কৃষিই সমৃদ্ধি

ANNUAL REPORT

2022-23

BANGLADESH INSTITUTE OF NUCLEAR AGRICULTURE

September 2023

ANNUAL REPORT
2022-23

BANGLADESH INSTITUTE OF NUCLEAR AGRICULTURE
BAU CAMPUS, MYMENSINGH-2202, BANGLADESH
September 2023

Compiled and Edited by:

- Dr. Md. Abdul Malek, Director (Research)
- Dr. Md. Monjurul Islam, CSO (RC)
- Dr. Md. Roknuzzaman, SSO, Research Coordination Office

Published by:

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

Phone : (029966) 67834, 67835, 67837, 66127
Fax : (029966) 67842, 67843, 62131
E-mail : dirresearch@bina.gov.bd
monjurul2004@yahoo.com
Website : www.bina.gov.bd

Composed by:

Dr. Md. Roknuzzaman

PREFACE

Bangladesh Institute of Nuclear Agriculture (BINA) Annual Research Report 2022-23 would inaugurate a new dimension of research findings exposure. I am certainly delighted to note that this report emphasizing key research outcomes dealing with the use of nuclear and other advance techniques. This report covers several very important sectors of agriculture including food security, livelihood enhancement as well as socio-economic improvement of the country. Many technologies, such as varietal development of cereals (rice and wheat), oilseeds (mustard, rapeseed, groundnut, sesame, soybean and sunflower), pulses (lentil, mungbean, blackgram, chickpea, grasspea, pigeonpea), jute, horticultural crops (fruits, vegetables and spices) have already been found suitable for different agro-ecological zones. Apart from the varietal development attention was also placed on non-commodity fields as soil and water management, crop physiological aspects, cropping systems, plant nutrient, pest management, adaptive research and production economics. Emphasis was concentrated on biotechnological research for generating high yielding and climate tolerant crop types and hill farming. This study demonstrates that the scientists of this institute are devoted to create technologies which are appropriate as well as sustainable leading to food and nutritional security of the country. During this period substantial progress was made towards the development of new crop kinds. Six crop varieties were released/registered during this period which are BINA mash3, BINA moog12, BINA sarisha12, BINA soafeda1, BINA chinabadam11 and BINA dhan26. A total of 510 adaptive trials/block farming using BINA developed crop varieties were undertaken at the farmers' field in partnership with the Department of Agricultural Extension (DAE) and BINA Sub-stations and regional station. To motivate farmers and popularize the BINA developed crop varieties/technologies to the end users a total of 65 farmers training courses were organized during this period and 4102 male and female farmers were trained on cultivation of BINA developed improved crop varieties across the country. Besides these, various TV programme were telecasted to market some BINA crop varieties.

I recognize the endeavors that aid with the publication with genuine gratitude to knowledge contribution of deep capacities. This annual report would be highly functional for all scientists, academics, planners, policy makers as well as interested individuals involving agricultural research and development concern in the country and overseas.

Dr. Mirza Mofazzal Islam
Director General

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.

PLANT BREEDING DIVISION

RESEARCH HIGHLIGHTS

Rice

Three selected rice lines viz. BLB-P-19, MEF-27 and BN-P-318 have been sent to SCA for DUS test for releasing variety. The line BLB-P-19 is Bacterial leaf blight (BLB) resistant and selected for the cultivation in T. *Aman* season. It matured within 115-120 days and produced grain yield of 6.0-6.5 tha^{-1}. Another Blast resistant rice line BN-P-318 was selected for the cultivation in T. *Aman* Season. The growth duration of BN-P-318 is 110-115 days and produced 6.50-7.00 tha^{-1} of grain yield. The line MEF-27 was selected for the growth duration of this line is 140-145 days and produced grain yield of 7.0-7.5 tha^{-1}.The line MEF-27 is suitable for the cultivation at haor areas. Apart from this three lines, Fe and Zn enriched rice line IZSD-26 was selected for T. *Aman* season which matured within 110-115 days and produced 5.5-6.0 tha^{-1} of grain yield.

Wheat

One selected promising line BWM-M-1-2-1 produced higher yield (4.01tha^{-1}) than the check variety BARI Gom-28 (3.91 tha^{-1}) will be evaluated.

Rapeseed

One rapeseed variety has been released named as BINA Sarisha12 having low erucic acid (26%), early maturing (82-86 days) with higher (2.0 tha^{-1}) seed yield. Two promising rapeseed mutants (RT-38 and RT-39) were selected for further trials on the basis of their yield stability and other agronomic traits. Twenty mutants and eight advanced rapeseed lines from different trials also been selected in respect of maturity along with some others yield components.

Sesame

Two promising white seed coat color sesame mutants (SM-25 and SM-26) has been selected in respect of higher seed yield potential and other agronomic characters. From these two mutants one mutant will be applied to the NSB for releasing as a new variety. Nine advance sesame mutants were selected from different trials on the basis of their agronomic performances.

Soybean

Two advanced soybean mutants (SBM-22 and SBM-25) were selected as promising mutants and fifteen advanced soybean mutants were selected based on early maturing along with higher seed yield.

Sunflower

Nine promising sunflower mutants were found as early maturing along with higher seed yield potential from different generations.

Groundnut

Yield of the mutant, B6/282/80 was 2.04 tha^{-1} which was higher than the check variety Binachinabadam-4 (1.96tha^{-1}). The mutant line B6/282/80 had higher shelling percentage and bigger kernel size. The groundnut variety BINA Chinabadam11 has been released by NSB for Rabi and Kharif season.

Five promising mutants of groundnuts were selected for advanced yield trial (AYT) on the basis of early maturity and higher seed yield.

Mungbean

Two promising mutants MB-03 and MB-07 were selected for earliness, synchronous pod maturity, disease tolerant and higher yield from preliminary yield trial.

Jute

Two mutants BJM-10-1-3 and BJM-10-1-5 had taller plant height and higher fiber yield than the parent, JRO-524 have been selected for regional Yield Trial in the next season.

On-farm and on-station yield trial of rice lines for earliness and higher grain yield

Due to the significance impact of rice in ensuring national food security and income for those with low incomes, achieving self-reliance in rice production and maintaining price stability are significant goals in low-income countries. Developing short duration rice cultivars is considered to be one of the most effective and economic approaches for ensuring food security particularly in northern part of the country. The objectives of the study were to investigate the yield potential of the selected line over locations. For this experiment, 2 lines MPQR-12, MPQR-62 with two check varieties BRRI dhan49 & BRRI dhan75 were used during *T.Aman* season 2022-23 at different location under the supervision of BINA HQ and BINA Sub-stations. The experiment was followed RCB design with three replications. The size of unit plot was 4.0m × 5.0m. Plant to plant distance was 15cm and row to row distance was 20cm. Data on days to flowering, days to maturity, plant height, total number of tillers hill^{-1}, number of effective tillers hill^{-1}, panicle length, filled grain and unfilled grains panicle^{-1} and grain yield (t ha^{-1}) were recorded at harvest from five randomly selected competitive plants plot^{-1}. The collected data were analyzed with Statistix 10 package. Significant variations were observed among the lines and check varieties for most of the characters in both of individual location and combined over locations. Results from combined mean over locations, it was revealed that MPQR-12 performed better in term of earliness (108 days), higher filled grains panicle^{-1} (125) than the two checks. The highest grain yield of MPQR-12 was found in BINA HQ farm, Mymensingh (4.57 tha^{-1}) and the lowest was found at BINA Sub-station Ishwardi (4.27 tha^{-1}). Yield performance of 2 rice lines are not satisfactory comparing to the checks. Further yield trial should be carried out in next season for confirmation of the results.

