadhan-17 showed good stability (6.34 t ha^{-1}), while BRRI dhan87 yielded the lowest (5.86 t ha^{-1}). IRBN-18 combined desirable traits including medium plant height, higher tiller production, and better grain filling efficiency. Sunamganj was the highest-yielding location. The results demonstrate that IRBN-18 possesses superior yield advantage, balanced agronomic traits, and broad adaptability, making it the most promising candidate for recommendation in Aman season.

On-farm and on-station yield trial of IRBBN rice lines

The trial assessed two lines (IRBBN-18, IRBBN-31) against two checks (Binadhan-17, BRRI dhan87) across three locations BINA HQ Mymensingh and two substations Sunamganj and Rangpur, conducted in Aman, 2024 season following RCB design with three replications. IRBBN-31 demonstrated superior performance, achieving the highest combined mean yield (7.39 t ha^{-1}) and excelling in key yield componentslike highest effective tillers (11.77 $hill^{-1}$), the highest number of filled grains (132.11 $panicle^{-1}$), and the fewest unfilled grains (16.44). It also had a slightly higher grain weight (25.34g) and a taller, vigorous stature compare with the check varieties producing the highest combined mean yield of 7.39tha^{-1}, which was superior to Binadhan-17 (6.21tha^{-1}) and BRRI dhan87 (6.24tha^{-1}), while IRBBN-18 yielded moderately (5.89tha^{-1}). Environment-specific responses showed Sunamganj as the most favorable site with the highest overall mean yield (6.88tha^{-1}), followed by Rangpur (5.88 t/ha), while BINA HQ recorded the lowest yield (5.67tha^{-1}). Overall, the results indicate that IRBBN-18 and IRBBN-31 are superior and stable high-yielding lines with promising potential for varietal release.

On-farm yield trial of IRBPHN rice lines

A yield trial was conducted during Aman 2024 season to evaluate two lines (IRBPHN-5, IRBPHN-44) against two check varieties (Binadhan-17, BRRI dhan87) at two locations, following Randomized Complete Block Design following three replications. IRBPHN-44 was the standout genotype, producing the highest mean grain yield (5.94 t ha^{-1}), which was

comparable to Binadhan-17 (5.81 t ha^{-1}) and superior to BRRI dhan87 (5.25 t ha^{-1}). This high yield was attributed to its significantly longer panicles (29.5 cm), highest tillering capacity (12.26 $hill^{-1}$), and bold grains (25.16g), which compensated for a moderate number of filled grains. The Nalitabari sub-station was favorable environment than BINA HQ. IRBPHN-5, despite having the best spikelet fertility (lowest unfilled grains), yield was less (5.38 t ha^{-1}) due to shorter panicles and lighter grains. The results identify IRBPHN-44 as the promising candidate line due to its high yield and desirable panicle architecture, recommending it for further evaluation.

Zonal yield trial of rice mutant derived from NERICA-4

This study evaluated the performance of two mutant lines (RM-16(N)-8, RM-16(N)-10) derived from NERICA-4 against the check variety BRRI dhan102 across four locations BINA HQ Mymensingh, BINA sub-station Iswardi, Chapainawabganj, and Rangpur) in Aman season 2024 using a Randomized Complete Block Design with three replications. The mutant lines were matured earlier (139 days vs. 144 days) and shorter in plant stature (~86 cm vs. 102.5 cm), potentially reducing lodging risk. RM-16(N)-8 showed the highest tillering ability (13.58 $hill^{-1}$). The mean grain yield of RM-16(N)-10 (7.03 t ha^{-1}) and outperforming RM-16(N)-8 (6.79 t ha^{-1}) were not significantly higher than that of the check variety (7.02 t ha^{-1}). The trial demonstrates that RM-16(N)-10 combines early maturity, short stature, high tillering, and yield, can be a candidate mutant and suited to the Aman season.

Program Area-II: Varietal Improvement of oilseeds

Rapeseed-mustard

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

An on-station and on-farm yield trial was conducted during the Rabi season 2024–2025 to evaluate the performance of an M_8 rapeseed (*Brassica rapa* var. *toria*) mutant line (RT-38) in comparison with the check variety Binasarisha-10 at BINA Headquarters, Mymensingh; BINA Sub-stations, Rangpur and Magura; and farmer's fields in Rangpur and Magura, following a randomized complete block design with three replications. Data on phenology, yield components, and seed yield were collected and analyzed. RT-38 matured earliest (83 days) compared with Binasarisha-10 (84 days) and produced significantly taller plants (110cm) with a higher number of branches per plant (7), siliquae per plant (145), and longer siliquae (5.27 cm). The mutant also recorded the highest combined mean seed yield (1298 $kgha^{-1}$), slightly higher than the check variety (1272 $kgha^{-1}$), though the difference was not statistically significant. Location means indicated consistent performance of RT-38 across environments. The results suggest that the mutant RT-38 possesses desirable agronomic traits and yield potential comparable to the commercial check, making it a promising mutant line for future release after further multi-location trial.

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

An on-station and on-farm yield trial was conducted during the Rabi season 2024–2025 to evaluate the performance of three rapeseed (*Brassica napus*) mutants (RM-28, RM-34, and RMT-14) alongside two check varieties (Binasarisha-9 and BARI Sarisha-18) for earliness,

yield, and yield attributes at BINA Headquarters, Mymensingh; BINA sub-stations at Rangpur, Magura, and Nalitabari; and farmer's fields in Tangail and Manikgonj following a randomized complete block design with three replications. Data were recorded on phenological and yield-contributing traits. Significant variations ($p < 0.05$) were observed among genotypes across locations. Maturity period ranged from 79 to 96 days, with RM-34 being the earliest (79 days) and BARI Sarisha-18 the latest (96 days). RM-34 and Binasarisha-9 (98 cm) attained the shortest plant heights, while BARI Sarisha-18 has the tallest plant (115 cm). RM-28, RM-34, RMT-14 and BARI Sarisha-18 produced the highest number of branches (3 branches plant^{-1}). RMT-14 recorded the highest number of siliquae plant^{-1} (67) among the mutants. RMT-14 produced the highest seed yield (1562 kgha^{-1}) followed the mutants RM-34 (1457 kgha^{-1}) and whereas BARI Sarisha-18 produced (1380 kgha^{-1}). Based on combined analysis across environments, RMT-14 and RM-34 showed superior and stable performance compared to the other mutants, indicating their potential for further multi-location and multi-year evaluations before varietal release.

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

A regional yield trial was conducted during November 2024 to evaluate three M_6 rapeseed (*Brassica campestris*) mutants RMT-22, RMT-25, and RMT-26 against the check varieties Binasarisha-11 and BARI Sarisha-14 across four locations in Bangladesh (BINA HQs, Mymensingh; BINA sub-stations at Rangpur, Cumilla, and Nalitabari). The experiment followed a randomized complete block design with three replications. Data were recorded on phenological and yield-contributing traits. Significant variations were observed among genotypes across locations. Maturity ranged from 82 to 83 days, with RMT-26 exhibiting the tallest plants (117 cm) and RMT-22 producing the highest siliquae plant^{-1} (135). Seed yield over locations ranged from 1089 to 1347 kgha^{-1}, with RMT-22 (1347 kgha^{-1}) and RMT-26 (1279 kgha^{-1}) outperforming the check varieties. These findings indicate the superior performance of RMT-22 and RMT-26 under diverse environmental conditions, warranting further multilocation and multiyear evaluations before potential release as improved varieties.

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

An advanced yield trial was conducted to evaluate three M_6 rapeseed (*Brassica napus* L.) mutants (RM-12, RM-13 and RM-19) along with two check varieties (Binasarisha-9 and BARI Sarisha-18) at five locations: BINA Headquarters Farm (Mymensingh) and BINA Sub-stations at Rangpur, Magura, Ishurdi, and Nalitabari during the 2024–2025 Rabi season. The experiment followed a randomized complete block design with three replications, using a plot size of (4mx5m) 20 m² and a row spacing of 25 cm. Significant genotypic variation was observed for most yield-contributing traits across individual and combined analyses. Maturity duration ranged from 80 to 112 days, with RM-12 being the earliest (80 days) and BARI Sarisha-18 the latest (112 days). Plant height varied from 94 cm (RM-19) to 118 cm (BARI Sarisha-18). RM-19 recorded the highest number of branches plant^{-1} (5 in combined mean) and produced 79 siliquae plant^{-1}, while Binasarisha-9 produced the maximum siliquae plant^{-1} (89). The most productive check, BARI Sarisha-18, yielded 1943 kgha^{-1}, followed by RM-12 (1798 kgha^{-1}) and RM-19 (1761 kgha^{-1}). Considering earliness, agronomic performance, and yield stability across environments, RM-12 and RM-19 were identified as promising mutant lines for further rapeseed breeding programs.

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

A preliminary yield trial was conducted to evaluate the performance of four M_6 rapeseed (*Brassica napus* L.) mutants RMT-41, RMT-45, RMT-47 and RMT-48 along with two check varieties, Binasharisha-4 and Binasharisha-9 at three locations: BINA HQS farm (Mymensingh), BINA sub-station Magura, and BINA sub-station Barishal during 2024–25 Rabi season. The experiment was laid out in a randomized complete block design with three replications, and standard agronomic practices were followed. Significant variation ($p \leq 0.05$) was observed among genotypes for most traits across locations. Maturity duration ranged from 80 days (RMT-45) to 88 days (Binasharisha-4). The tallest plants (117 cm) were produced by RMT-47, while RMT-41 and RMT-48 recorded the highest number of branches plant^{-1} (7) and siliquae plant^{-1} (137). Maximum seeds siliqua^{-1} (22) and greater siliqua length (5.59 cm) were obtained from RMT-41 and RMT-45. Combined over locations, seed yield ranged from 1,559 kgha^{-1} (RMT-47) to 1,841 kgha^{-1} (RMT-41), followed by RMT-45 (1,814 kgha^{-1}) and RMT-48 (1,765 kgha^{-1}). Based on superior yield and yield-contributing traits, RMT-41, RMT-45, and RMT-48 were selected for advanced multi-location yield trials.

Sesame

On-station yield trial with M_7 sesame mutants

An on-station yield trial was conducted during March–June 2025 to evaluate two M_7 sesame mutants (ESE-03 and ESE-06) along with the check variety BARI Til-4 at five locations: BINA HQs farm, Mymensingh; BINA Sub-station farms at Ishurdi, Magura, and Gazipur and farmer's field in Magura. The experiment followed a randomized complete block design with three replications, using a unit plot size of 20 m² (4 m × 5 m) and 25 cm row spacing. Standard agronomic practices were applied and data on growth, yield and yield components were collected and statistically analyzed. Significant differences ($p < 0.05$) were observed among genotypes for most traits across locations. Days to maturity ranged from 84 to 87 days and plant height varied from 104 cm to 109 cm. Mutant ESE-03 recorded the highest mean number of capsules plant^{-1} (74) with highest number of seeds capsule^{-1} (78). The mutant ESE-03 produced highest 1000-seed weight (2.78 g) along with the highest seed yield (1385 kgha^{-1}) followed by ESE-06 (1280 kgha^{-1}) and BARI Til-4 (1251 kgha^{-1}). Location-wise, the highest yields were obtained at Ishurdi (1339 kgha^{-1}) and Mymensingh (1335 kgha^{-1}). Overall, ESE-03 showed superior performance in yield and yield-contributing traits, suggesting its potential as a high-yielding sesame variety; however, further multi-location and multi-year evaluations are recommended to confirm its stability.

Regional yield trial with M_6 sesame mutants

A regional yield trial was conducted during March–June 2025 at three locations e.g. BINA Headquarters Farm, Mymensingh; BINA Sub-station, Ishurdi; and BINA Regional Station, Gazipur to evaluate the performance of four promising M_6 sesame mutants (SKM-02, SKM-04, SES-05, and SES-11) along with two check varieties (Binatil-4 and BARI Til-6). The experiment was laid out in a randomized complete block design (RCBD) with three replications. Data were

recorded on phenological and yield contributing traits. Significant variations were observed among the genotypes across locations. Days to maturity ranged from 80 (SES-11) to 82 days (SKM-02, SKM-04, SES-05). SKM-02 and BARI Til-6 produced the tallest plants (125cm) while SES-05 was the shortest (117 cm). SES-11 exhibited the highest number of capsules per plant (69) with highest 1000-seed weight (3.04 g). and SKM-04 produced the highest number of seeds per capsule (101) with the longest capsule length (2.19 cm). In terms of seed yield, SKM-04 (1447 kgha^{-1}) and SES-11 (1426 kgha^{-1}) outperformed the checks while SES-05 produced the lowest yield (1246 kgha^{-1}). Across locations, the highest yields were recorded at BINA HQ, Mymensingh (1327 kgha^{-1}) followed by Gazipur and Ishurdi. The results indicate that SKM-04 and SES-11 are promising for higher yield potential and desirable yield attributes further multi location and next year evaluations for confirmation.

Preliminary yield trial with promising sesame mutants

A preliminary multi-location yield trial was conducted during March 2025 at four locations HQ Mymensingh, Sub-station Nalitabari, Sub-station Ishurdi, and Sub-station Magura to evaluate the growth and yield performance of promising sesame (*Sesamum indicum* L.) mutants along with check varieties. The experiment was laid out in a randomized complete block design with three replications, and standard agronomic practices were followed. Data on phenology, plant height, branching, capsule traits, seed size, and yield were recorded and analyzed. Significant variations were observed among genotypes and locations, as well as for genotype × location interactions. Days to maturity ranged from 83 to 84, the mutants SM-31, SM-32 and SM-33 maturing earliest in 83 days. SM-34 exhibited the tallest plants (121 cm) followed by SM-36 (118cm), while ISD local and BARI Til-4 had the shortest plant (110 cm). Branch number per plant was highest (4) in BARI Til-4 and SM-34 whereas the other mutant and check ISD local had three (3) branches. The mutant SM-31 (2.52 cm) and SM-35 (2.50 cm) produced longest capsule. SM-34 produced the maximum capsules plant^{-1} (62) followed by SM-36 (61) and SM-33 (60). SM-33 recorded the highest seeds capsule^{-1} (83) followed by SM-31 (82), SM-36 (81) and SM-34 (80). 1000-seed weight varied from 2.65 to 2.95 g with SM-34 being superior. The highest seed yield was obtained from SM-36 (1340 kgha^{-1}) followed by SM-31 (1332 kgha^{-1}), SM-33 (1324 kgha^{-1}) and SM-34 (1323 kgha^{-1}). The mutants SM-31, SM-33, SM-34 and SM-36 demonstrated superior yield potential and desirable morphological traits, suggesting their suitability for further evaluation and possible release in sesame breeding programs targeting diverse environments.

Soybean

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

A multi-location field experiment was conducted to evaluate the performance of three soybean genotypes (SCM-5, SCM-8, SCM-11) and one check (Binasoybean-6) across three locations BINA HQ farm (Mymensingh), Barishal substation, and Noakhali substation. Significant variability was observed among genotypes and locations for all measured traits, including plant height (PH), number of branches plant^{-1}, pods plant^{-1}, pod length, seeds pod^{-1}, 100-seed weight, days to maturity and seed yield. The genotype SCM-8 recorded the highest plant height (110 cm), pods plant^{-1} (89) and seed yield (2241kgha^{-1}), but took the longest time to mature (125

days). SCM-11 exhibited the highest 100-seed weight (18.56) with seed yield (2321 kgha^{-1}) while SCM-5 had the highest seed yield (2537 kgha^{-1}) across locations. Among locations, Noakhali substation was superior for yield-contributing traits, particularly pods plant^{-1} (99) and seed yield (2365 kgha^{-1}) followed by BINA HQs farm and Barishal. Overall, SCM-5 and SCM-8 were identified as high-yielding genotypes with promising agronomic traits for soybean production under varied agro-ecological conditions in Bangladesh.

Regional yield trial with selected soybean mutants

Five promising mutants (SBM-32, SBM-33, SBM-34, SBM-35 and SBM-36) along with two check varieties Binasoybean-3 and Binasoybean-6 were evaluated through this trial. This experiment was conducted at BINA HQS farm Mymensingh and BINA Sub-station farms Barishal during January to April 2025. This experiment was laid out in randomized complete block design with three replications. 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 130 days (SBM-32). Plant height ranged from 42cm (SBM-35) to 95cm (Binasoybean-3) and branches plant^{-1} ranged from 3 (SBM-32, SBM-35, Binasoybean-6 & 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 Binasoybean-6 & 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-32. SBM-36 had the highest pod length (3.25) followed by Binasoybean-3 (2.88) & Binasoybean- 6 (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}).

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.

Preliminary yield trial with selected soybean mutants

A field study was conducted at two locations Barishal and Mymensingh to evaluate the performance of seven soybean genotypes including BINA soybean7 and six mutant lines (SBM-24-41, SBM-24-42, SBM-24-43, SBM-24-44, SBM-24-45 and SBM-24-46. Significant variation

was observed among genotypes and over locations for all recorded agronomic traits. Days to maturity ranged from 113 days (SBM-24-41) to 117 (SBM-24-42) days with mutant lines generally maturing. Plant height was highest for BINA soybean7 (58 cm), while the shortest plants were noted for SBM-24-42 (48 cm). The number of pods plant^{-1} was highest in BINA soybean7 (55) followed by SBM-24-44 (50), SBM-24-41 (47) and SBM-24-46 (46). Seed yield varied notably, ranging from 1708 kgha^{-1} (SBM-24-41) to 3089 kgha^{-1} (SBM-24-45). On average, Mymensingh outperformed Barishal in terms of seed yield and other yield attributes. Among the genotypes, SBM-24-44, SBM-24-45, SBM-24-43 and SBM-24-46 demonstrated superior performance in both environments making them promising mutants for future varietal development.

Sunflower

On-station and on-farm yield trial with promising sunflower mutants

A field trial was conducted across four locations Farmer's field Barishal, Jamalpur, Mymensingh, and Nalitabari to assess the performance of three sunflower genotypes (BARISurjomukhi-3, SFM-2 and SFM-5) based on plant height (PH), head diameter (HD), number of seeds per head, 100-seed weight and seed yield (kgha^{-1}). Significant variations were observed among genotypes and locations. Genotype SFM-2 exhibited the highest plant height (146.87 cm) and seed yield (1674kgha^{-1}) over locations, followed by SFM-5 (137.47 cm, 1620 kgha^{-1}), while BARI Surjomukhi-3 had the shortest height (107.71 cm) and lowest yield (1530 kgha^{-1}). Among locations, the Farmer's field Barishal recorded the highest average seed yield (1772 kgha^{-1}), followed by Jamalpur (1732 kgha^{-1}), Mymensingh (1576 kgha^{-1}), and Nalitabari (1420 kgha^{-1}). SFM-2 at Barishal yielded the highest seed output (1852 kgha^{-1}), indicating strong genotype by environment interaction. The results suggest that SFM-2 is a promising genotype for high seed yield potential.

Regional yield trial dwarf inbred line of Sunflower

A regional yield trial was conducted to evaluate the performance of two sunflower (*Helianthus annuus* L.) dwarf inbred lines, SDM-3 and SDM-5, along with the check variety BARI Surjomukhi-3 at four agro-ecological regions of Bangladesh Barishal, Mymensingh, Noakhali, and Satkhira. The experiment followed a randomized complete block design (RCBD) with three replications, and standard agronomic practices were applied. Data were recorded on phenological and yield attributes, including days to maturity, plant height, head diameter, number of seeds per head, 100-seed weight, and seed yield. Significant variation was observed among genotypes and locations. Across environments, SDM-5 matured the latest (108 days) and recorded the tallest head diameter (18.31 cm), the highest number of seeds per head (759), the greatest 100-seed weight (6.49 g), and the highest mean seed yield (1984 kgha^{-1}), outperforming the check variety. Location-wise, Noakhali recorded the highest mean yield (1861 kgha^{-1}), followed closely by Satkhira, Mymensingh, and Barishal. The results indicate that SDM-5 possesses superior adaptability and yield potential, making it a strong candidate for future varietal release and commercial cultivation in diverse and stress-prone agro-climatic zones of Bangladesh.

Preliminary yield trial of promising Sunflower mutants

A field evaluation of sunflower mutants and varieties was conducted at three locations Jamalpur, Mymensingh, and Nalitabari to assess agronomic performance including maturity, plant height, head diameter, seed traits, and yield. Eight genotypes (BARI Surjomukhi-3, SDPN-1, SDPN-2, SDPN-3, SDPN-4, SFM-4, SF6, and SFM-7) showed significant variation among environments. The experiment was conducted in RCBD design with 3 replications. 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.

Among the tested entries, SFM-7 consistently recorded the highest seed yield (2045.56 $kgha^{-1}$) over locations, with a notably large head diameter (22.11 cm) and high seed count per head (812.44), making it the top performer. It also showed superior performance at Mymensingh and Nalitabari with yields of 2032 and 2037 $kgha^{-1}$ respectively. SDPN-2 was another promising genotype, producing 1965.22 $kgha^{-1}$ and the highest 100-seed weight (9.29 g), along with the maximum seed number per head (918.11), indicating its potential for high productivity. In contrast**,** SDPN-3 and SFM-6 had the lowest yields (1287.44 and 1314.33 $kgha^{-1}$) probably due to lower seed weight and seed number. Amon locations Mymensingh **l**ed in average yield (1700.75 kg/ha), followed by Nalitabari and Jamalpur. Plant height was taller in Jamalpur, while head diameter was highest in Mymensingh.

Overall, SFM-7 and SDPN-2 emerged as the most promising genotypes for further sunflower improvement programs due to their consistent performance across environments.

Groundnut

On-farm and on-station yield trial of groundnut lines

An on-farm and on-station yield trial was conducted to evaluate the performance of high-yielding groundnut lines during Rabi season 2024. Three advanced lines (BCB-2-6-3, BCB-3-4-3, BCB-3-4-5) and two checks (Binachinabadam-10, BINA Chinabadam-12) were tested across six locations, including five sub-stations (Rangpur, Ishurdi, Khagrachuri) and BINA HQ, Mymensingh. The experiment followed a randomized complete block design (RCBD) with three replications. Significant variation was observed in growth and yield attributes over locations. The tallest plants were recorded at Rangpur (103.93 cm, BINA Chinabadam-12), while shorter plants observed at BINA HQ and Ishurdi. Branching was highest in BINA Chinabadam-12 and Binachinabadam-10, whereas pod number per plant was maximized in Binachinabadam-10 (22.05 pods mean), especially at Ishurdi (25 pods). Pod and kernel weights were highest in BCB-2-6-3 (112.63 g) and BCB-3-4-5 (108.15 g), while Binachinabadam-10 produced less weighted pods (75.17 g), highlighting trade-offs between pod size and number. Shelling percentage was superior in BCB-3-4-5 (68.78%) and Binachinabadam-10 (69.05%). Overall yield was highest in BCB-3-4-5 (2.72 t/ha), followed by BINA Chinabadam-12 (2.58 t/ha) and BCB-2-6-3 (2.57 t/ha), with better performance in Rangpur and Ishurdi and lower yields at Khagrachuri (1.39–2.36 t/ha). The study indicates that while Binachinabadam-10 produced higher pod number and

branching, its less weighted pods limit yield potential. In contrast, BCB-3-4-5 and BCB-2-6-3 combine bold pods, high kernel weight, and efficient shelling, providing stable, high yields across diverse environments. BINA Chinabadam-12 also showed adaptability, suggesting BCB-3-4-5 as a promising line for further evaluation.

Progrm Area-II: Varietal Improvement of Pulse Crops

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

This study was conducted at the BINA sub-station farms and farmer's fields in Magura and Ishurdi farmer's fields during Rabi season of 2024-25. The objective was to evaluate the yield performance and adaptability of four gamma-induced lentil mutant (LM-250, LM-137, LM-150, and LM-11) compared to the check variety BARI Masur-8. The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. The results indicated that the combined average yield of the mutant lines was 1554.50 kg/ha (LM-250), 1469.50 kg/ha (LM-137), 1782.75 kg/ha (LM-150), and 1987.25 kg/ha (LM-11), while BARI Masur-8 yielded 1568.50 kg/ha. The mutants showed significant differences in maturity, with LM-250 (96.25 days) and LM-137 (97.50 days) maturing earlier than the check variety (111.75 days). Among the mutants, LM-11 emerged as the most promising, showing superior branching (2.83 branches/plant) and pod production (119.25 pods/plant), leading to the highest yield. The findings suggest that LM-11, with its early maturity and high yield, has the potential to enhance lentil production in Bangladesh.

Growing of M_8/M_7 generation of lentil

The experiments were conducted at BINA Sub-station farm, Magura. A total of 5 M_7 plants were harvested from four doses: 150 Gy, 200 Gy and 250 Gy. Seeds of these M_7 plants were grown in plant-progeny-rows along with the mother variety. Another set of 9 M_8 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, erect plant type, and disease reactions. Altogether, 4 M_7 and 6 M_8 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.

Project: Varietal improvement of blackgram through induced mutation

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

This study was conducted at two locations, Ishurdi and Chapainawabganj, to assess the growth and yield attributes with two promising blackgram mutants along with a check variety BARI Mash-3. The study was conducted at BINA substations Magura, Ishurdi, Chapainawabganj, and Gopalganj during the Kharif-2 season of 2024. The experiment was laid out in a randomized complete block design with three replications. Intercultural operations were done for the proper growth and development of plants in each plot. Plant height varied significantly across varieties

and locations. The combined mean confirmed that BM-42 (46.45 cm) and BARI Mash-3 (45.17 cm) were generally taller than BM-4 (41.39 cm). The combined mean showed that BM-4 had 3.39 branches per plant, outperforming BM-42 (2.59) and BARI Mash-3 (2.27). The combined mean also confirmed that in case of pods/plant and seeds/pod BM-4 (51.57 pods/plant and 6.98 seeds/pod) outperformed BM-42 (42.11 pods/plant 5.42) and BARI Mash-3 (35.64 pods/plant and 5.41 seeds/pod) respectively. The combined mean yield was 1933 kg/ha for BM-4, far exceeding BM-42 (1686 kg/ha) and BARI Mash-3 (1661 kg/ha). The results clearly demonstrate that BM-4 is the best-performing blackgram mutant in terms of branches per plant, pods per plant, seeds per pod, seed weight, and yield under different environmental conditions. Therefore, BM-4 can be recommended as a promising high-yielding blackgram variety for cultivation in Bangladesh.

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, Ishurdi, and Gopalganj (Faridpur) during Kharif-2 season of 2024. The experiment was laid out in a randomized complete block design with three replications. Intercultural operations were done for the proper growth and development of plants in each plot. Significant differences were observed among varieties. BM-42 recorded the tallest plants (45.83 cm), followed by BARI Mash-3 (43.66 cm), whereas BM-4 produced the shortest plants (40.78 cm). BM-4 produced significantly more branches (3.23) compared to BM-42 (2.55) and BARI Mash-3 (2.30). BM-4 exhibited the highest number of pods per plant (45.10), followed by BM-42 (37.66), while BARI Mash-3 had the lowest (30.24). This trait strongly influenced the final seed yield. BM-4 produced significantly more seeds per pod (6.24) than BM-42 (5.73) and BARI Mash-3 (4.77). Ishurdi location particularly favored higher seed set in BM-4 (6.87). BM-4 consistently outperformed others with yields ranging from 1785–1873 kg/ha, with a combined mean of 1817 kg/ha. BM-42 and BARI Mash-3 yielded 1604 kg/ha and 1524 kg/ha, respectively. The superior performance of BM-4 was associated with higher branching, more pods per plant, greater seeds per pod, and higher seed weight. The study demonstrated that BM-4 is the most promising blackgram mutant, performing consistently better than BM-42 and BARI Mash-3 across three locations in Bangladesh. Adoption of BM-4 could significantly enhance blackgram productivity and contribute to food and nutritional security.

Advanced yield trial with five promising blackgram mutants

The trial was conducted with five promising blackgram mutants along with a check variety, BARI Mash-3, at Magura. 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. The research findings show that average yield performance of all the five mutant lines (BM-235, BM-46, BM-63, BM-41, BM-43) and the check variety BARI Mash-3 were recorded 1456 kg/ha, 1571 kg/ha, 1782 kg/ha, 1478 kg/ha, 1481 kg/ha and 1477 kg/ha respectively. The study revealed significant genetic variability among blackgram mutants and the check variety at Magura. BM-

63 proved to be the best performer, producing the highest seed yield (1782 kg/ha) along with superior yield-contributing traits such as higher pod number, seed set, and 100-seed weight. In contrast, the check variety BARI Mash-3 showed lower yield potential. Therefore, BM-63 may be considered as promising mutant line for yield improvement and recommended for further evaluation.

Project: Varietal improvement of grasspea through induced mutation

Regional yield trial with five promising grasspea mutants along with two check varieties during Rabi 2024-25

The experiment was conducted at research farm of BINA sub-station Magura, Ishurdi, Barishal as well as in Farmer's field of Magura, Goplagonj and Barishal during Rabi season, 2024-25. The Objective was to evaluate the yield performance of five grasspea genotypes/mutants (GM-300, GM-307, GM-305, GM-328, GM-401) compared to check variety BARI Kheshari-2 across multiple agro-ecological zones to identify high-yielding and adaptable genotypes. The experiment was conducted in a randomized complete block design with three replications. The research findings show that combined over locations average yield performance of all the five mutant lines (GM-300, GM-307, GM-305, GM-328, GM-401) and the check variety BARI Kheshari-2 were recorded 1829 kg/ha, 1575 kg/ha, 1740 kg/ha, 1483 kg/ha, 1503 kg/ha and 1545 kg/ha respectively. Two mutants GM-300 (109.7 days) and GM-305 (109.5 days) matured faster than BARI Kheshari-2 (119.7 days). GM-300 and GM-305 were superior, producing early maturity, moderate plant height, higher pod numbers, larger seeds, and the highest seed yield. Therefore, GM-300 and GM-305 can be recommended for multi-location trials to improve grasspea productivity and ensure stable yields across diverse agro-ecological zones.

Growing of M_5/M_7 generation of grasspea

The experiments were conducted at research farm of BINA sub-station Magura during Rabi season, 2024-25. The Objective was to evaluate the yield performance of grasspea genotypes/mutants. 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. A total of 22 M_5 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_7 mutants were selected on the basis of earliness, the number of pods, and disease reactions. Further selection will be done in the next generation.

BIOTECHNOLOGY DIVISION

Program Area I: Genetic Engineering and Tissue Culture

Cloning of *OsMGD* from FR13A through Gateway technology

The objective of this study was to clone the *OsMGD* gene from the submergence-tolerant rice genotype FR13A into a plant expression vector using Gateway technology, to facilitate its future functional characterization in transgenic plants. Total RNA was isolated from FR13A and reverse transcribed to synthesize cDNA. The *OsMGD* coding sequence was amplified in two PCR steps: the first PCR (PCR1) with gene-specific primers and the second PCR (PCR2) with Gateway adapter primers, using Q5 High-Fidelity DNA polymerase (NEB, USA). The resulting PCR fragments were flanked by attB sites, enabling recombination with the Gateway entry vector pDONR221 (Invitrogen), which contains the *ccdB* gene. Site-specific recombination was catalyzed by BP Clonase, yielding *OsMGD* entry clones. The entry clones were transformed into *E. coli* DH5α competent cells using the heat-shock method. Transformants were selected on LB agar plates supplemented with 50 mg/ml kanamycin. Positive colonies were screened by colony PCR with gene-specific primers. Plasmids from confirmed colonies were isolated using the PureLink™ Plasmid Isolation Kit (Invitrogen, USA). For final cloning, the confirmed *OsMGD* entry clones will be subjected to LR recombination with the binary plant expression vector pB2WG7, containing the cauliflower mosaic virus (CaMV) 35S promoter and a herbicide resistance (Basta) gene, using LR Clonase enzyme mix. Successful amplification of the *OsMGD* coding region was achieved by PCR1 and PCR2. Recombination into pDONR221 produced stable entry clones, which were verified through colony PCR and plasmid isolation. The next step involves LR recombination into pB2WG7 to generate the final plant expression construct for functional analysis.

Optimization of media/protocol for callus regeneration from non-aromatic rice to produce aromatic rice by gene editing

Mutations in the betaine aldehyde dehydrogenase gene (*OsBADH2*, LOC_Os08g32870) have been identified as the genetic basis of aroma in rice. The present study aimed to establish a tissue culture protocol from high-yielding non-aromatic rice variety BINA dhan25, developed by the Bangladesh Institute of Nuclear Agriculture (BINA). Prior to applying genome editing, experiments were conducted to optimize callus induction and regeneration in BINA dhan25 using different culture media compositions. Two media formulations, MS1 (MS salts enriched with casein hydrolysate, L-proline, and gelrite) and MS2, were tested with varying concentrations of 2,4-D (2.0, 2.5, and 3.0 mg/L). Results showed that MS1 consistently outperformed MS2 for both embryogenic callus induction and regeneration efficiency. The highest embryogenic callus induction (47.22%) was achieved with 2.5 mg/L 2,4-D in MS1 medium, giving an average of 39.83% across treatments, compared to 31.37% in MS2. Similarly, shoot regeneration was significantly enhanced in MS1, with 2.5 mg/L 2,4-D yielding 75.34% regeneration and an average of 70.51%, compared to 60.78% in MS2. Rooting was also more robust under the optimized MS1 conditions, demonstrating its superiority for efficient plant regeneration. The study established an efficient and reproducible tissue culture protocol for BINA dhan25, identifying MS1 medium supplemented with 2.5 mg/L 2,4-Dwhich is optimal for embryogenic callus induction and regeneration. These findings provide a reliable platform for

CRISPR/Cas9-mediated targeted mutagenesis of *OsBADH2*, enabling the development of novel aromatic rice lines with high-yield and fine-grain attributes of BINA dhan25.

Structural and functional characterization of Universal stress proteins in tomato

This study represents a comprehensive genome-wide analysis and functional characterization of the Universal Stress Protein (USP) gene family in tomato (*Solanum lycopersicum*), establishing their integral role in abiotic stress adaptation. Twenty-one *SlUSP* genes were identified and validated across the tomato genome, confirming the presence of the conserved USP domain in all members. Structural analysis revealed a distribution across 10 chromosomes and a notable diversity in exon-intron architecture, including intronless genes like *SlUSP13* and *SlUSP14*, suggesting evolutionary mechanisms like retrotransposition. The encoded proteins varied significantly in size and physicochemical properties, with subcellular localization predicting specialized functions—while most were cytoplasmic, several were predicted in the nucleus, chloroplasts, and mitochondria (*SlUSP7, SlUSP13, SlUSP14*), highlighting their spatial specialization in stress response. Phylogenetic analysis grouped the *SlUSPs* into six major clusters demonstrating evolutionary relationships with other plant species and suggesting functional divergence within the family. Promoter analysis revealed a high density of hormone- and stress-responsive *cis*-regulatory elements, indicating that the genes are tightly modulated by external and internal signals. The functional assessment involved exposing tomato seedlings to 10% PEG-6000-induced osmotic stress to simulate drought conditions. Quantitative Real-Time PCR (qRT-PCR) revealed distinct temporal expression patterns for three key candidates. *SlUSP5* exhibited the most vigorous response, showing a progressive and sustained upregulation that exceeded a fivefold increase in expression at the 3-hour mark, strongly positioning it as a key regulator of sustained osmotic stress adaptation. In contrast, *SlUSP1* demonstrated a sharp, late-phase induction, increasing by more than fourfold by the 3-hour mark, suggesting a critical role in the prolonged stress response, while *SlUSP4* showed only marginal changes. Collectively, this work provides a foundational resource for the *SlUSP* family in tomato, identifying *SlUSP1* and *SlUSP5* as superior candidate genes for future functional validation and genetic engineering efforts aimed at enhancing drought tolerance in tomato cultivars.

Agronomic Performance of Somaclonal Variants Derived from BRRI dhan89 through Tissue Culture

This experiment was aimed at evaluating eight tissue culture-derived lines (TC-5 to TC-12) against the original parent across key agronomic traits, aiming to identify superior genotypes for enhanced productivity and adaptation. The lines were assessed for Days to Maturity (DM), Plant Height (PH), Filled Grains per Panicle (FGP), and Grain Yield/ Plant (YPP). Two variants exhibited significantly higher yield potential: TC-10 recorded the highest grain yield at 38.97 g,/plant followed by TC-9 at 38.87 g /plant, surpassing the parental yield of 37.49 g. Yield superiority in TC-10 was supported by its highest number of Filled grains Panicle-^{1} (149.33), confirming improved reproductive efficiency. Variants TC-11 and TC-12 completed their growth cycle and matured approximately 11 days earlier (at 134 days) than the parent variety (145 days), offering substantial benefits for crop rotation and escape from late-season stresses. Based on the balanced performance across multiple desirable traits, the line TC-10 was identified as the most

promising variant derived directly from the somaclonal variation. These findings confirm the efficacy of utilizing induced variation for targeted rice breeding improvements.