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

Bacterial leaf blight (BLB) of rice, caused by *Xanthomonas oryzae*pv. *Oryzae (Xoo)*, is a major pathogen that negatively impacts rice production. This experiment was carried out to assess high yield attributes of two BLB resistant rice lines along with check variety BRRI dhan75 tested in *Aman* season during 2022 at BINA HQs farm, Mymensingh and BINA Sub-station farm Rangpur, Ishwardi & Nalitabari and farmer's field of Mymensingh and Netrokona. The size of unit plot was 4.0m × 5.0m and plant spacing was 15cm × 20cm. Data on days to flowering, days to maturity, plant height, total number of tillers plant^{-1}, number of effective tillers plant^{-1}, panicle length, number of filled and unfilled grains panicle^{-1}, 1000-grain weight and grain yield/plot were recorded at harvest from five randomly selected competitive plants/plots. Maturity was assessed by plot basis. Plot yield was converted to tha^{-1}. Recorded data were finally subjected to proper statistical analyses. The results obtained from these trials of individual location and mean over locations for all characters are presented. Most of the characters showed significant differences among the lines and check for three individual locations and mean over locations. In respect of yield, BLB-P-19 produced the highest grain yield (6.24 tha^{-1}) followed by BLB-P-26 (5.83 tha^{-1}). The higher

yield is contributed by the higher number of filled grains panicle^{-1} than the check variety at all the locations. It also produced the higher thousand grain weight than the check variety. There were no significant difference among the test lines and check for the number of total tillers and effective tillers. Both lines were found resistant to BLB while check showed susceptible in visual observation at all locations. Quality assessment was done based on kernel length and L/B ratio. The kernel shape and size of BLB-P-19 and BLB-P-26 was long-slender (mm) and medium-slender (mm), respectively where the BRRI dhan75 was medium. BLB-P-19 showed better yield potential and agronomic performance, better grain quality characters over the check varieties and tolerance to BLB. Considering BLB resistance and high yield performance, BLB-P-19 could be selected for further evaluation for releasing a BLB resistant variety in T. *Aman* season.

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

Bacterial blight (BB) is caused by Xanthomonas oryzaepv. oryzae (Xoo), a most destructive disease of rice, mostly in Asia, including Bangladesh.This experiment was carried out to assess high yield attributes of one BLB resistant rice line i.e. BLB-P-42 along with one check BRRI dhan28 in *Boro* season during 2022-23 at BINA HQs farm, Mymensingh and BINA Sub-station farm at Ishwardi, Sunamganj, Nalitabari, Cumilla and farmer's field of Mymensingh. Plant to plant and line to line distance were maintained 15cm and 20 cm, respectively. The size of unit plot was 5.0m × 4.0m. The experiment was laid out following RCB design with three replications. Data on days to flowering, days to maturity, plant height, total number of tillers hill^{-1} number of effective tillers hill^{-1}, panicle length, filled and unfilled grains panicle^{-1}, 1000-grain weight and grain yield/plot were recorded at harvest from five randomly selected competitive plants/plots. Maturity was assessed by plot basis. Plot seed yield was converted in tha^{-1}. Recorded data were finally subjected to proper statistical analyses.

The results revealed from on-farm and on-station yield trials of individual location and mean over locations for all the characters are presented. Results mean over three locations, on an average, some characters showed significant differences and some other shows non-significant among the lines and check for both individual locations and mean over locations. Among the lines and check varieties, BLB-P-42 had the longest plant height at all the locations. The highest number of total tillers hill^{-1} and number of effective tillers hill^{-1} were observed at almost all the locations but not significantly difference with the check. It also had the longest panicle and the highest number of filled grains panicle^{-1} at almost all the locations. This line (7.01t/ha) produced significantly highest yield at mean over locations than the check variety (6.26 tha^{-1}). It had almost same duration with check BRRI dhan58. It also had the lowest thousand grain weight (21.21 g) which indicate fine grain quality. Quality assessment was done based on kernel length and L/B ratio. The kernel shape and size of BLB-P-42 was long-slender where the BRRI dhan58 was medium. Considering BLB resistance and high yield performance, BLB-P-42 could be selected for further evaluation to release it as a BLB resistant variety in *Boro*season.

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

Rice Blast caused by the fungal pathogen *Magnaporthe oryzae* is one of the most devastating diseases worldwide. This experiment was carried out to assess the yield and yield attributes of one blast resistant rice lines along with one check variety BRRI dhan49 in*Aman* season during 2022 at BINA HQs farm, Mymensingh, BINA sub-station farm Rangpur, Cumilla, Magura and Nalitabari and farmer's field of Mymensingh and Rangpur. Seeds were sown on 2-10th July 2022 and transplanted on 25-31 July 2022 at different locations. The experiment

was followed RCB design with three replications. The size of unit plot was 4.0m × 5.0m. Plant to plant distance was 15cm and row to row distance was 20cm. 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 necessary. Data on days to maturity, plant height, total number of tillers hill^{-1}, number of effective tillers hill^{-1}, panicle length, filled and unfilled grains panicle^{-1} and 1000-grain weight were recorded after harvesting from five randomly selected hills. Maturity and yield data were recorded plot basis. Plot seed yield was converted to tha^{-1}. Finally, the yield data were converted to tha^{-1}. Recorded data were finally subjected to proper statistical analyses. The results revealed from advanced yield trials of individual location and mean over locations for all the characters are presented**.** Results mean over three locations, on an average, all characters showed significant differences among the lines and check for both individual locations and mean over locations. Among the lin and check varietiy, BRRI dhan49 had produced the longest duration (126 days) at all the locations. Longer panical length and highest number of filled grains were observed at Rangpur, Nalitabari and Mymensingh, Nalitabari and Rangpur, respectively by line BN-P-318 (Table 6)**.** Higher grain yield was observed in BN-P-318 at most locations except Magura, Rangpur and Cumilla. This line matured 10-12 days earlier than the check variety BRRI dhan49 at all locatios. Quality assessment was done based on kernel length and L/B ratio. The kernel shape and size of BN-P-318 is long-slender where the BRRI dhan49 is medium. Based on the yield performance, earliness and resistance against blast and grain quality, BN-P-318 could be selected for further evaluation to release it as a blast resistant variety.

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

Blast is a serious disease caused by the fungal pathogen *Magnaportheoryzae* of rice. It causes considerable damage to rice and crop loss in rice growing regions worldwide. On-farm and on-station trials were carried out with two lines (BN-P-114 & BN-P-120) along with two check varieties (BRRI dhan58 & BRRI dhan86) at BINA HQs farm Mymensingh and sub-station farm at Nalitabari, Magura, Sunamganj and farmer's field at Mymensingh and Netrokona during *Boro* season of 2022. Seedlings were planted in RCB design with three replications. Unit plot size was 5.0m × 6.0m. Plant to plant and row to row distance were 15cm was 20cm, respectively. Data on days to flowering, days to maturity, plant height, total number of tillers plant^{-1} number of effective tillers plant^{-1}, panicle length , filled and unfilled grains panicle^{-1}, 1000-grain weight and grain yield were recorded from five randomly selected plants of each plot. Plot seed yield was converted to t/ha. Recorded data were finally subjected to proper statistical analyses and are presented.The results obtained from the on-farm and on-station trials of individual locations and mean over locations for all the characters are presented. Significant differences were observed among the lines and the check variety for yield and yield attributing character. BN-P-114 performed better among the lines and check variety in terms of yield. It produced the highest grain at all the locations except Nalitabari and Sunamganj. The highest grain yield was found at BINA HQS farm Mymensingh (8.43 tha^{-1}) followed by Magura (8.27 tha^{-1}). The higher grain yield of BN-P-114 is attributed by the higher number of effective tillers hill^{-1} and number of filled grains panicle^{-1}. The duration of BN-P-114 was higher than the check variety BRRI dhan86 at all locations. Based on the yield performance and resistance against blast, BN-P-114 could be selected for further evaluation to release it as a blast resistant variety.