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

The primary objective was to determine the expression profile of the heat-responsive gene *CaChiVI2* under controlled thermal stress conditions though qRT-PCR for validating its potential as a candidate gene for developing heat-resilient varieties. Gene expression levels were measured across four temperature regimes: 22°C (control), 30°C, 37°C, and 45°C. The results suggested that *CaChiVI2* is a true heat-inducible gene in CKN-1 genotype, with its expression levels confirming a strong correlation with increasing temperature. The induction was found to be highly significant at the moderate stress level and peaking at 37°C with a robust 4.28-fold increase in expression. The upregulation of a physiologically relevant stress temperature confirms the gene's primary role in activating the plant's defense response against heat. A sharp decline in gene expression was observed when temperature raised to 45°C, indicating that associated enzymatic activity and its transcriptional machinery is highly sensitive and susceptible to inhibition by extreme thermal conditions. The next logical step is cloning of the *CaChiVI2* gene and its subsequent introduction into susceptible elite genotypes using *Agrobacterium-mediated* transformation. This genetic engineering approach will be aimed to constitutively or conditionally express the gene, thereby functionally validating its capacity to confer improved thermotolerance in sweet pepper plants.

Study on *In vitro* responses of high yielding wheat cultivar through regeneration capacity

The main goal of this experiment was to establish an optimized, reproducible tissue culture protocol by assessing the callus induction and regeneration capacity of two important Bangladeshi wheat genotypes, BARI Gom-30 and BARI Gom-32. The experiment successfully identified the optimal conditions for the two-step process: the concentration of 2.0 mg/L 2,4-D was determined to be the most effective for maximizing primary callus induction for both genotypes, with induction rates of 82.04% for BARI Gom-30 and 82.26% for BARI Gom-32. Concentrations exceeding to 3 mg/L, resulted in decreased induction and an undesirable increase in non-regenerative structures (NRS). In regeneration phase, the study found that the inclusion of 1 mg/L BAP was key to promoting successful greening and the formation of embryogenic calli. Overall, BARI Gom-30 demonstrated superior regenerative potential compared to BARI Gom-32. The most effective shoot and root regeneration were achieved using media supplemented with various combinations of NAA and BAP, or IAA, validating a robust and high-efficiency protocol. This established in vitro regeneration system provides the required technological platform for future targeted genetic manipulation and accelerated breeding programs aimed at enhancing major traits like disease resistance and yield.

Programme Area II: Marker Assisted Selection/Marker Assisted Backcross Breeding

Advanced yield trial with high yielding and short duration rice lines

The study aims to enhance the yield potential of Binadhan-16, a short-duration, moderately high-yielding rice variety, through the introgression of the two yield-related QTLs from *O. rufipogon* using a marker-assisted backcrossing approach. During Boro season of 2024–25, six advanced rice lines along with three standard checks (Binadhan-16, BRRI dhan96, and Binadhan-17) were evaluated in a randomized complete block design (RCBD) with three replications at BINA Headquarters, Mymensingh. Each genotype was planted in 16.0 m² plots (4.0 m × 4.0 m) with 20 cm between rows and 15 cm between plants, using a single seedling per hill. Fertilizers were applied at 120:25:40:10:4 kg/ha of N, P, K, S, and Zn, respectively, and standard agronomic practices were followed throughout the experiment. Three advanced rice lines were selected based on duration, plant height, and yield compare to the checks for further evaluation. The tested lines and checks differed significantly and showed promising result in grain yield, plant height, and maturity. The highest yield was recorded by Bina (Bio)16*08/BC2-S7-14-8 (9.03 t/ha), followed by Bina (Bio)16*08/BC2-S7-14-11 (8.93 t/ha) and (Bio)16*08/BC2-S7-1-2-42 (8.74 t/ha). The shortest plant height was observed in Bina (Bio)16*08/BC2-S7-14-2 (89.2 cm), followed by Bina(Bio)16*08/BC2-S7-14-8 (91.8 cm), while the tallest was Binadhan-16 (120 cm), followed by (Bio)16*08/BC2-S7-1-2-42 (118 cm). The selected lines will be transplanted for further evaluation in the next season.

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

Hybridization programs were initiated using *Kataribhog* × *Oryza rufipogon* and *Binadhan-13* × *BR5* crosses to enhance yield potential and lodging resistance. Unit plot size was 0.50 m × 1.0 m, with plant spacing of 15 cm (within rows) and 20 cm (between rows), using one seedling per hill. Fertilizer was applied at 120:25:40:10:4 kg/ha of N:P:K:S:Zn, following standard agronomic practices.

In T. Aman 2024, approximately 15 F_5 (Katarobhog × *Oryza rufipogon*) plants were selected from 35 segregating F_4 populations based on superior plant type compared to the parents. Molecular analysis was performed to confirm the presence of the fragrance gene (*BADH2*) in selected lines. Additionally, 5 F_4 lines were selected from 21 F_3 populations (Binadhan-13 × BR5) during the same season. Seeds from selected plants were harvested and stored for the next season.

HORTICULTURE DIVISION

Project: Varietal improvement of fruits

Collection and evaluation of major fruits germplasm

A total of 28 major fruits germplasm has been collected from local and abroad which was planted in the field. The local germplasm were collected from farmers' home garden and nursery. These landraces. 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, yield and yield contributing characteristics.

Evaluation of Mango germplasm

About 11 germplasm (Bombay green, Shinduri,Neel uddin, Karate colombo, Mulgoba, Kewsani, Black stone, Honeydew, Sofeda mango, Rajpuri, Keshington pride etc) of mango have been planted and maintained in the Germplasm Centre. Four genotypes of mango, namely MI -009, MI -019, MI - 052, and MI -076 were identified after screening. Among 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.

Collection and evaluation of minor fruits germplasm

A total of 19 minor fruits germplasm has been collected from the different parts from local and abroad and planted in the field. The local germplasm were collected from farmers' home garden and nursery. These landraces. 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 *(Annona squamosa L)* germplasm were studied under laboratory condition of Horticulture Division, BINA, during 2024-2025. Two genotypes, namely AS003 and AS005 were identified after screening. The result indicated that wide range of variability observed 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 performances on the basis of fruit weight, number of seeds/fruits, TSS value and yield (kg plant^{-1}).

Evaluation of exotic Jamun germplasm

Fruit characteristics of four exotic jamun (*Syzygium cumini*) germplasm were studied under laboratory condition of Horticulture Division, BINA, during 2024-2025. Two genotypes of jamun germplasm, namely SC007 and SC009 were identified after screening. Plant height and number of primary branches were 4.23 m 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 5.52 g having 2.82 cm length and 2.11 cm diameter. Seed weight was 1.25 g and edible portion was 77.35%. Ripe fruit was black in color and TSS in fruit juice was 13.20%. The plant produced 5.47 kg fruit.

Evaluation of local Pomelo germplasm

Five germplasm of pomelo (*Citrus grandis)* viz. CG -001, CG -002, CG -003, CG -004 and CG -005 were evaluated at the laboratory of Horticulture Division, BINA, during 2024-2025. Fruit weight of the germplasm ranged from 465g (CG -004) to 855g (CG -001). The highest edible portion was obtained (67.55%) in CG -003. TSS varied from 10-12%. The highest number of segments 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 germplasm of bael (*Aegle marmelos L)* was observed in case of different characteristics. The highest plant height was recorded in case of AM -004 (2.94 m) but base girth was the highest from AM -005 (135 cm). AM -001 was superior with bigger canopy size (2.0×1.7 m). The highest number of fruits (22) was found from AM -003 with maximum yield (18.85 kg plant^{-1}). There were variations among the quantitative fruit characters also. Maximum fruit weight was obtained from AM -004 (856 g) with large sized fruit (11.3×10.55 cm). But AM -001was superior with maximum TSS (40%), edible portion (65.66%).

Evaluation of exotic Bedana (pomegranate) germplasm

An experiment was carried out at 2024-2025 to evaluate five pomegranate (*Punica granatum)* germplasm. 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 fruits. Plant height was maximum (288 cm) in PG -002 and minimum (225 cm) in PG -030 and the base girth was recorded maximum (29 cm) in PG -007, whereas it was noticed minimum (16 cm) in PG -02. Individual fruit weight was recorded maximum (325 g) in PG -039. The germplasm PG -001 contained maximum total soluble solids (14.8 %). Fruit color of most of the germplasm was observed orange red, while aril color was 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 15 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 landraces 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 (*Artocarpus heterophyllus)* germplasm namely AH -001 and AH -002 were studied at the BINA HQ's Farm, Mymensingh. Plant height, plant spreading and male inflorescences were recorded. The average plant height was observed to be 3.85 m. Maximum

plant height was recorded in AH -02 (4.21 m) and minimum plant height was recorded in AH -001 (2.77 m). All the germplasm were observed to produce male inflorescences and one of the germplasms was found to produce male inflorescences from the month of July 2024 which was the sign of off-season and year-round behavior.

Evaluation of exotic Longan germplasm

Two exotic longan (*Nephelium longana*) 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 (%) 5 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 14). The highest TSS was found in EL- 003 (22.23%).

Screening of M_1V_1 population of Sweet orange, Sapota, Jamun and Pomegranate

Twenty four M_1V_1 mutants of sweet orange, 29 M_1V_1 mutants of sapota, 15 M_1V_1 mutants of pomegranate and 21 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 of sweet orange (*Citrus sinensis)* and three check varieties ($WNMD_0P_1$, MMD_0 P_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 pomelo root stock. MMutant $MMD_{20}P_1$ showed maximum number of fruits (187) per plant, accumulated higher TSS (11.00 %) and minimum number of seed $fruit^{-1}$ (6) whereas the minimum number of fruits (77) $plant^{-1}$ and maximum number of seeds $fruit^{-1}$ (13) were recorded in $WNMD_0$ P_1**.** The maximum length of fruit (8.07 cm), breadth of fruit (7.20cm) and weight of individual fruit (198 g) as well as yield $plan^{-1}$ (34.33 kg $plant^{-1}$) was found in $MMD_{20}P_1$ mutant. Considering fruit characteristics $MMD_{40}P_1$ mutant was found promising.

Growing of M_1V_1 population of lime

The experiment was conducted with 3 M_1V_1 populations of lime (*Citrus aurantiifolia)* and a check variety (CAD_0P_1) where the scions irradiated with 20 Gy, 40 Gy, 60 Gy and 80 Gy of gamma ray. Result found that the mutant $CAD_{20}P_1$ showed maximum number of fruits (255) per plant, weight of individual fruit (139g), accumulated higher TSS (7.0 %), minimum number of seeds $fruit^{-1}$ (5), maximum length of fruit (5.05cm), breadth of fruit (4.71 cm) and yield (34.54 kg $plant^{-1}$) were recorded in $CAD_{40}P_1$whereas the minimum no. of fruit (147), length of fruit (4.60 cm), breadth of fruit (4.21 cm) and weight of individual fruit (107 g), maximum number of seed $fruit^{-1}$ (14) and minimum yield (14.04 kg/plant) were found in CAD_0P_1 mutant.

Screening of pomegranate germplasm

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. Result showed that the germplasm PG-2 (India-2) produced the maximum number of fruits (74 fruits plant^{-1}), longer length and breadth of fruit were 5.5cm and 5.44cm, respectively whereas the minimum number of fruits (26 fruits plant^{-1}), shorter length and breadth (4.42cm and 4.6cm) of fruit were recorded in PG-7 (Indian Bedana-2). PG-2 (India-2) germplasm had the highest TSS (16.50 %) and maximum weight of fruit plant^{-1} (211 g) and yield /plant(14.50kg) whereas the lowest TSS (14.00 %), minimum weight of fruit plant^{-1} (124 g) and yield/plant(4.40kg) 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) of sapota (*Punica granatum)* and one check variety (MAD0P1) at the BINA HQs, Mymensingh.to create genetic variabilityscions of sapota were irradiated with 20Gy, 40Gy and 60Gy of gamma ray. Irradiated scions were grafted on khirni root stock. Result from the experiment, found that the mutant MAD20P9 showed maximum number of fruits (35fruits plant^{-1}) per plant, accumulated higher TSS (25.8 %), length of fruit (7.1 cm), breadth of fruit (6.5 cm) and weight of individual fruit (311 g) as well as yield plant^{-1} (19.02 kg/plant). The minimum number of fruits (31) per plant, accumulated higher TSS (22.20 %), length of fruit (4.6 cm), breadth of fruit (4.5 cm) and weight of individual fruit (121 g) as well as yield plant^{-1} (3.75 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 mutants (SCD5P5, SCD10P2, SCD10P6, SCD15P6 and SCD15P8) of jamun (*Syzygium cumini)* 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. Result found that SCD15P8 mutant showed the highest TSS (13.74 %), length of fruit (2.8 cm), breadth of fruit (2.4 cm) and weight of individual fruit (13.88g) as well as yield plant^{-1} (8.78 kg plant^{-1}). The lowest TSS (10.80 %), length of fruit (2.1 cm), breadth of fruit (1.9cm) and weight of individual fruit (10.11g) as well as yield plant^{-1} (5.60 kg plant^{-1}) were recorded in SCD0P1. Considering fruit number, length and breadth of fruit, %TSS and yield potentiality of SCD15P8 mutant was found promising.

Name of the Project: Improvement of Vegetables

Growing of F_1 generation of some bottle gourd lines

A field experiment was conducted during Rabi 2024-25 in horticultural field of Bangladesh Institute of Nuclear Agriculture. This experiment was laid out randomized complete block design with three replications. Seventeen F_1 lines with 1 commercial variety (Mithila1 control) of bottle gourd were used . to evaluate the performance of the seventeen F_1 lines. Vine length, number of

branch plant^{-1}, days to 1st female flower, fruit length, fruit girth, number of fruit and individual fruit weight were recorded. Mithila1 which was 2.4 m long. Maximum branch 10.50 plant^{-1} was found in P17P8 cross combination while minimum branch number 5.5 plant^{-1} was found in P7P18. The cross combination P1P18 required minimum 45. days to produced 1st female flower. The cross combination of P11P3 produced longest fruit which was 52.25 cm long contrary to P5P1 cross combination gave the shortest fruit which was 24.5 cm long. The cross combination P16P2 produced thicker fruit (50.25 cm) but thinner fruit was found in P14P9 cross combination (30 cm). Maximum number of fruits and fruit yield plant^{-1} were found in P5P1 cross combination those are 17 and 30.13 kg respectively. On the other hand, minimum number of fruit (1.00) and fruit yield (2.53 kg) were recorded in P6P5 cross combination.

Growing of F_4 generation of some commercial hybrid of tomato

The BARI Hybrid Tomato-4, BARI Hybrid Tomato-8 and Lalbahadur were use in this experiment. Among 170 populations only eleven plants were selected for further evaluation and homogeneity observation. To maintain the pedigree plant pigmentation, pant height, flower cluster^{-1}, fruit cluster^{-1}, no. of cluster plant^{-1}, no. of fruit plant^{-1}, fruit length, fruit diameter, single fruit weight, 1st harvest, and fruit yield plant^{-1} were recorded. According to number of fruit and fruit weight yield t ha-1 was calculated. t in BARI Hybrid Tomato-4 (15) but maximum no. of fruits plant^{-1} was recorded in BARI Hybrid Tomato-4. Moderate no. of fruits plant^{-1} and single fruit weight were recorded in Lalbahadur16 (A) due to this BARI Hybrid Tomato-4 genotype produced maximum fruit yield (117 t ha^{-1}).

Radio-sensitivity test and growing of M_1 generation of tomato

The BARI Tomato-15 and nine irradiation doses 0, 200, 250, 300, 350, 400, 450, 500, and 550 Gy were used as treatment of this experiment. In lab test seed germination rate was recorded at 3, 4, 5 and 6 days after sowing and seedling height, root length and number of roots were recorded at 10 days after sowing. In glass house test days to taken 1st emergence, seed germination rate at 7 days after sowing, leaf breath and leaf length at 16 days after sowing were recorded. Green plant, violet and variegated leaf plant were recorded. Seedling height, shoot length and number of leaves also recorded at transplanting stage. In lab test seed germination rate, seedling height and root length were gradually decrease with the increase of irradiation doses. On the other hand, number of roots was variable but this experiment was revealed that but gradually decreased with the increase of irradiation doses. In glass house test days to 1st emergence were increase with the increase of irradiation doses. Maximum seed germination rate was found in control (0 Gy) at 7 days after sowing. The seed germination rate was randomly affected by irradiation doses but gradually decrease with the increase of irradiation doses. Leaf breath, leaf length, plant height, shoot length, number of leaves gradually decreases with the increase of irradiation doses. Three types of plant were found like Green leaf , violet leaf and variegated leaf plant. In control (0 Gy) 100 percent plant was green in color. In 200 Gy 99 percent plant was green in color and 1 percent plant was violet in color. Number of violet plant was increase with the increase of irradiation doses. Plants with variegated leaf were found with the 300 Gy and gradually increase with the increase of irradiation doses.

Reverse breeding through F_2 generation of commercial hybrids of tomato (PhD Programme)

A non-replicated experiment was conducted during Rabi 2024-2025 in horticulture research field of Bangladesh Institute of Nuclear Agriculture. F_2 generation of 23 commercial hybrid *viz.* Lal bahadur, BRAC 1701, Durjoy, Summerking, BARI Hybrid Tomato-8, TM027, Red stone, Sawsan8323, Shukhi, Udayon plus, Tidy plus, Moon, Bijli-11, Bahubali, Dipali, Sultan, Prottasha, Uttaran+, Comet, Puhong14, Puhong903 and Shenfen were used as treatments in this experiment. Stem Pigment, number of branch plant^{-1}, plant height (cm), flower cluster^{-1}, fruit cluster^{-1}, number of cluster plant^{-1}, number of fruit plant^{-1}, fruit length (cm), fruit diameter (cm), individual fruit weight (g), 1st harvest @ DAT and fruit yield plant^{-1} of each genotype was recorded to see the segregation pattern of mentioned commercial varieties. Especially number of flower and number of fruit cluster-1 was observed carefully to identify the male sterile plant. The plant failed to set fruit but other plant of the same variety was able to set fruit primarily that plant considered as male sterile plant and that plant will study in next season. In this experiment three genotypes were identified as male sterile. These were categorized to stamens twisted, unopened flowered and stigma exerted.

General combining ability of some tomato germplasm

Five tomato varieties *viz.* BARI Tomato-14, BARI Tomato-18, Binatomato-13, world champion and walter were used in this experiment. BARI Tomato-14, BARI Tomato-18 and Binatomato-13 were used as female plant on the other hand two varieties *viz.* world champion and walter were used as male plant. Thus BARI Tomato-14×Walter, BARI Tomato-18×Walter, Binatomato-13× Walter, BARI Tomato-14× World champion, BARI Tomato-18×World champion and Binatomato-13×World champion these six cross were made. Success rate of crosses, fruit size and number of seeds within fruit were satisfactory. Seeds from individual fruits were collected and stored. Stored seeds will be grown in next winter to evaluate the F_1 performance.

Growing of F_2 generation of commercial hybrids and some OP variety of bitter gourd

These lines were derived from eight commercial hybrids, one mutant line and one local variety through reversed breeding. Controlled sib-mating and hand pollination were employed to ensure genetic purity. Finally, seeds from successfully settled fruits were harvested and stored for F_3 generation development.

Growing of M_1 generation of okra (*Abelmoschus esculentus*)

An experiment was conducted followed by non-replicated design and 3 Okra variety (2 local and 1 exotic) were selected based on the required characteristics for irradiation with 200, 300, 400 and 500 Gy of gamma rays to grow M_1 population. The objective of this experiment was to select desirable plants having higher fruits yield, seed yield, early maturing potentiality and yellow mosaic virus tolerance. The selection of the plants was on the basis of higher no. of leaves/plant, no of fruits/plant, number of seed/fruit, fruit length (cm), fruit weight (g) and YMV incidents and tolerance level.

Improvement of spice crops

Advanced yield trial of M_7 mutants of onion (*Allium cepa l.*) (bulb to seed)

Four M_6 mutants of onion (ACM-022, ACM-023, ACM-026 and ACM-030) with BARI Piaz-1 as a check variety were planted in the row-planting method on 20 November 2024. 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. The crop was harvested on 15 April, 2025. Data on days to heading, number of umbel/plant, number of floret/plant, seed set (%), no.of seeds/umbel,1000 seed weight and seed yield/plant were recorded (Table.). On the basis of seed yield/plant ACM-022, ACM-023 and ACM-030 onion mutants were selected for further trial.

Screening of M_5 onion (*Allium cepa l.*) generation for high yield and quality (seed to bulb)

Nine onion mutants with parent were transplanted in plant progeny-rows at BINAHQs Farm, Mymensingh on 25 December 2024. Data was recorded on average individual bulb weight, bulb diameter, brix (%) & Twin (%) from five randomly selected plant from each plot. $LK/80/M_5/P_{10}$ having the highest individual bulb weight (35g). Brix is one of the major storability characters of onion. Highest brix (%) indicates that longest storability of that mutant $LK/80/M_5/P_3$ having highest brix (15.1%) and $LK/50/M_5/P_{12}$ having lowest 7.6 % brix. Considering the overall performance and brix (%)five mutants have been selected for future trial.

Screening of M_1V_3 generation of Turmeric (*Curcuma longa* L.)

The field experiment was conducted during 2024-25 at the Horticulture farm to evaluate the performance of M_1V_3 generation of Turmeric. The experiment was followed non-replicated design and sown separately (variety and dose wise). line to line and plant to plant distances were 30cm and 15 cm respectively. Data were recorded on no. of fingers/hill, wt.of fingers(g), no.of mother rhizome and wt.of mother rhizome. On the basis of yield and yield attributes five mutants were selected for growing M_1V_4 population.

Growing of M_3 generation of Black cumin (*Nigella sativa* L.)

To create variability for short duration with high yielding, local variety (Shariatpur) was irradiated with different gamma irradiation doses (100 Gy, 150 Gy, 200 Gy, 250 Gy, 300 Gy). Data on various characters such as plant height, No of branches , No of pod/plant , Seed/pod, Total seed weight/plant (g) were recorded from randomly selected plant. Most of the M_3 plants were harvested on 10/03/25 and seeds stored for next season.

Growing of M_1V_2 generation of Garlic (*Allium sativum* L.)

M_1V_2 mutants of garlic were sown in plant progeny-rows at BINA HQ farm, Mymensingh on 06 November 2024. Data on plant height, no. of leaves/plant, neck diameter, weight of individual bulb, no. of clove/bulb & clove length were taken. Considering the overall performance 11 mutants with control were selected and bulb harvested on 17 March for growing further generation.

Screening of selected populations of Coriander (*Coriandrum sativum* L.)

Coriander (dhoney) a strong-smelling annual herb rich in dietary fibers, vitamin c, vitamin k and other proteins. Therefore, we collect two local cultivars were grown on 06 November 2024 in plant progeny rows at Horticulture research field, BINA, Mymensingh with high yield (seed) and leafy. The populations of coriander seeds were harvested on 22/02/24 and preserve as breeding material for next season.

Screening of selected chili germplasm (*Capsicum frutescens* L.)

Four promising chili lines were evaluated at BINA HQs farm, Mymensingh to evaluate the yield and yield attributing character. Seeds were sown in the seedbed for seedling on November and 35 days aged seedlings were transplanted in December 2024 at HQs farm. Among these genotypes, CFG-043 produced highest plant height (112.6 cm) and the shortest plant height was recorded in CFG-22-02 (82.3 cm). According to leaf length CFG-22-02 produced highest leaf length and leaf breadth was in CFG-041 & CFG-043 (3.5cm). From the trial CFG-043 was found most promising followed by CFG-041 & 042 and CFG-22-02.

Name of the project: Improvement of flowers

Growing M_1V_3 generation of gladiolus germplasm

A field experiment was carried out from November 2024 to April 2025 at the Bangladesh Institute of Nuclear Agriculture (BINA) headquarters to assess M_1V_3 gladiolus mutants for their morphological, floral, and color traits. Six different treatments—$MV_3D_{50}R$, $MV_3D_{20}RM$, $MV_3D_{40}W$, $MV_3D_{50}Y$, $MV_3D_{40}V$, and $MV_3D_{50}M$ were evaluated based on plant height, leaf count, inflorescence length, rachis length, flower features, corm production, and flower color parameters. Among them, $MV_3D_{50}Y$ showed the tallest plants (166.3 ± 7.1 cm), the highest number of leaves (16.0 ± 2.0), and the longest inflorescences (96.7 ± 1.5 cm), while $MV_3D_{20}RM$ was the shortest (116.0 ± 1.0 cm) in height. $MV_3D_{40}V$ had the higher number of flowers per spike (16.0 ± 1.0), $MV_3D_{40}W$ produced the largest flowers (10.7 cm diameter) and the highest corm yield (3.0 ± 0.0 per plant). Colorimetric analysis showed that $MV_3D_{50}R$ and $MV_3D_{20}RM$ had the highest lightness values (L* = 80.9 ± 0.05), whereas $MV_3D_{50}Y$ had the lowest lightness (20.8 ± 6.1) along with a greenish hue (a* = −2.5 ± 1.2). $MV_3D_{40}W$ exhibited the strongest yellow coloration (b* = 24.6 ± 40.1). Finally, the corms from the survived plants were bulked as per dose and floret color and kept in refrigerator for M_1V_4 generation in the next growing season.

Screening of MV_1 generation of Rose

A pot experiment was conducted at the Bangladesh Institute of Nuclear Agriculture (BINA) headquarters to evaluate M_1V_1 rose mutants for growth, yield, and flower quality compared to the control. Four treatments $MV_1D_{20}RP_3$, $MV_1D_{20}RP_7$, $MV_1D_{20}RP_{10}$, and $MV_1D_{20}RP_{14}$ were assessed for plant height, number of primary branches, number of flowers pl^{-1} , flower diameter, Length of cut flower stalk, vase life, and flower color. Plant height ranged from 50 to 55 cm, where $MV_1D_{20}RP_3$ was the tallest. The control had the most primary branches (12), but all mutants produced more flowers. $MV_1D_{20}RP_7$ had the highest number (18) of flowers. $MV_1D_{20}RP_{10}$ had the largest flower diameter (9.9 cm), while $MV_1D_{20}RP_7$ had the longest stalks (30.5 cm) and the longest vase life (12 days). On the other hand, the control had 9 days vase life. The mutants showed various flower colors and shapes, like blackish red high-centered and dark

red blooms, unlike the control's red globular flowers. Overall, $MV_1D_{20}RP_7$ was the best genotype for better flower yield, quality, and vase life.

Collection and screening of exotic flowers suitable for commercial cultivation

To identify suitable flower varieties from exotic sources with attractive flower colors, flower yield and longer vase life a field experiment was conducted at BINA HQs farm during July 2024 to June 2025. A total of 183 germplasms were collected across several species36 varieties of roses, 22 of adenium, 20 of gerbera, 32 of chrysanthemum, 28 of bougainvillea and 45 of other ornamentals including pothos, cactus, rain lily, and caladium were collected.

Name of the project: Improved management practices for flowers

Effect of different growing media on the yield and flower quality of gerbera

A field experiment was conducted at BINA HQs farm from November 2024 to April 2025 to evaluate two gerbera varieties (Ankur and Submarine) under different growing-media treatments for growth, flowering and sucker production. The factorial experiment consisted of Factor A: Variety (V_1= Ankur; V_2: Submarine) and Factor B= growing media (T_0: Control (Native soil); T_1 = Native soil + Chemical fertilizer (recommended dose) ; T_2 = Native soil + vermicompost (1:1); T_3 = Native soil + cocopeat (1:1); T_4 = Native soil + vermicompost + cocopeat (2:1:1); T_5= Native soil + vermicompost + cocopeat (2:1:1) + Chemical fertilizer (recommended dose). Results revealed that organic media significantly improved gerbera growth and flowering compared to control while chemical fertilizer treatments were not effective. The combined mix of **vermicompost + cocopeat (T_4)** produced the tallest plants (49.03 cm), maximum flowers (8.5/plant), largest blooms (8.8 cm), and highest sucker count (3.5). **Ankur** excelled in height and flower size, while **Submarine** produced more flowers and suckers under T_4.

Effects of pinching on growth and flowering of chrysanthemum

To find out the optimum pinching method for better flower production of chrysanthemum a field experiment was conducted at BINA HQs farm during October 2024 to February 2025 following RCBD with three replications. Six varieties Yellow Charm (V_1), Dolly Orange (V_2), Bronze Elegance (V_3), Pink Cloud (V_4), Yellow Button (V_5), and Match Sticks (V_6) were evaluated under three pinching methods: no pinching (P_0), single pinching (P_1), and double pinching (P_2). Results showed that, chrysanthemum traits varied significantly among varieties and pinching treatments. Single pinching generally increased branching, flower count, and flowering duration, while Pink Cloud (V_4) with double pinching produced the highest flowers (305.7) and longest bloom (92 days). Plant height showed the least variation, whereas flower number and branching were highly variable.

Name of the project: Postharvest Technology development of Horticultural crops

Effect of gamma irradiation on shelf life, quality of Amrapalli mango

A study was conducted at the postharvest laboratory, Horticulture Division, BINA from July to October 2024 to evaluate the effects of gamma irradiation and oligosaccharide treatments on the shelf life and quality of Amrapalli mangoes. The treatments were T_o = control; T_1= gamma irradiation @ 400 Gy ; T_2 = gamma irradiation @ 600 Gy ; T_3 = 0.5% chitosan oligosaccharides;

T_4 = 1.0% chitosan Oligosaccharides; T_5 = 0.5% alginate oligosaccharides; T_6 = 1.0% alginate oligosaccharides; T_7 = 0.5% pectin oligosaccharides and T_8 = 1.0% pectin oligosaccharides. Results showed that, weight loss was greatly reduced by using 0.5% pectin oligosaccharides (T_7) which had the lowest weight loss (12.39%) after 10 days compared to the control (15.01%). Disease incidence and severity were also lower in the T_2 (600 Gy irradiation) and T_7 treatments. The firmness of the mangoes stayed better in these treated groups. Total soluble solids (TSS) and color changes were well controlled by these treatments, slowing down the ripening process. The shelf life of mangoes was extended to 12 days with T_2 and T_7 treatments while it lasted only 7 days in the control. In summary, gamma irradiation at 600 Gy and 0.5% pectin oligosaccharides helped keep the mangoes fresh longer, reduced losses after harvest, and improved their market value.

Effects of gamma irradiation on shelf life and quality of capsicum

A study was conducted at the Postharvest Laboratory, Horticulture Division, BINA from March to April 2025 to evaluate the effects of different gamma irradiation doses (0, 200, 400, and 600 Gy) on the shelf life and quality of 'Indira Gold' capsicum under ambient storage conditions (28.6°C, 80% RH). Results showed that weight loss increased over time in all samples but was lowest in the capsicums treated with 400 Gy (I_2) with only 3.98% loss after 18 days, compared to 5.52% in the untreated control (I_0). Quality ratings were better in irradiated fruits, especially at 200 Gy (I_1) and 600 Gy (I_3), which stayed fairly good (score under 5) even after 18 days, while the control had poor quality (score 5). Overall, gamma irradiation, particularly at 400 Gy, helped slow down the weight loss and quality loss, making capsicums last longer under normal storage.

Active and intelligence packaging for reducing postharvest losses of high value vegetables broccoli

A study was conducted at the Postharvest Laboratory, Horticulture Division, BINA from January to February 2025 to evaluate the effects of different packaging materials and storage conditions on the shelf life and quality of broccoli var. 'Green Crown'. Broccoli heads were collected from commercial growers and subjected to various packaging treatments, including 25 and 50 µ LDPE, PP, HDPE, vacuum packaging, and an unwrapped control. Storage was under ambient room conditions (22±2°C) and refrigerated conditions (4±0.5°C). Weight loss was significantly higher in unwrapped samples, reaching 75.2% at 30 days under refrigeration, while vacuum packaging with HDPE 50 µ (T_2P_7) had the lowest weight loss (1.4%) at 30 days. Freshness scores decreased rapidly in unwrapped broccoli but remained high (score 9) in vacuum packaging and 50 µ HDPE treatments throughout 30 days of refrigerated storage. Total soluble solids (TSS) were better maintained under refrigeration, with LDPE (T_2P_2) and HDPE (T_2P_6) treatments sustaining moderate levels (5.07–5.87%) at 30 days, whereas vacuum packaging showed a TSS decline to 2.90%. Shelf life was longest with 50 µ HDPE packaging under refrigeration, extending up to 35 days, compared to only 12 days for unwrapped broccoli. In conclusion, refrigerated storage combined with vacuum or thick HDPE packaging effectively reduced weight loss, preserved freshness and TSS, and greatly extended the shelf life of broccoli, offering promising postharvest solutions to reduce losses and maintain quality.

Effects of gamma irradiation and drying periods on shelf life and quality of dehydrated pineapples (Most Project)

A study was conducted at the Postharvest Laboratory, Horticulture Division, BINA (May–July 2025) to evaluate the effects of drying duration and gamma irradiation on the quality, sensory attributes, and shelf life of dehydrated pineapple (*Honey Queen*). Treatments comprised three drying periods (8, 10, and 12 h) and three irradiation doses (0, 1000, and 2000 Gy) in a CRD with five replications. Fresh pineapple contained 84.4% moisture, 16.5 °Brix TSS, pH 5.6, and 42.5 mg/100 g vitamin C. Dry matter (81.7-86.1%), TSS (36.5-40.7 °Brix), and vitamin C (5.1-5.8 mg/100 g) varied significantly with drying time; longer drying reduced moisture and increased TSS. Color analysis showed that 12 h drying improved lightness (L* = 35.6) and chroma (16.52) while reducing total color difference (ΔE* = 10.38) from fresh fruit. TSS increased with both irradiation and drying, peaking at 43.1 °Brix in T_2D_3 (2000 Gy, 12 h). Vitamin C retention was highest in T_1D_1 (1000 Gy, 8 h). Sensory scores were highest in T_2D_3 for overall acceptability (8.7), taste (9.3), and color (8.6). All treatments maintained "good" quality with no fungal growth after 60 days at ambient storage. The combination of 2000 Gy irradiation and 12 h drying was optimal for sweetness, sensory quality, and microbial safety of dehydrated pineapple

Effects of gamma irradiation and pulp sugar concentrations on shelf life and quality of pineapple jam (Most Project)

A study was conducted at the Postharvest Laboratory, Horticulture Division, BINA (May–July 2025) to assess the effects of gamma irradiation and sugar concentration on the quality, sensory attributes, and shelf life of pineapple (*Honey Queen*) jam. Treatments comprised two pulp-to-sugar ratios—50% (J_1) and 75% (J_2)—and three irradiation doses (0, 1000, and 2000 Gy) in a CRD with five replications. Fresh pineapple contained 86.4% moisture, 15.5 °Brix TSS, and 44.3 mg/100 g vitamin C. J_2 exhibited higher dry matter (77.7%) and TSS (74.6 °Brix) with lower moisture (22.3%) than J_1 (73.3%, 70.8 °Brix, 26.7%). Color analysis showed significant darkening after processing, with L* dropping from 44.8 in fresh pulp to 10.6 (J_1) and 6.13 (J_2), and hue shifting from 95.71° to 39.88°–47.82°. TSS increased during storage, peaking in J_2I_0 (66.7 °Brix at 60 DAI), while vitamin C declined, with highest retention in J_1I_2 (3.7 mg/100 g at 60 DAI). Sensory evaluation revealed J_2I_1 (75% sugar, 1000 Gy) achieved the highest overall acceptability (8.7) and taste score (9.3), followed by J_1I_1 (8.4). All treatments maintained "good" color, "pleasant" flavor, and no fungal growth after 60 days at 25 ± 3 °C. Results indicate that 1000 Gy irradiation with 75% sugar yields optimal sensory quality and stability in pineapple jam.