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

Malnutrition among women and children are extremely prevalent in Bangladesh. Bangladeshi children become stunted growth and underweight due to micronutrient deficiencies,

particularly iron (Fe) and zinc (Zn) deficiency. The objective of this experiment was to develop high yielding rice varieties with improved nutritional quality with high zinc (Zn≥24 mg/kg) and iron in polished grain. The experiment was carried out to assess overall performance for better grain quality and higher grain yield of two iron and zinc enriched rice lines along with one check variety BRRIdhan62 during *Aman* season 2022 at BINA HQs farm Mymensingh, BINA Sub-station farm at Nalitabari, Jamalpur and farmer's field at Mymensingh. The experiment followed RCB design with three replications. The size of unit plot was 4.0m × 5.0m. Plant to plant distance was 15cm and row to row distance was 20cm. Data on days to flowering, days to maturity, plant height, total number of tillers and effective tillers hill^{-1}, panicle length , filled and unfilled grains panicle^{-1}, 1000 grain weight and grain yield plot^{-1} were recorded at harvest from five randomly selected competitive hill. Maturity was assessed plot basis. Plot seed yield was converted to tha^{-1}. Recorded data were finally subjected to proper statistical analyses and are presented. It is observed that the results obtained from regional yield trials of individual location and mean over locations for all characters presented. Most of the characters showed significant differences among the lines and check for four individual locations and mean over locations. From mean over locations, it appeared that the IZSD-26 had significantly higher number of total tillers hill^{-1} (12.57), number of effective tillers hill^{-1} (11.86) and higher number of filled grains (164.95) at locations than the check variety, BRRIdhan62 (Table 8). There was no significant difference between the test line and check for the number of unfilled grain and 1000-grain weight. Grain yield of IZSD-26 was significantly higher (6.49 t/ha) at mean over locations than the check variety BRRIdhan62. But the check variety BRRI dhan62 was matured (105 days) earlier than the both lines, IZSD-26 (111 days) and IZSD-10 (114 days). The mean grain Fe concentration of rice lines IZSD-26 and IZSD-10 were 19 and 14 mg/kg and 6 and 4 mg/kg in unpolished & polished rice, respectively. The mean zinc concentration of rice lines were 45 and 51 mg/kg and 26 and 29 mg/kg in unpolished & polished rice, respectively, which was higher than that of BRRI dhan62 (19 mg/kg). Considering Fe, Zn content and higher yields, the line IZSD-26 could be selected for further evaluation.

On-farm and on-station yield trial of two rice lines for earliness and higher grain yield in haor areas

Haor is a term used to describe low-lying areas that are prone to flooding and are submerged in water for several months every year. Longer duration and plant height characteristics of Boro rice varieties often become the victim of flash flood. Short duration and high yielding Boro rice variety can be blessings for these areas. The objectives of the study were to investigate the evaluation of selected line over locations. One early maturing *Boro* rice line MEF-27 was evaluated over locations along with two check varieties BRRI dhan86 and BRRI dhan28. The experiment was conducted at BINA HQs farm Mymensingh, BINA Sub-station farm at Sunamgonj including haor regions farmer's field at Sunamganj, Netrokona and Brahmanbaria. The experiment followed RCB design with three replications. The size of unit plot was 5.0 m × 4.0 m. Plant to plant distance was 15cm and row to row distance was 20cm. Data on days to flowering, days to maturity, plant height, total number of tillers and effective tillers plant^{-1}, panicle length, filled and unfilled grains panicle^{-1}, 1000-grain weight and grain yield/plot were recorded after harvesting from five randomly selected plants. Maturity was assessed plot basis. Plot seed yield was converted to tha^{-1}. The data were statistically analyzed. From the results, significant variations were observed for all the characters at all the locations. It was observed that MEF-27 matured 5-7 days delayed (147 days) than the check variety BRRI dhan28 (142 days) and BRRI dhan86 (141 days). MEF-27 produced highest grain yield (7.00 tha^{-1}) followed by BRRI dhan86 (6.27 tha^{-1}) and BRRI dhan28 (5.68 tha^{-1}). At farmer's field, the highest grain yield was found in MEF-27 (7.56 tha^{-}

^{1}) at Bishombopur farmer's field followed by BRRI dhan86 (5.75 tha^{-1}). MEF-27 produced the highest grain yield and filled grain (7.87 tha^{-1}& 186.53) at BINA sub-station Sunamgonj. In our country flash flood usually comes at haor areas from the 1st week of April to 2nd week. It causes huge loss of *Boro* rice at Haor areas. The line MEF-27 is matured 142-147days, it could escape early flash flood at haor areas. Considering short duration and higher yield, the line MEF-27 could be selected for further evaluation to release it as a variety.

Regional yield trial of two rice lines for earliness, better grain quality and higher yield

There are some scopes of increasing cropping intensity from existing 192% by improved the cropping patterns by utilizing short duration T.aman variety. Regional yield trial were carried out with two lines along with one check variety (BRRI dhan75) at BINA HQs farm Mymensingh and sub-station farm at Nalitabari, and farmer's field at Ishwardi, during T. *Aman* season of 2022. Seedlings were planted in RCB design with three replications. Unit plot size was 5.0m × 4.0m. Plant to plant and row to row distance were 15cm and 20cm, respectively. Data on days to flowering, days to maturity, plant height , total number of tillers and effective tillers plant^{-1}, panicle length, filled and unfilled grains panicle^{-1}, 1000 grain weight and grain yield/plot were recorded from five randomly selected plants of each plot. Plot seed yield was converted to t/ha. Recorded data were finally subjected to proper statistical analyses and are presented.The results obtained from the on-farm and on-station trials of individual locations and mean over locations for all the characters are presented. Significant differences were observed among the lines and the check variety for yield and yield attributing characters. EFSD-58 performed better among the lines and check variety in terms of yield. EFSD-58 produced the highest grain yield among the lines and the check variety at all the locations. The highest grain yield was found at Nalitabari (5.69 tha^{-1}) followed by Mymensingh, (5.64 tha^{-1}). The higher yield of EFSD-58 is attributed by the higher number of effective tillers plant^{-1}, number of filled grains panicle^{-1} and panicle length. The duration of EFSD-58 almost same (103-107 days) compare to the check variety BRRI dhan75 at all locations. The grain quality parameters data are presented in the Table11. The lines EFSD-58 and EFSD-21 had the head rice recovery % of 69.78 and 66.36, respectively. The line EFSD-58 had the longest grain (6.54mm) and the highest L/B ratio (3.17) indicating that the line produced medium slender grain. Other line and the check variety produced medium slender grain. Based on the yield performance and grain quality EFSD-58 could be selected for further evaluation to release it as variety.

Regional yield trial of Brown Plant Hopper (BPH) resistant rice lines in *Boro* season 2022-2023

The production of rice is negatively impacted by a variety of biotic and abiotic variables. About 52% of the world's rice crop is lost each year due to biotic factors, with insect pest attacks being responsible for about 21% of that loss. At the reproductive stage, BPH can destroy more than 28% of the dry matter of affected rice plants and also spread viral infections. The major goal of this research is to choose BPH resistant lines for reducing BPH damage. For this experiment, 3 lines BPH-P-020, BPH-P-034, BPH-P-065 with the check variety BRRI dhan58 were used during *Boro* season 2022-23 at different locations. The experiment was followed RCB design with three replications. The size of unit plot was 4.0m × 5.0m. Plant to plant distance was 15cm and row to row distance was 20cm. Data on days to flowering, days to maturity, plant height, total number of tillers hill^{-1}, number of effective tillers hill^{-1}, panicle length, filled grains and unfilled grains panicle^{-1} and grain yield were recorded after harvesting from five randomly selected plants hill^{-1}. The collected data analyzed wherever applicable. Data were analyzed. Significant variations were observed among the lines and check varieties for plant height, panicle length no. of filled and unfilled

grains in both of individual location and combined over location (Table 12). Results from combined mean over locations, it is revealed that BPH-P-034 performed better in term of yield (6.90t/ha) than the check variety BRRI dhan58 (6.80 t ha^{-1}) followed by BPH-P-020 (6.24 t ha^{-1}) and BPH-P-065 (6.14 t ha^{-1}). The highest field grains was observed in BPH-P-034 (119) followed by BPH-P-065 (108) and BPH-P-020 (104). Maturity duration, no. of total tillers $hill^{-1}$, no. of effective tillers $hill^{-1}$ and unfilled grains were not significantly different among the lines and check variety.

Regional yield trial of Brown Plant Hopper (BPH) resistant rice lines in *T. Aman* season 2022

The production of rice is negatively impacted by a variety of biotic and abiotic variables. Around 52% of the world's rice crop is lost each year due to biotic factors, with insect pest attacks being responsible for about 21% of that loss. At the reproductive stage, BPH can destroy more than 28% of the dry matter of affected rice plants and also spread viral infections. The major goal of this research is to choose BPH resistant lines for reducing BPH damage. For this experiment, 3 lines BPH-P-034, BPH-P-043, BPH-P-065 with the check variety BRRI dhan49 were used during *T. Aman* season 2022 at different locations of BINA HQ and BINA Sub-stations. The experiment was followed RCB design with three replications. The unit plot size was 4.0m × 5.0m. Plant to plant distance was 15cm and row to row distance was 20cm. Data on days to flowering, days to maturity, plant height, total number of tillers $hill^{-1}$, number of effective tillers $hill^{-1}$, panicle length, filled grain and unfilled grains $panicle^{-1}$ and grain yield were recorded at harvest from five randomly selected plants $plot^{-1}$. Maturity was assessed plot basis. The data for the characters under study were statistically analyzed wherever applicable. Data were analyzed using Statistix 10 package. Significant variations were observed among the lines and check varieties for plant height, panicle length and unfilled grains in both of individual location and combined over location (Table 13). Results from combined mean over locations, it was revealed that BPH-P-065performed better in term of yield (6.24t ha^{-1}) than the other 2 lines BPH-P-034 (5.56t ha^{-1}), BPH-P-043 (5.70t ha^{-1}) and check variety BRRI dhan49 (5.45t ha^{-1}). BPH-P-034, BPH-P-043, BPH-P-065 all the three lines mature nearly 10-12 days (114-115 days) earlier than the check variety (126-127days). Number of total tillers $hill^{-1}$, no. of effective tillers $hill^{-1}$ and filled grains $panicle^{-1}$ were not significantly different among the lines and check variety.

Regional yield trial of high yielding NIRICA mutants

To select early, with non- shattering grains as well as to assess the yield potential over locations, the experiment was conducted during Boro 2022-23 seasons at BINA Headquarters farm: Mymensingh, BINA substation: Rangpur and Chapinawabganj and farmer's fields respectively. The experiment was conducted by following RCB design with three replications by maintaining unit plot size 4.0 m × 5.0 m. It was observed that plant height of two mutants lines RM-16(N)-8-1 and RM-16(N)-10-1 was shorter (113.61 cm and 116.17 cm) than the check variety BRRI dhan58 (118.33 cm). RM-16(N)-8-1 and RM-16(N)-10-1 had statistically higher number of effective tillers (11.27 and 11.60 respectively) comparing to BRRI dhan58 (9.35).The highest number of filled grains $panicle^{-1}$ were observed in RM-16(N)-10-1 (147.75) followed byRM-16(N)-8-1 (138.42). The mutants RM-16(N)-8-1 and RM-16(N)-10-1 had produced higher yield (6.85 & 7.24 tha^{-1} respectively) than the BRRI dhan58 (6.80). Considering the yield & yield attributes of the mutants RM-16(N)-10-1 and RM-16(N)-8-1 will be evaluated in the next trail to release as a variety.

Advanced yield trial of high-yielding rice lines

This trial was carried out with two rice lines derived from Binadhan-16×NERICA-4 along with a check BRRI dhan87 to assess the yield performance over locations. The experiment was conducted at BINA HQSs farm Mymensingh, BINA sub-stations' farm Ishurdi and Magura during the T. *Aman* season of 2022. The trial followed the RCB design with three replications having the unit plot size of 4m × 3m. The row-to-row and plant-to-plant distances were 20 cm and 15 cm, respectively. Standard production practices for water and nutrition management, and disease and pest control were followed. The two tested lines are intermediate in plant height which is shorter than the check BRRI dhan87. The line B-32-2-3 produced 5.41 t/ha of grain yield which is higher than the check variety. Estimation of the heritability% depicted that the plant height (0.9) and growth duration (0.97) were highly heritable traits in the studied lines while heritability in the case of yield (0.58) was lower. The line B-32-2-3 was selected for further trial.

Advanced yield trial of blast nursery rice lines (IRBN) in *Boro* season

Of the 10 major diseases that Bangladeshi varieties are most susceptible to blast are more dangerous, it can destroy 70% of crop yields for the farmers of Bangladesh, who grow the cereals each year. So, we need a blast resistant rice variety. Farmers will benefit if any blast resistant rice variety developed in Bangladesh. Therefore, the objective of the experiment was to select desired lines for blast resistance with higher grain yield.This experiment was conducted with six IRBN rice lines to select desirable lines having Blast resistance, higher grain yield, short duration, suitable for *Boro* season. The popular short duration *Boro* variety BRRI dhan74 and BAU dhan-3 were used as check variety at BINA HQS farm, Mymensingh. The seeds were sown on 5th December 2022 and transplanted the field on 7th January 2023. The experiment was laid out in RCBD with three replications. Unit plot size was 4m x 3m and spacing between hills and rows were 15 cm and 20 cm, respectively. Data on plant height, effective tillers hill^{-1} no. of filled grains panicle $^{-1}$ and panicle length were recorded from five randomly selected plants from each plot. Grain yield data were recorded from an area of 6.0 m^2. Finally, all the recorded data were subjected to proper statistical analyses. At BINA HQs farm, four lines IRBN-11, IRBN-14, IRBN-18 & IRBN-34 produced grain yield 8.95, 9.96, 8.38 & 8.28 t ha^{-1}, respectively. In BINA Sub-station farm Comilla IRBN-9, IRBN-14 & IRBN-18 produced grain yield 8.59, 8.77 & 8.59 t ha^{-1}, respectively. IRBN-14, IRBN-18 performed better at both locations that will be evaluated in further yield trial in next season.

Advanced Yield Trial of brown plant hopper resistant rice lines in *Aman* season 2022

The production of rice is negatively impacted by a variety of biotic and abiotic variables. Around 52% of the world's rice crop is lost each year due to biotic factors, with insect pest attacks being responsible for about 21% of that loss. At the reproductive stage, BPH can destroy more than 28% of the dry matter of affected rice plants and also spread viral infections. The major goal of this research is to choose BPH resistant lines for reducing BPH damage.Therefore, the objective of the experiment wasto select the desired rice lines with BPH resistance and higher yield. This experiment was carried out to assess insect resistant with high yield attributes of six rice lines along with one check variety Binadhan-17 tested in *Aman* season at BINA Headquarter farm, Mymensingh and BINA Substation, Cumilla. Seeds were sown on 29th June 2022 and transplanted to the field on 26 July 2022 at Mymensingh and Cumilla. The experiment followed RCB design with three replications. The size of a unit plot was 4.0 m × 3.0 m. Plant to plant distance was 20 cm and row to row distance was 20 cm. Data on plant height (cm), number of effective tillers plant^{-1}, panicle length(cm), number of filled grains panicle^{-1} were recorded after harvesting from 5 randomly selected hills. Days to fifty 50% flowering and days to maturity was assessed plot basis. Recorded data were finally

subjected to proper statistical analyses.It is observed that the plant height of the lines were ranged from 103.11 cm to 128.49cm. IRBPH-35 was the tallest (128.49 cm) and IRBPH-5 had the shortest (103.11 cm). The panicle length ranged 23.99 cm to 29.07cm. The longest panicle length was observed in IRBPH-44, while shortest panicle length (23.99 cm) was observed in IRBPH-5. The panicle length of check varietyBinadhan-17 was 24.19cm. There were 3 lines had longer panicle length than check varieties. The number of filled grains per panicle ranged from 199 to 253. The highest number of filled grains (253) was observed in IRBPH-5, while lowest number of filled grains was observed in check variety.Grain yield ranged from 4.90 to 6.30 tha^{-1}in BINA HQs Mymensingh and 5.51 to 7.37 tha^{-1} in BINA Sub-station Comilla. In combined mean over location grain yield ranged from 5.35 to 6.82 t/ha. IBPHN- 35 had maximum yield which was followed by IBPHN- 44, IBPHN-38. and Binadhan-17 had comparatively lower yield (5.44 t/ha).IRBPH-35, IRBPH-38, IRBPH-44 had higher yield at both location then the check variety but IRBPH-21performed better than the check variety in BINA HQS but not at BINA Sub-station farm Comilla. Based on Grain yield four lines IRBPH-35, IRBPH-38, IRBPH-44 and IRBPH-21 have been selected and will be evaluated in the advanced yield trial in next *Aman* season.