Name of the project: Development of variety through in combination of tissue culture and nuclear techniques

Optimization of gamma irradiation dose and effect of gamma rays on the *in vitro* mutagenecity of lily

This study evaluated the effect of eight gamma irradiation doses, from 0.5 to 4 Gy, on Madonna explants compared to a control. The experiment was conducted with the objective of optimizing

irradiation doses for mutagenesis, considering on primary growth. Data were recorded on the percentage of callus induction, days required for callus and leaf initiation, and leaf number. Results showed a negative correlation between gamma doses and explant response rate, with higher doses reducing callus formation and increasing the number of days required for callus initiation.

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

An experiment was conducted in 2024-25 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 mgL^{-1} NAA + 1.0 mgL^{-1} BAP (T_1) and 0.5 mgL^{-1}NAA + 2.0 mgL^{-1} BAP (T_2), with a control group (T_3). V_2 performed significantly better than other genotypes and T_2 yielded the best results, while no regeneration occurred in the control group. Bud initiation was fastest in V_1T_2 (3.57 days) 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. V_2T_2 also produced the longest shoots and highest leaf numbers. The study also reported the significant variances among varieties in *in vitro* bulblet production and root development. V_2 produced maximum no. of bulbelts (2.48), leaves at 60days (4.65) and survival rate (5.84) compared to other genotypes. T_2 also yielded the best overall results in root growth, bulblets no.(3.26) and superior leaf growth and survival rate (7.89). The interaction between variety and treatment was significant, with the V_2T_2 combination showing the highest bulblet number (3.81), leaf number (6.96), survival rate (8.84), and enhanced leaf dimensions. Conversely, treatments without growth regulators (T_3) showed uniformly underperformed.

SOIL SCIENCE DIVISION

SECTION II: SOIL CHEMISTRY AND SOIL FERTILITY

POTENTIAL EFFECT OF DIFFERENT SOURCES OF LIMING MATERIALS FOR INCREASED SOIL PH AND INCREASED CROP PRODUCTION

The soil pH 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, during 2022-23 and 2023-24. There were seven treatments for this study (T_1: 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 replications. The sesame variety Binatil-2 was used as a test crop in this study. The treatment T_6 which is the combination of RCF with the lime and biochar application significantly increased yield in two seasons. The treatment T_6 which is the combination of RCF with the lime and biochar application significantly increased pH in 2023 and T_5 which is the combination of RCF with the lime and poultry manure application significantly increased pH in 2024. The initial pH value was 4.8 in the experiment site and has increased due to the different treatments to 5.8 in 2023 and 6.05 in 2024 which are very noticeable. Soil organic matter acts as a major sink and source of soil carbon and SOM is ordinarily estimated to contain 58% C. The mean organic matter ranged from 1.04-1.21 and there is decreasing trend in organic matter after the crop cultivation.

EFFECT OF DIFFERENT ORGANIC AMENDMENTS TO REDUCE SALINITY FOR RICE PRODUCTION IN SALINE SOIL OF BANGLADESH

Saline soil is reluctant for crop production which reduce crop yield in the coastal saline area of Bangladesh. The objective of the present study was to mitigate the adverse effects of soil salinity through organic amendments (wooden ash, rice straw, rice husk ash) during the Boro rice cultivation for increase yield. The field experiment was conducted at the farmer's fields of Tala upazilla under Satkhira district with Binadhan-10, a saline tolerant rice variety in dry season. There were five treatment combinations viz. 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}, 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 highest grain yield (5.71 t ha^{-1}) of Boro rice was observed in treatment T_2 which was statistically similar to T_4 and T_5. But significantly increased compared to the control treatment in 2023-24 season. The straw yield was also found the highest (6.67 t ha^{-1}) in T_2 treatment which was statistically identical with T_5. The lowest yield was recorded in treatment T_1 at both the cases of grain and straw yields. The effect of incorporation of different organic matters along with the fertilizers in the second year (2024-25) of Boro rice was largely similar to that of the first-year crop. The highest grain yield was produced (5.53 t ha^{-1}) from treatments T_2 which is significantly different among the treatments. The highest straw yield was produced (6.49 t ha^{-1}) from treatment T_3 (Rice husk ash + rice straw) which was followed by T_4 in 2024-25 season. In both cases, the lowest yields were observed in control (T_5) treatment. Apart from the study, the soil analyses express a little positive change in soil carbon content but other elements (N, P, K and S) are found almost similar due to one season

crop cultivation. The combined effect of organic amendment reduced the stress caused by salinity on rice production in T_2 treatments in saline prone regions, which is advantageous for Bangladeshi farmers. Application of organic substances reduced the salinity which thus helps for physiological growth of rice.

ASSESSING THE EFFECT OF NITROGEN MANAGEMENT PRACTICES ON NUE IN RICE BASED CROPPING SYSTEM USING ^{15}N TECHNIQUE

A field experiment was conducted during the Boro season of 2025 at Ghior upazila, Manikganj to assess the effects of different nitrogen (N) management practices on yield, nitrogen uptake, and nutrient use efficiency (NUE) of rice using the ^{15}N isotopic technique. The study followed an RCBD with four treatments: T1 (Control), T2 (Farmer's Practice), T3 (RDF), and T4 (Soil Test Based—STB). A 1 m² micro-plot with ^{15}N-labelled urea was used to measure total N uptake. Results showed significant differences among treatments, with T4 (STB) producing the highest grain yield (5.80 t ha^{-1}), dry matter, and total N uptake (110.24 kg ha^{-1}). NUE and N recovery were also highest in T4, indicating better utilization of applied nitrogen. Post-harvest soil nutrient levels showed minimal changes after one season. Overall, soil test-based fertilizer management (STB) proved most effective for improving rice yield, dry matter production, and nitrogen use efficiency. The study highlights the importance of proper nitrogen management for sustainable rice production in Bangladesh.

VALIDATION OF KHAMARI APPS FERTILIZER RECOMMENDATION AT DIFFERENT LOCATIONS OF BANGLADESH (PHASE-II- KGF PROJECT)

A series of on-farm validation experiments were conducted at Jamalpur, Mymensingh (Nandail and Gouripur), and Ishwardi (Pabna) to evaluate the effectiveness of fertilizer recommendations generated by the *Khamari App* under Phase-II of the KGF Project. Three major crops—brinjal, country bean, and broccoli—were tested across multiple farmer's fields, each with two treatments: T1: Khamari App fertilizer dose and T2: Farmer's practice, using 30 decimals per location. For brinjal (BARI Begun-10) at Nandail, Mymensingh, the Khamari App treatment produced higher yield (20.75 t ha^{-1}) compared to farmer's practice (19.70 t ha^{-1}), along with better plant height, fruit size, and number of fruits per plant. Gross margin was also higher in T1 (Tk. 5,94,425), reflecting a 5.32% yield increase. In country bean (BARI Shim-10) at Gouripur, Mymensingh, T1 produced a yield of 11.15 t ha^{-1} against 10.90 t ha^{-1} in T2, with improvements in pod traits and plant growth. Gross margin increased to Tk. 4,29,600 in T1, showing a 2.29% yield advantage over farmer practice. For broccoli (Sakata variety) at Sadar, Jamalpur, the Khamari App recommendation resulted in significantly higher yield (19.69 t ha^{-1}) compared to farmer practice (16.23 t ha^{-1}). Yield contributing characters improved consistently under T1, and gross margin increased by 20.14%, the highest among all tested crops. Overall, results across locations confirmed that the *Khamari App* provides more efficient and profitable fertilizer recommendations than farmer's traditional practices. The app-based nutrient management not only enhanced crop growth and yield but also reduced fertilizer costs in many cases, demonstrating strong potential for large-scale adoption to improve farm productivity in Bangladesh.

EFFECT OF LEGUME RESIDUE INCORPORATION ON GREENHOUSE GAS EMISSION FOR RICE BASED CROPPING PATTERN

The study investigated the effect of legume residue incorporation on greenhouse gas (GHG) emissions, soil health, and system productivity in rice-based cropping patterns across two locations: BINA headquarters farm, Mymensingh, and BINA sub-station farm, Ishwardi. Three cropping patterns—Wheat–Mungbean–T.aman; Lentil–T.aus–T.aman; and Mustard–Boro–T.aman—were evaluated under five residue–fertilizer management treatments: T1: Residue + PKS (no N), T2: Residue + full recommended NPKS, T3: Residue + PKS + 75% of recommended N, T4: No residue + full recommended NPKS **T5:** Control (no residue + no N). Legume residues produced within the system were incorporated according to treatment design. The final crop, T.aman rice, was monitored for methane (CH_4) and nitrous oxide (N_2O) emissions using the closed chamber method. Results from the first year (2023–24) showed that treatments receiving legume residue combined with the recommended fertilizer dose (T2) consistently produced the highest grain yield across all patterns and locations, while residue incorporation with reduced nitrogen (T3) produced statistically similar yields, indicating improved nitrogen use efficiency. Absolute control (T5) produced the lowest yield in all cases. Residue incorporation contributed to improve soil conditions, higher tiller number, greater panicle fertility, and increased biomass production. Mustard and lentil crops grown in the second year (2024–25) showed substantial residue biomass potential for incorporation into succeeding crops. Overall, preliminary findings highlight that legume residue incorporation enhances soil fertility, boosts crop productivity, and holds potential for reducing GHG emissions through improved nutrient cycling and nitrogen management. The ongoing second year of experimentation will strengthen the understanding of long-term effects on soil health and system productivity.

EFFECT ON SOIL QUALITY DUE TO BRICK KILNS EMISSION AROUND THE AGRICULTURAL LAND

The study was conducted during January–April 2025 at Sadar and Fulbaria upazila of Mymensingh to assess the impact of brick kiln emissions on soil quality of adjacent agricultural lands. Soil samples were collected from ten brick kiln sites at a distance of 50–100 m, from 0–15 cm depth, during the dry season. Composite samples were analyzed for pH, organic carbon (OC), and heavy metals (Pb, Zn, Fe, Mn, Cu, Cr, Cd, Ni) following standard laboratory procedures. Soil pH ranged from 5.02 to 7.07, indicating slightly acidic to neutral conditions, while OC content varied widely (0.56–3.02%), reflecting inconsistent organic matter status due to burning effects and cropping intensity. Concentrations of heavy metals showed spatial variation across sites. Lead (1.15–2.02 ppm), zinc (0.31–1.30 ppm), copper (1.19–2.80 ppm), chromium (0.283–1.57 ppm), cadmium (0.022–0.096 ppm), and nickel (0.081–0.185 ppm) were all within their respective permissible limits for agricultural soils. However, manganese (8.02–97.67 ppm) and iron (85.0–155.1 ppm), though essential micronutrients, showed elevated levels in some locations, which may pose phytotoxic risks under acidic conditions. Overall, the findings indicate that brick kiln emissions contribute to variations in soil chemical properties, particularly organic matter depletion and accumulation of certain heavy metals. Although most heavy metal concentrations remain within safe limits, continuous exposure may lead to long-term soil degradation and potential risks to crop productivity. Regular monitoring and adoption of

sustainable brick-kiln management practices are therefore recommended to safeguard agricultural soil health.

EFFECT OF NANO FERTILIZER ON NUTRIENT USE EFFICIENCY (NUE) AND CROP YIELD IMPROVEMENT

Nitrogen is one of the most limiting nutrients for rice production, but its low use efficiency under conventional fertilization remains a major challenge for sustainable agriculture. Excessive reliance on urea in Bangladesh and other rice-based systems often results in low recovery, high volatilization, and significant nitrogen losses that contribute to soil degradation and environmental pollution. Nano fertilizers, such as nano-urea, have recently emerged as a promising technology to improve nitrogen use efficiency (NUE) by enabling better nutrient absorption, reduced losses, and sustained release. To evaluate the potential of nano urea, two consecutive pot experiments were conducted at the Bangladesh Institute of Nuclear Agriculture (BINA), HQs during the 2023-24 and 2024-25 Boro rice seasons. A Completely Randomized Design (CRD) with five treatments and three replications was used, with treatments consisting of combinations of pilled urea and foliar sprays of IFFCO nano-urea. The rice variety Binadhan-24 was transplanted into 15 pots filled with 10 kg of silt-loam soil per pot. The results indicated that the full-dose urea treatment (T_1) produced the highest grain yield (66.3-66.4 t ha^{-1} equivalent). However, three nano-urea sprays without soil-applied urea (T_5) produced a nearly similar grain yield (64.6 t ha^{-1}), along with the highest harvest index (0.225-0.226) and improved straw nitrogen concentration. Importantly, post-harvest soil N was higher in nano-urea treatments, with the treatment T_5 retaining 1.11% compared to only 0.12% in the treatment T_1. These results demonstrate that although conventional urea achieves maximum yield, foliar nano-urea sprays can sustain yields, improve NUE, and enhance soil N balance, thereby reducing dependency on bulk chemical fertilizers. The findings provide evidence for adopting nano-fertilizer technologies to achieve both productivity and sustainability in rice cultivation.

IMPROVEMENT OF NUTRIENT USE EFFICIENCY (NUE) AND CROP PRODUCTIVITY THROUGH NITROGEN RATES AND IRRIGATION IN A RICE-RICE CROPPING SYSTEM

Field experiments were conducted in the rice-rice cropping system at BINA Sub-station Nalitabari (25.0988 N, 90.2244 E) during four consecutive seasons (2023-24, 2024-25) to evaluate the effects of nitrogen (N) rates and irrigation management on grain yield, total dry matter (TDM), total N uptake (TNU), nitrogen recovery (REN), and nitrogen use efficiency (NUE) in Boro (dry season) and T. Aman (wet season) rice. A split-plot design containing three irrigation systems: farmers' practice (FP), continuous 3 cm standing water (CSW), and alternate wetting and drying (AWD) as main plots, and four N fertilizer levels (0%, 80%, 100%, and 120% of recommended dose) as sub-plots. Across both seasons, the 100% N rate (N2) under CSW generally produced the highest grain yield and TDM. AWD maintained competitive yields and NUE while conserving water. Significant interactions between N rate and irrigation were noted for several parameters. We recommend 100% N application combined with optimal irrigation management to enhance NUE and productivity in the rice-rice cropping system.

EFFECT OF DIFFERENT ORGANIC MATERIALS AND LIMES ON PHYSICALS PROPERTIES OF SOIL AND YIELD OF CROPS

Soil acidity is a major constraint for crop production, and more than 30% of the cultivable land in Bangladesh is affected by low pH. To improve acidic soil conditions and enhance crop productivity, a field experiment was conducted during March 2025 at the BINA Regional Station, Gazipur. The study aimed to evaluate the effects of different organic materials and lime on soil physical properties and sesame yield. The experiment was laid out in a Randomized Complete Block Design (RCBD) with seven treatments and three replications. The treatments included: T1: Native fertility, T2: 100% STB chemical fertilizer, T3: 2 t ha^{-1} dolomite + 100% STB, T4: 5 t ha^{-1} cow dung + 80% STB, T5: 2 t ha^{-1} vermicompost + 80% STB, T6: 5 t ha^{-1} cow dung + 2 t ha^{-1} dolomite + 80% STB, and T7: 2 t ha^{-1} vermicompost + 2 t ha^{-1} dolomite + 80% STB. Sesame variety Binatil-2 was used as the test crop. Results indicated that the application of dolomite and organic amendments significantly improved soil pH and sesame yield compared to the control. The highest seed yield (1.30 t ha^{-1}) was recorded in T3, where dolomite was applied with the full STB dose. However, T7 produced a comparable yield (1.27 t ha^{-1}) while saving 20% chemical fertilizer, demonstrating the efficacy of integrating dolomite with vermicompost for yield optimization. Organic carbon content in postharvest soil increased notably in T6 (0.81%) and T4 (0.80%), indicating improved soil health. Soil pH increased from an initial value of 4.8 to 6.04 in T7, suggesting that combined application of lime and organic materials effectively ameliorates soil acidity. Overall, the study reveals that the integrated use of dolomite and organic amendments not only enhances soil chemical properties but also improves sesame productivity while reducing reliance on chemical fertilizers. Such management practices offer a sustainable approach for improving acidic soils in Bangladesh.

MOLECULAR CHARACTERIZATION OF EARTHWORM SPECIES USED IN THE PRODUCTION OF VERMICOMPOST

Earthworms play a vital role in soil fertility and vermicompost production, but their accurate species identification is essential for optimizing composting efficiency and ecological studies. The present study aimed to identify earthworm species collected from vermicomposting beds and pit of the Soil Science Division, Bangladesh Institute of Nuclear Agriculture (BINA), using molecular DNA techniques with the cytochrome oxidase I (CO1) mitochondrial marker. Eleven specimens (BDBINAVC.1–11) were collected, their genomic DNA extracted, quantified (1.69–1.90 purity range), and amplified with universal primers LCO1490 and HCO2198, yielding ~700 bp PCR products. Sequenced amplicons were subjected to BLAST search, phylogenetic analysis (neighbor-joining, Tamura–Nei model), and intra-population diversity assessment. Results confirmed all 11 samples as *Eisenia andrei*, showing 99.5–100% similarity with reference sequences, while also displaying close relatedness to *E. fetida* (98.78%). Two distinct CO1 genotypes were detected, differentiated by SNP substitutions at nucleotide positions 323 and 356, with a genotype diversity of 0.4369. Phylogenetic trees clustered *E. andrei* isolates with strong bootstrap support (98%), while *E. andrei*, *E. fetida*, and *Eudrilus eugeniae* formed sister clades. The study demonstrates the effectiveness of CO1 barcoding for accurate species identification of earthworms and provides baseline molecular data on *E. andrei* strains associated with vermicompost production in Bangladesh.

CHARACTERIZATION OF VERMIWASH PRODUCED FROM VERMICOMPOST

Organic alternatives to chemical fertilizers are increasingly recognized for their role in sustaining soil fertility and reducing environmental degradation. Vermiwash, a nutrient-rich liquid extract obtained as a byproduct of vermicomposting, has shown potential as a biofertilizer and biocontrol agent. The present study was conducted at the Soil Science Division of the Bangladesh Institute of Nuclear Agriculture (BINA), Mymensingh, during 2024–25 to characterize the chemical composition of vermiwash produced from different vermicompost treatments and evaluate its antifungal efficacy. The experiment was laid out in a randomized complete block design with four treatments: cow dung (T_1), cow dung + rock phosphate (T_2), cow dung + earthworm (T_3), and cow dung + rock phosphate + earthworm (T_4). Vermiwash was collected periodically and analyzed for physicochemical properties. Vermiwash produced by using cow dung and earthworm species (*Eisenia andrei*) showed highly efficient with the necessary macro and micronutrients and below the detected limit of heavy metals, indicating its potential for sustainable field application. It obtained pH and EC value 8.75 and 10.32 mS/cm. Organic carbon, NH_4-N, NO_3-N, P, K, S, Ca and Mg concentration were observed 0.08%, 10.77 ppm, 76.20 ppm, 22.20 mg/L, 503.80 mg/L, 92.60 mg/L, 493.37 mg/L and 211.11 mg/L respectively. Vermiwash exhibited antifungal activity, inhibiting *Fusarium oxysporum* growth by up to 63.44%.

COMPARATIVE STUDY OF VERMIWASH AND COMMERCIAL NUTRIENT SOLUTIONS IN HYDROPONIC SPINACH PRODUCTION

Hydroponic vertical farming is increasingly important for ensuring food security through efficient resource use, climate and pest control, and land conservation—especially in areas with limited arable land. In this study, conducted at the Bangladesh Institute of Nuclear Agriculture (Mymensingh) during the winter of 2024–25, the efficacy of vermiwash as an alternative or supplement to commercial and fertilizer-based nutrient solutions in hydroponic spinach (*Spinacia oleracea* L.) production was evaluated using the passive Kratky method. Treatments tested included: T_1 (fertilizer solution control), T_2 (commercial nutrient solution), T_3 (full-strength vermiwash diluted 1:9), T_4 (50% vermiwash + 50% commercial nutrient), and T_5 (50% vermiwash + 50% fertilizer solution). Spinach seedlings were transplanted into net pots within glasshouse cages, with roots partially immersed in treatment solutions. After 25 days, biomass and morphological parameters were assessed. A hydroponic study using the Kratky method revealed that combining 50% vermiwash with 50% commercial nutrient solution (T_4) significantly increase in length, root volume, fresh and dry weight of shoot and root of plant as opposed to the control (T_1: Fertilizer solution), suggesting potential use of vermiwash as an organic nutrient source in the hydroponic systems and ability to reduces the use of commercial nutrient solution. For nutrient concentration and uptake by shoot and root of spinach, same trend was not observed for all nutrients. Treatment T_4 led to significantly higher sulphur uptake in both shoot and root, while T_3 (full-strength vermiwash) showed maximum root uptake of organic carbon, nitrogen, phosphorus, and potassium.

EFFECTS OF DIFFERENT DOSES OF FERTILIZERS ON RELAY CROPPING SYSTEM IN T.AMAN –MUSTARD (RELAY CROP)-T.AUS CROPPING SYSTEM

A field experiment was conducted at BINA Sub-station, Gopalganj (2024–25) to assess the effects of different fertilizer doses on mustard grown as a relay crop and on the T. aman–Mustard–T. aus cropping pattern. Six fertilizer treatments were tested in an RCBD. Mustard was sown 15 days before harvesting T. aman to shorten the planting gap. Fertilizer treatments significantly influenced yield of both crops. The highest grain yield of T. aman (6.1 t ha^{-1}) and seed yield of mustard (1.72 t ha^{-1}) were obtained from 150% N + 100% PKS (T_5). The control produced the lowest yields. Results suggest that N_{126} P_{12} K_{50} S_7 kg ha^{-1} for T. aman and N_{161} P_{24} K_{54} S_{22} Zn_2 B_2 kg ha^{-1} for mustard are suitable for maximizing yield in the relay cropping system. Final recommendations for the full pattern will be made after harvesting T. aus.

EFFECTS OF DIFFERENT DOSES OF FERTILIZER ON RELAY CROPPING PATTERN IN T. AMAN-MUSTARD (RELAY CROP) - BORO RICE

An experiment was conducted to find out the effects 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 2024-25. Mustard was grown as relay crop. Six treatments were used in the experiment which were 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 T.aman (Binadhan-17), mustard (Binasharisha-9) and Boro rice (Binadhan-14). The experiment was laid out in a randomized complete block design with three replications. In the first crop of the cropping pattern, the treatment T_4 (6.5 t ha^{-1}) gave the maximum grain yield of T. aman. In the second (Mustard) and third crop (Boro rice), the treatment T_4 (125% NPKS) also gave maximum seed yield of mustard (Binasharisha-9) and Boro rice (Binadhan-14). 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 the 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 compared to 100%NPKS.

EFFECTS OF DIFFERENT DOSES OF FERTILIZER WITH BANANA RESIDUE-BASED VERMICOMPOST ON RELAY CROPPING PATTERN T. AMAN-MUSTARD (RELAY CROP) - BORO RICE

An experiment was conducted to determine the effects of different doses of chemical fertilizers, combined with the integrated use of vermicompost, on three crops in a 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 headquarters, Mymensingh, during 2024-25. Mustard was grown as a relay crop. Six treatments were used in the experiment which were T_1: 100% PKS, T_2: 100% NPKS from chemical fertilizer (CF), T_3: 75% N from VC+ 25% N from CF + 100% PKS from CF (IPNS), T_4: 50% N from VC + 50% N from CF+ 100% PKS from CF (IPNS), T_5: 75% N from VC+ 25% N from CF + 100% PKS from CF (Non-IPNS) and

T_6: 50% N from VC + 50% N from CF+ 100% PKS from CF (Non-IPNS) for T.aman (Binadhan-17), mustard (Binasharisha-9) and Boro rice (Binadhan-14). The experiment was laid out in a randomized complete block design with three replications. In the first crop of the cropping pattern, the treatment T_4 (5.0 t ha^{-1}) gave significantly higher grain yield of T. aman rice. In the second (Mustard) and third (Boro rice) crop, the treatment T_4 (1.15 t ha^{-1}) gave maximum seed yield of mustard and the treatment T_4 (4.3 t ha^{-1}) gave maximum grain yield of Boro rice (Binadhan-14). The results revealed that T_4: 50% N from VC + 50% N from CF+ 100% PKS from CF (IPNS) from vermicompost combined with other chemical fertilizers might be a good option for the cultivation of whole cropping pattern.

SECTION II: SOIL MICRONUTRIENTS AND HEAVY METALS

EFFECT OF ORGANIC FERTILIZER APPLICATION TIMING AND DOSE ON SOIL AND CROPS

A field experiment was conducted at BINA Sub-station, Rangpur, to assess the effects of organic fertilizer timing and dose in combination with chemical fertilizers on mustard, late Boro rice, and post-harvest soil properties. Six treatments combining recommended chemical fertilizers (RCF) with vermicompost (1.5–3.5 t ha^{-1}) were evaluated in RCBD. Mustard yield responded significantly, with the highest seed and straw yields under 100% RCF + 3.5 t ha^{-1} vermicompost (T_4). For Boro rice, grain and straw yields were highest in T_2 (100% RCF + 1.5 t ha^{-1} VC). Soil analyses showed increased organic carbon, total N, and mineral N under integrated fertilizer use, particularly T_4. Results indicate that combining chemical fertilizers with higher vermicompost doses improve crop performance and enhances soil fertility compared to chemical fertilizers alone.

EFFECT OF NITROGEN AND ORGANIC CARBON DOSES ON CROPS AND SOIL

A field experiment was conducted at BINA Headquarters, Mymensingh, to assess the effects of organic carbon (rice straw) and nitrogen (urea) doses on the yield performance of T. aman, mustard, and Boro rice, as well as on post-harvest soil properties. The study followed a factorial RCBD with two organic carbon levels (OC_1: control; OC_2: 3% OC using rice straw) and three urea doses (U_0, U_1: 100% recommended, U_2: 125% recommended). Results showed that higher urea doses (U_2) consistently increased yield and yield-attributing traits in all crops. Organic carbon had positive effects on T. aman, while mustard and Boro rice responded better under OC_1, likely due to temporary nutrient immobilization from straw decomposition. Post-harvest soil analysis indicated that OC_2 and U_2 significantly increased soil nitrogen and organic carbon content. Overall, combined use of rice straw and higher urea doses improved soil fertility, while crop yield responses varied depending on crop type and nutrient interactions.

EFFECT OF ORGANIC AND INORGANIC FERTILIZERS ON MICRONUTRIENT AVAILABILITY IN POTATO-BORO-T.AMAN RICE CROPPING PATTERN

A field experiment was conducted in AEZ-3 of Rangpur to assess the impact of integrated organic and inorganic fertilizer management on the productivity of potato (Cardinal variety) and Boro rice (Binadhan-14) within a Potato–Boro–T. Aman cropping pattern. The objectives were

to determine the impact of different organic and inorganic fertilizer treatments on the concentration and forms of essential micronutrients (e.g., Zn, Fe, Mn, Cu, B) in the soil; to evaluate the uptake and accumulation of these micronutrients in potato, boro rice, and T. Aman rice crops under the applied treatments; to identify an optimal integrated nutrient management strategy that enhances micronutrient availability and improves crop yield and quality in the Potato-Boro-T. Aman rice cropping patterns. Six treatments were applied, combining recommended NPKS doses with vermicompost (VC), cowdung (CD), poultry manure (PM), micronutrients (Zn and B), T_0: Control, T_1: NPKS (RFD), T_2: NPKS + Zn_4B_2, T_3: NPKS + 2 t ha^{-1} VC, T_4: NPKS + 2 t ha^{-1} PM, T_5: NPKS + 2 t ha^{-1} CD. For potato, the highest tuber yield (32.82 t ha^{-1}) and haulm biomass (15.37 t ha^{-1}) were recorded in T_3 (NPKS + VC), followed by T_2 (NPKS + Zn_4B_2). The treatments for boro in combination of T_0 (control), $T_{1.1}$ NPKS (RFD), $T_{2.1}$: NPKS, $T_{3.1}$: NPKS + 1.5 t ha^{-1} VC, $T_{4.1}$: NPKS + 1.5 t ha^{-1} PM, $T_{5.1}$: NPKS + 1.5 t ha^{-1} CD. Boro rice showed superior growth and yield under T3.1 (NPKS + VC), with the tallest plants (91 cm), highest tiller count, longest panicles, and maximum grain (6.49 t ha^{-1}) and straw yield (7.66 t ha^{-1}). Treatments with VC, CD, and PM significantly enhanced performance compared to NPKS alone and the control. Application of vermicompost combined with NPKS consistently delivered the best results across both crops, underscoring its role in improving soil health and crop productivity in floodplain agro-ecosystems.

BIO-FORTIFICATION OF MAIZE CROP WITH IRON (Fe), ZINC (Zn) AND SELENIUM (Se) BY FOLIAR APPLICATION

Micronutrient malnutrition, particularly deficiencies of Fe, Zn, and Se, remains a major challenge in Bangladesh. Field experiments were conducted at farmers' fields of Rangpur (AEZ 27) and Natore (AEZ 25) to assess the impact of foliar application of Iron (Fe), Zinc (Zn), and Selenium (Se) on the bio-fortification and yield of maize. The study included 8 treatments: a control (NPKS) and 7 foliar nutrient combinations involving $FeSO_4$, $ZnSO_4$, and Se powder at different concentrations. The experiment followed a randomized complete block design with three replications, using 9 m^2 plots at both locations. Foliar application produced significant improvements in grain micronutrient concentrations. In Rangpur, Fe increased from 23.26 ppm (T_1) to 64.86 ppm (T_2), Zn from 14.38 ppm to 28.92 ppm (T_5), and Se from 0.160 ppm to 0.237 ppm (T_8). In Natore, Fe rose from 28.79 ppm to 60.21 ppm (T_2), Zn from 17.58 ppm to 41.73 ppm (T_3), and Se from 0.111 ppm to 0.213 ppm (T_4). The combined treatment T_8 (0.25% $FeSO_4$ + 0.25% $ZnSO_4$ + 0.05% Se) consistently produced the highest yields 9.35 t ha^{-1} in Rangpur and 9.26 t ha^{-1} in Natore alongside balanced micronutrient enrichment. This study confirms that foliar bio-fortification is an effective and scalable strategy to enhance maize nutritional quality and productivity, offering strong potential to address micronutrient deficiencies in Bangladesh.

EFFECTS OF ORGANIC AMENDMENTS ON CONTAMINATED SOIL AND ITS EFFECT ON THE YIELD AND UPTAKE OF HEAVY METALS BY CROP (POT EXPERIMENT)

Heavy metal contamination of agricultural soils has emerged as a major threat to crop production, food safety, and human health. This study evaluated the effects of different organic amendments e.g. poultry manure, vermicompost, biochar, and rice husk ash on the remediation of contaminated soils and their subsequent influence on the growth, yield, and heavy metal

uptake of water spinach (*Ipomoea aquatica*). A pot experiment was conducted at BINA headquarters, Mymensingh, using soils collected from industrially contaminated farm field. The treatments significantly improved soil fertility, reduced bioavailability of heavy metals (Cd, Pb, Ni, Cu, Zn, Fe), and enhanced biomass production. Organic amendments, particularly biochar and vermicompost, were most effective in immobilizing Cd and Pb, reducing their accumulation in plant tissues, and lowering associated health risks (DIM and HRI). Poultry manure and rice husk ash enhanced soil nutrient status while simultaneously limiting heavy metal transfer to edible plant parts. These findings suggest that organic amendments can play a vital role in mitigating heavy metal risks while sustaining safe vegetable production in contaminated soils.

SECTION III. SOIL MICROBIOLOGY AND BIOFERTILIZER

EVALUATION OF RHIZOBIAL STRAINS ON GROWTH, NODULATION AND YIELD OF COUNTRY BEAN IN POT CONDITION

The study was conducted in microbiology laboratory of Soil Science Division of BINA, Mymensingh during 2024-2025 to screening, selection and evaluation of efficient *Rhizobium* strains for country bean cultivation and determine the nitrogen fixing, growth promoting ability of rhizobia strains on country bean crops. Healthy plants were collected from different areas of Mymensingh, Ishwardi and Rangpur districts and uprooted carefully and nodules were collected from the roots. Ten *Rhizibium* strains were isolated from root nodules of country bean (CBR-1, CBR-2, CBR-3, CBR-4, CBR-5, CBR-6, CBR-7, CBR-8, CBR-9 and CBR-10) crops, and selected on the basis of their better growth on yeast extract mannitol agar for their morphological, biochemical characterization. These bacterial isolates identified as *Rhizobium* sp. on the basis of their morphological such as circular, entire, smooth creamy white, raised, opaque, some translucent and mucous and biochemical characterization such as bromothymol blue (BTB) test, Glucose peptone agar (GPA) test and catalase test. To observe the effectiveness of the isolated *Rhizobium* strains, biochemical test viz. salinity tolerant (in laboratory condition) and nodulation tests will be done in pot condition filled with sterilized sand. These findings highlight the potential of native rhizobial strains to enhance country bean productivity and support sustainable agriculture.

EFFECT OF RHIZOBIAL STRAINS ON GROWTH, NODULATION AND YIELD OF COWPEA IN POT CONDITION

The study was conducted in microbiology laboratory of Soil Science Division of BINA, Mymensingh during 2024-2025 to screening, selection and evaluation of efficient *Bradyrhizibium* strains and determine the nitrogen fixing, growth promoting ability of rhizobia strains on cowpea crops. Healthy plants were collected from different areas of Mymensingh, Ishwardi and Rangpur districts and uprooted carefully and nodules were collected from the roots. Ten *Bradyrhizibium* strains were isolated from root nodules of cowpea (CoPR-1, CoPR-2, CoPR-3, CoPR-4 CoPR-5, CoPR-6, CoPR-7, CoPR-8, CoPR-9 and CoPR-10)) crops, and selected on the basis of their better growth on yeast extract mannitol agar for their morphological, biochemical characterization. These bacterial isolates identified as *Bradyrhizibium* sp. on the basis of their morphological such as circular, entire, smooth creamy white, raised, opaque, some translucent and mucous and biochemical characterization such as bromothymol blue (BTB) test, Glucose peptone agar (GPA) test and catalase test. To observe the

effectiveness of the isolated *Bradyrhizobium* strains, biochemical test viz. salinity tolerant (in laboratory condition) and nodulation tests will be done in pot condition filled with sterilized sand. These findings will be highlighted the potential of native rhizobial strains to enhance cowpea productivity and support sustainable agriculture.

EFFECT OF *BRADYRHIZOBIUM* STRAINS ON NODULATION AND YIELD OF SOYBEAN VARIETIES IN POT CONDITION

A pot experiment was conducted to evaluate the effectiveness of inoculated *Bradyrhizobium* strains on nodulation and yield of BINA released soybean varieties namely Binasoybean-6 (V_1) and Binasoybean-7 (V_2) during January,2025 to April, 2025. There were seven treatments viz. T_1: I_o (Control), T_2: I_2 (N@ 28.0 kg ha^{-1}), T_3: I_2 (STRS-4), T_4: I_3 (SB-4), T_5: I_4 (SB-5), T_6: I_5 (SB-7) and T_7:I_6 (Mix isolated inoculants). The experiment was laid out in RCBD two factor design with three replications in pot condition. Seeds were sown on 6 January 2025. Full dose of phosphorus, potassium, sulphur, zinc and molybdenum were applied as basal application @ 30, 50, 20, 3 and 1.5 kg ha^{-1} and full dose of Nitrogen fertilizer (T_2: N@ 28.0) were applied at the time of pot preparations. The seeds were inoculated with the culture of *Bradyrhizobium* strains in each pot except control pots (T_1: I_o –Control and T_2: I_2 -N@ 28.0 kg ha^{-1}). Binasoybean-7 produced highest nodule number (16.67) in treatment T_7 followed by treatment T_3 (15.67) than treatment T_3 (16.17) than the Binasoybean-6. In case of pod $plant^{-1}$ in treatment T_3 (23.0 g) followed by the treatment T_7 (22.23 g) in Binasoybean-7 showed significant results than treatment T_7 (20.33) in Binasoybean-6. In case of 100 seed weight and seed weight $plant^{-1}$ in treatment T_7 (13.24 g, 5.73 g) in Binasoybean-7 showed significant results than treatment T_7 (13.10g, 5.50 g) in Binasoybean-6. and it was minimum (1.78 g and 0.96 g) in absolute control. In this study, it might be concluded that Binasoybean-7 inoculated with *Bradyrhizobium* strains showed better results than Binasoybean-6 inoculated with *Bradyrhizobium* strains and BINA biofertilizer strain STRS-4 (treatment T_3) performed better results compare with three new isolated strains (SB-4, SB-5 and SB-7) and Mix inoculants of new isolated strains performed better results compare with BINA biofertilizer strain STRS-4. Mix inoculants of new isolated strains could be used as bio inoculants for the pulse crop.