Advanced yield trial of bacterial blight nursery rice lines (IRBBN) in *Aman* season 2022

Bacterial leaf blight (BLB) of rice caused by *Xanthomonas oryzae*pv. *oryzae* (*Xoo*) is a major pathogen that has negatively impacts on rice production. BLB causes yield losses generally ranging between 10-30%, but which can be as high as 80%, depending on the location, season, weather, crop growth stage and cultivar. The development of a BLB-resistant rice cultivar through a gene introgression breeding program is critically important as there are no chemicals or management practices known to reduce the severity of BLB. The objective of the experiment was to select rice lines resistant to bacterial blight with higher grain yield. This experiment was carried out to assess disease tolerant, short duration with high yield attributes of four rice lines along with check variety and Binadhan-17 tested in *Aman*' 2022 at BINA HQS farm, Mymensingh and BINA sub-station, Comilla. Seeds were sown on 28th June 2022 and transplanted to the field on 26th July 2022. The experiment was followed by RCB design with three replications. The size of a unit plot was 4.0 m × 3.0 m. Plant to plant distance was 20 cm and row to row distance was 20 cm. Recommended doses of fertilizers 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 (cm), number of effective tillers $plant^{-1}$, panicle length (cm) and number of filled grains $panicle^{-1}$ were recorded after harvesting from five randomly selected hills. Days to 50% flowering and days to maturity were assessed plot basis. Recorded data were finally subjected to proper statistical analyses. From the Table18, days to maturity of IRBBN-31 and check variety Binadhan-17 took longest time (110 days) and IRBBN-9, IRBBN-17 took shortest time (105-107 days) to mature at both locations. All the lines produced taller plant than check varieties. The shortest plant height (101.42 cm) was found in check variety Binadhan-17. Total tillers were found the highest in check variety Binadhan-17 and IRBBN-9 at both locations and combined mean over locations.. Binadhan-17 produced highest number of effective tillers (12) at Cumilla and it was similar with another line IRBBN-9. All lines had produced taller panicle length than check variety. IRBBN-9 had produced tallest panicle length (29.20 and 28.22 cm) at both locations. IRBBN-17 and IRBBN-31 had produced highest 1000 seed weight (25gm) at both locations. From combined mean over locations it was observed that the check variety Binadhan-17 had produced highest yield (5.85tha^{-1}) than other lines. The yield ranged from 4.99-5.19 tha^{-1} those are not satisfactory. IRBBN-9, IRBBN-31 performed comparatively better at BINA sub-station Comilla that can be selected for next evaluation during *Aman* season-2023.

Advanced yield trial of one mutant derived from Kasalath

To select early, high yielding lines the research was performed at five locations viz. BINA Headquarters, Mymensingh, and Substation at Rangpur, Ishwardi, Chapainawabganj and Sunamganj. The experiment was followed by Randomized Complete Block Design (RCBD) with three replications. The size of the unit plots were 4.0 m × 5.0m. It was observed that plant height of RM-Kas-80(C)-1 mutant line was 117.09 cm and was statistically taller than the check variety BRRI dhan49 (103.45 cm). RM-Kas-80(C)-1 had statistically lower number of effective tillers (10.50) contrasting to BRRI dhan49 (11.43). Panicle length of RM-Kas-80(C)-1 was recorded as 26.85cm comparing to BRRI dhan49 (22.90 cm). The highest number of filled grain panicle^{-1} was observed in the check BRRI dhan49 (158.17) while lower filled grain panicle^{-1} was found in RM-Kas-80(C)-1 mutant (134.35). The mutant RM-Kas-80(C)-1 had produced lower yield (5.52 tha^{-1}) than the BRRI dhan49 (5.59 tha^{-1}).

Advanced Yield Trial of 18 mutants for salinity and high temperature

The experiment was conducted at BINA Headquarter field, BINA Substation Ishwardi, BINA Substation Chapainawabganj and BINA Substation Satkhira in 29th November, 2022 to select early, high yielding, salinity and high temperature tolerant lines. The lines BNDR are the mutants derived from gamma irradiation of local improved germplasms (LIRG-2 & LIRG-4) collected from the Southern part of Bangladesh. This research is continuing since 2018 onward. Two checks (viz. Binadhan-10 and BRRI dhan86) were also included in this experiment. The experiment was followed by Randomized Complete Block (RCB) design with 2 replications by maintaining unit plot size 3m×2m. In BINA HQ mymensingh, the line BNDR-17 had higher yield (8.48t/ha) comparing to the checks Binadhan-10 (7.10 tha^{-1}), and BRRI dhan86 (6.01 tha^{-1})

In BINA substation, Ishwardi, line BNDR-26 had higher yield (8.38 tha^{-1}) comparing to the checks Binadhan-10 (8.24 tha^{-1}), and BRRI dhan86 (5.79 tha^{-1}). In BINA substation, Chapainawabganj, the line BNDR-55 had higher grain yield (6.78t/ha) comparing to the checks variety Binadhan-10 (5.09 tha^{-1}), and BRRI dhan86 (3.5 tha^{-1}). In BINA substation, Satkhira, the line BNDR-49 had higher yield (9.42 t/ha) comparing to the checks Binadhan-10 (6.91 tha^{-1}), and BRRI dhan86 (6.32 tha^{-1}). By assessing yield and yield contributing characteristics over different locations, BNDR-17, BNDR-26, BNDR-49 and BNDR-55 lines can be selected for the Regional Yield Trial (RYT) for evaluation.

Preliminary yield trial of submergence tolerant rice lines

Submergence have been the major constraint in rice production. The present study was conducted to evaluate submergence tolerant rice lines for high yield attributes.Eleven rice lines along with two checks, Binadhan-11 and BRRI dhan52 were tested in *Aman* season at BINA HQSs farm, Mymensingh. The trial followed the RCB design with three replications with a unit plot size of 2m × 2m. The row-to-row and plant-to-plant distances were 20cm and 15cm, respectively. Standard production practices for water and nutrition management, and disease and pest control were followed. Data on plant height, number of effective tillers/hill, panicle length and filled grains panicle^{-1} (no.) were recorded at harvest from five randomly selected hills plot^{-1}. Days to flowering and maturity were assessed plot basis. Recorded data were finally subjected to proper statistical analyses. It was observed that the average range of plant height among the lines and check variety were 95cm to 153cm. The line IRSSTN-FP-6 had the highest plant height whereas IRSSTN 3 had the lowest. There all the parameters showed significant differences among genotypes. The highest number of effective tillers/plant (9.73) was found in IRSSTN-FP-8. The filled grains panicle^{-1} and unfilled grains panicle^{-1} ranged from 90.50gm to 157.73gm and 20.93 to 57.60gm respectively. Grain yield

plot^{-1} ranged from 5.17 tha^{-1} to 7 tha^{-1}. IRSSTN-FP-12 had maximum yield (7tha^{-1}) whereas IRSSTN 6 had minimum yield (5.17 tha^{-1}). There are three lines (IRSSTN-FP-8, IRSSTN-FP-9 and IRSSTN-FP-12) produced higher grain yield (tha^{-1}) than both check varieties BRRI dhan52 and Binadhan-11 where IRSSTN-FP-2 and IRSSTN-FP-5 produced higher grain yield (tha^{-1}) only than the Binadhan-11. Based on higher grain yield IRSSTN-FP-8, IRSSTN-FP-9, IRSSTN-FP-12, IRSSTN-FP-2 and IRSSTN-FP-5 have been selected for further evaluated in next season.

Preliminary yield trial of drought-tolerant rice mutants

This trial was carried out with 15 rice mutants derived from NERICA-4 and Binadhan-17. The experiment was conducted at BINA HQS farm, Mymensingh during *Boro* season, 2022-23. The trial followed the RCB design with two replications with a unit plot size of 2m × 2m. The row-to-row and plant-to-plant distances were 20cm and 15cm, respectively. Standard production practices for water and nutrition management, and disease and pest control were followed. The growth duration of the mutants varied from 134 days to 143 days while the check BRRI dhan89 took 144 days to mature. The mutant BN-R-17-8 had the shortest plant height (87cm) while the mutant BN-R-17-5 was the tallest (105cm). The check variety BRRI dhan89 was 106cm tall. In case of yield, five mutants produced more than 8.0 t/ha yield. The highest yield was produced by the mutant BN-R-17-4 which was 8.75t/ha. Estimation of the heritability% depicted that the plant height (0.97) and growth duration (0.99) as well as yield (0.85) were highly heritable traits in the studied mutants. The mutant BN-R-17-5 had a long slender grain with an L/B of 3.63 followed by mutant BN-R-17-6 having medium slender grain (L/B=2.57). The selected lines will be evaluated further for stability and adaptability.

Preliminary yield trial for high yielding, short duration and cold tolerant rice lines

To select early, high yielding and cold tolerant lines, the experiment was conducted at BINA Headquarter field, Sunamganj Substation field, Farmer's field at Sunamganj, farmer's field Panchagar on 20th November, 2022. The lines BNCR were developed from the crossing between Nepalese dhan and Binadhan-17. Three checks (viz. BRRIdhan67, BINA dhan25 and Binadhan-17) were also included in this experiment. The experiment was followed by Randomized Complete Block (RCB) design with 2 replications. In farmer's field, Tahirpur, Sunamganj, the line BNCR-27 had higher yield (8.53 t/ha) comparing to the checks BINA dhan25 (7.79 tha^{-1}), Binadhan-17 (6.5 tha^{-1}) and BRRI dhan67 (5.94 tha^{-1}). The line BNCR-68 had higher yield (8.34t/ha^{-1}) comparing to the checks BINA dhan25 (7.27 tha^{-1}), Binadhan-17 (6.63 tha^{-1}) and BRRI dhan67 (6.36 tha^{-1}) at BINA substation field, Sunamganj. In BINA HQ, Mymensingh, the line BNCR-60 had higher yield (8.76t/ha) comparing to the checks BINA dhan25 (6.86 tha^{-1}), Binadhan-17 (6.60 tha^{-1}) and BRRI dhan67 (7.30 tha^{-1}). In Jamalganj, Sunamganj, the line BNCR-20 had higher yield (8.80 t/ha^{-1}) comparing to the checks BINA dhan25 (7.40 tha^{-1}), Binadhan-17 (6.71 tha^{-1}). The line BNCR-39 had higher yield (8.53t/ha) comparing to the checks BINA dhan25 (7.9 tha^{-1}), Binadhan-17 (8.2 tha^{-1}), BRRI dhan67 (6.1tha^{-1}) and BRRI dhan28 (6.0tha^{-1}) at farmer's field, Panchagar. The lines BNCR-27, BNCR-39, BNCR-60, BNCR-68 and BNCR-120 can be selected with respect to earliness and high yielding characters for Advanced Yield Trial (AYT) evaluation.

Preliminary yield trial for high yielding and non-shattering rice lines

To select early, high yielding and non-shattering rice lines, the experiment was undertaken at BINA Headquarters, Mymensingh by maintaining plant to plant and row to row distance 20cm and 15cm respectively. The two parents (Binadhan-14 and BRRI dhan28) and one check (BRRI dhan81) were also included in this experiment. The experiment was followed by non-replicated design by maintaining unit plot size was 2m × 1m. Among the selected

lines, higher effective tillers plant^{-1} was observed in two mutants BN-RM-P-2-2-3 (11.5) and BN-RM-P-2-2-4 (11.5). Maximum filled grain (145.7) was found in the BN-RM-P-3-3-1 mutant line while minimum filled grain (127.6) was observed in BN-RM-P-2-2-3 mutant line. The lowest unfilled grain (20.35) per panicle was found in check variety BRRI dhan81 but maximum unfilled grain (24.53) found in line BN-RM-P-2-2-2. The highest grain yield (7.34 t/ha^{-1}) was obtained in BN-RM-P-5-1-4 mutant whereas lowest yield was found in the parent BRRI dhan28 (6.30 t/ha^{-1}). According to the yield and yield contributing characters, the lines BN-RM-P-2-1-3, BN-RM-P-3-3-1, BN-RM-P-5-1-2 and BN-RM-P-5-1-4 can be selected for the Advanced Yield Trial (AYT).

Observation yield trial of International Rice Tungro Nursery (IRTN) rice lines

Total 15 International Tungro Rice Nursery Lines (IRTN) were evaluated for grain yield along with yield check BRRI dhan87. The experiment was conducted during *Aman* season 2022 at BINA HQ farm, Mymensingh and it was non-replicated. The unit plot size was 2.0m × 2.0m with a plant-to-plant distance of 15cm and row-to-row distance of 20cm. 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. The lines were selected based on grain yield. The growth duration of the tested lines varied between 124 days (BN-R-21-2) to 137 days (BN-R-21-6) while the check matured in 133 days. The plant height ranged from 102cm (BN-R-21-2 and BN-R-21-4) to 111cm (BN-R-21-3). The highest yield was produced by line BN-R-21-1 which was 7.01 tha^{-1} while the check produced 6.26 tha^{-1} yield. The selected lines will be used for further evaluation.

Observation yield trial of International Rice Stem Borer Nursery (IRSBN) rice lines

Total 10 IRRI Stem borer Rice Nursery Lines were used for the yield trial including yield check BRRI dhan87 and TN1. The experiment was conducted during *Aman* season 2022-23 at BINA HQS farm, Mymensingh and BINA sub-station farm at Cumilla. The unit plot size was 2.0m × 2.0m with a plant-to-plant distance of 15 cm and row-to-row distance of 20 cm. 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. The data obtained from Cumilla was excluded as yield was heavily hampered due to water logging and bird infestation. The lines were selected based on yield and the line which produced more than 6.35 tha^{-1} yield were selected. The growth duration varied between 122 days (BN-R-22-1) to 130 days (BN-R-22-3) while the check BRRI dhan87 and TN1 matured in 133 and 118 days, respectively. The plant height ranged from 101cm (BN-R-22-3) to 116cm (BN-R-22-2). The highest yield was produced by the line BN-R-22-3 which was 7.36 tha^{-1} while the check produced 6.26 tha^{-1} yield.

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

Rainfed lowland rice in Bangladesh occupies an important place in the economy. Although favored by rainwater, the rainfed lowlands have many problem arising with their different ecological conditions. The objective of this experiment was to evaluate 30 International Low Land Rice Nursery Lines (IRLON) for their yield ability along with yield check Binadhan-11. The experiment was conducted during *Aman* season 2022-23 at BINA HQS farm, Mymensingh with two replication. The unit plot size was 2.0m × 2.0m with a plant-to-plant distance of 15cm and row-to-row distance of 20cm. Standard production practices for water and nutrition management, and disease and pest control were followed.The agronomic performances of the selected lines were evaluated and twelve (12) lines were selected based on grain yield. The growth duration of the tested lines varied from 101 days (IRLON-11) to

127 days (9008) while the check matured in 117 days. The plant height ranged from 98cm (IRLON-16) to 117cm (9008). The highest yield was produced by line IRLON-21 which was 6.57 tha^{-1} while the check produced 5.69 tha^{-1} yield. The selected lines will be used for further evaluation at low land areas.