EVALUATION OF RHIZOBIAL INOCULANTS ON GROUNDNUT IN FIELD CONDITION

Two field experiments were conducted at Nawvangar Char, Jamalpur Sadar, Jamalpur and Majdia, Ishwardi for evaluation of rhizobial inoculants on groundnut in field condition during February to June, 2025. There were five treatments viz. T_1: Control (No Inoculant, No Fertilizer); T_2: $N_{24}P_{24}K_{30}S_{24}$ Zn_1B_1+I_0; T_3: I_1 (GN-2) + $P_{24}K_{30}S_{24}$ Zn_1B_1; T_4:I_2 (GN-4) + $P_{24}K_{30}S_{24}$ Zn_1B_1; T_5 : I_3 (GNB-5) + $P_{24}K_{30}S_{24}$ Zn_1B_1. The objective was to determine effects of rhizobial inoculants on growth, nodulation and yield of groundnut. The experiment was laid out in split-plot design with three replications. Unit plot size was 9 m^2 (3m × 3m). The seeds were inoculated with the culture of *Rhizobium* strains in each plot except two plots (T_1: Control and T_2: $N_{24}P_{24}K_{30}S_{24}Zn_1B_1$+$I_0$). Seeds were sown on 2 February 2025 at Nawvangar Char, Jamalpur Sadar, Jamalpur and 9 February 2025 at Majdia, Ishurdi. T_4 (I_2 (GN-4) + $P_{24}K_{30}S_{24}Zn_1B_1$) showed overall good performances in Majdia, Ishwardi than Nawvangar Char, Jamalpur Sadar, Jamalpur followed by T_3 (I_1 (GN-2) + $P_{24}K_{30}S_{24}$ Zn_1B_1) treatment.

ISOLATION OF RHIZOBIAL STRAINS FROM ROOT NODULES OF PEA AND CHARACTERIZATION IN LABORATORY ENVIRONMENT

A laboratory study was conducted at the Soil Science Division of BINA Headquarters to isolate effective rhizobial strains for pea (Pisum sativum L.) cultivation and evaluate their nitrogen-fixing and growth-promoting potential. Healthy pea plants were collected from Ishurdi, Natore, and Chapainawabganj, and root nodules were carefully harvested. In the microbiology laboratory, nodules were surface sterilized using 95% alcohol and 3% hydrogen peroxide, followed by washing with sterile distilled water. Sterilized nodules were crushed, and bacterial suspensions were streaked onto Congo Red Yeast Extract Mannitol Agar (CRYEMA) plates, then incubated at 28°C for 5–7 days to obtain rhizobial colonies. Pure isolates were characterized using bromothymol blue (BTB) tests, and morphological and biochemical analyses, including catalase and oxidase activity tests. All isolates produced alkalinity in BTB media and exhibited enzymatic activities indicative of nitrogenase protection. A total of ten rhizobial strains were successfully isolated, sub-cultured on YEMA slants, and maintained at 4°C for further study. These findings highlight the potential of native rhizobial strains to enhance pea productivity and support sustainable agriculture.

EFFECT OF SALINITY TOLERANT RHIZOBIAL STRAINS ON GROWTH, NODULATION AND YIELD OF GROUNDNUT IN POT CONDITION

The experiment evaluated the use of salinity-tolerant *Rhizobial* strains to alleviate salt stress in groundnut (*Arachis hypogaea L.*) under induced salinity (2-7 dSm^{-1}). Salinity significantly reduced growth, nodulation, and yield parameters in all groundnut treatments. However, inoculation with the superior strains mitigated these negative effects compared to the uninoculated control. STGN-4 emerged as the best performer for vegetative growth and nodulation, showing significant increases in effective nodules (25.00), total nodules (53.00), root length (11.00), and branches (5.33). Conversely, STGN-10 excelled in yield metrics, achieving the highest pod (18.67) and grain yield (29.4 gm) $plant^{-1}$. The superior performance is attributed to the strains' enhanced Biological Nitrogen Fixation (BNF) and Plant Growth-Promoting (PGP) activities, supporting better root colonization and function under osmotic stress. The study concludes that using carefully selected, salt-tolerant *Rhizobial* strains is a highly effective, eco-friendly, and economical strategy to enhance growth and secure viable groundnut yields in saline soils.

PRODUCTION OF BIOFERTILIER FOR LENTIL, CHICKPEA, COWPEA, FELON, MUNGBEAN, SOYBEN, BLCKGRM AND GROUNDNUT (AMOUNT 600 KG)

Activty-1: Production and distribution of BINA biofertlizers in 2024-2025

An amount of 704.0 kg biofertilizers were produced for production of soybean, mungbean, lentil and groundnut. 620.4 kg were distributed to farmers, scientists, research students and other agricultural practitioners (Table 1). The highest amount of biofertilizer produced and distributed was of mungbean followed by groundnut and soybean this year.

Table 1. Biofertlizers production and distribution at BINA in 2024-2025

Sl. No	Crop	Production (kg)	Distribution (kg)
1	Soybean	125.0	116.8
2	Mungbean	220.0	200.6
3	Lentil	130.0	102.0
4	Groundnut	225.0	198.0
5	French bean	4.0	3.0
	Total	704.0	620.4

Activty-2: Training of farmers and extension personnel on benefits and application of biofertilizer

Three training programmes were arranged at three Sub-stations of BINA to create awareness about benefits and application method of biofertilizer to the farmers and extension personnel. The name of the Sub-stations of BINA are BINA Sub-station Barisal, BINA Sub-station Ishwardi, and BINA Sub-station Chapainawabganj.

AGRONOMY DIVISION

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

A field experiment was conducted at the BINA HQs Farm, Mymensingh during the Aman season of 2024 to evaluate the effects of transplanting dates on yield and yield-contributing traits of selected Aman rice mutants/varieties. The experiment followed a randomized complete block design (RCBD) with three replications, comprising two transplanting dates, July 30 (D1) and August 15 (D2) and five rice genotypes: BNDR, BN-RM-P-33, RM-12-250-1, BNCR-1 and BINA dhan26. Significant variations were observed among transplanting dates, genotypes and their interactions for most measured traits. Late transplanting (D2) resulted in significantly higher grain yield (5.42 t ha^{-1}) and straw yield (6.91 t ha^{-1}) compared to early transplanting. Among the tested genotypes, BINA dhan26 exhibited superior performance, producing the highest grain yield (5.58 t ha^{-1}), 1000-seed weight (23.49 g), number of effective tillers $hill^{-1}$ (13.53) and filled grains $panicle^{-1}$ (159.99). Interaction effects showed that transplanting BINA dhan26 on August 15 yielded the maximum grain output (5.70 t ha^{-1}) followed by BNDR on the same date. The lowest yield was recorded in BN-RM-P-33 transplanted on July 30. These findings suggest that optimizing transplanting time, particularly around mid-August and selecting high-yielding genotypes such as BINA dhan26 or BNDR can significantly enhance Aman rice productivity under the studied agro-ecological conditions.

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

A field experiment was conducted at the BINA HQs Farm, Mymensingh during the 2024–25 Boro season to determine the optimum transplanting date for maximizing yield performance of different Boro rice mutants and varieties. The study was arranged in a split-plot design with three replications, comprising two transplanting dates, 15 January (D1) and 25 January (D2) as main plots and thirteen rice mutants/varieties as sub-plots. Significant differences were observed among transplanting dates, genotypes and their interactions for most agronomic traits. Transplanting on 15 January resulted in marginally higher grain yield (6.78 t ha^{-1}) than 25 January (6.73 t ha^{-1}) along with greater plant height (98.72 cm) and total tillers per hill (12.06). However, transplanting on 25 January led to longer panicles (25.54 cm) and a higher number of filled grains $panicle^{-1}$ (132.85). Among the genotypes, Bina (Bio)-42-2 produced the highest grain yield (8.07 t ha^{-1}) and plant height (108.83 cm) followed by BRRI dhan89 with 7.88 t ha^{-1}. In contrast, IRSSTN-13 recorded the lowest grain yield (5.59 t ha^{-1}) despite high 1000-seed weight (30.04 g). The transplanting date × variety interaction was significant with Bina (Bio)-42-2 transplanted on 25 January achieving the highest grain yield (9.43 t ha^{-1}). These results suggest that transplanting Bina (Bio)-42-2 around 25 January is optimal for maximizing Boro rice productivity under the agro-ecological conditions of Mymensingh.

Improved cropping pattern with BINA released varieties uses for Synchronized farming in Cumilla regions

A study was conducted in the Cumilla region during the 2024–25 cropping year to develop improved and synchronized cropping patterns using BINA-released varieties, aiming to enhance

land-use efficiency and economic returns for smallholder farmers. The existing Aus–Aman–Mustard–Fallow system was replaced with high-yielding, region-specific crop varieties on 1 Bigha (33 decimals) of land. Field data were collected from two locations, Muradnagar and Choddagram focusing on input costs, yields, output values and benefit-cost ratios (BCR) for each crop season. The proposed pattern in Muradnagar: Aus (Binadhan-21)–Aman (BINA dhan26)–Mustard (Binasarisha-11)–Sesame (Binatil-2)—yielded a total BCR of 1.74 with an input cost of Tk 47,000 and an output value of Tk 82,800. In Choddagram, the pattern: Aus (Binadhan-21)–Aman (Binadhan-17)–Mustard (Binasarisha-11)–Sesame (Binatil-2)—achieved a slightly higher BCR of 1.78 with an input cost of Tk 53,500 and output value of Tk 95,379. Crop-wise, Binadhan-21 showed BCRs of 1.54–1.69, BINA dhan26 recorded 1.66 and Binadhan-17 achieved 1.73. Among Rabi crops, Binasarisha-11 had the highest BCR (1.90–1.96) followed by Binatil-2 (1.74–1.86). These results suggest that synchronized cropping systems incorporating BINA-released varieties can significantly improve land productivity and profitability by eliminating fallow periods. The proposed cropping patterns offer a viable strategy for sustainable intensification and income enhancement in the Cumilla region.

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

An experiment was conducted at a farmer's field in Khagrachari during the Kharif-1 season of 2024–25 to evaluate the yield performance and competitiveness of different intercropping combinations between sesame (*Binatil-2*) and mungbean (*Binamoog-8*) for sustainable intensification in the hill tracts. The study included five treatments: sole mungbean, sole sesame and three intercropping systems with row ratios of 4:2, 2:4 and 3:3 arranged in a randomized complete block design (RCBD) with three replications. Results showed that the 3:3 intercropping system produced the highest grain yields for both sesame (1.7 t ha^{-1}) and mungbean (1.5 t ha^{-1}) significantly outperforming other intercropping treatments ($p < 0.05$). Competitive ratio (CR) analysis indicated more balanced competition in the 3:3 intercropping system (CRs = 1.30, CRm = 0.76) while other treatments showed crop dominance. Land Equivalent Ratio (LER) values exceeded unity for all intercropping systems, confirming yield advantages over sole cropping with the 3:3 intercropping system achieving the highest LER (1.85), mungbean equivalent yield (3.06 t ha^{-1}) and sesame equivalent yield (2.94 t ha^{-1}). These findings suggest that sesame–mungbean intercropping in a 3:3 row arrangement maximizes land use efficiency, ensures balanced crop competition and enhances overall productivity and profitability. The system is recommended for hill tract farmers as a viable strategy for sustainable intensification and improved livelihoods.

Evaluation of yield performance of intercropping combinations between Groundnuts and French bean in hill tracts

An intercropping experiment was conducted at a farmer's field in the Khagrachari district during the Rabi season of 2024–25 to evaluate the yield performance of different groundnut and French bean combinations for sustainable intensification in hill tracts. The study included five treatments: sole French bean, sole groundnut and three intercropping systems, Groundnut: French bean in 4:2, 2:4 and 3:3 row ratios using Binachinabadam-8 and a local French bean

variety. The experiment followed a randomized complete block design (RCBD) with three replications. Results revealed that intercropping treatments outperformed sole cropping in terms of land equivalent ratio (LER), groundnut equivalent yield (GEY) and French bean equivalent yield (FEY). The 3:3 intercropping system produced 1.9 t ha^{-1} groundnut and 2.7 t ha^{-1} French bean while the 4:2 system yielded 1.5 t ha^{-1} groundnut and 3.2 t ha^{-1} French bean. The highest LER was recorded in 4:2 system (2.48) closely followed by T5 (2.46) indicating superior land use efficiency. Competitive ratio (CR) analysis showed relatively balanced competition in 3:3 row (CRg = 0.7; CRf = 1.4) whereas 2:4 row was dominated by French bean (CRf = 2.1). The highest GEY (5.36 t ha^{-1}) and FEY (4.68 t ha^{-1}) were obtained from 4:2 system but 3: 3 row demonstrated a better balance between productivity and crop competition. These findings suggest that intercropping groundnut and French bean particularly in a 3:3 row arrangement, enhances overall productivity, optimizes resource use and promotes sustainable agriculture in hill tract conditions.

Determination the efficacy of different herbicide suppressing weed species in T. aman rice

A field experiment was conducted at BINA HQs Farm, Mymensingh during the T. Aman season of 2024–25 to evaluate the efficacy of different herbicides in suppressing weed species and their impact on rice yield. The experiment included ten treatments comprising various pre- and post-emergence herbicides: Pretilachlor 50EC, Indofit, 2,4-D Amine, Bispyribac-sodium, Penoxsulam, Cyhalop, Bispyribac-sodium + Penoxsulam, Bensulfuron-methyl + Bispyribac-sodium alongside an untreated control with Binadhan-17 as the test crop. The study was laid out in a randomized complete block design (RCBD) with three replications across two locations and plot size of 8 m × 5 m. Results showed that the control plot recorded the highest weed infestation with a weed density of 103.2 m^{-2}, fresh weight of 241.78 g m^{-2} and dry weight of 87.58 g m^{-2}. Among treatments, Indofit 50EC achieved the highest weed control efficiency (81.61%) and resulted in a grain yield of 4.60 t ha^{-1}. However, the Penoxsulam-treated plot produced the highest grain yield of 5.17 t ha^{-1} indicating its superior efficacy in balancing weed suppression and crop productivity. These findings suggest that while several herbicides effectively control weed populations, Penoxsulam stands out as the most effective option for maximizing grain yield in T. Aman rice under the tested conditions.

Determination the efficacy of different herbicide suppressing weed species in *boro* rice

A field experiment was conducted at BINA HQs Farm, Mymensingh during the Boro season of 2024–25 to evaluate the efficacy of different herbicides in controlling weed species and their impact on the yield of Boro rice. The study comprised ten treatments, including a control and nine herbicidal applications—Pretilachlor 50EC, Indofit, 2,4-D Amine, Bispyribac-sodium, Penoxsulam, Cyhalop, Bispyribac-sodium + Penoxsulam, Penoxsulam (alone) and Bensulfuron-methyl + Bispyribac-sodium using BINA dhan25 as the test variety. The experiment was laid out in a randomized complete block design (RCBD) with three replications across two locations with each plot measuring 8 m × 5 m. Results showed that the untreated control plot exhibited the highest weed infestation with a weed density of 138.52 m^{-2}, fresh biomass of 328.24 g m^{-2} and dry biomass of 89.84 g m^{-2}. Among the treatments, Penoxsulam demonstrated the highest weed control efficiency (83.52%) and produced the highest grain yield (5.24 t ha^{-1}) followed closely

by the combination treatment of Bensulfuron-methyl + Bispyribac-sodium. These findings highlight that while several herbicides are effective in reducing weed pressure, **Penoxsulam** is the most efficient in maximizing grain yield in Boro rice under the tested conditions.

Effect of different herbicide suppressing weed infestation in Maize at Kashiar Char, Sadar Mymensingh

Weed infestation poses a major constraint to maize productivity in the charland areas of Bangladesh. To assess effective weed management strategies, a field experiment was conducted during the Rabi season of 2024–25 at Kashiar Char, Sadar, Mymensingh, to evaluate the efficacy of two herbicides, Glufosinate ammonium and Atrazine in suppressing weed infestation in maize. The trial was laid out in a randomized complete block design (RCBD) with three replications. Treatments included an untreated control, Glufosinate ammonium and Atrazine. Data were recorded on weed species composition, weed density (plants m^{-2}), fresh and dry biomass (g m^{-2}) and weed control efficiency (WCE). The control plot exhibited seven weed species with the highest weed density (78 plants m^{-2}), fresh weight (35.00 g m^{-2}) and dry weight (19.21 g m^{-2}). Application of Glufosinate ammonium reduced weed density to 30.5 plants m^{-2} and achieved the highest WCE (85.0%) while Atrazine recorded the lowest weed density (25.5 plants m^{-2}) and lowest biomass (fresh weight: 19.58 g m^{-2}; dry weight: 11.30 g m^{-2}) with a WCE of 80.65%. Both herbicides significantly outperformed the control in reducing weed pressure. The results suggest that **Glufosinate ammonium** is most effective for overall weed control while **Atrazine** is preferable when minimizing weed biomass is prioritized. These findings support the use of targeted herbicide strategies for effective weed management in maize cultivation on charland soils.

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

A field experiment was conducted at Southkhali, Saronkhola, Bagerhat during the Boro season of 2024–25 to investigate the effect of salicylic acid (SA) on the yield and yield-contributing traits of rice grown under saline stress conditions. The study evaluated eight treatments: control and foliar applications of SA at concentrations of 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, and 3.5 mM applied at 30, 60, and 90 days after transplanting. The experiment followed a randomized complete block design (RCBD) with three replications. Peak soil salinity in the experimental site was recorded at 9.1 dS m^{-1} on April 26. Results revealed that SA application significantly enhanced rice yield and yield-related traits under saline conditions. The 3.0 mM SA treatment produced the highest grain yield (5.98 t ha^{-1}) closely followed by 2.5 mM (T5) with 5.93 t ha^{-1}. The improved performance is attributed to SA-mediated regulation of stomatal closure, ion homeostasis and antioxidant activity, which collectively enhanced photosynthetic efficiency, proline accumulation, and nutrient uptake under salinity stress. Lower SA concentrations (0.5–1.0 mM) also showed improved salt tolerance though to a lesser extent. These findings demonstrate that exogenous application of salicylic acid particularly at 2.5–3.0 mM can mitigate salinity-induced yield losses and improve productivity in rice cultivated in saline-prone coastal areas.

Determination the effect of top dressing sulfur on tillering dynamics and yield attributes of T. aman rice

A field experiment was conducted at BINA HQs Farm, Mymensingh during the Aman season of 2024 to evaluate the effect of top-dressed sulfur on tillering dynamics and yield attributes of **T. Aman rice** using the variety **BINA dhan26**. The primary objective was to determine the optimum sulfur dose for enhancing tiller production and maximizing grain yield. The experiment was laid out in a randomized complete block design (RCBD) with six treatments: control, 4 kg S ha^{-1}, 5 kg S ha^{-1}, 6 kg S ha^{-1}, 7 kg S ha^{-1} and 8 kg S ha^{-1} using **Cumulous-DF (80% sulfur)** as the sulfur source. Sulfur was applied as a second top dressing 25 days after transplanting. Results revealed significant effects of sulfur on tillering and yield traits. The highest grain yield (5.25 t ha^{-1}) was obtained with 6 kg S ha^{-1} followed by 7 kg S ha^{-1} (5.17 t ha^{-1}). The control plot recorded the lowest yield. Enhanced yield at 6 kg S ha^{-1} was attributed to increased tiller number, panicle formation and improved grain filling due to better sulfur availability. Yield declined slightly or plateaued beyond this dose indicating no further agronomic advantage. The findings suggest that **6 kg ha^{-1} of top-dressed sulfur** is the optimum rate for improving tillering dynamics and yield attributes of T. Aman rice in the tested agro-ecological conditions.

Resolve of GHGs in rice cropping system through tillage management of rice residue

A field experiment was conducted at BINA HQs Farm, Mymensingh during the Boro season of 2024–25 to determine the optimum tillage and residue management practices for enhancing rice yield and minimizing greenhouse gas (GHG) emissions. The study aimed to assess the effects of different tillage methods and rice residue cutting heights on crop performance and emissions of methane (CH_4) and nitrous oxide (N_2O). The experiment followed a randomized complete block design (RCBD) with three replications comprising four tillage treatments, farmer practice: dry tillage 30 days before transplanting, residue incorporation 60 days before transplanting, continuous flooding during final land preparation and three residue cutting heights—0 cm, 15 cm, 30 cm and 45 cm. GHG data were collected using a closed chamber method and analyzed with FTIR and Calcmate software. Results showed that **early residue incorporation** significantly reduced **N_2O emissions** compared to conventional dry and wet tillage. In contrast, **CH_4 emissions increased** with higher residue cutting heights. Grain yield and yield-contributing traits were moderately influenced by tillage with **continuous flooding** achieving the highest grain (5.75 t ha^{-1}) and straw yield (7.23 t ha^{-1}) likely due to improved soil conditions. Residue retention positively affected yield with **45 cm cutting height** producing the highest grain yield (6.12 t ha^{-1}), straw yield (7.75 t ha^{-1}), effective tillers (10.38) and filled grains $panicle^{-1}$ (169.22). The interaction between tillage and residue height was significant where tillage with continuous flooding during final land preparation combined with 45 cm rice residue cutting height resulted in the highest grain (6.26 t ha^{-1}) and straw yield (7.94 t ha^{-1}) while residue incorporation 60 days before final land preparation with no residue retention (0 cm cutting height) produced the lowest (5.07 t ha^{-1}). The findings suggest that continuous flooding during final land preparation combined with 45 cm residue retention optimizes yield and reduces soil degradation, while early residue incorporation minimizes N_2O emissions, contributing to more sustainable rice production in saline-prone and GHG-sensitive environments.

Determination of greenhouse gas in rice cropping system through residue management by tillage manipulated

A field experiment was conducted at BINA HQs Farm, Mymensingh during the Boro season of 2024–25 to determine the optimum timing of tillage and rice residue management practices for enhancing yield and minimizing greenhouse gas (GHG) emissions. The study evaluated three tillage timings: residue incorporation one month before final land preparation (farmer practice), residue incorporation just after harvest and residue incorporation during final land preparation along with four residue cutting heights: 0 cm, 15 cm, 30 cm and 45 cm. The experiment followed a Randomized Complete Block Design (RCBD) with three replications. Methane (CH_4) and nitrous oxide (N_2O) emissions were measured using the closed chamber method aided by FTIR and Calcmate software. Results showed that tillage operations conducted closer to the final land preparation particularly just after harvest and final land preparation significantly reduced CH_4 and N_2O emissions compared to the farmer practice. Residue height also had a pronounced effect: increasing cutting height from 15 cm to 45 cm substantially lowered GHG emissions and improved crop performance throughout the growth stages. While tillage timing had limited influence on yield attributes, residue retention greatly enhanced plant height, tiller number, filled grains and grain yield. The highest yield (6.00 t ha^{-1}) and straw yield (7.56 t ha^{-1}) were obtained under the combined treatment of residue incorporation during final land preparation with 45 cm residue height while the lowest yield (4.37 t ha^{-1}) occurred in no residue. These findings highlight the synergistic benefits of **timely tillage** and **residue retention** particularly with higher stubble heights, in improving rice yield and mitigating GHG emissions. Adopting residue incorporation during final land preparation combined with 45 cm cutting height can support more sustainable and climate-resilient rice production in GHG-sensitive regions.

Determination of GHGs emission in rice based cropping system through irrigation management practices

A field experiment was conducted at BINA HQs Farm, Mymensingh during the Boro season of 2024–25 to evaluate the effect of irrigation management on greenhouse gas (GHG) emissions and yield performance in rice. The study aimed to assess the impact of intermittent irrigation practices, particularly alternate wetting and drying (AWD) on methane (CH_4) and nitrous oxide (N_2O) emissions in boro rice cultivation. The treatments included continuous flooding (CF), moderate flooding up to dough stage (MF) and AWD up to panicle initiation stage, tested on two rice varieties: Binadhan-24 and BINA dhan25 in a randomized complete block design (RCBD) with three replications. GHG measurements were taken using the closed chamber method supported by FTIR and Calcmate software. Results showed that AWD significantly reduced CH_4 emissions throughout the growing period (14 to 84 DAT) while CF released the highest CH_4. However, AWD increased N_2O emissions particularly between 17 to 70 DAT, highlighting a trade-off between CH_4 and N_2O mitigation. Among the varieties, Binadhan-24 emitted more N_2O but recorded superior yield performance. Binadhan-24 under AWD produced the highest grain yield (7.28 t ha^{-1}), straw yield (8.25 t ha^{-1}), effective tillers (12.73) and 1000-seed weight (28.51

g). In contrast, the lowest yield (5.41 t ha^{-1}) was recorded under BINA dhan25 with CF. Overall, AWD proved to be the most effective irrigation strategy for reducing CH_4 emissions while maintaining or improving grain yield. Binadhan-24 responded best under AWD suggesting its potential for climate-smart rice production. The study highlights the importance of integrating water-saving irrigation with variety selection to optimize yield and minimize environmental impacts in rice ecosystems.

Quantification of GHGs in rice cropping system through nitrogen management practices

A field experiment was conducted at BINA HQs Farm, Mymensingh during the Boro season of 2024–25 to evaluate the effect of nitrogen (N) fertilizer sources and application rates on greenhouse gas (GHG) emissions and yield performance in rice cultivation. The study aimed to identify nitrogen management practices that enhance Nitrogen Use Efficiency (NUE) while minimizing emissions of methane (CH_4) and nitrous oxide (N_2O). The experiment followed a Randomized Complete Block Design (RCBD) with three replications and unit plot size of 5 m × 4 m. Data on N_2O and CH_4 emissions were collected using a closed chamber method and analyzed using FTIR and Calcmate software. Yield and yield components were recorded and statistically analyzed using LSD. Results revealed that increasing nitrogen levels significantly elevated CH_4 emissions between 28 and 56 days after transplanting (DAT) while the source of nitrogen influenced both emission levels and yield outcomes. Neem-coated urea and urea super granule (USG) showed reduced GHG emissions compared to prilled urea due to slower nitrogen release and reduced volatilization losses. Among the fertilizer sources, neem-coated urea recorded the highest grain yield (4.83 t ha^{-1}) and straw yield (6.34 t ha^{-1}). Nitrogen application at 90 kg ha^{-1} significantly improved plant height, effective tillers, panicle length, filled grains and grain yield (5.93 t ha^{-1}) compared to the control. The interaction effect was also significant; the combination of neem-coated urea at 90 kg N ha^{-1} resulted in the highest grain (6.13 t ha^{-1}) and straw yield (7.69 t ha^{-1}) suggesting a synergistic effect of source and rate. The study concludes that optimized nitrogen management specifically using neem-coated urea at 90 kg ha^{-1} enhances rice productivity while mitigating GHG emissions offering a sustainable strategy for climate-smart rice cultivation.

Effect of rice straw biochar mitigating greenhouse gas emission from paddy soil

A field experiment was conducted at BINA HQs Farm, Mymensingh during the Boro season of 2024–25 to evaluate the impact of rice straw biochar on greenhouse gas (GHG) emissions and rice yield. The primary objective was to assess the efficacy of different biochar application rates in reducing methane (CH_4) and nitrous oxide (N_2O) emissions from paddy soils while improving crop performance. The experiment followed a randomized complete block design (RCBD) with eight treatments: control and biochar applied at 1 to 4 t ha^{-1} (Biochar 1 t ha^{-1}, Biochar 1.5 t ha^{-1}, Biochar 2 t ha^{-1}, Biochar 2.5 t ha^{-1}, Biochar 3 t ha^{-1}, Biochar 3.5 t ha^{-1}, Biochar 4 t ha^{-1}) each replicated three times. Gas samples were collected using the closed chamber method and analyzed with FTIR and Calcmate software. Data on yield and yield components were statistically analyzed using LSD. Results showed that biochar application between 2.5 and 3.5 t ha^{-1} significantly reduced N_2O emissions, particularly from 14 to 35 days after transplanting (DAT) and lowered CH_4 emissions between 28 and 84 DAT. The reduction in GHG emissions was attributed to improved soil aeration, enhanced microbial activity and reduced mineralization

of labile carbon. Biochar-amended plots demonstrated improved plant growth and yield performance. Plant height, effective tillers and filled grain numbers increased with biochar levels with the highest grain yield (5.89 t ha^{-1}) and straw yield (7.65 t ha^{-1}) recorded at 3 t ha^{-1}. Yields plateaued or declined beyond this rate indicating an optimal application threshold. The findings highlight the dual benefits of biochar in climate-smart agriculture mitigating GHG emissions and enhancing rice productivity. An application rate of 3 t ha^{-1} is recommended as the most effective for maximizing yield and environmental benefits in Boro rice systems.

Enhancing rice productivity and mitigating greenhouse emission from paddy soil with plant growth regulator

A field experiment was conducted at BINA HQs Farm, Mymensingh during the Boro season 2024–25 to evaluate the effects of plant growth regulators (PGRs) on rice yield performance and greenhouse gas (GHG) emissions from paddy soils. The objective was to assess the potential of PGRs in improving rice productivity while reducing methane (CH_4) and nitrous oxide (N_2O) emissions of key contributors to global warming in flooded rice systems. The study included five PGR treatments: Nitrobenzene, Gibberellic acid (GA_3), Auxin, Chlorophenoxy acetic acid and Cytokinin applied at 20, 40 and 60 days after transplanting (DAT). Two rice varieties—Binadhan-24 and BINA dhan25 were tested in a randomized complete block design (RCBD) with three replications. GHG emissions were measured using a closed chamber method supported by FTIR and Calcmate software. Yield and yield components were also recorded and statistically analyzed. Results showed that foliar application of PGRs significantly reduced CH_4 and N_2O emissions between 35 to 84 DAT with the greatest reduction observed under Cytokinin and GA_3 treatments. This mitigation effect is attributed to enhanced root oxygen release, improved nitrogen uptake and suppression of methanogenic microbes in the rhizosphere. Cytokinin produced the highest grain yield (6.39 t ha^{-1}) and straw yield (8.09 t ha^{-1}) followed by GA_3. Yield improvements were driven by increased tillering, effective panicles and filled grain numbers. Among varieties, Binadhan-24 outperformed BINA dhan25 in grain yield (6.83 vs. 5.92 t ha^{-1}) likely due to its higher 1000-seed weight and better biomass allocation to reproductive parts. The interaction effect was significant; the combination of Binadhan-24 with Cytokinin or GA_3 resulted in the highest grain yield (up to 7.09 t ha^{-1}). These findings suggest that specific PGRs particularly Cytokinin and GA_3 can play a dual role in enhancing rice yield and mitigating GHG emissions making them viable tools for climate-smart rice production systems.

CROP PHYSIOLOGY DIVISION

Effect of high temperature at reproductive stage on grain quality of short duration Aman rice lines/ genotypes

Temperature is one of the most important environmental factors influencing crop growth, development and yield. Temperature is becoming the major concern for plant scientists worldwide due to the changing climate. Grain filling is the final stage of growth in cereals where fertilized ovaries develop into caryopses. Grain filling in cereals depends on carbon from two sources: current assimilates transferred directly to the grain and assimilates redistributed from reserve pools in vegetative tissues prior post-anthesis. This study was carried out to assess the effect of high temperature at total reproductive stage of Aman rice genotypes. The experiment was conducted with seven rice genotypes viz., Kasalat, NP-5,N-22, NPT-12,IN-105, NP_8 and NP-2. The experiment was set in CRD with three replications during Aman season of 2024. Yield and yield contributing characters specially grain number per panicle and grain weight per hill were significantly decreased. Results also revealed that SPAD data, chlorophyll a, chlorophyll b, and nitrate reductase activity were higher in control but chlorophyll a and chlorophyll b decreased with high temperature stress. Pollen sterility percentage was also increased because of high temperature. MDA and H_2O_2 were also increased compare to control. All the morphological parameters markedly decreased because of high temperature stress. Considering grain quality aborted seed, cracked grain, unfilled white seed were higher and grain colour was abnormal which may affect in consumers choice. So, high temperature actually affects the final yield of Aman rice lines/genotypes at reproductive stage but NPT-12, NP-11, N-22 showed better yield under high temperature stress.

Effect of high temperature on yield at flowering stage of Boro rice lines/genotypes

An investigation was carried out with 14 rice genotypes viz. SHD-5R, BRRI-92, Indian-313, Acc-85-1, Babilon-3R, BP-606, Indian-505, BRRI-104, BRRI-58, BHR-2, BRRI-29, BRRI-89, BRRI-102 and Binadhan-25 to assess the effect of high temperature at flowering stage. The experiment was set in CRD with three replications in during Boro seasons 2024-25. Temperature was 39^0C at flowering stage for about 6 days. Results revealed that panicle length, filled grain/panicle, grains/ panicle number, 1000 seed weight, straw weight and grain weight/hill lower in case of high temperature stress. Unfilled grain markedly increased is different genotypes under high temperature stress, it looks higher in BP-606 followed by BRRI dhan-89. Grain panicle^{-1} (no) was higher in SHD-5R followed by BRRIdhan-104. Grain weight hill^{-1} (g) observed higher in Binadhan-25 followed by BRRI-102, BRRI-58 and BP-606. Thousand grain weight was observed higher in Indian-505, Indian-313, Babilon-3R, BRRI-102 and Binadhan-25. In case of pollen sterility, it looks less in Indian-313, BP-606, BRRI-29 and BRRI-92. Reactive Oxygen Species (ROS), the determination result of MDA and Hydrogen per oxide reveals higher in most of the genotypes, but less in SHD-5R, Indian-505 and BRRI-58. Grain quality also analyzed and source and sink relationship was computed. High amylose content observed in SHD-5R, Indian-313, BP-606 and BRRI-58. Protein percentage was higher in BRRdhanI-92 followed by Indian-313. Babilon-3R, Indian-313, BRRI-102; and Binadhan-25 showed better yield under high temperature stress.

Screening of cold tolerant rice genotypes at panicle initiation stage to reproductive stage based on physiological criteria

Cold stress is an emerging threat for rice production in Bangladesh particularly in Boro season. In this regard, development of cold tolerant high yielding rice varieties could be an important approach to meet up the demand of bursting population in our country. The study was aimed to characterize the cold tolerance Boro rice genotypes and to find out the tolerant genotypes. Cold stress in rice actually induces flower abortion, pollen abnormality and ovule infertility, causes breakdown of successful fertilization that affects in source sink activities and leads low seed set, aborted seed, increased unfilled grain and finally low grain yield. A pot experiment was conducted at the pot yard with 23 rice genotypes. The land race genotypes were critically observed for morpho-physiological screening. Plant height was observed in RD3027 followed by Accno 3304, maximum number of effective tiller was observed in RD3027 followed by Accno3432 and BNCR-35. Panicle length showed longer with maximum grain filling in Accno3420 followed byAccno3400. Pollen sterility looks less in no RD3072, Accno3400, PNR166 and Accno3420. The 100 grain weight was observed higher in Accno3410 followed by RD-3072. Grain yield observed higher in RD3072 followed by Acc. No3202 and Accno3410. These genotypes can be used as a genetic material for further breeding purpose.

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

A pot experiment was conducted with eight sesame genotypes at BINA, Mymensingh to find out the water logging tolerance genotypes on the basis of morphological, biochemical, 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 maximum temperature was about 38-40^{0}C. Results revealed that all the genotypes were markedly decreased under waterlogging stress which causes leaf senescence and root anoxia that reduces the ability to absorb nutrients that decreased chlorophyll content of the leaf. Under water logging, all morpho-physiological parameters and yield attributes drastically reduced than control plant in 48 hours and 60 hours water logging. Chlorophyll content by maintaining SPAD value that drastically decreased, MDA and Hydrogen per oxide showed increasing tendency under different water logging comparing to control plant. MTM-7, MTM-4, Thai-2, MTM - 5 can comparatively tolerate up to 60 hour water logging condition and can be used for further breeding purpose and molecular findings.