Observation yield trial of nine advanced salt tolerant rice lines

Rice is considered one of the most salt sensitive cereals, however, a great genetic diversity exists within rice species for salinity tolerance. Therefore, the present study was undertaken to evaluate 9 advanced salt tolerant rice lines compare them with standard variety, Binadhan-17 (salt sensitive) and Binadhan-10, BRRIdhan97 (salt tolerant) at Sathkhira region under field conditions. The unit plot size was 2m × 2m. The row-to-row and plant-to-plant distances were 20cm and 15cm, respectively. Standard production practices for water and nutrition management, and disease and pest control were followed. Nine lines were selected from the trial based on their agronomic performance. The mutants matured in between 146 and 147 days. The plant height ranged from 80 (SAL-52) to 97cm (Binadhan-10). Four lines produced higher number of filled grain per panicle ranged from 81.95 to 98.33 than check Binadhan-10. But, interestingly Binadhan-17 produced highest no. of filled grain per panicle. SAL-52, 15021, SAL-73, 15011 had aparently same duration (143-146) with check Binadhan-10. SAL-52, SAL-44 had the lowest hundred grain weight (2.44g). Based on yield contributing characters, SAL-52, IRSSTN-21, SAL-73, IRSSTN-11 and IRSSTN-10 lines were selected for further evaluation in next *Boro* season.

Observation yield trial International Irrigated Rice Nursery (IIRON) lines

Total 38 International Irrigated Rice Nursery Lines were used for the yield trial including yield check BRRI dhan87 during *Aman* 2022-23. Seventeen selected rice lines from the 38 lines were evaluated during *Boro* 2022-23. The experiment was conducted following RCB design with two replications at BINA HQ farm, Mymensingh. The unit plot size was 2.0m × 2.0m with a plant-to-plant distance of 15cm and row-to-row distance of 20cm. 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. The lines were selected based on yield and the lines which produced more than 6.20 tha^{-1} yield were selected. The growth duration varied between 119 days (BN-R-18-14) to 133 days (BN-R-18-12) while the check matured in 138 days. The plant height ranged from 102cm (BN-R-18-12) to 127cm (BN-R-18-10). The highest yield was produced by line BN-R-18-16 which was 7.45 tha^{-1} followed by BN-R-18-11 and BN-R-18-12 (7.22 tha^{-1}) while the check produced 6.88 tha^{-1} yield. The lines were selected based on yield and the line which produced more than 7.90 tha^{-1} yield were selected. The growth duration varied between 142 days (BN-R-18-13 and BN-R-18-16) and 145 days (BN-R-18-5) while the check BRRI dhan89 matured in 142 days and BRRI dhan88 matured in 145 days. The plant height ranged from 90cm to 100cm. The highest yield was produced by line BN-R-18-12 which was 8.04 tha^{-1} followed by BN-R-18-5 (7.93 tha^{-1}) while the check BRRI dhan88 and BRRI dhan89 produced 7.68 tha^{-1} and 7.92 tha^{-1} yield, respectively.

Observation yield trial of 9 mutants for premium quality and higher yield

To select early, premium quality and higher yielding lines, the research was undertaken during Aman 2022-23 at BINA Headquarters, Mymensingh and BINA substation, Rangpur. The parent Binadhan-7 was used in this experiment. The experiment was followed by Randomized Complete Block (RCB) design with 3 replications by maintaining unit plot size 1.0 m × 2.0 m.The line P-3-3 showed lowest plant height (79.67) comparing to check Binadhan-7 (84.33 cm). The check Binadhan-7 produced higher tillers number (12.80)

whereas the line P-3-3 had greater tillers number (5.83) among all the lines. Maximum filled grain (133.55) was found in the P-3-4 line while minimum grain (95.72) was observed in P-2-1 line. Lowest unfilled grain (21.13) per panicle was found in P-6-1 line but maximum unfilled grain found in check Binadhan-7 (23.57). Maximum yield (5.98 t/ha) was obtained in the line P-3-4 contrasting to the check Binadhan-7 (5.16 t/ha), Considering yield and yield contributing characters, line P-3-3, P-2-1 and P-6-1 lines can be selected for the Preliminary Yield Trial (PYT) evaluation.

Observation yield trial of short duration and cold tolerant 63 rice lines suitable for Northern areas

Seeds of selected lines for short duration and cold tolerance were sown on 20th November, 2022 at BINA substation, Rangpur by maintaining plant to plant and row to row distance 15cm and 20cm respectively. The parent Binadhan-7 was used in this experiment. The experiment was followed by Randomized Complete Block (RCB) design with two replications by maintaining plot size 2.0 m × 1.0 m. In BINA Substation, Rangpur, the line BNCR-105 had shorter duration (135 days) comparing to the check varieties *viz*. Binadhan-17 (167 days), BINA dhan25 (169 days) and BRRI dhan67 (157 days). Among the 63 rice lines, 17 were selected (BNCR-1, BNCR-2, BNCR-5, BNCR-8, BNCR-21, BNCR-30, BNCR-32, BNCR-35, BNCR-37, BNCR-42, BNCR-44, BNCR-54, BNCR-64, BNCR-74, BNCR-90, BNCR-115 and BNCR-121) on the basis of yield and yield contributing characters.

Observation yield trial of 22 mutants for premium quality and higher yield

To select early, premium quality and higher yield, the seeds of selected were sown on 30th June, 2022 at BINA Substation, Ishwardi and Magura by maintaining Plant to plant and row to row distance 20cm and 15cm respectively. Two checks (viz. BRRI dhan49 and Binadhan-17) were also included in this experiment. The experiment was followed by Randomized Complete Block (RCB) design with 2 replications. In BINA Substation Ishwardi, the mutants L4-250-4-10-2, L4-250-P-3(2)-4, and L2-250-17-P-1 were exhibited higher yield (8.60, 7.81, and 7.81 tha^{-1} respectively) than the other mutants and the check variety BRRI dhan49 (6.83) and Binadhan-17 (7.37 tha^{-1} respectively and In BINA Substation Magura, the mutants L4-250-4-10-2, L4-250-5(1)-P-1, and L2-250-17-P-1 were exhibited higher yield (8.36, 8.23, and 7.90 tha^{-1} respectively) than the other mutants and the check variety BRRI dhan49 (6.23) and Binadhan-17 (7.27 tha^{-1} respectively). The mutant lines L4-250-4-10-2, L4-250-P-3(2)-4, L2-250-17-P-1, L4-250-5(1)-P-1, and L2-250-17-P-1 could be selected for the Advanced Yield Trial (AYT) in term of earliness, high yielding and premium quality (slender grain) characteristics.

Accelerating the Genetic Gains in Rice (AGGRi)-IRRI Project: Breeding Zone trials

This trial is composed of 190 advanced breeding lines developed at IRRI-HQ with 6 global (IRRI 147, IRRI 240, IRRI 241, IRRI 242, IRRI 154 and A69-1) and 4 local (BRRI dhan28, BRRI dhan67, BRRI dhan99 and Binadhan-10) check varieties. The germinated seeds were sown on 15 December, 2022 in the seedbed. Thirty-nine days old seedlings were transplanted on 23 January, 2023 following the alpha lattice design. The unit experimental plot size was 4.32 m^2 (27 hills × 4 rows). Two-three seedlings per hill were transplanted, maintaining a 15 cm distance between plant to plant and 20 cm between rows. Intercultural operations were performed to ensure proper growth of the rice plants following BRRI guidelines. All the rice plants were harvested from each plot separately, and data were collected on days to 50% flowering (DF), days to 80% maturity (DM), plant height (PH), number of harvested hills per plot, plot yield (g), and grain moisture content (%). Plant height was recorded from randomly

selected 3 hills of each plot. Grain yield (GY) data were adjusted to Kg/ha. Finally, the collected data were tabulated and analyzed using single-environment analysis following Alpha-Lattice Design using RStudio version 4.1.1. The populations randomly distributed as shown in Figure 1 for growth duration, plant height and grain yield. The majority of the traits were within the value of a normal distribution. Significant differences were found among the genotypes for growth duration (days), plant height (cm) and grain yield ($Kgha^{-1}$). Average grain yield of the genotypes was 4976.33 $Kgha^{-1}$ with an average plant height of 93 cm and average growth duration of 142 days. In addition, heritability is important to quantify the precision of field trials and determine the response to selection. Therefore, the heritability for growth duration (days), plant height (cm) and grain yield ($Kgha^{-1}$) were calculated as 0.44, 0.49and 0.24, respectively. Among the 190 lines the top 20 lines based on grain yield ($Kgha^{-1}$). The line IR21LT1178 produced the highest grain yield (7001.143 Kgha-1) followed by IR21LT1339 (6756.401 $Kgha^{-1}$), IR21LT1026 (6734.63 $Kgha^{-1}$) and IR21LT1184 (6714.993 $Kgha^{-1}$). The line IR21LT1178 was 82 cm tall and required 140 days to mature. The selected lines will be evaluated in stage 2 trial.