Studies of plant ideotype of some selected cherry tomato genotypes for higher yield

The investigation was conducted on four cherry tomato genotypes, to investigate about cherry plant architecture, branches pattern, flower cluster, flower arrangement, fruit setting, and yield. As cherry tomato looks indeterminate type and it gives more secondary branches and gives more flower cluster and perform maximum good quality fruit in a cluster and thereby to assess the cherry plant architecture and canopy, orientation of branches is suitable for suitable for maximum yield, quality fruit and avoid parasitic leaves. Results revealed that all the parameters are statistically significant except flower cluster/plant and different among the genotypes. Trumbling red looks to be a bushy type and plant height is lower comparing to other cherry

genotypes. Maximum height observed in Cherolla followed by Lupitus. Secondary branch markedly increased in Cherolla, and Lupitas compairing to others. Flower cluster looks maximum in Cherolla followed by trumbling red. Maximum fruit observed in Trumbling red followed by Cherolla and Lupitus. Good quality cherry ball size tomato gives quality fruit weight which will be gladly accepted by the consumers. Finally, maximum fruit yield showed in Cherolla type cherry tomato followed by trumbling red and Lupitus genotype. Hence, these genotypes could be better utilized for further breeding programme for the improvement of fruit yield.

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

A pot experiment was conducted with 7 mustard genotypes viz., CPD-1, CPD-2, Binasorisa-11 CPD-4, CPD-5, CPD-6 and CPD-3 at BINA pot yard, Mymensingh. The main objective is to assess the effect of water logging during seedling stage on mustard growth and development and to identify water logged tolerant genotypes of mustard.

Three water logging treatments viz., control, 48 hours and 72 hours water-logged period were imposed at 30 days of seedlings of the mustard genotypes. Morphological, yield component and expression of reactive oxygen species were determined. The collected data were analyzed statistically. Results revealed that under water logging condition, different morpho-physiological parameters, yield and yield contributing characters reduced drastically compared to control plant. Plant height and no of branches looks to be higher in Binasorisa-11 and number of siliquaplant^{-1} was higher in CPD-3 followed by CPD-6. Aborted seed was higher in Binasorisa-11 followed by CPD-5. Siliqua per plant was higher in CPD-4 and seed per siliqua was more in CPD-3 followed by CPD-6. Length of the siliqua was higher in CPD-4 followed by CPD-6. Seed weight per plant looks to be higher in CPD-6 followed by CPD-4. Considering treatment effect, SPAD reading reduced drastically as leaf chlorosis arises but MDA and Hydrogen per oxide increased under different water-logging condition. SPAD value was higher in CPD-6 followed by CPD-4, MDA and hydrogen peroxide increased but looks less in CPD-6 followed by CPD-4. Considering above information it can be concluded that CPD-6 and CPD-4 looks better after recovery though seedlings water logged in 48 hours and 60 hours. These genotypes showed a tolerant tendency though water submersed the plants.

Effect of foliar application of thiourea to mitigates drought Stress in rice

This pot experiment at BINA evaluated drought tolerance in rice genotypes under 100%, 60%, and 40% field capacity (FC). Thiourea (TU) was applied at 500 and 1000 mg/L with Tween-20 as a foliar spray weekly. Treatments included control, drought stress, TU alone, and their combinations in a three-factorial randomized design with five replications. Binadhan-17 outperformed BRRI dhan75 under drought. TU, especially at 1000 mg/L, significantly improved yield, antioxidant activity, and chlorophyll content, mitigating drought effects. The results highlight thiourea's potential to enhance rice resilience and productivity under water-limited conditions.

Mitigating salt stress in soybean through exogenous application of calcium

Salinity stress significantly hampers soybean growth and productivity. This study investigated the effect of exogenous calcium (Ca) application in mitigating salt stress (8 dS m^{-1} NaCl) in three mutant lines and one variety of soybean. Calcium was applied as foliar spray (5, 10, and 15 mM) every alternate day starting at 40 days after sowing. Results showed that 10 mM Ca application notably improved salt tolerance, reducing visual injury symptoms across all genotypes. The findings suggest that moderate Ca supplementation enhances salinity stress tolerance in soybean, offering a potential strategy for improving crop performance in saline soils.

Evaluation of soybean genotypes for salinity tolerance based on physiological criteria

An experiment was conducted from January to May 2025 at the pot yard of BINA using five soybean genotypes (Binasoybean-6, Binasoybean-7, SBM-34, SBM-35, and SBM-36). It followed a two-factor RCBD with three replications, testing four salinity levels (0, 60, 80, 100 mM) and the five genotypes. Physio-biochemical traits such as chlorophyll, proline, total soluble sugar, MDA, and H_2O_2 were analyzed. At pod maturity, growth and yield data were recorded. Chlorophyll content decreased with increasing salinity, with the highest reduction at 100 mM. Binasoybean-6 had the lowest proline accumulation, and H_2O_2 levels increased under salinity. SBM-35 and SBM-36 had lower sugar content under salinity. The highest seed yield $plant^{-1}$ (7.21 g) was found in Binasoybean-7 at 60 mM, while SBM-34 had no yield at 100 mM.

Evaluation of mungbean genotypes for salinity tolerance based on physiological criteria

An experiment was conducted at the BINA pot yard (Jan–May 2025) using ten mungbean genotypes (Binamoog-8, BMS-13, BMS-22, BMS-28, BMS-29, BMS-30, BMS-31, BMS-32, BMS-40 and MBM-477-4) under four salinity levels (0, 60, 80, and 100 mM) in a two-factorial RCBD with three replications. Physiological and biochemical traits such as chlorophyll, proline, total soluble sugar, MDA, and H_2O_2 were analyzed, along with growth and yield data at pod maturity. BMS-22 showed increasing chlorophyll *b* up to 60 mM, while BMS-30 had higher total chlorophyll. BMS-29 accumulated the most proline, and BMS-40 maintained lower H_2O_2 under high salinity, indicating better membrane stability. MBM-477-4 showed the highest increase in soluble sugar. Overall, BMS-22, BMS-31, BMS-32, and BMS-40 performed well under salinity stress.

Effect of seedling number on growth and yield of Binadhan-25

An experiment was conducted at research field of Bangladesh Institute of Nuclear Agriculture (BINA) from January to May 2025 using a Randomized Complete Block Design (RCBD) with three replications. Thirty day old seedlings were transplanted with four treatments: S1 (one seedling hill-1), S2 (two seedlings hill-1), S3 (three seedlings hill-1), and S4 (four seedlings hill-1). S1 produced the highest grain yield (7.32 t ha^{-1}) and harvest index (90.81%), while S3 gave the highest straw yield (9.83 t ha^{-1}). Results indicated that single seedling per hill performed best, suggesting farmers should avoid using extra seedlings to save labor, time, and cost.

Spikelet sterility in rice in response to different transplanting dates and nitrogen application rates

Rice is the most widely cultivated staple food crop in Asia, where the Asia–Pacific region produces and consumes over 90% of the world's supply. In Bangladesh, Boro rice contributes significantly to total rice production but is constrained by spikelet sterility. Recently, BINA released a fine-grain basmati-type variety, BINA dhan25, for the Boro season. Although this variety yields more than other fine-grain cultivars, it suffers from spikelet sterility, reducing overall productivity. Field experiments were conducted to evaluate the effects of transplanting date and nitrogen application on the yield and yield-related traits of BINA dhan25. Treatments included four transplanting dates 30 December 2024, 15 January, 30 January, and 15 February 2025 and four nitrogen levels: 80 kg N/ha (N1), 160 kg N/ha (N2), 240 kg N/ha (N3), and 320 kg N/ha (N4). The trial followed a randomized complete block design (RCBD) with two factors and three replications. Each plot measured 2.0 m × 3.0 m, and 35-day-old seedlings were transplanted at 15 cm × 20 cm spacing. Results showed significant effects of both transplanting date and nitrogen application on growth and yield attributes. The highest number of effective tillers was observed in T4N1, while the lowest occurred in T1N4. Maximum total tillers were recorded in T4N4. Panicle length was greatest in T1N3 and T4N4, whereas T1N1 had the shortest. Grain number per panicle was highest in T3N1 and lowest in T2N3. Unfilled grains were most frequent in T1N1 and least in T2N4, indicating that early transplanting with low nitrogen increased spikelet sterility. However, the study revealed that early transplanting combined with low nitrogen application resulted in poor plant growth and higher spikelet sterility, thereby reducing the yield potential of BINA dhan25.

Morpho-molecular characterization of rice landraces growing in Khulna region

The identification of salt-tolerant rice landraces is essential, as they represent valuable genetic resources for breeding programs aimed at enhancing yield stability under saline conditions. An experiment was conducted at the BINA Sub-station, Satkhira, during the Kharif-II season of 2024 to evaluate rice cultivars for salinity tolerance and yield performance. A total of 171 cultivars, including 166 Bangladeshi landraces and 5 high-yielding varieties, were tested in an alpha lattice design with two replications, with each unit plot measuring 2 m × 1 m. Fertilizer application and crop management practices were followed according to recommended guidelines. Phenotypic data were collected from five randomly selected plants per plot and analyzed using R software. Results revealed significant differences among cultivars for all studied traits, demonstrating wide genetic variation. Plant height showed moderate variability, while the number of effective tillers per hill varied significantly (7.10-30.00), indicating large differences in tillering ability. Panicle length exhibited relatively low variability, whereas the number of filled and unfilled grains per panicle showed high degrees of variation. Thousand-seed weight also differed widely, reflecting the presence of both bold- and slender-grain types. Overall, the findings highlight the considerable genetic diversity present in rice landraces of the Khulna region, particularly in key yield contributing traits such as effective tillers, filled grains per panicle, and thousand-seed weight, underscoring their potential use in breeding programs for salinity tolerance and yield improvement.

PLANT PATHOLOGY DIVISION

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

Three advanced lines of groundnut (BCB-3-4-3, BCB-3-4-5 and BCB-2-6-3) along with two check varieties (Binachinabadam-10 and Binachinabadam-12) were evaluated under field conditions at Mymensingh during the Rabi season of 2024–25 for resistance to foot and root rot and cercospora leaf spot. Disease incidence and severity were assessed using standard scales for the diseases. Mean foot and root rot incidence ranged from 5.3–12.0%, while cercospora leaf spot incidence ranged from 45.6–55.1% with severity scores of 2.2–3.5. All three advanced lines showed a moderately resistant reaction to both diseases whereas the check varieties exhibited moderately susceptible reactions, indicating potential for the lines in disease management programs.

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

Seven soybean mutants (SBM-33, SBM-34, SBM-35, SBM-36, SCM-5, SCM-8 and SCM-11) along with two check varieties (Binasoybean-5 and Binasoybean-7) were evaluated under natural field conditions at BINA farm, Mymensingh during Rabi season of 2024-25. Foot and root rot incidence was assessed using a 0–9 scale while yellow mosaic severity was recorded on a 0–8 scale. Collar rot incidence ranged from 10.66–16.41%, with all mutants showing moderately susceptible reactions. Yellow mosaic disease incidence varied between 43.3–65%, with severity scores of 4.1–5.7. All mutants displayed moderately resistant reaction to yellow mosaic, whereas Binasoybean-5 and Binasoybean-11 showed slightly lower resistance. These findings suggest the tested soybean mutants had resistance traits against yellow mosaic disease and moderate susceptibility to foot and root rot.

Evaluation of mustard-rapeseed mutants against alternaria blight disease

A study was conducted to identify resistant mustard genotypes against *Alternaria* leaf blight caused by *Alternaria brassicicola* and *A. brassicae*. During the reporting period (November 2024 to April 2025), a comprehensive field screening of 100 mustard-rapeseed genotypes was conducted under natural epiphytotic conditions to evaluate their resistance to *Alternaria* blight. Although no genotype exhibited complete resistance to leaf infection, four genotypes showed moderately resistant reactions. In contrast, pod infection assessments revealed stronger resistance responses, with 32 genotypes classified as resistant and 45 as moderately resistant, indicating tissue-specific variation in disease response. The reliability of field screening was further validated through detached leaf and seedling inoculation assays, where typical Alternaria blight symptoms developed within 72 hours and 7 days post-inoculation, respectively. To strengthen resistance identification, molecular screening was conducted using four QTL-linked markers (*Lu 3043, Lu 207198, M8,* and *M9*) on fourteen selected mustard genotypes exhibiting resistant to moderately resistant field reactions. Marker *Lu 3043* detected resistance-associated alleles in three mutant lines and one released variety, while *Lu 207198* identified resistance loci across mutant lines and several BARI, BINA, and BAU cultivars. Markers *M8* and *M9* demonstrated the highest efficiency, detecting resistance loci in most mutant and cultivated genotypes, confirming their suitability for marker-assisted selection.

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

A field study was conducted to evaluate the resistance of three advanced black gram mutants (BM-4, BM-42 and BM-63) and one check variety (BARI Mash-3) against cercospora leaf spot (CLS), powdery mildew and yellow mosaic virus (YMV) under natural infection. Disease incidence and severity were recorded from flowering to maturity stages. BM-63 exhibited the lowest CLS severity (score 3) and was moderately resistant, while BM-4, BM-42 and BARI Mash-3 were moderately susceptible. For powdery mildew, all mutants showed moderate resistance (severity score 2) with lower incidence than BARI Mash-3 (severity score 3). Regarding YMV, BM-42 and BM-63 were moderately susceptible, while BM-4 and BARI Mash-3 were susceptible with higher severity (score 7). Finally, BM-63 consistently exhibited better resistance across the tested diseases, indicating its potential for further breeding programme.

Evaluation of different formulation of *Trichoderma* based biofungicide

An experiment was conducted to evaluate two formulations of *Trichoderma* based bio-fungicides: solid and powder formulation against major diseases of tomato, chilli, and cucumber. For the solid formulation, sterilized chickpea bran was inoculated with *Trichoderma* discs and incubated for one month, whereas for the powder formulation, *Trichoderma* biomass from potato dextrose broth was blended with talc and air-dried. Field evaluation was carried out at BINA HQ during the Rabi season of 2024–25 in RCBD design with three replications. The solid formulation (50 g/m²) was applied to soil at three days prior to transplanting, while the powder formulation (10 g/L) was sprayed twice at post-transplanting. Results showed that both formulations suppressed tomato and chilli root rot. Powder formulation achieved 100% reduction of tomato late blight and chilli anthracnose, whereas solid formulation achieved 45.4% and 68.4% reduction, respectively. In cucumber, solid formulation fully suppressed root rot, while powder formulation reduced it by 50%.

Characterization of different isolates of *Trichoderma* and their evaluation against soil borne disease

Ten *Trichoderma* isolates were molecularly characterized and evaluated for their efficacy against *Sclerotium rolfsii*, the causal agent of root rot disease. Dual culture assays revealed substantial inhibitory effects, with mycelial growth inhibition ranging from 74–79%, the highest recorded by isolate BINA_Tri_iso_04 (79%). To further assess their potential under controlled conditions, pot experiments were conducted on brinjal and chilli seedlings. *Trichoderma* formulations were applied to sterilized soil prior to pathogen inoculation. Results indicated significant reductions in disease incidence, with brinjal showing 33.5–46.2% reduction and chilli 35.0–44.9% compared to untreated controls. Among the isolates, BINA_Tri_iso_01 achieved the greatest disease suppression in brinjal (46.2%), while BINA_Tri_iso_05 was most effective in chili (44.9%). These findings demonstrated the promising biocontrol potential of selected *Trichoderma* isolates, particularly BINA_Tri_iso_01, BINA_Tri_iso_04 and BINA_Tri_iso_05, for managing soil-borne diseases and supporting sustainable crop production systems.

Antagonistic activity of Trichoderma sp. against Fusarium oxysporum in rhizosphere of tomato triggers the expression of host defense genes

This study was aimed to investigate the antagonistic potential of *Trichoderma asperellum* against *Fusarium oxysporum f. sp. lycopersici* in the tomato rhizosphere and its impact on host defense gene expression. In greenhouse trials, four treatments- Control (T_0), *Trichoderma* (T_1), *Fusarium* (T_2), and *Trichoderma* + *Fusarium* (T_3) were evaluated for disease incidence, severity, and yield. T_1 significantly reduced disease incidence (10.2–12.38%) and severity (score 2–3), resulting in the highest yield (up to 1.4 kg/ha). In contrast, T_3 showed the highest disease incidence (25.84%) and lowest yield (0.6–0.7 kg/ha), suggesting antagonism was less effective under artificial inoculation. In vitro assays confirmed strong suppression of *F. oxysporum* growth by *T. asperellum*, achieving 90% inhibition within 48 h. Gene expression analysis revealed that defense-related genes (*PAL, PR4, CH5*) were strongly induced under *Trichoderma+Fusarium* treatment, with *PAL* consistently active and *CH5* showing a dramatic surge at 72 h. These findings highlighted *Trichoderma*'s dual role in suppressing *Fusarium* and priming tomato defense pathways, underscoring its potential as a bio-control agent for sustainable disease management in tomato cultivation.

Management of Stemphylium Blight Disease in Lentil

An experiment was carried out at BINA Sub-station, Magura during Rabi 2023–24 to evaluate chemical fungicides and bio-control agents for managing Stemphylium blight disease in lentil. Treatments included Amister Top 325SC (200 g/l azoxystrobin + 125 g/l difenoconazole), Filia 525SE (propiconazole 12.5% + tricyclazole 40%), Rovral 80WP, Curzate M-45, along with *Trichoderma asperellum*, Bioderma, Dynamic (*Bacillus*), *Bacillus subtilis*, and *Pseudomonas fluorescens*. Disease incidence and severity were assessed under natural field conditions using a 0–5 scale. Significant differences were observed among treatments for disease parameters and yield. The untreated control exhibited the highest disease incidence (90%) and severity (4.87) with the lowest seed yield (0.86 t/ha). Filia (26.67%) and Amister Top (28.33%) recorded the lowest disease incidence and severity (2.93), producing the highest yields (2.31 and 2.24 t/ha). Rovral also reduced incidence to 30% and yield 2.05 t/ha. Among bio-control agents, *P. fluorescens* and Bioderma moderately suppressed disease and improved yield. But, Amister Top and Filia proved most effective, significantly reducing disease severity and enhancing yield under field conditions.

Assessing the Status of Rice Bakanae Disease in Bakanae Prone Areas in Bangladesh

To evaluate the status of rice bakanae disease in bakanae-prone areas of Bangladesh, focusing on Cumilla, Sunamganj, Kishoreganj, Netrokona, Habiganj, Moulvibazar, Sylhet, Noakhali, Brahmanbaria and Mymensingh districts. In the current phase, samples were collected from Mymensingh district across three upazilas such as Tarakanda, Gauripur, and Sadar covering three farmer's fields per location. Disease incidence varied widely, ranging from 1.32% to 50.00%. Farmers' fields exhibited notably higher infection rates (5.35–50.00%) compared to research fields (1.32–2.38%) with the highest incidence observed in Hatshira (50.00%) in BINA dhan25. Infection levels in BINA dhan25 were inconsistent, with infected plants per hill reaching up to 72.22% in some fields. Cropping patterns such as T. Aman–Boro and T. Aman–Mustard–Boro were associated with varying infection intensities. Samples have been preserved at –20°C for subsequent pathogen isolation and characterization. Additional surveys across other districts

will be conducted in the upcoming Aman season to generate a comprehensive status report on bakanae disease in Bangladesh.

In-vitro evaluation of some chemical fungicides against *Alternaria* sp.

An *in vitro* study was conducted to evaluate the efficacy of 15 chemical fungicides against *Alternaria* sp., the causal agent of mustard leaf blight, using the poison food technique under a completely randomized design with three replications. The tested fungicides included Rovral 50WP (Iprodione 50%), Amister Top 325SC (250g/L Azoxystrobin + 125gm/L Difenoconazole), Oxicob 50WG (88% copper oxychloride), Contaf 5EC (Hexaconazole), Tilt 250EC (Propiconazole), Curzate (64% mancozeb + 8% Cymoxanil), Acibin 28 SC (20% Azoxystrobin + 8% Ciproconazole), Orgazim Plus 50WP (Iprodione 25% + Carbendazim 25% WP), Cabrio Top (5% pyraclostrobin + 55% Metiram), Nativo 75 WG (Trifloxystrobin and tebuconazole), Nemispore 80 WP (Mancozeb), Autostin 50WP (Carbandazim), Score (Difenoconazol), Companion (Mancozeb 63% + Carbendazim 12% WP)), and Trooper 75 WP (Tricyclazole) at four concentrations (0.025, 0.05, 0.1, and 0.2%). The most virulent isolate (Mym-1) was cultured on PDA plates, and radial mycelial growth was measured after 10 days. Fungicides Tilt, Acibin, Nativo, and Score completely inhibited mycelial growth even at the lowest concentration (0.025%), demonstrating their high antifungal activity. Other fungicides showed variable inhibition depending on concentration. The results suggested that these fungicides, particularly Tilt, Acibin, Nativo, and Score had strong potential for managing *Alternaria* leaf blight in mustard.

Field evaluation of selected chemical fungicides for controlling Alternaria blight of mustard

A field experiment was conducted to evaluate the efficacy of seven chemical fungicides against Alternaria blight of mustard. The fungicides tested were Amistar Top 325 SC (azoxystrobin 200 g/L + difenoconazole 125 g/L), Tilt 250 EC (propiconazole), Acibin 28 SC (azoxystrobin 20% + cyproconazole 8%), Nativo 75 WG (trifloxystrobin + tebuconazole), Score 25 EC (difenoconazole), Rovral 50 WP (iprodione 50%), and Contaf 5 EC (hexaconazole). These fungicides were selected based on prior in vitro screening using the poison food technique. The field trial was conducted at the BINA Headquarters Farm, Mymensingh, following a randomized complete block design (RCBD) with three replications. Each experimental unit had a plot size of 2.0 m × 1.0 m. The mustard variety *Binasarisha-11* was used, and disease severity was assessed using a 0–5 disease rating scale. Disease incidence reached 100% in all treatments, indicating uniform disease pressure. However, significant variation was observed in disease severity. Among the tested fungicides, Acibin 28 SC, Nativo 75 WG, Rovral 50 WP, and Amistar Top 325 SC were the most effective in reducing disease severity, with no statistically significant differences among them. Numerically, Acibin 28 SC recorded the lowest disease severity, with 22.26% on leaves and 25.86% on siliquae, followed by Rovral 50 WP, Nativo 75 WG, and Amistar Top 325 SC. In terms of yield performance, Nativo 75 WG produced the highest seed yield, followed by Acibin 28 SC, Rovral 50 WP, and Amistar Top 325 SC. Overall, the results indicate that these fungicides, particularly Acibin 28 SC and Nativo 75 WG, are effective options for managing Alternaria blight of mustard under field conditions.

Management of total aflatoxin concentration in groundnut and cashew nut using gamma irradiation

Aflatoxins, toxic metabolites produced mainly by *Aspergillus flavus* and *A. niger*, poses serious health risks in stored groundnuts and cashewnuts. This study assessed the effect of gamma irradiation at doses of 1, 2, 4, 6, 8, and 10 KGy on total aflatoxin concentration in raw and roasted samples collected from Mymensingh markets. Aflatoxin levels were measured using ELISA immediately after 4 days at 25^0C and after 3 months at 4°C storage. Results showed a significant reduction of aflatoxin with increasing radiation dose in both nuts. Raw samples generally exhibited greater toxin reduction than roasted ones. Lower storage temperature (4°C) with longer duration led to more stable and consistent decreases in aflatoxin compared to the moderate reductions observed at 25°C after 4 days. The highest dose (10 KGy) consistently achieved the greatest aflatoxin decline, lowering contamination below FDA acceptable limits in many cases. These findings demonstrated that gamma irradiation could effectively reduce aflatoxin levels in groundnut and cashew nut with enhancing nut safety for consumption.

Diagnosis of Plant Diseases using AI-based Software in Bangladesh

Plant diseases and pests are significant constraints to agricultural productivity in Bangladesh, often causing substantial economic losses. To address the limitations of conventional disease diagnosis typically slow, expert-dependent, and resource-intensive an artificial intelligence (AI)-powered software was developed for accurate and timely identification of diseases and insect pests in rice, brinjal, potato, wheat, maize, and chilli. The software incorporates a bilingual interface (Bangla and English), real-time image-based detection, and management recommendations tailored to specific crop-pathogen interactions. By June 2025, the software demonstrated high diagnostic accuracy, covering 17 diseases and 8 major insect pests using a dataset of over 20,000 images. The system offers practical benefits such as early warning alerts, reduced pesticide misuse, improved decision-making, and increased adaptive capacity to climate variability, thereby supporting environmentally sustainable crop protection strategies

Development and Implementation of a Digital Field Data Collection Notebook: Enhancing Efficient Research and Data Management

Efficient and accurate data collection is essential for reliable agricultural research. A mobile-based digital data collection platform, known as the BINA Notebook, was developed to replace traditional manual entry systems for field experimentation. This system comprises a mobile application for field data collectors and a web-based administrative dashboard, enabling real-time or offline data entry, user-linked traceability, automated validation, and structured submission workflows. Enhanced transparency, supervisory control, and feedback integration have significantly improved the quality, accuracy, and timeliness of research data. The implementation of this digital notebook has streamlined agricultural research operations, reduced human error, and provided a scalable solution for managing large datasets in multi-location field trials.

Antagonistic mechanism of *Pseudomonas fluorescens* against bacterial blight disease

This study aimed to characterize a virulent strain of *Xanthomonas oryzae pv oryzae* (*Xoo)* causing bacterial leaf blight of rice and explore biological management using endophytic bacteria isolated from rice plants. The *Xoo* isolate was initially characterized morphologically on NBY

media, confirmed as virulent through pathogenicity testing, and later identified at the molecular level. Five endophytic bacterial isolates with antagonistic activity were screened, among which BDIso-6A showed the highest inhibition (84%) and demonstrated strong plant growth-promoting traits, including IAA production, phosphate solubilization, siderophore and HCN production, and ammonia synthesis BDIso-6A, identified as *Pseudomonas fluorescens* (Accession No. PV602348.1), was evaluated for its biocontrol potential through seed priming (T1), seedling priming (T2), and foliar spray (T3) in both susceptible (IR-24) and resistant (Binadhan-17) rice varieties. Seed priming with BDIso-6A significantly upregulated defense-related genes *OsPAL1* (19.24-fold), *OsWRKY45* (17.92-fold), *OsPR1a* (11.54-fold), and OsPR10a (9.00-fold) and enhanced antioxidant enzyme activity: POD (93.25%), SOD (334.51%), APX (207.84%), PPO (413.64%), while reducing MDA content by 62.54%. BDIso-6A treatment reduced BLB incidence by 33.33% and disease index by 24.00%, while significantly improving vegetative growth and yield traits, including 1000-grain weight (26.21%), root length (39.61%), and shoot length (21.35%). Overall, *P. fluorescens* BDIso-6A showed strong potential as a biological alternative to chemical control of BLB in rice.

Phenotypic and molecular screening of mutants/advanced lines of rice against blast disease

This study conducted to screen cultivable and IRRI-provided rice lines for blast (*Magnaporthe oryzae*) resistance genes using molecular markers and to assess their resistance phenotypically. Thirty (30) rice genotypes were screened for four major blast-resistant genes (*Pi9, Pi-54, Pish*, and *Pita-2*) using gene-based molecular markers (RM276, RM206, RM302, and RM155) at the Plant Pathology Division, BINA. Out of 30 studied rice genotypes, 21 were identified as carriers of the *Pi9* gene, while 21 genotypes possessed the *Pita-2* gene and 2 carried the Pish gene. Notably, only 2 genotypes were found to contain the Pish genes, indicating their rarity within the sample The genetic frequencies of 2 blast resistant genes ranged from 6.67% to 70%. The resistant gene Pi9 and pita-2 were widely distributed (70%) among the selected genotypes. Based on the phenotypic resistance screening, 3 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 BRRI dhan75, which combined three resistance genes (*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 can be concluded that advanced line BN-P-102 and indigenous cultivar Sete Pajam-2 will be promising candidates for developing the resistant variety against blast disease of rice. In addition, the AUDPC result indicates that control measures should be taken as soon as disease occurs in the field.

Evaluation of rice mutant lines and local germplasms against bacterial blight disease and detection of resistant genes using molecular marker

Among the rice diseases, bacterial blight (BB) caused by *Xanthomonas oryzae pv. oryzae* (*Xoo*) is one of the oldest and most devastating diseases in Bangladesh. But till now there is no

effective highly resistant variety developed against this disease in Bangladesh. Owing to that, molecular-phenotypic screening and allelic diversity of 3 major BB resistant genes (*xa13, Xa21, and Xa23*) were determined in 30 rice genotypes with 3 previously synthesized gene based molecular markers (*Xa13*Prom, *pTA248*, and *03STS1*) at Plant Pathology Division, Bangladesh Institute of Nuclear Agriculture, Mymensingh from June 2023 to August 2024. Out of 30 studied rice genotypes only 1 cultivated variety (BRRI Dhan-101**)** and 1 advance line (RH-18) contain the *Xa21*. Based on the phenotypic resistance screening, 12 genotypes showed resistance (R), 12 genotypes showed moderately resistance (MR), 6 genotypes showed moderately susceptible (MS). Notably, the *Xa4+xa5* combination was found in 23 genotypes with moderately resistance to resistance phenotypic responses, while *Xa4+Xa21* was found in 1 cultivated variety (BRRI Dhan-101) exhibiting resistance reaction. The *Xa4+xa5+xa13* gene combination was found in 1 advanced line (BLB-P-003) displaying highly resistance. Combining two or more BB resistant genes was more effective in providing resistance against *Xoo* compared to a single resistant gene found in this study. The study using the area under disease progress curve (AUDPC) method demonstrated a rapid progression of BB disease in the studied rice genotypes with resistant genes over 21 days, with symptoms appearing in 16.29% of plants by 7 days after inoculation (DAI), 25.56% of plants affected by 14 DAI, and near 30% affected by 21 DAI, showing an initial rapid spread followed by a slower rate of progression. It can be concluded that advanced line RH-18 and cultivated variety BRRI dhan101 will be promising candidates for developing the resistant variety against BB disease of rice in Bangladesh. In addition, the AUDPC result indicates that control measures should be taken as soon as disease symptom appears in the field.

Phenotypic and *QTL* based screening of mutants/advanced lines of rice against sheath blight disease

A study was aimed to screen out the presence of resistant gene(s) in IRRI-provided advanced lines and cultivated rice varieties using allele mining through *QTL*s based molecular markers to sheath blight resistant genes and to assess the resistance performance of sheath blight resistant gene(s) containing rice genotypes through phenotypic screening. The experiment was conducted in the laboratory of plant pathology division and research field at Bangladesh Institute of Nuclear Agriculture (BINA). Resistance screening targeted *qSBR11-2* and qSBR7-1 using molecular markers RM209 and RM336, revealing distinct amplicons (150 by and 200 bp, respectively). This study employed molecular and phenotypic approaches to identify resistant genotypes among 27 rice lines. Molecular screening targeted QTLs *qSBR11-2* (RM209) and qSBR7-1 (RM336). The qSBR11-2 gene was detected in four advanced lines (RH-18, RH-22, RH-23, HR-14) and one cultivated variety (BRRI dhan62). The *qSBR7-1* gene was identified in 10 advanced lines, including RH-18, RH-23, and HR-14, and in BRRI dhan62. Both genes were present in BRRI dhan62. Phenotypic resistance screening revealed that seven genotypes (BN-P318, BRRI dhan62, BRRI dhan75, HR-10, HR-11, HR-13, HR-14) exhibited moderate resistance (MR) at 7 days after inoculation (DAI). The HR-14 mutant line maintained MR at 14 DAI, suggesting its potential as a genetic source of ShB resistance. AUDPC analysis indicated rapid disease progression, with symptoms appearing in 49.79% of plants by 7 DAI, rising above 50% by 14 DAI. The findings highlight the importance of early intervention when symptoms first appear and emphasize HR-14 as a promising candidate for resistance breeding programs.

Isolation and variation in virulence of single-spore isolates of Plasmodiophora brassicae causing clubroot disease in mustard

The present experiment was conducted to develop a reliable technique for isolating single spores of *Plasmodiophora brassicae* causing clubroot disease and to assess the variation in virulence among isolates collected from different infected mustard fields. By studying single-spore isolates, researchers aimed to uncover the pathogenic diversity within field populations of *P. brassicae*, which is critical for understanding disease dynamics and for guiding breeding and management strategies. Molecular confirmation of the pathogen was conducted using species-specific primers *Pb18sF* (5'-AAACAACGAGTCAGCTTGAATGC-3') and *Pb18sR* (5'-AGGACTTGGCTGCG GATCAC-3'), targeting a conserved region to ensure accuracy of identification. As a result of the study, an efficient inoculation protocol was established, allowing the controlled infection of mustard seedlings with single-spore suspensions. The susceptible varieties BARI sarisha-18 and BINA sarisha11 showed characteristic root galling, validating the effectiveness of the inoculation method. Resting spores were successfully stained with Evans blue for microscopic visualization, aiding in the identification and handling of individual spores. Molecular detection through PCR produced the expected ~200 bp amplicon in a 1.5% agarose gel, confirming the presence of *P. brassicae* in the infected tissue samples. Additionally, a reproducible protocol was developed for the isolation of single spores, providing a foundation for future genetic and virulence studies. The output of this research contributes significantly to understanding the pathogenic variability of *P. brassicae* populations infecting mustard in Bangladesh. It highlights the importance of studying single-spore isolates for identifying aggressive strains that may overcome existing host resistance. This knowledge can be utilized to predict potential disease outbreaks, guide the deployment of resistant varieties, and improve integrated management practices. Ultimately, the experiment paves the way for more targeted and sustainable solutions to combat clubroot disease in mustard crops.

ENTOMOLOGY DIVISION

Eco-friendly management approaches against fall armyworm of maize

A field experiment was conducted to evaluate the effectiveness of two bio-rational, one microbial organic and three synthetic insecticides against fall armyworm (FAW) of maize. The experiment was laid out at BINA farm, Mymensingh during the khaif-I season of 2025, following a randomized complete block design with three replications. The treatments were: T_1 = Seed treatment with tetraniliprole 200 SC (Vaego) + army-lure + spinosad 45 SC (Tracer) and chlorantraniliprole 18.5 SC (Coragen); T_2 = Seed treatment with tetraniliprole 200 SC + army-lure + spinosad 45 SC (Tracer) and spinetoram 11.7 SC (Delegate); T_3 = Seed treatment with tetraniliprole 200 SC + army-lure + spinosad 45 SC (Tracer) and isocycloseram 20 SC (Incipio); T_4 = Seed treatment with tetraniliprole 200 SC + army-lure + Bacillus thuringiensis (Bt) and chlorantraniliprole 18.5 SC (Coragen); T_5 = Seed treatment with tetraniliprole 200 SC + army-lure + Bt and spinetoram 11.7 SC (Delegate); T_6 = Seed treatment with tetraniliprole 200 SC + army-lure + Bt and isocycloseram 20 SC (Incipio); and T_7 = Untreated control. Insecticides were applied at 15, 23, 36, and 47 days after sowing. Data on FAW plant and cob infestation were collected at 10 days after application and analyzed using R software. Results revealed that the lowest cumulative plant infestation (26.23%) occurred in T_2, representing a 12.57% reduction over the untreated control. Similarly, T_2 recorded the lowest cob infestation (19.94%), with a 39.78% reduction over control. Yield performance was highest (4.42 t ha^{-1}) in T_5, followed by T_2. Based on infestation reduction and yield outcomes, T_2 (tetraniliprole 200 SC + army-lure + spinosad 45 SC + spinetoram 11.7 SC) demonstrated strong potential as a bio-rational and eco-friendly management option for sustainable control of FAW in maize.

Evaluation of some new insecticides against Brown Plant Hopper

A field experiment was conducted at BINA farm, Mymensingh during the 2024–25 cropping season to evaluate new insecticides for the management of brown planthopper (BPH under natural infestation conditions. Insecticide samples supplied by respective companies were forwarded by the Sub-Committee for Pesticide Testing and Registration (Sub-PTAC) to the Entomology Division, BINA for testing. The experiment was laid out in a randomized complete block design with three replications, and insecticides were applied at company-recommended doses. The treatments were: T_1 = Safeguard 5 WDG (Emamectin benzoate 5% w/w) @ 1.0 kg/ha; T_2 = Naptune 80 WDG (Nitenpyram 20% + Pymetrozine 60% w/w) @ 60 g/ha; T_3 = Spider 5 GR (Clothianidin 5% w/w) @ 52.47 kg/ha; T_4 = X-Furan 5 GR (Clothianidin 5% w/w) @ 28 kg/ha; and T_5 = KBS Experts 80 WDG (Nitenpyram 20% + Pymetrozine 60% w/w) @ 60 g/ha. Mortality of BPH was recorded at 24 hours after treatment (24 HAT) and 48 hours after treatment (48 HAT), and mean values were calculated across replications. The results indicated that all insecticides exhibited different levels of mortality and were found effective against BPH. The results of the field trials were submitted to Sub-PTAC for further consideration in the pesticide registration process.

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

A field experiment was conducted at BINA farm, Mymensingh during the Kharif-I season of 2024–25 to develop a bio-rational pest management approach against cucurbit fruit fly

(*Bactrocera cucurbitae*) in bitter gourd. The experiment was arranged in a randomized complete block design (RCBD) with three replications and six treatments: T_1 = Attract and kill trap (individual); T_2 = Attract and kill trap + Azadirachtin 0.1% (Fytomax); T_3 = Attract and kill trap + (Chlorfenapyr + Emamectin benzoate); T_4 = Attract and kill trap + Emamectin benzoate (Suspend 5 SG); T_5 = Pheromone-impregnated yellow sticky trap; and T_6 = Untreated control. Standard agronomic practices were followed, and insecticides were applied at 60 days after transplanting. Data were collected on total and infested fruits, number and weight of healthy marketable fruits, and fruit fly catches in traps, with percent infestation and reduction over control calculated and analyzed using R software. Results revealed that Attract and kill trap + Azadirachtin 0.1% (T_2) recorded the lowest fruit infestation, with a 78.05% reduction over the untreated control, followed by Attract and kill trap + (Chlorfenapyr + Emamectin benzoate) (T_3), which showed a 49.82% reduction over control. The highest fruit infestation was observed in the untreated control (T_6). In terms of yield performance, Attract and kill trap + Emamectin benzoate (T_4) produced the highest cumulative marketable yield (6.93 t/ha) followed by Attract and kill trap + (Chlorfenapyr + Emamectin benzoate) (T_3) with 5.68 t/ha. These findings demonstrate that integrating attract and kill traps with bio-rational insecticides particularly Azadirachtin and Emamectin benzoate, provides an effective and eco-friendly management strategy against cucurbit fruit fly in bitter gourd.

Effect of gamma irradiation on sterility of cucurbit fruit fly

An experiment was conducted from March to June 2025 in the growth room of the Entomology Division, BINA to confirm the previous year's findings on the effect of gamma radiation doses on the sterility of cucurbit fruit fly. The pupae of cucurbit fruit fly were irradiated with 30 Gy, 40 Gy and compared with unirradiated pupae (0 Gy control). The study was laid out with three replications, 50 pupae per replication for each treatment. Adult emergence percentage was recorded and for sterility testing, irradiated and normal adults were paired (15 irradiated males × 15 normal females for 30 Gy and 40 Gy, and 15 normal males × 15 normal females as control) in replicated cages. Sliced sweet gourds were supplied as an oviposition medium and the presence of larvae in the F_1 generation was examined. Adult emergence from pupae was almost similar to normal and irradiated pupae. Larvae only emerged at 0 Gy in the F_1 generation. There were no larval emergences at 30 and 40 Gy, which revealed that 30 and 40 Gy of irradiation to pupae was found to induce sterility of the cucurbit fruit fly

Determination of radiation dose to control red flour beetle in storage

An experiment was conducted during 2024–25 at the Entomology Laboratory, BINA, Mymensingh to determine the effective gamma irradiation dose to control red flour beetle. The stock colony was maintained on cashewnut under controlled conditions and the experiment was laid out in a completely randomized design (CRD) with five replications. The treatments consisted of eight irradiation doses: 300, 350, 400, 450, 500, 550, 600, and 700 Gy, along with an untreated control. Larvae, pupae and adults (30 larvae, 20 pupae and 30 adults per replication) were exposed to irradiation from a gamma source. Alive beetles were recorded at 2, 4, 7, 9, 11, and 13 days after irradiation. Results revealed that after 2 days of irradiation, the lowest survival was observed at 700 Gy (31.6 beetles), followed by 600 Gy and 550 Gy, while the highest survival (35.6 beetles) was recorded in untreated control. At 4 days, survival remained lowest at

700 Gy (24.2 beetles) which was statistically similar to 600 Gy, whereas the control recorded 37.6 beetles. By 7 days after irradiation, no live beetles were detected at 700 Gy and survival at 600 Gy was also significantly reduced. Complete mortality was observed at 600 Gy by 9 days, which was statistically similar to 550, 500 and 450 Gy. At 11 days, live beetles were recorded only at the lower doses (300, 350 and 400 Gy), while by 13 days, no beetles were alive in any irradiation dose except the untreated control, which continued to show an increasing number of live beetles. The findings confirmed that 700 Gy of gamma irradiation killed all developmental stages of the red flour beetle within 7 days of irradiation.

Screening of advanced rice lines against major insect pests in the field

An experiment was conducted at BINA Farm, Mymensingh during the Boro season of 2024–25 to observe the reaction of advanced rice lines against major insect pests under natural field conditions. The study was laid out in a randomized complete block design (RCBD) with three replications. The unit plot size was 4 m × 2 m, and transplanting was done on 23 January 2025. The treatments included nine advanced rice lines (N4-17-8, BN-P-120, N4-17-6, N4-17-4, BLB-P-42, BN-P-114, IIRON-5, BN-HR-26, and BN-HR-28) along with a susceptible check variety, TN1. No protective measures were applied to control insect pests. Data on dead heart incidence were recorded at 45 days after transplanting, while white head incidence was recorded 10 days before harvest. Results indicated that no major insect pests were observed during the experimental period except for yellow stem borer. No dead heart symptoms were recorded at the tillering stage. Minor differences in white head incidence were observed among the tested lines and the check variety, ranging from 0.18% to 1.06%, which were well below the economic threshold level (ETL: 10–15% for dead hearts and 5% for white heads).

Screening of IRSBN rice lines against rice stem borer

An experiment was conducted in collaboration with the Plant Breeding Division at BINA Farm, Mymensingh during the Aman season of 2024 to evaluate the reaction of advanced rice lines against stem borer. The study was laid out in a randomized complete block design (RCBD) with three replications. The treatments included three advanced rice lines (IRSBN-4, IRSBN-1 and T-21-6) along with a check variety, BRRI dhan87. No protective measures were applied to control insect pests. Dead heart incidence was recorded at 45 days after transplanting, and white head incidence was recorded 10 days before harvest. No dead heart symptoms were found during the tilleringstage in advanced line IRSBN-1 and very small differences, ranges from (0.36% to 1.53%) were observed among the two tested lines and one check variety of rice. In respect of white head symptom, no infestation was observed among the tested lines and check variety except IRSBN-1. All the infestations were below the economic threshold level. (ETL: 10-15% for dead hearts, 5% for white head).

Screening of soybean lines against major insect pests

A field experiment was conducted at BINA Farm, Mymensingh during the Kharif-II season of 2024 to evaluate five soybean lines (SCM-5, SCM-11, SCM-17, SBM-22, SBM-23) and one check variety (Binasoybean-5) against major insect pests, including jassid, whitefly, aphid, leaf roller and pod borer, under naturally infested conditions. The study was laid out in a randomized complete block design with three replications. Data were recorded on five randomly selected plants per plot from the vegetative stage to harvesting. Results indicated that no jassid infestation

was observed in any of the tested lines, while the check variety Binasoybean-5 showed minimal infestation (2.26%). Whitefly infestation was highest in SCM-5 (8.62%) and SCM-11 (6.57%), whereas Binasoybean-5 remained free from infestation. Aphid incidence was lowest in SCM-17 (9.08%), statistically similar to SBM-22 (12.03%) and SCM-11 (12.74%), while the highest aphid infestation occurred in SCM-5 (28.05%) followed by Binasoybean-5 (20.37%). Leaf roller infestation ranged from 4.17% (SBM-22) to 12.97% (SCM-17) with no significant differences. Very little infestation by pod borer was observed in the lines and check variety and there were no statistically significant differences among them.

Screening of advanced groundnut lines against some major insect pests

A field experiment was conducted during the Rabi season of 2024–25 at BINA Substation, Rangpur to evaluate the performance of advanced groundnut lines against major insect pests. The experiment was laid out in a randomized complete block design (RCBD) with three replications, unit plot size of 3 m × 2 m and line-to-line spacing of 30 cm. Four advanced groundnut lines (BCB 3-4-5, BCB 3-1-2, BCB 3-4-1, BCB 3-4-3) and a check variety (Binachinabadam-4) were assessed for jassid, hairy caterpillar, cutworm, leaf roller and pod borer under natural infestation, without any protective measures. Data were recorded on five representative plants per plot from the vegetative to reproductive stages. Results showed no significant differences between the lines and the check variety for jassid, leaf roller and pod borer infestations. The highest infestation by cutworm was observed in BCB 3-1-2 (7.14%). No significant differences were observed between BCB 3-1-2 (7.14%) and BCB 3-4-5 (6.93%) in respect of leaf infested by cutworm but statistically significant with BCB 3-4-3 (4.67%), BCB 3-4-1(5.8%) and Binachinabadam-4 (5.91%). Hairy caterpillar infestation was highest in the check variety Binachinabadam-4 (6.70%) followed by BCB 3-1-2 (5.44%) and the lowest infestation was found in BCB 3-4-3 (3.61%) and BCB 3-4-5 (4.32%).

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

A field experiment was conducted at BINA Substation, Ishurdi during Kharif-I 2025 to evaluate the performance of an advanced mungbean mutant (MBM-656-51-2) and a check variety (BARI Mung-6) against major insect pests under natural infestation. The study was laid out in a randomized complete block design (RCBD) with three replications and the unit plot size was 3 m × 4 m. Recommended fertilizers and normal cultural practices were applied. Data on jassid, whitefly, hairy caterpillar, leaf roller, thrips, pod borer and yield were recorded from five representative plants per plot from the vegetative stage to harvest. Results showed that jassid infestation was higher in BARI Mung-6 (6.30) than in MBM-656-51-2 (4.17). No significant differences were observed in whitefly and leaf roller infestation. Hairy caterpillar infestation was higher in MBM-656-51-2 (9.63%) than in BARI Mung-6 (7.55%). The mutant MBM-656-51-2 significantly differed and performed better than the check variety (BARI Mung-6) in respect of percent inflorescence infested by thrips (8.9%) and percent pod infested by pod borer (7.51%).

AGRICULTURAL ENGINEERING DIVISION

Future climate scenario and its impact on hydrologic components

Understanding and estimating regional climate change under different anthropogenic emission scenarios is pivotal for informing societal adaptation and mitigation measures. Global Climate Models (GCMs) allow the behaviour of the climate to be simulated under various conditions (e.g., different atmospheric greenhouse gas). Climate models can inform policymakers with information and evidence to start making well-informed decisions about future environmental actions. The objectives were: (1) To predict climate change using Global Climate Model, and (2) 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 (1985-2014). The models were categorized based on the indicators and validation efficiency (data of 2015-2022). Based on the performance of 35 models, the top 3 models were selected and used for predicting the future scenario of rainfall and mean temperature (monthly data). This study was made for Dinajpur, Cumilla, Khulna, and Rangamati region. The hydrological parameters such as ET_0, PET, runoff, recharge, and drought indices (e.g., Aridity index, Water availability index) were calculated using predicted climatic data. The Dinajpur region shows a lower temperature than the other regions, and the second lowest rainfall amount (after Rajshahi). Here, the temperature of cold months (Nov.-Jan.) as well as hot months (April, September) show an increasing trend towards the temporal scale. Dinajpur, Khulna and Rangamati regions showed negative anomalies in the near future (2041-50). These negative anomalies would have implications for crop production as well as for water-balance. 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. Relatively more water deficit during dry period, and more water surplus during monsoon period are observed. The results urge for appropriate planning or preparedness for remedial measures.

Growing of BINA developed varieties for input data generation of Decision Support System (for climate change Studies)

Sustainable agriculture requires accurate data and predictive tools. The present study was undertaken to generate real-time input data by cultivating BINA (Bangladesh Institute of Nuclear Agriculture) developed crop varieties. This data will be integrated into a Decision Support System (DSS) designed to assess and adapt crop performance under different climate change scenarios. Objectives were: (1) To cultivate selected BINA-developed crop varieties under field conditions, (2) To generate agro-physiological, phenological, and yield data, (3) To support the development and validation of a DSS for climate-resilient agriculture, and (4) To analyze the adaptability and resilience of BINA varieties under varying weather conditions. The experiment was carried out at BINA HQ farm during Aman and Boro season of 2024-25. Treatments were: T_1= Normal /well irrigated, T_2= Deficit irrigation (3 days AWD for rice; irrigation at 60% depletion of available soil moisture for wheat). Data on plant height, panicle length, number of effective tillers/hill, number of grains and unfilled grains/panicle, and grain yield were taken from 10 randomly selected plants from each plot. Appropriate statistical analyses were performed for the comparison of the means of each character. The impact of climate change of newly developed varieties of BINA will be predicted by using Decision Support System for Agrotechnology Transfer (DSSAT 4.8). The calibration process involved adjusting genetic

coefficients within the model so that simulated outputs closely matched observed field performance, ensuring that the model could reliably replicate crop growth patterns and yield outcomes under local conditions. During Aman season, rainfall provides free irrigations. Application of AWD needs only in dry breaks before Panicle Initiation (PI) and keeping shallow water from PI to dough is important. According to our data, BINA dhan25 have the water saving capacity of 15% without yield sacrifice.

Performance Evaluation of Low-Cost Grain Dryer Developed by BINA

Post-harvest grain losses remain a significant challenge for small and medium-scale farmers in Bangladesh, largely due to inefficient drying methods. To address this, the BINA Portable Grain Dryer was evaluated at BINA HQ, Mymensingh, to assess its technical performance, efficiency and economic feasibility. A batch of 200 kg of freshly harvested paddy with an initial moisture content of 17% was dried using the LPG-powered dryer for 4 hours. Heated air was circulated through forced convection, maintaining an average grain bed temperature of 35 °C, which ensured uniform drying without compromising grain quality. By the end of the cycle, the moisture content was successfully reduced to 12%, removing a total of 11.4 kg of moisture at a moisture removal rate of 2.85 kg h^{-1}. The system achieved an effective drying capacity of 50.31 kg h^{-1} with minimal drying loss (0.105%). Fuel consumption was low, requiring only 1.51 kg of LPG over the 4-hour session. The operating cost was Tk 0.75 kg^{-1}, making the system cost-competitive compared to conventional drying methods. These findings demonstrate that the BINA Portable Grain Dryer is a technically efficient, cost-effective, and farmer-friendly solution capable of reducing post-harvest losses, improving grain quality, and enhancing storage stability. Wider deployment, coupled with farmer training and potential development of hybrid or solar-assisted models, could significantly contribute to sustainable grain management and national food security.

Effects of Biochar in soil moisture conversation and water use efficiency

Efficient water management is crucial for sustainable wheat production under water-scarce conditions. A field experiment was conducted at the BINA HQ farm during 2024–25 to evaluate the effect of biochar application on irrigation water savings and water use efficiency (WUE) of BARI Gom-32. The experiment was laid out in a randomized complete block design with three replications and six treatments: T_0 (control), T_1 (biochar without irrigation), T_2 (biochar + irrigation at crown root initiation [CRI]), T_3 (no biochar + irrigation at CRI), T_4 (biochar + irrigation at CRI + maximum tillering), and T_5 (no biochar + irrigation at CRI + maximum tillering). Results revealed that T_2 produced the highest grain yield (3.93 t ha^{-1}), demonstrating that a single irrigation at CRI with biochar application is sufficient to achieve maximum productivity while reducing irrigation water use. Remarkably, T_1 (biochar without irrigation) achieved a moderate yield (3.67 t ha^{-1}), highlighting biochar's potential to improve soil moisture retention and sustain yields under moisture-limited conditions. Although T_4 enhanced several yield-attributing traits, it did not surpass T_2 in final grain yield, suggesting that additional irrigation may not always be beneficial. The findings underscore that biochar combined with a single irrigation at CRI stage offers an effective strategy for saving irrigation water, improving WUE, and maintaining high wheat yields, making it a promising practice for climate-resilient wheat production in Bangladesh.

System development/ establishment of drip irrigation for high value crops and Sprinkler irrigation for minor irrigated crops

This experiment was undertaken to develop and establish drip irrigation systems for high-value crops and sprinkler irrigation systems for minor irrigated crops. The primary goal was to enhance water use efficiency, reduce water loss, and improve crop productivity. The objectives were: i. to design and install drip irrigation systems suited for high-value crops (e.g., vegetables, fruits, spices), ii. to develop sprinkler irrigation systems appropriate for minor irrigated crops (e.g., pulses, oilseeds), iii. to compare water use, crop yield, and economic benefits of modern irrigation methods with conventional practices. The experiment was carried out at BINA HQ farm during 2024-25. High-value crops: capsicum and cucumber were chosen for drip irrigation. Minor crops: Sesame, mustard, and mung bean were selected for sprinkler irrigation. Both drip and sprinkler systems were set up. Using drip irrigation, water saving up to 40–50% compared to flood irrigation and increase in yield by 20–30% due to uniform moisture availability and reduced disease incidence. Use of sprinkler Irrigation ensures uniform water application and better saving of water, about 30%. It also improved germination and crop growth in minor crops. The experiment demonstrated the successful establishment of drip and sprinkler irrigation systems, showing significant advantages in terms of water use efficiency, yield improvement, and economic returns. Adoption of these systems can support sustainable agriculture, particularly in water-stressed regions.

Development of profitable cropping pattern using water saving technology at BINA HQ and its sub stations areas

Optimizing cropping patterns is essential for improving water use efficiency (WUE) and maximizing profitability under limited water availability. A field experiment was conducted at BINA HQ and BINA Sub-stations (Ishwardi and Magura) during 2024–25 to compare the productivity and profitability of the existing T. Aman–Mustard–Boro cropping sequence with a proposed T. Aman–Mustard–Sesame–T. Aus sequence under varying irrigation regimes. The experiment was laid out in a randomized complete block design with three replications on 10-decimal plots. Data on soil moisture dynamics, rainfall, and irrigation applications were recorded throughout the growing seasons, and economic analyses were performed using R software. Results revealed that the proposed pattern produced average yields of 5.74, 1.34, 1.04, and 4.80 t ha^{-1} for T. Aman, Mustard, Sesame, and T. Aus, respectively, whereas the existing pattern produced 5.74, 1.34, and 6.27 t ha^{-1} for T. Aman, Mustard, and Boro. Although Boro yield was higher than T. Aus, the overall system productivity of the proposed pattern, expressed in rice equivalent yield, was greater. Economic analysis showed that the proposed pattern generated a gross return of Tk. 876,620 ha^{-1}, a gross margin of Tk. 291,230 ha^{-1}, and a BCR of 1.50, which exceeded those of the existing pattern (BCR = 1.42). These findings suggest that T. Aman–Mustard–Sesame–T. Aus is a more profitable and water-efficient alternative to the conventional pattern, reducing irrigation water demand while improving system productivity and economic returns. Adoption of this pattern could enhance farm profitability and resource-use efficiency under similar agro-climatic conditions.

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 *[gas emission part is conducted and reported by Soil Sci. Division, BINA]*

Efficient water management is critical for sustainable rice production, particularly in the face of increasing global food demand and concerns over greenhouse gas emissions. A field experiment was conducted during the Boro season at a synchronized cropping area in Nokla, Sherpur to evaluate the effect of alternate wetting and drying (AWD) irrigation on grain yield, water use, and methane (CH_4) emission from rice fields. The experiment used Boro rice (SL8H Super Hybrid) and was laid out in a randomized complete block design with four replications and two irrigation treatments: T_1 = AWD (water added when the water level inside a perforated 25-cm pipe dropped by 15 cm) and T_2 = continuous flooding (farmer's practice). Standard fertilizer doses and agronomic management practices were followed. Results indicated that AWD significantly increased grain yield (6.46 t ha^{-1}) compared with continuous flooding (5.80 t ha^{-1}), corresponding to an 11.38% yield increase. AWD saved 15.9% irrigation water, requiring only 1210 L of water to produce 1 kg of rice compared to 1550 L under continuous flooding. Moreover, AWD plots matured 4–6 days earlier than non-AWD plots, potentially enabling timely planting of subsequent crops. The increased yield under AWD was likely due to improved tillering, enhanced soil aeration, and stimulated microbial activity, which accelerated nutrient mineralization. These findings confirm that AWD is a water-saving and climate-smart rice management practice, improving water productivity, enhancing yield, and reducing methane emissions, thereby contributing to sustainable rice production and environmental protection.

ADAPTIVE RESEARCH AND EXTENSION DIVISION

Block farming of BINA released aman rice varieties at Mymensingh and Kishoreganj

Block farming with BINA released aman rice varieties were conducted at the farmer's fields in two districts in collaborations with Department of Agricultural Extension (DAE) during aman season of 2024 to evaluate the performance at different areas for widening their adoption by the farmers. Area of each block was 10 bigha. Spacing between line-to-line and plant-to-plant was 20 cm and 15 cm, respectively. Fertilizers were applied as per recommendation. Transplanting dates ranged from July 16 to August 10, 2024 and age of seedlings were 20 to 25 days.

Based on the data of block farming plots, the average grain yields of Binadhan-11, Binadhan-17, Binadhan-20, and BINA dhan26 were 4.57, 5.93, 4.50, and 6.35 t ha^{-1}, with maturity periods of 117, 118, 126, and 116 days, respectively. Farmers of both districts were found keen to cultivate BINA released aman varieties.

Demonstration of BINA released aman rice varieties at Mymensingh and Kishoreganj

Field demonstrations with BINA released aman rice varieties were conducted at the farmer's fields in two districts in collaborations with DAE during aman season of 2024 to evaluate the performance at different areas for widening their adoption by the farmers. Area of each plot was 1 bigha. Spacing between line-to-line and plant-to-plant was 20 cm and 15 cm, respectively. Fertilizers were applied as per recommendation. Transplanting dates ranged from July 20 to August 20, 2024 and age of seedlings were 20 to 25 days.

Based on the data of demonstration plots the average grain yield of Binadhan-11, Binadhan-17, Binadhan-20, BINA dhan26 were 4.74, 6.05, 4.65, 6.44 t ha^{-1} with maturity period of 117, 117, 128, 116 days respectively. Farmers of both districts found keen interest to cultivate the varieties in upcoming years.

Adaptive trial of two mutants BN-P-114, BN-P-120 with BRRI dhan86 in farmers' field

Adaptive trials with two boro rice mutants BN-P-114 and BN-P-120 were conducted alongside the check variety BRRI dhan86 to evaluate their performance under field conditions during boro season of 2024-25. The trials were conducted farmers field at Kalikapur of sadar upazila, Mymensingh and arranged in RCBD design with three replications. Plot size was 5.0m x 6.0m with spacing between line-to-line and plant-to-plant was 20 cm and 15 cm, respectively. Fertilizers were applied as per recommendation. Thirty five days old seedlings were transplanted on 20 January 2025. Data on plant height, maturity, 1000-grain weight, and grain yield were recorded at harvest and analyzed.

The data from the 2024-25 Boro season performance of the rice mutants and check variety reveals that while **BN-P-120** and **BN-P-114** show similar plant heights (around 100 cm) and take approximately 148 days to mature, **BRRI dhan86** is slightly shorter and matures earlier, in 137 days. The 1000-grain weight varies moderately, with **BRRI dhan86** having the heaviest grains, followed by **BN-P-114**, and **BN-P-120** having the smallest grains. However, the most significant variation is observed in **grain yield**, where **BN-P-114** leads with the highest yield of 7.65 t ha^{-1}, followed closely by **BRRI dhan86** at 5.85 t/ha and **BN-P-120** at 5.75 t/ha. The coefficient of variation for grain yield is the highest (14.13%), suggesting a considerable level of variability in

yield performance, likely due to environmental and genetic factors. Overall, **BN-P-114** shows superior yield potential, while **BRRI dhan86** offers advantages in grain weight and early maturity, making it suitable for different agricultural priorities.

Block farming of BINA released boro rice varieties at Mymensingh and Kishoreganj

Block farming with BINA released boro rice varieties were conducted at the farmer's fields at two districts in collaborations with DAE during boro season of 2024 to evaluate the performance of this variety at different areas for widening its adoption by the farmers. Area of each plot was 5 bigha. Spacing between line-to-line and plant-to-plant was 20 cm and 20 cm, respectively. Fertilizers were applied as per recommendation. Transplanting dates ranged from 20 to 31 January 2025 and age of seedlings were 35 to 40 days.

Based on the data of block farming plots, the average grain yield of Binadhan-24 and BINA dhan25 were 6.34, 5.85 t ha^{-1} with maturity period of 142, 140 days ,respectively. Farmers of both districts found keen interest to cultivate the varieties in upcoming years.

Demonstration of BINA released boro rice variety at Mymensingh and Kishoreganj

Field demonstrations with BINA dhan25 was conducted at the farmer's fields of two districts in collaborations with DAE during boro season of 2024 to evaluate the performance of this variety at different areas for widening its adoption by the farmers. Area of each plot was 1 bigha. Spacing between line-to-line and plant-to-plant was 20 cm and 20 cm, respectively. Fertilizers were applied as per recommendation for BINA dhan25. Transplanting dates ranged from 25 December to 15 January 2025 and age of seedlings were 35 to 40 days.

Based on the data of 171 field demonstration plots, the average grain yield was 5.90 t ha^{-1} with maturity period of 140 days. Farmers of Mymensingh were found keen to cultivate BINA dhan25.

Demonstration of aus rice variety Binadhan-19 at Mymensingh and Kishoreganj

Field demonstrations with drought tolerant Binadhan-19 was conducted at the farmer's fields at two districts in collaborations with DAE during aus season of 2025 to evaluate the performance of this variety at different areas for widening its adoption by the farmers. Area of each plot was 1 bigha. Spacing between line-to-line and plant-to-plant was 20 cm and 15 cm, respectively. Fertilizers were applied as per recommendation for Binadhan-19. Transplanting dates ranged from 26 April to 10 May, 2025 and age of seedlings were 20 to 22 days.

Based on the data of 41 field demonstration plots the average grain yield was 4.13 t ha^{-1} with maturity period of 105 days. Farmers of both districts were found keen to cultivate Binadhan-19 in upcoming years.

Block farming of aus rice variety Binadhan-21 at Mymensingh and Kishoreganj

Block farming with drought tolerant Binadhan-21 was conducted at the farmer's fields at two districts in collaborations with DAE during aus season of 2024-25 to evaluate the performance of this variety at different areas for widening its adoption by the farmers. Area of each plot was 5

bigha. Spacing between line-to-line and plant-to-plant was 20 cm and 15 cm, respectively. Fertilizers were applied as per recommendation for Binadhan-21. Transplanting dates ranged from 26 April to 16 May, 2025 and age of seedlings were 20 to 22 days.

Based on the data of 6 block farming plots, the average grain yield was 4.12 t ha^{-1} with maturity period of 104 days. Farmers of both districts were found interested to cultivate Binadhan-21 in upcoming years.

Block farming of rapeseed variety Binasarisha-9, Binasarisha-11 and BINA sarisha12 at Mymensingh and Kishoreganj

Block farming with BINA developed rapeseed varieties was conducted at the farmer's fields at two districts in collaborations with DAE during rabi season of 2024-25 to evaluate the performance of this variety at different areas for widening its adoption by the farmers. Area of each plot was 10 bigha. As per farmers' practice, all varieties were broadcasted in the field. Fertilizers were applied as per recommendation. Sowing dates ranged from last week of October to 2nd week of November, 2024.

Based on the data of block farming plots, the average grain yield of Binasarisha-9, Binasarisha-11 and BINA sarisha12 were 1.57, 1.60, 1.32 t ha^{-1} with maturity period of 85, 82, 85 days, respectively. Farmers of both districts were found interested to cultivate BINA varieties in upcoming years.

Demonstration of rapeseed variety, Binasarisha-9 and Binasarisha-11 at Mymensingh and Kishoreganj

Field demonstrations with Binasarisha-9 and Binasarisha-11 were conducted at the farmers' fields in two districts in collaboration with DAE during the rabi season of 2024-25 to evaluate the performance of this variety in different areas for widening its adoption by the farmers. Area of each plot was 1 bigha. As per farmers' practice, both varieties were broadcasted in the field. Fertilizers were applied as per recommendation. Sowing dates ranged from last week of October to 2nd week of November, 2024.

Based on the data of demonstration plots, the average grain yield was 1.55, 1.69 t ha^{-1} with a maturity period of 86, 87 days respectively. Farmers of both districts were found interested in cultivating the varieties in the upcoming years. Farmers of Kishoreganj district responded best to the varieties for their late sowing potential. Farmers appreciated the good yield performance, although their land was prepared a bit later than the ideal time. In such a case, they did not receive much yield previously when cultivating local varieties.

Performance of Binasarisha-9 under zero tillage conditions at different locations

Zero tillage refers to a farming practice where the soil is left undisturbed by plowing or tilling. This method involves planting crops directly into the residue of the previous crop without disturbing the soil structure. Zero tillage helps maintain soil health, prevents soil erosion, and improves water retention. Mustard crops are often grown in areas that may suffer from erosion, and zero tillage helps prevent this by maintaining the soil structure. It helps retain moisture, especially in arid or semi-arid regions, which is crucial for mustard growth. Zero tillage practice

was followed with Binasarisha-9 at farmers' field of different upazilas in Mymensingh and Kishoreganj districts during rabi season of 2024-25. Size of each plot was 1 bigha and suitable places were selected for this study.

Based on the data of 16 plots, the average seed yield was 1.36 t ha^{-1} with a maturity period of 86 days. Farmers of both districts were found interested in cultivating Binasarisha-11 as their cultivation cost was minimal.

Performance of Binatil-2 at Mymensingh and Kishoreganj during 2024-25

Field demonstration with Binatil-2 was conducted at the farmers' fields in two districts in collaboration with DAE during the kharif-1 season of 2024-25 to evaluate the performance of this variety in different areas for widening its adoption by the farmers. Area of each plot was 1 bigha. As per farmers' practice, Binatil-2 was broadcast in the field. Fertilizers were applied as per the recommendation for Binatil-2**.** Sowing dates ranged from 1st week to last week of March 2025.

Based on the data of demonstration plots, the average grain yield was 1.38 t ha^{-1} with maturity period of 88 days. Farmers of Kishoreganj district were found keen to cultivate Binatil-2.

Performance of Binachinabadam-6, Binachinabadam-8 and Binachinabadam-10 at Mymensingh and Kishoreganj

Field demonstration with Binachinabadam-6, Binachinabadam-8 and Binachinabadam-10 were conducted at the farmer's fields at two districts in collaboration with DAE during rabi season of 2024-25 to evaluate the performance of the varieties at different areas for widening its adoption by the farmers. Area of each plot was 1 bigha. Spacing between line-to-line and plant-to-plant was 20 cm and 15 cm, respectively. Fertilizers were applied as per recommendation for Binachinabadam-6, Binachinabadam-8 and Binachinabadam-10. Sowing dates ranged from 1st to 3rd week of January 2025.

Based on the data of demonstration plots, the average grain yield was 2.15, 2.41, 1.6 tha^{-1} with maturity periods of 140, 143, and 141 days for Binachinabadam-6, Binachinabadam-8, and Binachinabadam-10, respectively. Farmers of Kishoreganj district were found keen to cultivate Binachinabadam-8. Binachinabadam-8 is becoming a popular variety in both districts.

Demonstrations of Blackgram variety, Binamash-2 at Mymensingh and Kishoreganj

Field demonstration with Binamash-2 was conducted at the farmer's fields at two districts in collaboration with DAE during kharif-2 season of 2024-25 to evaluate the performance of this variety at different areas for widening its adoption by the farmers. Area of each plot was 1 bigha. As per farmers' practice, Binamash-2 was broadcasted in the field. Fertilizers were applied as per recommendation for Binamash-2. Seeds were sown during 3rd week of August to 2nd week of September 2024. Seeds were sown at a depth of 2-3 cm by line sowing. Distance between plant to plant was 5 cm in a row, while line to line distance was maintained 40 cm.

Based on the data of demonstration plots, the average grain yield was 1.22 t ha^{-1} with maturity period of 75 days. Farmers of Kishoreganj district were found keen to cultivate Binatil-2.

Demonstrations of turmeric variety, Binahalud-1 at different locations of Mymensingh

Field demonstrations with Binahalud-1 were conducted at the farmer's fields of different upazila of Mymensingh district to evaluate the performance for widening its adoption by the farmers. Area of each plot was 1 bigha. Fertilizers were applied by farmers as per recommendation for Binahalud-1. Rhizomes were transplanted from last week of April to 2nd week of May, 2024.

The result based on the data of demonstrations plots, the average rhizome yield of Binahalud-1was 30.4 t ha^{-1}. The maturity period of Binahalud-1 was 295 days. Farmers preferred Binahalud-1 for its good yield performance.

Establishment of BINA-Technology Pilot Area (BINA-Village)

The Bangladesh Institute of Nuclear Agriculture (BINA) develops improved rice and mustard varieties to enhance yield and sustainability in farmers' fields. To promote their adoption, a BINA-Technology Pilot Area (BINA-Village) was established at Mohir Kharua, Gafforgaon, Mymensingh. Demonstration trials were conducted during Aman, Rabi, and Boro seasons to evaluate the performance of selected BINA varieties (Binadhan-17, Binadhan-20, Binadhan-24, BINA dhan25, Binasarisha-9, and Binasarisha-11) in terms of maturity, yield, and farmer preference.

During Aman season of 2024-25, Demonstration with T. aman (Binadhan-17, Binadhan-20) were conducted at BINA technology village of Mymensingh district for widening its adoption by the farmers. Area of each plot was 1 bigha. Results depicted that rice varieties of Binadhan-17, Binadhan-20 produced average grain yield of 6.1 and 4.5 t ha^{-1} with average maturity period of 115, 127 days, respectively.

During rabi season of 2023-24, Demonstration with Mustard (Binasarisha-9, Binasarisha-11) at Mymensingh district for widening its adoption by the farmers. Area of each plot was 1 bigha. The average yield of Binasarisha 9 and 11 was 1.33 and 1.36 t ha^{-1} respectively. The maturity period of Binasarisha 9 and 11 was 87 and 80 days. Farmers preferred Binasarisha-11 for its good yield performance.

During boro season of 2024-25, Demonstration with Boro (Binadhan-24, Binadhan25) at Mymensingh district for widening its adoption by the farmers. Area of each plot was 1 bigha. The average yield of Binadhan-24 and BINA dhan25 was 6.10 and 5.70 t ha^{-1} respectively. The maturity period of Binadhan-24 and BINA dhan25 was 150 and 145 days. Farmers preferred Binasarisha-11 for its good yield performance.

Head-to-Head Adaptive Trial with different BINA released varieties at Mymensingh and Kishoreganj district

The head-to-head adaptive trials conducted in Mymensingh and Kishoreganj districts during 2024-25 revealed notable performance variations among BINA-released varieties and existing counterparts. Each head-to-head adaptive trial was conducted on 6 bighas of land, where one BINA-released potential variety was compared with an existing variety (check) for yield performance. In addition to the primary comparison, other BINA varieties were planted alongside as per the season, to enhance the authenticity and robustness of the experiment. The side varieties included **Binasarisha-9, Binadhan-24, BINA dhan25, Binachinabadam-6, Binachinabadam-8,** and **Binachinabadam-10, Binadhan-21,** which were observed for their performance in parallel with the main varieties.
The result based on the data of 9 trials, **Binasarisha-11** demonstrated superior yield performance compared to both **Maghi Sarisha** and **BARI Sarisha-14,** making it a promising option for farmers in Mymensingh. Similarly, **Binachinabadam-8** outperformed the local **Golachipa** variety in Pakundia, Kishoreganj, indicating its adaptability and potential for higher productivity in local conditions. These varieties suggest significant benefits in terms of yield and could contribute to enhancing overall agricultural output in these districts. However**, Binadhan-24** and **BINA dhan25** showed slightly lower yields compared to **BRRI dhan-100**, especially in areas like Gafargaon, suggesting a need for further refinement in certain locations. **Binadhan-19,** on the other hand, exhibited yield performance similar to **BRRI dhan98**, highlighting its potential for broader adoption where BRRI dhan98 is commonly cultivated. Overall, these trials provide valuable insights for selecting the most suitable varieties for different regions, with emphasis on yield improvement, local adaptability, and future breeding enhancements to maximize productivity.

Promotional Activities for popularizing the BINA developed varieties and technologies during 2024-25

For popularizing the BINA developed varieties and technologies, the ARE Division organized training for farmers and Sub Assistant Agriculture Officers (SAAO), field days at crop harvest and Workshop for Officers of DAE and other agricultural organizations. To accelerate adoption, ARE Division conducted **11 farmers' training sessions (650 participants)**, **1 SAAO training (50 participants)**, **7 field days (350 participants)**, and **2 workshops (200 participants)** during 2024–25.

AGRICULTURAL ECONOMICS DIVISION

Cost and return analysis of Binadhan-10 in Bangladesh

The study was undertaken to determine the costs and return of the salt tolerant rice variety Binadhan-10 in the study areas (Satkhira, Khulna, Feni, Patuakhali, Noakhali, Chattogram and Cox's Bazar). This study was based on primary data which were collected from 280 Binadhan-10 producing farmers. The objectives were: i) To identify socio-demographic profile of the farmers of the salt tolerant rice variety Binadhan-10 ; ii) To determine the costs and return of Binadhan-10 in the study areas and iii) To find out the constraints faced by the producers. The average per hectare yield of Binadhan-10 was 4976 kg, and the yield was highest at Khulna (5210 kg), followed by Satkhira (5100 kg), Patuakhali (5002 kg), Noakhali (4950 kg), Cox's Bazar (4902 kg), Feni (4890 kg), and Chattogram (4780 kg). The per hectare average total cost was found to be Tk. 103258, and the highest cost was in Chattogram (Tk. 105645), followed by that in Cox's Bazar (Tk. 104610), Patuakhali (Tk. 104561), Noakhali (Tk. 103574), Feni (Tk. 101894), Satkhira (Tk. 101763), and Khulna (Tk. 101761), respectively. The per hectare average net return was Tk. 36725, and that was the highest in Khulna (Tk. 44919), followed by Cox's Bazar (Tk. 39469), Satkhira (Tk. 37617), Feni (Tk. 36086), Noakhali (Tk. 35786), Chattogram (Tk. 31907), and Patuakhali (Tk. 31291), respectively. The average price of Binadhan-10 was Tk. 27.00 Kg^{-1}, and that was the highest at Cox's Bazar (Tk. 28 Kg^{-1}) and the lowest at Patuakhali and Satkhira (Tk. 26 Kg^{-1}. The BCR was estimated at 1.36 and 167 on a full cost and variable cost basis, respectively, implying that the Binadhan-10 cultivation at the farm level was profitable. The BCR of Binadhan-10 was the highest in Khulna (1.44 & 1.76), followed by Cox's Bazar (1.38 & 1.71), Satkhira (1.37 & 1.70), Noakhali (1.35 & 1.67), Feni (1.35 & 1.66), Chattogram (1.30 & 1.61), and Patuakhali (1.30 & 1.60), respectively. The first-ranked problem was cases of high salinity causes yield loss (64%) and non-availability of salt-tolerant varieties (88%) in all areas. Other problems were pests and diseases that hamper the potential yield in the study areas (82%), followed by lack of training (47%), lack of technical know-how (39%), and lack of storage facilities (22%).

Yield gap analysis of Binachinabadam-8 in Bangladesh.

The study was conducted in six major Binachinabadam-8 growing areas of Bangladesh, namely Noakhali, Patuakhali, Barguna, Feni, Cumilla and Gopalganj. The objectives were (i) To determine the yield gap at the farm level (ii) To identify the factors affecting the yield gap; (iii) To estimate the costs and return and (iv) To suggest some policy guidelines to minimize the yield gap. A total of 300 farmers were randomly selected as sample size by using multistage sampling method in the study area, 50 from each District. Data were collected from Binachinabadam-8 growers through interview schedule. Some descriptive statistics were used in analyzing the collected data. In the study, costs and return analysis were done on both cash cost and full cost basis.

The per hectare average yield of Binachinabadam-8 at the research station was 1.85 t. The highest yield per hectare was obtained from Cumilla (2.09 t), followed by Gopalganj (1.95 t), Feni (1.86 t), Patuakhali (1.81 t), Barguna (1.81 t), and Noakhali (1.61 t). The estimated average yield gap I was 0.20 t ha-1 (8.35%), and average yield gap II was 0.33 t ha^{-1} (15.04%). The lowest total yield gap was 0.41 t ha-1 (9.21%) observed in Cumilla,

and it was the highest at 0.59 t ha^{-1} (14.115%) in Noakhali district. Considering all, the average yield gap was 0.52 t ha^{-1} (11.56%), and there was much scope for yield enhancement in the variety. The analysis revealed that the per hectare total variable cost of Binachinabadam-8 cultivation was Tk. 59103, which was 62.10% of the total cost of production. On an average, the total cost of production in the field level of Binachinabadam-8 was Tk. 95171 ha^{-1}, where 37.90% was fixed cost and 62.10% was variable cost. The highest cost per hectare at the farm level was in Cumilla (Tk. 98123), followed by Patuakhali (Tk. 97558), Feni (Tk. 97001), Barguna (Tk. 95274), Noakhali (Tk. 92550), and Gopalganj (Tk. 90521), respectively. The per hectare average gross margin of Binachinabadam-8 cultivation was found Tk. 122579. The highest net return per hectare (Tk. 116909) comes from Cumilla district, and the lowest net return (Tk. 58167) comes from Noakhali district for Binachinabadam-8. BCR over full cost basis was the highest at Cumilla (2.19), followed by Gopalganj (2.17), Feni (1.88), Barguna (1.82), and Noakhali (1.63) for Binachinabadam-8, respectively. BCR was 1.91 on full cost basis in all study areas, which indicates that all of the Binachinabadam-8 producers were economically profitable. If we could reduce these gaps, our total production per year will be increased which will support in achieving food security as well as Sustainable Development Goals (SDGs).

Financial profitability of BINA dhan25 in some selected areas of Bangladesh.

This study evaluated the financial profitability and key production constraints of BINA dhan25 in six major cultivating districts of Bangladesh: Cumilla, Rangpur, Sunamganj, Mymensingh, Gopalganj and Barishal. A total of 300 farmers (50 per district) were selected through simple random sampling, and primary data were collected using a structured interview schedule. Costs and returns were analyzed on both cash cost and full cost bases to estimate profitability. The results revealed that the average total cost of cultivating BINA dhan25 was Tk. 113,906 per hectare, where variable costs accounted for 72% and fixed costs 28%. Human labour represented the highest cost component (38.9%), followed by machinery (13.6%), irrigation (12.7%) and land use (12%).The average yield across locations was 4,896 kg/ha, with Rangpur showing the highest yield (5,763 kg/ha), while Barishal recorded the lowest. The average gross margin and net return were found to be Tk. 71,480 and Tk. 39,534 per hectare, respectively. Profitability indicators demonstrated that BINA dhan25 cultivation is economically viable, yielding a Benefit Cost Ratio (BCR) of 1.87 on a variable cost basis and 1.35 on a full cost basis. Despite its profitability, BINA dhan25 growers encountered several production challenges. The most frequently reported constraint was unfilled grains (81%), followed by Bakanae disease (54%), broken rice during milling (31%), pest infestation (25%), lack of training (21%) and limited access to quality seeds (16%).Overall, the study concludes that BINA dhan25 offers favorable economic returns to farmers across diverse agro-ecological regions. However, enhanced extension services, improved seed quality, timely pest and disease management and farmer training are essential to further boost productivity and sustain the expanding adoption of this variety.

Profitability and marketing system of Binadhan-20 in Bangladesh.

This study examines the profitability and marketing system of Binadhan-20 in six major producing districts of Bangladesh—Noakhali, Lakshmipur, Cumilla, Barishal, Jamalpur, and Chapainawabganj—using a multistage stratified random sampling method. A total of 240 respondents were selected, including 120 farmers and 120 intermediaries. Primary data were collected through structured interviews and analyzed using descriptive statistics, cost–return analysis, and marketing margin assessment. Results reveal that Binadhan-20 cultivation is financially profitable across locations, with an average total production cost of Tk. 81,706/ha, of which 66.06% constitutes variable cost and 33.94% fixed cost. Human labour accounted for the largest share of production expenses (50.55%), followed by land use (14.62%) and power tiller operation (8.46%). The average yield of 4,503 kg/ha generated a gross return of Tk. 113,072/ha, resulting in an average gross margin of Tk. 59,099/ha and a net return of Tk. 31,366/ha. The benefit-cost ratios of 2.09 (variable cost) and 1.38 (full cost) confirm strong economic viability. The marketing system of Binadhan-20 was found to operate through four major chains involving Faria, Bepari, Miller, Arathdar-cum-wholesaler, and Retailer. Marketing cost and margin analysis shows that millers incurred the highest marketing cost (Tk. 117.40/mound) due to processing, milling, and labor expenses, while retailers achieved the highest net margin (Tk. 53.60/mound). Marketing margins per mound were highest for millers (Tk. 125), followed by retailers and Beparis. Although the chain adds substantial value at different stages, inefficiencies remain. Farmers reported five major production constraints, with the unavailability of quality seed ranked highest (89%), followed by high fertilizer and pesticide prices (69%) and lack of training (61%). Intermediaries reported lack of market facilities (90%), inability to influence price setting (72%), and inadequate storage (63%) as the most pressing marketing challenges.

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

The study was conducted in 64 districts of Bangladesh to examine the area coverage of BINA developed rice, pulse and oilseed varieties during 2024-25 and suggest some policy guidelines. The specific objectives of the present study were: i) to examine the area coverage of BINA developed rice, pulse & oilseed varieties; ii) to identify major constraints of BINA developed rice, pulse & oilseed varieties cultivation; and iii) to suggest some policy guidelines. Field survey data were used for this study and those were collected from 64 districts through concern distinctions DAE office and substations of BINA. Both tabular and descriptive statistical analysis was used to fulfill the objectives. Finally, data were classified into 14 agricultural regions to identify the area coverage of BINA developed rice, pulses & oilseed varieties. It was seen that the overall area coverage of BINA developed rice varieties were 10.41%. Among the three seasons (Aus, Aman and Boro) the highest area coverage was found in Aman season that was 16.32% followed by Aus 10.89% and Boro 3.25%, respectively. In Aman season, the highest coverage was 9.73% for Binadhan-17 and the lowest was 0.01% for BINA dhan26 as a new variety. In Boro season, the highest coverage was 1.68% for BINA dhan25 and the lowest was 0.01% for Binadhan-5. In Aus season, the highest coverage was 8.08% for

Binadhan-19 and the lowest was 0.01% for Iratom-24. Among the 14 agricultural regions the highest area coverage was found 15.77% in Jashore region (Reg-13) and the lowest found 1.06% in Rangamati region (Reg-4).The overall area coverage of BINA developed pulse varieties were 9.60%. The highest area as well as coverage was found 15.80 % for Binamoog-8, respectively and lowest was seen 0.0001% in case of Binasola-4 and among the 14 regions the highest area coverage for pulses was found Barishal region 58.37% (Reg-6) and the lowest was found Rangamati region 0.00% (Reg-4), respectively. The overall area coverage of BINA developed oilseed varieties were 23.14%. The highest area coverage was found 21.10% for Binachinabadam-4 and the lowest 0.02% was seen in case of Binasoybean-7. And among the 14 regions the highest area coverage for oilseed was found in Jashore region 12.64% (Reg-13) and the lowest was found in Rangamati region 0.75% (Reg-4). Area coverage of BINA developed horticultural crop varieties were 0.20%. The highest area coverage was found 4.77% for Binalebu-1 and the lowest was found 0.01% for Binamarich-1 and among the 14 regions the highest area coverage for horticultural crop was found 507 ha (43.42%) in Rangpur agricultural region (region-8) and the lowest was found 0.001% in Khulna region (region-5). 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.

BINA REGIONAL AND SUB-STATIONS

BINA Regional Station, Gazipur

On-station yield trial of Bottle gourd mutant line

Seeds of BARI Lau-4 were irradiated and advanced mutants were evaluated to select desirable traits. Two mutant lines were tested in a randomized complete block design. Results showed significant variation in fruit number, weight, size, and yield, with the mutant line BL-4$M_7D_{150}P_{3-3}$ producing the highest yield (84.27 t/ha), largest fruits, and most fruits per plant. Conversely, BARI Lau-4 exhibited the lowest performance.

Technology Transfer – Up-scaling of BINA developed crop varieties in Gazipur region

A total of 573 demonstrations of BINA-developed varieties of Aman rice, mustard, sesame, Boro rice, turmeric, and groundnut were conducted across farmers' fields. Varieties such as Binadhan-16, Binadhan-17, Binadhan-20, and Binadhan-22 showed higher yields and popularity in various districts. The demonstrations aimed to evaluate performance and promote adoption of these improved varieties.

Validation trial of mustard varieties with zero tillage and optimum tillage

At four locations, two modern mustard varieties, Binasarisha-9 and BARI Sarisha-14, were tested under zero and optimum tillage. Binasarisha-9 achieved the highest seed yield of 1.44 t/ha, while BARI Sarisha-14 had a shorter life cycle (83 days). Although zero tillage reduces production costs, yields under optimum tillage were 13.77% higher, indicating the benefit of proper tillage practices for maximizing yield.

Evaluation of improved cropping pattern in Gazipur region

Different cropping patterns were tested to identify profitable sequences. The improved pattern—Aman (Binadhan-17) followed by Mustard (Binasarisha-11) and Boro (Binadhan-24)—proved more profitable than the existing pattern of Aman – Fallow – Boro. Farmers showed interest in adopting the recommended sequence, although further validation over larger areas is needed.

Head-to-head adaptive trial of existing potential and BINA released varieties

Eleven trials compared traditional and improved varieties across rice, mustard, and other crops. BINA dhan25 consistently outperformed older varieties such as Binadhan-24 and BRRI Dhan-89 regarding yield and maturity. For Aman rice, Binadhan-20 and BRRI Dhan-103 showed promising results; for Boro rice, BINA dhan25 and Binadhan-24 yielded higher than traditional checks.

Breeder and TLS seed production

A total of 775 kg of high-quality seeds, including breeder and truthfully labeled seeds, were produced at the regional center farm, supporting future cultivation and seed demand for BINA-released varieties across the region.

Training and Capacity Building

During the year 2024-25, 11 farmer's and SAAO's training programs, 10 field day programs were organized where 548 farmers and (SAAO) were trained and near 500 farmers were present in the field day programs.

BINA Sub-station, Rangpur

In order to select desirable high yielding foxtail millet mutants, seeds of irradiated and selected M_4 mutants with one check, BARI kawn-4 were grown and found FMM-800-7-11 this line produced the highest (1.98 tha^{-1}) yield among all mutants including the check variety.

In order to characterize the local aromatic germplasm from greater Dinajpur, 21 collected landraces were grown in Rangpur substation farm following Alpha lattice design with two replicates during 2024-25 T. Aman growing season and found BBRM-5 obtained the highest grain yield (6.5 tha^{-1}).

In order to select desirable high yielding cold tolerant rice lines grown 9 genotypes during Boro 2023-24, where 8 selected lines with one check. Among the all lines the highest mean grain yield 10.07 $tha^{-1}$was produced by BPR25-S-7 and the lowest 8.20 $tha^{-1}$by BPR8-1 -S**.** On the other hand, the promising line as BPR25-S-7 were early maturing also as 128 days.

In four crops based cropping pattern in upland ecosystem instead of three crops had the larger BCR.

Total of 16 block demonstrations were conducted with BINA released rice, mustard and groundnut varieties in Rangpur and Dinajpur region during 2024-25.

A total of 473 demonstrations and 4 head-to-head trials were conducted with BINA released rice and mustard.

Conducted 11 training, workshop and 06 field days at different location on different topic and crops during 2024-25.

BINA Sub-station, Ishurdi

Performance of Binamoog-8 & Binamoog-9 at different doses of NKS

Performance of Binamoog-8 & Binamoog-9 at different doses of NKS was conducted. Results revealed that significant variation was observed between the varieties. It was observed that Binamoog-9 had higher plant height than other varieties at $N_{30}k_{60}S_4$ doses. The highest number of pod plant^{-1} were produced at $N_{30}k_{60}S_4$ doses at Binamoog-9 , seed pod^{-1} and seed yield were produced highest in Binamoog-9 (2.18 tha^{-1}) at $N_{30}k_{60}S_4$.. Based on the present findings, Binamoog-9 at $N_{30}k_{60}S_4$ can ensure better yield with the highest economic return for the farmers.

Effect of Boron Fertilizer on the growth and yield performance of BINA sarisha12

In another experiment, the effect of Boron Fertilizer on the growth and yield performance of BINA sarisha12 was shown. Results revealed that significant variation was observed at various doses of Boron at the varieties. It was observed that BINA sarisha12 had higher plant height than other varieties at B_4 doses. The highest number of Siliquae plant^{-1} was produced at B_2 doses. The highest number of Seed Siliquae $^{-1}$ was produced at B_2. The highest number of 1000 seed weight and yeildplot^{-1} (2.16tha^{-1}) were produced at B_2 doses than at other doses. Based on the present findings, BINA sarisha12 at B_2 can ensure better yield with the highest economic return for the farmers.

Study on the performance of the cropping pattern

Four experiments were conducted at Sub-Station, Chatmohor, Lapur, and Natore Sadar during 2024-25 to determine a profitable cropping pattern for Pabna and Natore region with BINA-developed high-yielding varieties. Binadhan-17-Binasarisha-11-Binadhan-14 and Binadhan-17-Binamasur-8-Binatil-2 were found more profitable as compared to T. Aman – Mustard—Boro and T. Aman- Lentil – Fallow, respectively. In CP_2, T. Aman-Lentil-Sesame was cultivated under an improved cropping pattern, whereas T. Aman-Lentil-Fallow was cultivated under the 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 in CP_2 (15.57).

Preliminary yield trial of some rice lines for earliness, higher yield and better grain quality

The most effective tillers were produced by MR297-P-15 in Ishwardi and the mean over sites. The genotype MR297-P-22 produced the highest yield at Chatmohor and the mean over sites (5.96 ha/ha) compared to the other locations. The B17-P-24 line matured earlier among all the lines. These lines are suggested for further testing in the upcoming season based on the aforementioned talks, effective tillers plant, panicle length, filled grain panicle, and yield performance.

Varietal demonstration of cereals, pulse and oilseed crops

A total of 662 demonstrations were established on different high-yielding and new modern varieties of BINA in the Pabna, Natore, Sirajganj, Joypurhat and Bogura districts during 2024-25. In the Aman season rice varieties (Binadhan-17 and Binadhan-22) demonstration activities

were done in 2024-25. In the Rabi season, demonstrations of mustard varieties (Binasarisha-9, Binasarisha-11 and BINA sarisha12) noted that the mean seed yield was 1.90 tha^{-1} with 86 days duration. Demonstrations of Binamoog-8 revealed that a seed yield of 1.80 tha^{-1} was achieved at 84 days of maturity. From demonstrations of sesame (Binatil-2 and Binatil-4) varieties, a mean yield of 1.36 tha^{-1} was attained at 90 days duration. Turmeric yielded 33.00 t ha^{-1} with 330 days duration from 05 demonstrations. A total of 35 demonstrations of Binachinabadam-8 revealed that a seed yield of 2.38 tha^{-1} was achieved at 140 days maturity. In the Boro season, premium quality rice varieties (BINA dhan25), 105 demonstration activities were done in 2024-2025 with the mean yield of 7.50 tha^{-1} at 140 days duration.

Quality seed production of potential BINA-released varieties

A total amount of 2.27 ton breeder seed and 2.34 ton TLS was produced on different promising BINA-released varieties during 2024-25. A total of 275 farmers were trained on various aspects of BINA-released crop varieties and technologies to improve their existing skills and knowledge.

Farmers' training and field days for technology transfer

For mass technology dissemination and publicity, 14 farmer's field days (FFD) were conducted, with a total of 879 farmer participants during 2024-25. Seed demand of DAE and dissemination of BINA released promising crop varieties, BINA sub-station, Ishurdi, were produced seed and also in the farmers' field at different locations. In order to facilitate technology transfer and rapid extension, eight training programs were organized during the period of 2024-25, where a total of 275 farmers with SAAOs of DAE.

BINA Sub-station, Magura

On-station and on-farm yield trial with high yielding and early maturing rice lines

Multi-location on-station and on-farm trials were conducted with three gamma-irradiated rice mutants (ZM-231, ZM-611) derived from Indian Zirashail. The lines were evaluated alongside BRRI dhan96 for plant height, tillers, panicle traits, and grain yield.The mutant ZM-611 showed superior performance, producing an average yield of 8.19 t ha^{-1} across Magura, Cumilla, Sunamganj, and farmer fields, with significantly more filled grains (164 per panicle). ZM-611's The consistency of the mutant ZM-611, across environments and its advantage over the check suggest its strong potential to release as a high-yielding variety.

Growing M_3 generation of rice for earliness and higher yield

To induce earliness and yield improvement, an exotic red rice variety was irradiated with doses of 100–350 Gy and advanced to M_3 generation. Plants were grown at Magura during Boro, 2025. Although no prominent phenotypic variation appeared in this generation, seeds were harvested to continue evaluation in subsequent years.

Collection and evaluation of germplasm of different crops

Sixty germplasms — including 29 cereals, pulses, and oilseeds, and 31 fruit, spice, and ornamental accessions — were collected from Jashore, Jhenaidah, Chuadanga, Rajbari, Kushtia, and Meherpur. Materials such as local rice, mustard, sesame, lentil, mango, guava, jackfruit, and ornamentals were secured for characterization. Data on morphological and agronomic traits (e.g., plant height, flowering time, seed weight, fruit size, and color) are being recorded to identify promising sources for future breeding and varietal improvement.

Head to head adaptive trial (HHAT) of newly released sesame variety, BINA til5

Three head-to-head adaptive trials compared BINA til5 with the check BARI til-4 in Magura, Jashore, and Kushtia. BINA til5 gave the average yield of 1.22 t ha^{-1}, about 14% higher than the check, with slightly shorter crop duration (95 vs. 98 days). Both varieties were tolerant to disease, though infestation by hairy caterpillar was controlled with insecticides. Despite its good yield, farmers expressed preference for dark-seeded sesame due to market value, suggesting scope for developing black-seeded sesame variety.

Block farming with BINA varieties/technologies

Forty block demonstrations were established over 2024–25 across five districts to popularize BINA crop technologies. Results highlighted the adaptability of multiple varieties: Binadhan-17 yielded up to 6.85 t ha^{-1} in Aman; BINA dhan25 gave 6.95 t ha^{-1} in Boro; and Binamoog-8 matured in 61–64 days with yield of 1.66 t ha^{-1}. Oilseeds such as Binasarisha-9 and -11 achieved >2.0 t ha^{-1}. These outcomes reinforced the benefits of BINA varieties for diverse agro-climatic conditions.

Dissemination of BINA varieties/Technologies

Over 550 demonstrations were conducted to assess stability and farmer acceptance of BINA-developed crops. Varieties such as Binadhan-19, Binadhan-24, Binasarisha-9, Binachinabadam-8, and Binamoog-8 performed consistently, showing resilience to diseases and environmental

stresses. Their reliable yield and adaptability encouraged the integration of these varities into local cropping systems.

Evaluation of a three crops cropping pattern in Jhenaidah

A new pattern, T. Aman (Binadhan-17)–Mustard (Binasarisha-9)–Boro (Binadhan-24) was tested against the conventional Aman–Boro system. Conducted across three sites, the improved pattern increased cropping intensity from 200% to 300% and produced a gross margin of Tk 418,500 ha^{-1} with an BCR of 2.05. Incorporating mustard between rice crops significantly enhanced land-use efficiency, profitability, and sustainability.

Evaluation of a four-crop cropping pattern in Magura

A four-crop system, Aman (BINA dhan26)–Mustard (Binasarisha-11)–Mungbean (Binamoog-8)–Aus (Binadhan-19)was compared with the existing three-crop sequence. Conducted at three locations, it raised cropping intensity from 300% to 400% and achieved an BCR of 2.16. Farmers noted that replacing BINA dhan26 with short-duration Binadhan-17 could further improve yield and allow more flexible scheduling. Inclusion of mungbean enhanced soil fertility and added an additional income source.

Performance of BINA released promising crop varieties/technologies in BINA village

The trials in the BINA Technology Village showed varietal performance under farmer conditions. In Aman, Binadhan-17 gave the yield of 6.54 t ha^{-1}, while in Boro, Binadhan-24 had the yield of 7.88 t ha^{-1}. Rabi cropsBinasarisha-9, Binasarisha-11, and Binasarisha12 yielded between 1.65 to 1.97 t ha^{-1}, and Kharif crops such as Binatil-2 and Binamoog-8 yielded 1.22t ha^{-1} and 1.55 t ha^{-1}, respectively. The site proved effective for technology transfer and farmer engagement.

TLS seed production and purchase of BINA released crop varieties.

About 37.5 tons of truthfully labeled seed were produced or procured under revenue and project funds. Rice (Binadhan-7, Binadhan-17, Binadhan-24, BINA dhan25), pulses (Binamasur-8, Binakhesari-1, Binamoog-8), oilseeds (Binasarisha-9, Binatil-1,Binatil-2, Binatil-3, Binatil-4 and Binatil5), groundnut, and sesame contributed substantially, supporting a steady supply of quality seed to enhance adoption of improved varieties.

Training of farmers/seed dealers/SCA personnels and regional workshop on the use of BINA developed varieties/technologies

Ten structured training events and a regional workshop were held for 785 farmers, SAAOs, seed dealers, and NGO/INGO staff. These programs built capacity in cultivation practices, seed production, pest management, and integration of pulses and oilseeds into cropping systems. Participants gained practical skills and networking opportunities for accelerating technology dissemination.

Organizing field days to promote BINA-developed varieties and technologies

Twenty-one field days attracted about 1,050 participants, showcasing rice, pulses, oilseeds, groundnuts, sesame, and mungbean in real field conditions. Farmers and extension workers observed crop performance, discussed on the best management practices, and strengthened confidence in adopting high-yielding, climate-resilient BINA varieties.

BINA Sub-station, Satkhira

Application of Different Sources of Sulphur for Reducing Soil Salinity and Increasing rice Production in Coastal Region

Soil salinity is a major abiotic stress limiting rice productivity in coastal regions, where seawater intrusion, tidal flooding, and inadequate drainage accelerate salt accumulation in the soil. Excess salinity disrupts water and nutrient uptake, leading to poor crop growth and reduced yields. Sulphur (S) plays a vital role in improving soil structure, enhancing salt leaching, and reducing exchangeable sodium through ion exchange mechanisms. This study aimed to evaluate the effectiveness of different sulphur sources in reducing soil salinity and improving the productivity of the saline-tolerant rice variety Binadhan-10. The experiment was conducted during the Boro season of 2024–25 at a farmer's field in Varshimla, Kaligonj, Satkhira, using a randomized complete block design with seven sulphur treatments: T1 = Control, T2 = Elemental S, T3 = $CaSO_4 \cdot 2H_2O$ (gypsum), T4 = K_2SO_4, T5 = $MgSO_4$, T6 = 50% $CaSO_4 \cdot 2H_2O$ + 50% $MgSO_4$, and T7 = 50% K_2SO_4 + 50% $MgSO_4$, each replicated three times.

Significant differences were observed among treatments for yield-contributing traits including effective tillers, panicle length, filled and unfilled grains per panicle, and 1000-grain weight. The highest grain yield (5.52 t/ha) was recorded in T6, while the control produced the lowest yield (2.7 t/ha). Soil salinity increased progressively with crop age, but treatments T3 and T6 effectively reduced salinity buildup compared with others. Water salinity fluctuated due to rainfall but remained comparatively lower under T3 and T6 during key growth stages. The findings demonstrate that combined sulphur application, particularly T6, is highly effective in mitigating soil salinity and enhancing rice yield in coastal saline agroecosystems.

Leaching loss of Nutrient from Rice Fields under Different Fertilizer Management Practices in the Saline Region

Saline rice-growing areas frequently experience substantial nutrient losses because of poor soil drainage and high soluble salt levels, making efficient fertilizer management essential for sustaining crop productivity and reducing environmental pollution. This study quantified the leaching losses of major nutrients (N, P, K, and S) under five fertilizer management practices during the Boro season 2024. Treatments included a control (zero N), the recommended NPKS rate (T1), a 25% higher fertilizer rate (T2), a 25% reduced rate (T3), and a cowdung (2 t ha^{-1}) plus supplemented NPKS treatment (T4), arranged in a randomized complete block design.

All fertilizer treatments increased nutrient leaching compared with the control. The highest cumulative losses of ammonium-N (7.70 kg ha^{-1}), nitrate-N (9.50 kg ha^{-1}), phosphorus (0.46 kg ha^{-1}), potassium (4.70 kg ha^{-1}), and sulfur (4.57 kg ha^{-1}) occurred under the T2 treatment. Leaching intensity peaked at 30 days after transplanting and declined thereafter. The T4 treatment resulted in the lowest nutrient losses among fertilized treatments, followed by T3. These findings indicate that excessive fertilizer application enhances nutrient leaching in saline soils, whereas integrating organic amendments with inorganic fertilizers improves nutrient retention and promotes more sustainable rice production.

Fertilizer Dose Determination for Zero-Tillage Mustard Cultivation in Gher

Coastal gher soils are typically affected by high salinity and poor soil fertility, which limit nutrient availability and reduce crop productivity. Optimizing fertilizer management is therefore essential for sustainable mustard production, particularly under zero-tillage systems that offer benefits such as improved soil structure, reduced erosion, and enhanced water conservation. This study aimed to determine appropriate fertilizer doses and application timings for zero-tillage cultivation of Binasarisha-9 in gher areas. The experiment was conducted in farmers' fields at Harodda, Satkhira Sadar during the Rabi season of 2024–25 using a randomized complete block design with two factors and three replications. Factor A consisted of fertilizer application timing (10 days before sowing, 10 days after sowing, and 20 days after sowing), while Factor B included fertilizer doses (control, 50%, 75%, 100%, and 125% of the recommended chemical fertilizer dose). Data on yield and yield-contributing traits were collected from five randomly selected plants per plot and analyzed using R software.

Fertilizer application timing had limited influence on most traits, although significant differences were observed for secondary branches per plant, thousand-seed weight, and seed yield. Fertilizer dose significantly affected plant height, primary and secondary branches per plant, and thousand-seed weight, but had no significant effect on siliqua number, siliqua length, seeds per siliqua, or yield. Interaction effects were significant for most agronomic traits except siliqua length and seeds per siliqua. The highest yield (1.59 t ha^{-1}) recorded under the D1T3 combination (10 days before sowing × 75% RCF), whereas the lowest yields occurred in D1T1 and D2T1 (control treatments). These results suggest that applying 75% of the recommended fertilizer dose 10 days before sowing may offer an optimal nutrient management strategy for zero-tillage mustard cultivation in gher areas. Repetition of the experiment in subsequent seasons is recommended to validate these findings.

Up-scaling of BINA developed crop varieties in Khulna region

A total of 539 demonstrations were piloted during 2024-25 using BINA-developed different crop varieties to observe the yield performance and its adoption by the farmers in the Khulna region. Among the BINA-developed crop varieties namely Binadhan-10, Binadhan-17, Binadhan-19, Binadhan-21, Binadhan-23, BINA dhan25, Binasarisha-9, Binasarisha-11, Binachinabadam-8, Binakhesari-1, Binatil-2 and Binamoog-8 showed better performance and well accepted by the farmers of Khulna region.

There were about 77 tons of seeds of different BINA developed crop varieties produced and purchased and distributed 76.5 tons in the BINA substation farm, Satkhira during 2024-25.

One hundred farmers and 50 Sub-Assistant Agriculture Officers (SAAO) were trained on the cultivation procedure of BINA-developed crop varieties in changing climatic conditions to accelerate the adoption of BINA developed crop varieties. Fifteen field days for Binadhan-17, Binasarisha-9, Binasarisha-11, Binadhan-10, Binaholud-1, Binachinabadam-8 and Binamoog-8 were organized to motivate the farmers in Khulna region.

BINA Sub-station, Barishal

Comparative study of Soybean cultivars on the basis of their duration and yield performance cultivated in Barishal region

A field experiment was conducted in experimental field at BINA Sub station Barishal during rabi season of 2024-25 to investigate the best yield production of BINA developed popular soybean variety in southern region. This experiment was conducted in RCBD design with 5 varieties such as Binasoybean-3, Binasoybean-5, Binasoybean-6, BU soybean 2 and Sohag. The treatments were replicated thrice to avoid any effect of heterogeneity as per standard procedure. The size of the unit plots was 3.0 m × 2.5 m maintained 30cm line to line distance. Recommended full amount of phosphorus, potash, sulphur, zinc, boron and 75% nitrogen were applied as basal dose while the remaining amount of nitrogen was applied after 20 days. Intercultural practices were followed as and when necessitated. Yield contributing parameters were collected after physiological maturity. All data were subjected to statistical analysis separately by using analysis of variance technique by SPSS software. The difference among treatment means was compared by using Duncan's Multiple Range Test at 5% probability level.

Different soil fertility condition of soybean shown significant differences in morphological and yield attributes. The lowest flowering duration was observed at Binasoybean-6 and Sohag that was 55 days, maximum flowering duration was observed in Binasoybean-3 (64 days). Physiological maturity duration was more or less similar in all variety that was 101 days. Binasoybean-5 showed maximum plant height 83.46cm. Maximum number of branches was recorded in Binasoybean-6 (4.3) that was statistically similar to Binasoybean-3 (4.01) followed by BU soybean 2. Maximum number of pods was also observed in Binasoybean-6 (69.7) that was statistically different from other varieties. Number of seeds per pod was statistically similar in all varieties.

The result showed that, the highest 1000-seed weight found in BU soybean 2 (23g) followed by Binasoybean-6 (13g) that was statistically different from other varieties. Smaller seed size was observed in Binasoybean-5 and Sohag (8g). The highest seed yield was recorded from Binasoybean-6 (1.45 th^{1}) followed by Binasoybean-5 (1.35 th^{1}) that was statistically different from other varieties. It can be concluded from this experiment that Binasoybean-6 produce maximum grain yield in 100 days period.

Preliminary Yield Trial (PYT) for earliness and higher yield under rainfed condition

The seeds of selected lines were sown at BINA Headquarters field Mymensingh and BINA Substation Rangpur at 15 July 2024 by maintaining plant to plant and row to row distance 20cm and 15cm respectively. One check (viz. BRRI dhan87) was also included in this experiment. The experiment was followed by Randomized Complete Block design with 3 replications. A unit plot size was 3m × 2m. 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 necessitated. Data on plant height, effective tiller $hill^{-1}$, panicle length, filled and unfilled grains $panicle^{-1}$ and grain yield tha^{-1} was recorded. Finally, all the recorded data were subjected to proper statistical analyses as per design used.

Results showed significant variation among the lines and check for most of the characters in individual and over locations in combined analysis. From the result, it was observed that plant height of line RC-3-3-1 were 100.7 cm and 101.7 cm at BINA Headquarter's field and field of BINA substation Rangpur respectively which were statistically dwarfed than all the lines and check variety BRRI dhan87. The line RC-4-1-6 had statistically higher number of effective tillers (9.93 and 9.30) contrasting to other lines at both locations. Panicle length of RC-4-1-8 was recorded highest as 25.20 cm comparing to check BRRI dhan87 (22.63 cm) at the field of BINA Headquarter's, Mymensingh. The highest number of filled grain panicle^{-1} was observed in RC-4-1-8 line (100.8) while lower filled grain panicle^{-1} was found in RC-3-3-1 line (21.93). The line RC-4-3-1 had produced higher yield (6.37 and 6.20 tha^{-1}) than other advanced lines and check BRRI dhan87 (5.10 and 5.08 tha^{-1}) at research field of Mymensingh and Rangpur respectively. The mean duration of RC-4-3-1 were found 119 days over both locations. Considering duration, yield and yield contributing attributes, RC-4-3-1 and RC-4-3-2 can be evaluated for advanced yield trial (AYT).

Growing of M_5 rice mutants derived from Sarsaria for development of deep-water rice

Nine rice mutants exhibiting key deepwater traits including Sarsari, were evaluated under natural field conditions across three locations: Netrokona, Cumilla, and Sunamganj. The experiments followed a RCBD using 30 plots (2 m × 1 m each) with 1-meter spacing between plots. Seeds were broadcast on April 24 during 2024 wet seasons. Planting density was maintained at 20 hills per square meter, with two seedlings per hill at a spacing of 30 cm × 20 cm. Fertilizer was applied according to standard agronomic practices. Weather and water depth data were systematically recorded, with water levels monitored every 10 days using measuring scales and climate data sourced from local stations. As the monsoon intensified in July and August, water depth rose from 25 cm to 160 cm, rendering agronomic practices impractical. Nonetheless, seedlings adapted by floating (35–50 days after sowing) on the water surface facilitated by rapid leaf expansion and stem elongation. Harvesting was completed between November 21 and 25 after water levels receded and the crop reached full maturity under deep water conditions. All the traits were measured after harvesting.

At the farmer's field in Netrokona, the mutant line SRM-54, gave yielded 3.40 tha-^{1}, or 97% more than Sarsari. The mutant SRM-54 also gave yield of 3.13 tha^{-1} at Cumilla which is 89% higher over the parent. The mutant line SRM-68 gave highest yield (3.33 tha^{-1}) at Cumilla region contributing 132% greater than Sarsaria. In contrast, the parent line consistently produced lower grain yields across all locations. Notably, SRM-54 and SRM-68 consistently demonstrated enhanced tillering ability, attaining higher effective tiller plant^{-1} (6.33) in Cumilla and 6.13 in Netrokona, substantially outperforming the parent Sarsari, whose effective tiller plant^{-1} ranged between 3.80 and 4.77. In contrast, SRM-146 exhibited markedly reduced effective tiller plant^{-1} in multiple environments, with a low of 3.07 effective tillers plant^{-1} in Netrokona, reflects a substantial decline from the parental average. Panicle length further distinguished several mutant lines, with SRM-68 emerging as a superior genotype. This line recorded the longest panicles across years and locations, achieving and 25.58 cm in Cumilla surpassing the Sarsari parent, which typically ranged between 22.09 and 21.12 cm. Grain filling performance, evaluated by filled grains panicle-^{1}, revealed that several mutants surpassed the parental line by a considerable margin. According to the duration, yield and yield contributing characters, SRM-54 and SRM-68 can be evaluated to the next trial.

Screening of F_6 generation of rice for earliness with high yielding characters

Thirty five F_6 lines were evolved from Binadhan-5 crossing with BRRI dhan29 and Binadhan-17 to select high yielding, short duration, and lodging resistant plant/progenies. This experiment was conducted Boro season, 2025 at BINA Sub station Barishal, the homozygous lines will be placed on Observation Yield Trial in next growing season.

Comparative Study of Mustard varieties at Barishal region

An experiment was conducted in the research field of BINA Sub-station Barishal to evaluate five mustard varieties Binasarisha-9, Binasarisha-11, BINA sarisha12, BARI Sarisha-14, and BARI Sarisha-18 for yield and yield-related traits.

The varieties showed significant variability for all traits. Plant height ranged from 69.33 cm (BARI Sarisha-14) to 120.00 cm (BARI Sarisha-18). The number of branches varied from 4.33 to 5.33, with minor influence on yield. Siliqua length ranged from 5.00 to 6.33 cm, and siliquas per plant from 50.33 to 75.33, with BARI Sarisha-18 and Binasarisha-9 having the highest values. Seeds per siliqua varied from 19.00 (BINA sarisha12) to 29.67 (Binasarisha-9). The highest yields were obtained from BARI Sarisha-18 (1250.22 kg/ha) and Binasarisha-9 (1210.89 kg/ha), while BARI Sarisha-14 had the lowest (1045.55 kg/ha). Higher yield was associated with taller plants, more siliques, and higher seed numbers per siliqua. BARI Sarisha-18 and Binasarisha-9 performed best for most yield-contributing traits and overall productivity.

Up-scaling of BINA developed crop varieties in Khulna region

A total of 570 demonstrations were piloted during 2024-25 using BINA developed different crop varieties to observe the yield performance and its adoption by the farmers in the Barishal region. Among the BINA developed crop varieties mainly Binadhan-10, Binadhan-24, Binadhan-20, Binasarisha-9, Binasarisha-11, Binachinabadam-8, Binakhesari-1, Binatil-2, Binamoog-8, Binasoybean-5 and Binasoybean-6 showed better performance and well accepted by the farmers of Barishal region.

There were about 45 tons of seeds of different BINA developed crop varieties produced and purchased and distributed 40 tons in the BINA substation Barishal during 2024-25.

Six hundred fifteen farmers and 135 Sub-Assistant Agriculture Officers (SAAO) and 100 Agriculture Extension Officer were trained on the cultivation procedure of BINA developed crop varieties in changing climatic conditions to accelerate the adoption of BINA developed crop varieties.

Twenty field days for Binadhan-20, Binasarisha-9, Binasarisha-11, Binadhan-10, Binadhan-24, Binachinabadam-8 and Binamoog-8 were organized to motivate the farmers in Barishal region.

BINA Sub-station, Gopalganj

To induce genetic variability two wheat varieties were irradiated through gamma irradiations. Gamma irradiated mutant lines showed higher production at lower to moderate doses, with the optimum dose being 150 Gy for Binagom-1 and 200 Gy for BARI Gom33. To know the yield potential and adaptability of eight different rice lines developed through induced mutation and tissue culture field experiments were conducted in two different districts. The field evaluation of M6 generation of eight different rice genotypes identified a superior rice genotype, RM250-99-6A, which produced the highest average yield of 7.68t/ha over two locations. To developed efficient bio-fertilizer for chickpea inoculation, an experiment was conducted in Gopalganj sub-station. This inoculation experiment was conducted using eight different *Mesorhizobium* strains. Among the studied strains, a superior strain BCR 76 showed highly effective symbiosis with chickpea and produced the highest yield of chickpea 2.16 t/ha. Different plant growth – promoting bacterial strains were evaluated at field conditions. Inoculation of rice with plant growth-promoting bacterial strains along with 50% recommended dose of chemical fertilizer found two highly effective strains (GP3 and MCS 52) for maximizing the yield of Binadhan-21. Effect of different nano-fertilizers on growth and yield of sesame were studied. Application of different nano-fertilizers on sesame found a suitable combination of nano-urea and nano-DAP for producing the highest sesame yield (1.74 t/ha) at field conditions. Experiment on the optimization of appropriate time of transplanting for Binadham-16 and Binadhan-17 in Gopalganj showed that, 15 days seedling age for Binadhan-16, and 20 days for Binadhan-17 were suitable time for transplanting to get maximum yield. Cropping pattern experiment conducted at BINA sub-station Gopalganj found a profitable cropping pattern Faridpur region was suggested where all crops performed better in terms of yield and yield contributing characters. A total of 540 demonstrations were conducted at the farmer's fields in the Faridpur region using BINA developed different crop varieties to popularize among the farmers. For promoting the adoption of BINA developed crop varieties and their cultivation a total of 19 field days were organized at farmer field. To increase the knowledge and skills needed for improving the productivity of BINA developed different crop varieties, three farmers training, one sub-assistant agriculture officer, one agriculture officer and 2 workshops for DAE personnel, NGO peoples, seed entrepreneur, journalists were organized at Faridpur region. BINA developed different crop varieties and technologies were intensively disseminated at BINA technology village.

BINA Sub-station, Cumilla

Head-to-head adaptive trial (HHAT) of BINA released mustard-rapeseed variety Binasarisha-9 & Binasarisha-11

Head-to-head adaptive trials (HHAT) of mustard-rapeseed varieties demonstrated the superior yield performance of Binasarisha-9 and Binasarisha-11 over BARI sarisha-14 across four locations, with Binasarisha-9 providing 11–13% higher yield and a moderate maturity duration of 84–88 days. These results confirmed the suitability of BINA varieties for enhancing oilseed productivity under farmer-managed conditions.

Development of a profitable cropping pattern in Cumilla region

Two intensive four-crop cropping patterns were developed and validated in Burichang and Chauddagram Upazilas to replace low-intensity traditional systems. In Burichang, the introduction of Aman (Binadhan-17) – Potato (Diamond) – Sesame (Binatil-2) – Aus (Binadhan-19) increased rice equivalent yield from 7.44 to 19.01 t/ha and raised net returns to Tk 628,720/ha with a BCR of 2.84. In Chauddagram, a pattern integrating Aman (Binadhan-17), Rabi mustard (Binasarisha-11), Sesame (Binatil-2), and Aus (Binadhan-21) increased REY to 24.34 t/ha and improved net returns to Tk 325,131/ha (BCR 1.81). These results highlight substantial opportunities for year-round land use, profitability, and resilience in medium-high land ecosystems.

Seed production

Extensive breeder and truthfully labeled seed production was carried out for major rice, mustard, sesame, soybean, and groundnut varieties, ensuring timely availability of quality seed in the region. A total of 2.0 tons of breeder seed and 50 tons of truthfully labeled (TL) seed were produced.

BINA technology village

A BINA Technology Village was strengthened at Paharpur, Burichang, to promote participatory technology validation and farmer–scientist linkage. Crop museum plots of rice, mustard, and sesame facilitated on-farm learning and technology refinement. Large-scale block demonstrations (527 in total) were conducted on key BINA-developed varieties, including Binadhan-17, Binadhan-24, Binatil-2, Binasarisha-11, and Binalebu-1.

Block demonstration and Up-scaling of BINA developed different varieties in Cumilla region

Rice varieties demonstrated strong yield performance, with Binadhan-24 achieving up to 8.0 t/ha and Binadhan-17 around 7.1 t/ha. Oil crops such as Binasarisha-7 (1.9 t/ha) and Binatil-2 (1.4 t/ha), legumes including Binasoybean-5/-6 (2.3–2.4 t/ha), and groundnut varieties (up to 2.3 t/ha) showed promising outcomes. Citrus variety Binalebu-1 produced exceptionally high yields (25 t/ha), indicating strong potential for horticultural diversification.

Promotional activities

A total of 742 participants—including farmers, SAAOs, seed entrepreneurs, and dealers—received training on rice, oilseed, and citrus cultivation, seed processing, and improved production technologies. Field days organized across multiple locations facilitated farmer exposure and strengthened the dissemination of improved varieties. Overall, the activities of BINA Sub-station Cumilla during 2024–25 significantly contributed to enhancing agricultural productivity, improving seed systems, promoting diversified cropping, and strengthening technology adoption in the Cumilla region. The outcomes underscore the effectiveness of participatory research and adaptive technology dissemination in achieving sustainable agricultural development.

BINA Sub-station, Noakhali

Collection and Characterization of Local Germplasm

A local olive variety (Osmanthus fragrans L.) with a golden endocarp and a sweet taste, and a salinity-tolerant ber landrace (Ziziphus mauritiana L.), were collected for detailed characterization with assistance from the Plant Breeding/Horticulture division. The collected materials will be further evaluated in subsequent seasons for desirable traits, with emphasis on adaptability, distinctive morphological characteristics, and potential to contribute to the development of climate-resilient cultivars for future agricultural sustainability.

Development of a Suitable Cropping Pattern in The Farmer's Field of Noakhali

The experiment was conducted in Subarnachar, Noakhali, during 2024–25 to assess the feasibility of incorporating a short-duration Aus rice variety into the existing Aman–Groundnut cropping pattern. Two cropping patterns, CP1: Aman–Groundnut–Fallow and CP2: Aman–Groundnut–Aus, were evaluated using BINA varieties. Results showed that CP2 produced the highest total rice-equivalent yield (19.72 t ha^{-1}), significantly exceeding the existing pattern (14.51 t ha^{-1}). Including Binadhan-19 as a third crop improved land use efficiency and overall productivity. The study suggests that the Aman–Groundnut–Aus pattern may be more profitable; however, multi-year evaluation is recommended for final validation.

Block Farming of Aman Rice at Lakhsmipur District in 2024-25

A block farming initiative was implemented on 41 bigha of land in Kamalnagar upazila during the Aman season of 2024–25 to evaluate the performance of BINA-released rice varieties under farmers' conditions. Binadhan-17 and Binadhan-23 yielded higher (6.7 and 5.5 t ha^{-1}) than the check variety BRRI dhan95 (5.3 t ha^{-1}) and matured in fewer days. The results indicate that block farming with short-duration, high-yielding varieties such as Binadhan-17 and Binadhan-23 can enhance productivity and help farmers prepare for the next crop season in a timely manner. Additionally, block farming strengthened collective management practices, improved input efficiency, increased buyers' interest, and created opportunities for farmers to market their produce more effectively through uniform crop maturity and synchronized harvesting.

Demonstration and performance of BINA released varieties in the Chattogram region

Demonstrations of BINA-developed crop varieties were held across the Chattogram region during 2024–25 to assess field performance and promote farmer adoption. A total of 579 demonstrations covered rice, oilseed, pulse, groundnut, and fruit crops. Varieties tolerant to salinity and with desirable qualitative traits, including Binalebu-1 (seedless), Binadhan-10, Binadhan-23, Binachinabadam-6, Binasoybean-6, Binasarisha-9, and BINA sarisha12 (high oil content), attracted strong interest. Overall, the demonstrations confirmed the suitability and potential of BINA varieties across the region's diverse agro-ecological zones.

Production of quality seed of BINA released popular crop varieties

Seeds of BINA-released crop varieties were produced at the sub-station farms and in farmers' fields across multiple locations, and some of those seeds were purchased during 2024-25. A total of 49.25 t of TLS seed for various crops was produced at the Sub-station, Noakhali, during 2024-25.

Training on the use of BINA developed technologies

To transfer BINA-developed technologies, BINA Substation, Noakhali, organized a total of eleven training programs. Participants included farmers (both male and female), Sub-Assistant Agriculture Officers (SAAOs), Upazilla Agriculture Officers (UAOs), Agriculture Extension Officers (AEOs), and officers from various organizations. During 2024-25, five farmers' training sessions, two SAAO training sessions, two UAO training sessions, and two workshops were conducted.

Field Day

To motivate farmers to adopt BINA-developed varieties and technologies, a total of 13 field days on various crop varieties were organized in the Chattogram region.

BINA Sub-station, Jamalpur

Effect of biochar and vermicompost on Mustard production under minimum tillage

An experiment was conducted at BINA sub-station farm, Jamalpur in order to assess the effect of different organic amendments on soil nutrients, aggregation and crop yields. Five different fertilizers with manure treatments were assigned with minimum tillage (MT) practices in the 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} vermicompost + RCF (IPNS); T_5: 1 tha^{-1} biochar +1 tha^{-1} vermicompost + RCF (IPNS). Biochar and vermicompost based treatment (T_5: 1 tha^{-1} biochar +1 tha^{-1} vermicompost +RCF(IPNS) increased SOC accumulation, soil aggregate stability and improved soil structure.

Demonstration with different aman rice, mustard, Boro rice, Aus rice, sesame and groundnut varieties developed by BINA

A total of 437 demonstrations were successfully carried out to extend promising varieties/technologies among the farmers and SAAOs through seed distribution programme at different locations in Jamalpur and Tangail regions during 2024-25. A total of 93 demonstrations were carried with BINA released short duration high yielding boro rice variety (Binadhan-14, Binadhan-24 and BINA dhan25) which produced better yield with less maturity period than the check variety of local cultivars.

In total, 100 demonstrations were conducted with short duration high yielding Binasarisha-9, Binasarisha-11 and Binasarisha-12. Binasarisha-11 had the same yield and maturing time as the check variety of BARI sarisha-14. Binasarisha-11 had higher disease resistance capacity, varietal purity, more oil content than BARI sarisha-14. A total of 60 demonstrations were carried with high yielding sesame variety Binatil-2 which produced the seed yield 1.3 tha^{-1} along with the short maturity period of 89 days than BARI til-3. A total of 25 demonstrations were carried with high yielding groundnut variety (Binachinabadam-6, Binachinabadam-8) which produced better yield but lower maturity period than the check varieties of local cultivars (BARI chinabadam-9).

A total of 60 demonstrations were carried with high yielding Aus varieties which maturity period is less than BRRI dhan-48. The check variety was BRRI Dhan 48. BINA developed Aus rice varieties are mature earlier and high yielding than the check varieties. Average maturity period of Binadhan-21 was 105 days and Binadhan-21 mature at 99 days. Farmers are recommended to cultivate Aus as cluster to rectify bird infestation.

Training Programme

In order to transfer BINA developed technologies some farmers training was arranged by BINA Substation, Jamalpur. Twe regional workshop of Bina released popular varieties in Jamalpur and eight farmers training/ seed entrepreneur, UAO/AAO/AEO training were arranged in the year of 2024-25. Participants were farmer (both male and female).

Field Days

In order to motivate the farmer and evaluate the yield of BINA developed varieties, twenty (20) field days on different crop varieties were arranged by BINA Substation, Jamalpur in the year of 2024-25. The participants were farmer (both male and female) and SAAO and UAOs.

BINA Sub-station, Nalitabari

The combined effect of organic and inorganic fertilizers on the growth and yield of T. Aman rice (Binadhan-17) and mustard (Binasharisha-11) 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 highest number of tiller $plant^{-1}$, highest panicle length, number of filled grain $plant^{-1}$, 1000 seed weight which resulted 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 highest plant height, highest number of pod $plant^{-1}$, highest seed pod^{-1} and 1000 seed weight which resulted greater grain yield as compared to control treatment.

Block demonstration with different BINA released crop varieties in Sherpur and Netrokona Districts

110 demonstrations of T. Aman rice varieties with Binadhan-11, Binadhan-17, Binadhan-20, Binadhan-22 and BINA dhan26 produced average grain yield of 5.5 t ha^{-1} at Sherpur and Netrokona districts.

100 demonstrations of Boro rice varieties with Binadhan-10, Binadhan-24and BINA dhan25 produced average grain yield of 7.52 t ha^{-1}.

100 demonstrations of Mustard varieties with Binasharisha-11 produced average grain yield of 1.50 t ha^{-1}. The average maturity period was 81 days.

Profitable cropping pattern by BINA released varieties in Sherpur and Netrokona district.

Rice based pattern are in Sherpur and Netrokona district mostly Indigenous rice (60% local rice like as Tulsimala, Chinishail and Pajam)- Fallow- Boro rice (mainly Hybrid) (75 % land Covered). To increase the cropping intensity and change the cropping pattern to improve the socio-economic condition of the Sherpur and Netrokona farmers, BINA substation Nalitabari worked with specific advantages of crop varieties to the farmers adaptation at large scale and included BINA technologies in the existing cropping pattern as T. aman (Binadhan-11/17) –Rabi (Binasarisha-11) –Boro (Binadhan-24) during 2024-25 at Ambagan, Naliatabari, Sherpur. This experiment continued for last two year. It has been observed that this cropping pattern is being rapidly disseminated among the local growers.

Production of quality seed of BINA released popular crop varieties in Sherpur district.

Seeds of BINA released crop varieties popular in Sherpur and Netrokona district were produced at the sub-station farms and also in the farmer's fields of different locations and part of those seeds were purchased during 2024-25. Total 31.33 t of TLS seed of different crops were produced during 2024-25 under Bangladesh Institute of Nuclear Agriculture Sub-station, Nalitabari, Sherpur.

Training on the use of BINA developed technologies

In order to transfer BINA developed technologies eleven training programme was arranged by BINA Substation, Nalitabari, Sherpur. The participants were farmers (both male and female), Sub-assistant Agriculture Officer (SAAO) and officers of various organization. 8 farmer's training, two SAAO training, one workshop and thirteen field days were conducted at Sherpur and Netrokona districts during 2024-25 year.

Field Day

In order to motivate the farmers to adopt BINA developed varieties/technologies, thirteen field days on different crop varieties were organized in Sherpur and Netrokona district.

BINA Sub-station, Sunamganj

The Annual Research Report 2024–25 of BINA Sub-station, Sunamganj presents a series of field experiments, demonstrations, and technology dissemination activities aimed at improving crop productivity, cropping intensity, and farmers' adoption of BINA-developed varieties in the haor region.

Effect of Fe and Zn nanoparticles on growth and yield of groundnut

A field experiment was conducted at BINA Sub-station, Sunamganj to evaluate the effect of foliar application of iron (Fe) and zinc (Zn) nanoparticles on the growth and yield of groundnut (Binachinabadam-8). Seventeen treatments including different combinations and concentrations of Fe and Zn nanoparticles were tested following a randomized complete block design with three replications. Results indicated significant variation in growth and yield attributes. The combined application of RDF + Zn 100 mg L^{-1} + Fe 50 mg L^{-1} (T_8) produced the highest pod number per plant (34.0) and yield (3.00 t ha^{-1}). The study demonstrated that moderate levels of Fe and Zn nanoparticles synergistically improved groundnut productivity under haor conditions.

Role of different herbicides on growth, yield and weed control capacity of Boro rice

An on-station field experiment was conducted during Boro season (2024–25) to evaluate the efficacy of selected herbicides on weed control and yield performance of BINA dhan25. Four treatments—control, Pretilachlor 500 EC, Carfentrazone-ethyl 24 EC, and Pyrazosulfuron ethyl 10 WP—were tested. Carfentrazone-ethyl 24 EC showed superior weed control with the highest weed control index (82.23%), maximum filled grains per panicle (154.6), and the highest grain yield (6.27 t ha^{-1}). The results confirmed Carfentrazone-ethyl 24 EC as an effective herbicide for Boro rice cultivation in Sunamganj.

Evaluation of two-crop based cropping pattern with mustard and short-duration Aman rice

Field trials were conducted at Fenibill (Sunamganj sadar) and Masimpur (Biswamvarpur) to evaluate the feasibility of introducing mustard (Binasarisha-11) into existing single-crop Aman systems. The improved cropping pattern Aman–Mustard–Fallow significantly increased system productivity compared to Aman–Fallow–Fallow. Rice equivalent yield (REY) ranged from 10.28 to 11.63 t ha^{-1} in the improved pattern, compared to 5.65–6.38 t ha^{-1} in the existing system. The study demonstrated that inclusion of mustard effectively increased cropping intensity and farm income in haor areas.

Generation of three-crop based cropping pattern with mustard and Boro rice

A three-crop system comprising T. Aman (Binadhan-17)–Mustard (Binasarisha-11)–Boro (Binadhan-14) was evaluated at Biswamvarpur upazila. Compared to the traditional T. Aman–Fallow–Boro system, the improved pattern recorded a higher REY (15.44 t ha^{-1}) than the control (11.51 t ha^{-1}). The findings indicated that integrating mustard between rice crops enhanced land use efficiency and profitability, making the system suitable for medium-high lands of Sunamganj.

Evaluation of three-crop based cropping pattern with sesame and Aus rice

An experiment was conducted at Syedpur, Sunamganj sadar, to assess the feasibility of T. Aman–Sesame–T. Aus cropping sequence using BINA varieties. The improved pattern produced a higher REY (15.25 t ha^{-1}) compared to the existing T. Aman–Fallow–T. Aus system (10.57 t ha^{-1}). Sesame (Binatil-2) performed satisfactorily and added an additional income source during the Rabi season. The system was found agronomically viable and economically profitable.

Evaluation of three-crop based cropping pattern with groundnut and Aus rice

Field trials conducted at Muslimpur and Mollapara (Chhatak) evaluated groundnut-based three-crop systems. The cropping pattern T. Aman (Binadhan-17)–Groundnut (Binachinabadam-8/10)–T. Aus (Binadhan-19) achieved the highest productivity, with REY ranging from 18.6 to 19.37 t ha^{-1}, compared to 4.61–8.74 t ha^{-1} in traditional systems. Results confirmed that groundnut inclusion substantially improved cropping intensity and farmers' income in haor and basin lands.

Performance of BINA released crop varieties under demonstration

A total of 491 demonstrations of BINA-released rice, oilseed, pulse, and spice varieties were conducted across Sunamganj and the greater Sylhet region. Rice varieties such as Binadhan-17, Bina dhan25, Binadhan-24, and Bina dhan26 showed excellent yield performance and strong farmer acceptance. Oilseed crops including Binasarisha-11, Binatil-2, and Binachinabadam-8 also performed satisfactorily. The demonstrations confirmed the adaptability and stability of BINA varieties under farmer-managed conditions.

Seed production, training, field days and technology dissemination

During 2024–25, over 40.2 tons of truthfully labeled seed were produced, covering rice, oilseed, pulse, and spice crops. The sub-station organized farmer and extension personnel trainings, field days, and two regional workshops involving more than 1,000 participants. These activities enhanced farmers' awareness, technical skills, and adoption of BINA developed varieties and profitable cropping patterns in Sylhet region.

BINA Sub-station, Chapainawabganj

Exogenous Application of Salicylic Acid to Mitigate Drought Stress in Rice under Field Conditions

An experiment was conducted at the BINA Sub-station, Chapainawabganj to evaluate the effect of exogenous application of salicylic acid (SA) on drought-stressed rice. The study was designed as a randomized complete block design (RCBD) with three replications. The experiment included six treatments: T_1 (Control: no SA + no drought), T_2 (drought only), T_3 (500 µm SA), T_4 (500 µm SA + withdrawal of water for 15 days), T_5 (800 µm SA + withdrawal of water for 15 days), and T_6 (1000 µm SA + withdrawal of water for 15 days). The plot size was 2 m × 3 m, and the rice was transplanted according to recommended agronomic practices. Fertilizer application followed the BARC fertilizer guide. SA can be a practical approach to improving drought tolerance and sustaining rice productivity in drought-prone areas.

Demonstration with different aman rice, mustard, Boro rice, Aus rice, sesame and groundnut varieties developed by BINA

A total of 435 demonstrations were successfully carried out to extend promising varieties/technologies among the farmers and SAAOs through seed distribution programme at different locations in Chapainawabganj,Rajshahi and Naogaon regions during 2024-25. A total of 80 demonstrations were carried with BINA released short duration high yielding boro rice variety (Binadhan-14, Binadhan-24 and BINA dhan25) which produced better yield with less maturity period than the check variety of local cultivars.

In total, 95 demonstrations were conducted with short duration high yielding Binasarisha-9, Binasarisha-11 and Binasarisha-12. Binasarisha-11 had the same yield and maturing time as the check variety of BARI sarisha-14. Binasarisha-11 had higher disease resistance capacity, varietal purity, more oil content than BARI sarisha-14.

A total of 50 demonstrations were carried with high yielding sesame variety Binatil-2 which produced the seed yield 1.3 tha^{-1} along with the short maturity period of 89 days than BARI til-3.

A total of 10 demonstrations were carried with high yielding groundnut variety (Binachinabadam-6, Binachinabadam-8) which produced better yield but lower maturity period than the check varieties of local cultivars (BARI chinabadam-9).

A total of 90 demonstrations were carried with high yielding Aus varities which maturity period is less than BRRI dhan-48. The check variety was BRRI Dhan 48. BINA developed Aus rice varieties are mature earlier and high yielding than the check varieties. Average maturity period of Binadhan-19 was 99 days and Binadhan-19 mature at 101 days. Farmers are recommended to cultivate Aus as cluster to rectify bird infestation.

A total of 100 demonstrations with Binadhan-17, Binadhan-20 and Binadhan-22 were conducted at the farmer's fields in Rajshahi region. The check variety was BRRI dhan75. Average maturity period of Binadhan-17 was 110 days, Binadhan-20 was 125 days and Binadhan-22 was 115 days. Farmers are interested to cultivate Aman rice during T. Aman season in Rajshahi region.

A total of 20 demonstrations were carried with high yielding lentil variety Binamasur-8, which produced the seed yield 1.65 tha^{-1} along with the short maturity period of 105 days than BARI masur-8. A total of 20 demonstrations were carried with high yielding chickpea variety Binachola-6 which produced the seed yield 1.4 tha^{-1} along with the short maturity period of 122 days than check variety. A total of 10 demonstrations were carried with high yielding Mungbean variety Binamoog-8 which produced the seed yield 1.22 tha^{-1} along with the short maturity period of 70 days than check variety.

Training Programme

In order to transfer BINA developed technologies some farmers training was arranged by BINA Substation, Chapainawabganj. Two regional workshop of Bina released popular varieties in , Chapainawabganj and Six farmers training/ seed entrepreneur, Two training programme for SAAOs, one for UAO/AAO/AEO training were arranged in the year of 2024-25. Participants were farmer (both male and female).

Field Days

In order to motivate the farmer and evaluate the yield of BINA developed varieties, Ten (10) field days on different crop varieties were arranged by BINA Substation, Jamalpur in the year of 2024-25. The participants were farmer (both male and female) and SAAO and UAOs.

BINA Sub-station, Khagrachari

Screening of ozone stress introgressed rice (Oryza sativa L.) line/genotypes for greater grain quality and higher yield

Ground-level ozone stress poses a significant threat to rice productivity, necessitating the development of tolerant varieties. A field experiment was conducted during the Boro 2024–25 season at the Bangladesh Institute of Nuclear Agriculture (BINA) Sub-station farm in Khagrachari to evaluate the performance of 12 Kasalath-introgressed ozone-tolerant rice lines. These lines were compared against two check varieties: BRRI dhan28 and Binadhan-11. The evaluated genotypes exhibited significant variation in growth duration and morphological traits. Growth duration ranged from 131 to 148 days, while plant height varied between 77 cm (MFOL-1547) and 92 cm (MFOL-471). Yield analysis revealed that nine of the introgressed lines outperformed the check variety BRRI dhan28, with grain yields ranging from 6.32 to 6.83 t/ha. Based on superior yield-contributing characters and overall agronomic stability, nine promising lines—MFOL-1302, MFOL-1491, MFOL-471, MFOL-328, MFOL-2197, MFOL-1488, MFOL-1547, MFOL-1102, and MFOL-1956—were selected for further multi-location evaluation in the subsequent Boro season. These findings suggest that these Kasalath-derived lines hold high potential for stabilizing rice production in ozone-prone environments.

Farmers observation trials with T. Aman rice

Farmer observation trials were conducted in the Khagrachari district during the T. Aman 2024–25 season to evaluate the performance of Binadhan-12 and BINA dhan26 in comparison with the local check variety, Sylheti Pajam. The study aimed to identify high-yielding, adaptable varieties suitable for the unique agro-ecological conditions of the Chittagong Hill Tracts and to encourage regional adoption. Results indicated significant variations in morphological and yield parameters. Sylheti Pajam recorded the greatest plant height (114.5 cm), followed by BINA dhan26 (90.2 cm) and Binadhan-12 (88.9 cm). In terms of productivity, BINA dhan26 achieved the highest grain yield (5.8 t/ha), significantly outperforming Binadhan-12 (4.2 t/ha) and the local check (3.7 t/ha). Despite the higher raw yield of BINA dhan26, qualitative feedback revealed that farmers favored Binadhan-12 for its early maturity and superior fine-grain quality. The findings suggest that while BINA dhan26 is ideal for maximizing production, Binadhan-12 offers a strategic advantage for farmers seeking shorter crop durations and high-market-value grain, highlighting both varieties as suitable candidates for expanded promotional activities in the hill tracts.

Farmers observation trials with Aus rice

On-farm observation trials were conducted in the Khagrachari district during the Aus 2024–25 season to evaluate the performance of BINA-developed varieties (Binadhan-19 and Binadhan-21) against the widely cultivated check, BRRI dhan48. The study aimed to identify high-yielding, short-duration varieties capable of optimizing crop intensification in the Chittagong Hill Tracts. The experimental results indicated that while BRRI dhan48 exhibited superior vegetative growth—recording the tallest plants (103 cm), highest number of effective tillers (16.7), and longest panicles (23.3 cm)—it did not translate into the highest grain yield. Conversely, Binadhan-19 demonstrated the highest resource-use efficiency, producing the

maximum grain yield of 4.5 t/ha with the shortest maturity duration of 98 days. Binadhan-21 followed with a yield of 4.4 t/ha in 112 days, while BRRI dhan48 yielded 4.3 t/ha in 109 days. The findings highlight Binadhan-19 as the most promising variety for the region, as its combination of early maturity and high yield potential facilitates timely crop rotation and enhances overall system productivity in hill farming.

Observational trials of four mustard varieties

A field experiment was conducted at the BINA Sub-station Farm in Khagrachari during the Rabi season of 2024–25 to evaluate the performance of three BINA-developed mustard varieties (BinaSarisha-9, BinaSarisha-10, and Binasarisha-11) against the check variety BARI Sarisha-14. The study utilized a Randomized Complete Block Design (RCBD) with three replications to identify promising traits and high-yielding candidates suitable for regional farmer adoption. The results revealed significant variations in yield-contributing characters and maturity. While BARI Sarisha-14 matured earliest (85 days), it produced the lowest seed yield (1.2 t/ha). In contrast, BinaSarisha-10 recorded the highest number of siliquae per plant (47.4), and Binasarisha-11 exhibited the maximum number of seeds per siliqua (22.4). However, BinaSarisha-9 achieved the highest overall seed yield of 1.5 t/ha, outperforming Binasarisha-11 (1.4 t/ha) and BinaSarisha-10 (1.3 t/ha). Based on these findings, BinaSarisha-9 is recommended as a superior high-yielding variety for cultivation in the Khagrachari region to enhance oilseed productivity.

Development of improved cropping pattern in Chittagong Hill Tracts

A field study was conducted during the 2024–25 cropping cycle (Kharif-II, Rabi, and Kharif-I) in the Sadar, Panchari, and Dighinala upazilas of Khagrachari to evaluate the performance of high-yielding varieties developed by the Bangladesh Institute of Nuclear Agriculture (BINA). The primary objectives were to increase cropping intensity, improve land-use efficiency, and enhance soil health through the adoption of profitable cropping patterns. The proposed Aman–Mustard–Aus pattern—utilizing Binadhan-17/26, Binasarisha-11, and Binadhan-19/21—was compared against traditional local practices (Aman–Mustard–Fallow and Aman–Fallow–Aus). Results indicated that the early-maturing BINA varieties successfully facilitated a triple-cropping system, significantly outperforming existing local practices in terms of total yield and economic return. The proposed pattern achieved Benefit-Cost Ratios (BCR) of 1.40 in Sadar, 1.67 in Panchari, and 1.63 in Dighinala. These findings demonstrate that the integration of short-duration BINA varieties can effectively boost cropping intensity and farmer income in hill agroecosystems, providing a sustainable model for regional food security.

Up-scaling of BINA-Developed Varieties to Enhance Productivity and Farmer Income in the Chittagong Hill Tracts

A comprehensive series of 305 field demonstrations were conducted across diverse agro-ecological zones in Khagrachari, Rangamati, and Bandarban during the 2024–25 cropping cycle. The study aimed to evaluate the performance of high-yielding varieties (HYVs) developed by the Bangladesh Institute of Nuclear Agriculture (BINA) across five distinct seasons: Aman, Rabi, Boro, Kharif-I, and Aus. The results demonstrated substantial productivity gains across all crop categories. In T. Aman, Binadhan-17 and BINA dhan26 achieved average yields of 5.5 t/ha and 6.2 t/ha, respectively. The Boro season showed even higher rice productivity, with BINA dhan25

leading at 6.7 t/ha. Oilseed and pulse demonstrations during the Rabi and Kharif-I seasons were equally successful; Binasarisha-11 yielded 1.47 t/ha, Binachinabadam-8 produced 2.24 t/ha, and Binamoog-8 reached 1.12 t/ha. Notably, the turmeric variety Binaholud-1 recorded a significant yield of 31.2 t/ha. The study concludes that BINA-developed varieties are highly suitable for the hill agroecosystem. Their early-maturing traits provide a critical window for increasing cropping intensity, while their significantly higher yield potential offers a robust pathway for increasing the income and food security of hill tract farmers.

Quality seed production of potential BINA released varieties

To ensure the sustainability of high-yielding patterns, the BINA Sub-Station in Khagrachari, in collaboration with contract growers, produced 24.65 tons of quality seeds. These findings highlight the superior adaptability and yield potential of BINA varieties in the hill tracts, suggesting that large-scale adoption could significantly boost regional food security and farmer income.

Capacity Building and Technology Transfer: Strengthening the Agricultural Extension Value Chain in the Chittagong Hill Tracts

Effective dissemination of modern agricultural technologies requires a multi-stakeholder approach involving training, field-level demonstrations, and institutional coordination. During the 2024–25 reporting year, the BINA Sub-station in Khagrachari implemented a comprehensive capacity-building program aimed at bridging the gap between research and field adoption. Key activities included the training of 350 farmers and seed dealers, focusing on BINA developed high-yielding variety (HYV) management and quality seed production and preservation. To strengthen the extension network, two specialized training sessions were organized for entrepreneurs and frontline agricultural officers (AAEOs, SAPPOs, and SAAOs). Knowledge sharing was further facilitated through four strategic workshops involving 315 Department of Agricultural Extension (DAE) personnel, fostering institutional synergy. To demonstrate the real-world performance of climate-smart varieties, six field days were conducted, specifically showcasing the success of Binasarisha-11, BINA dhan25 and Binachinabadam-8. These initiatives collectively enhanced the technical competencies of local stakeholders, ensuring a more robust and responsive agricultural support system for the development of the hill tracts' agroecosystem.