Screening of direct seeded upland rice lines under field conditions for drought tolerance (AFACI project)

The field trials for the identification of drought-tolerant direct-seeded upland rice genotypes were conducted in 04 April, 2023 at the drought hotspots of Bangladesh located at Kantinagar, Kushtia Sadar, Kushtia. The trial comprises two sets and is conducted under stress and non-stress conditions following an augmented RCB design. Total plant materials were 140. The plant material comprises 130 test entries including 30 local entries. There were five global checks viz. IR13LT799, IRRI 163, IRRI 176, SAHBHAGI DHAN and IRRI 201and 5 local checks viz. Binadhan-19, Binadhan-21, BR-24, BRRI dhan48 and BRRI dhan83 were included in the trial. The seeds were sown on 04 April, 2023 directly into the soil in a four-meter-long plot with four grams of seeds for each line. The nutrient N, P, K, S and Zn were applied as urea, triple super phosphate, Muriate of potash, gypsum and zinc sulfate were applied @ 60, 10, 40, 10 and 4 kg N, P, K, S and Zn ha^{-1}, respectively. All the fertilizers except urea were applied as basal and urea was applied in three equal splits at 20, 35 and 45 days after seeding (DAS). Recommended and uniform crop management practices were followed in all cases. Appropriate measures were taken to manage insects and diseases. The soil type of the experimental plot is silty loam. The field capacity and wilting point of this field were approximately 30-33% and 14-16% (VWC), respectively. Data recording are ongoing according to the field book. Detailed data will be reported once the harvesting is completely done.

Evaluation of rice lines against blast

The rice blast that is caused by *Magnaporthe oryzae* is the most important and potentially damaging rice diseases worldwide and is especially prevalent in Bangladesh. This disease is responsible for yield losses ranging from 35 to 50% and 10 to 30% in each year worldwide. In Bangladesh, the yield losses 30 to 100% due to the cause of rice blast as compared to the developed countries. Therefore, four blast resistant rice (BINA-BR-4-10-18, BINA-BR-4-10-12, BINA-BR-4-10-15 and BINA-BR-4-10-19) lines carrying *Pi9* derived from a cross between Binadhan-17 and Pongsu Seribu 2 were developed by foreground and background selection. The present study was conducted to confirm four blast resistant introgressed rice lines against blast resistance using specific blast isolates through artificial inoculation. This experiment was conducted at BINA HQ farm in a protected blast screening house by spraying four different isolates of the blast pathogen *Magnaporthe oryzae* onto the four introgressed rice lines and two checks (1 BRRI Dhan

74, Moderately Blast resistant, 1 USV2, Universal susceptible variety) to observe the response of the rice blast disease and to assess the resistance of different genotypes against the four specificisolates followed randomized complete block design (RCBD) with 3 replications and every replication had 4 plants. Each replication had 6 rows for the 6 genotypes. Total 6 × 3 × 4 = 72 plants were sown in each Isolate specific plot. So, total plants were sown 72 × 4 = 288 for 4 Isolates specific areas. Sporulation, inoculation and disease scoring was followed by (JIRCAS) protocol. Among 6 genotypes, BINA-BR-4-10-12 showed the best resistance against all isolates followed by BINA-BR-4-10-15 and BINA-BR-4-10-19 in case of Isolate 1 and Isolate 4, respectively. All ckecks and all introgressed lines showed susceptibility against isolate 3 except BINA-BR-4-10-12 and BINA-BR-4-10-15. It means that isolate 3 was the most virulent among four isolates. Different disease severity of the four blast resistant introgressed lines and two checks varied in their disease reaction to four isolates. Highest disease severity (20, 68 & 94%) was observed 7, 14 and 21 days after inoculation in USV2, Universal susceptible variety in case of isolate 3 followed by other isolates. The lowest disease severity (0, 3 & 6%) was observed in respect of BINA-BR-4-10-12 followed by BRRI Dhan 74 and other introgressed lines except line BINA-BR-4-10-19.

Preliminary yield trial of some blast resistant rice lines

This experiment was carried out with four blast introgressed rice lines (BINA-BR-4-10-18, BINA-BR-4-10-12, BINA-BR-4-10-15 and BINA-BR-4-10-19), BRRI dhan87 as a check to assess the yield potential in T. Aman season. Seeds were sown on 7 July 2022 and transplanted during 28 August 2022. This experiment was conducted at BINA HQ farm, Mymensingh. The experiment was followed RCB design with three replications. The size of the unit plot was 3.0 m × 2.0 m. Seedlings were transplanted at a 15 cm distance within rows of 20 cm apart. Recommended doses of nitrogen, phosphorus, potassium, sulphur and zinc were applied in the form of Urea, TSP, MoP, Gypsum and Zinc Sulphate. Cultural and intercultural practices were followed as and when needed. Data on plant height, number of total tillers plant^{-1}, effective tillers plant^{-1}, panicle length, filled and unfilled grains panicle-^{1} and thousand seed weight were recorded after harvest from 5 randomly selected competitive plants. Maturity was assessed plot basis. Grain yield was recorded from an area of 6 m^2 which was later converted to t ha-^{1}. Finally, all the recorded data were subjected to proper statistical analyses. Results of all characters showed that there is no significant difference among the lines and checks except BINA-BR-4-10-19 in respect of days to maturity and (103 days) and plant height (98cm). That means BINA-BR-4-10-19 matures 15-20 days earlier than all lines and check. On the other hand, among the lines and check variety, BINA-BR-4-10-12 performed the best in terms of filled grain panicle^{-1} (176) and grain yield (6.79) followed by BINA-BR-4-10-19. From the above discussions, considering effective days to maturity, plant height, filled grain panicle^{-1} grain quality and yield performance, BINA-BR-4-10-19 and BINA-BR-4-10-12 are recommended for advanced trial in next Aman season.

Introgression of blast resistant genes (*Pi9, Pish, Pb1)* derived from IRRI blast resistant rice lines into Binadhan-17, BRRI Dhan 89 and BRRI Dhan 92 through marker-assisted backcrossing

Bangladesh Rice Research Institute (BRRI) has shown in their research findings that total 1280 isolates were collected and 331 isolates tested against 23 differential varieties (DV). Isolates of low virulence frequencies were observed in monogenic lines (MLs) having *Pi9, Pish, Pb1*genes. These genes were more compatible and widely distributed in Bangladesh. They suggested that these genes are useful for developing durable blast resistant variety. So, our present study was to produce F_1 seed derived from cross between recipient parents and resistant donor lines. For the development of blast resistant rice variety, 6 cross combinations were made using 3 recipient parents (BRRI Dhan89, BRRI Dhan92, Binadhan-17 with 3 blast

resistant (*Pi9, Pish, Pb1)* donor lines. F_1 plants have been confirmed using blast resistant linked gene markers. The confirmed F_1 plants were forwarded to generate the BC_1F_1.

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

In total, 80 neck blast samples (*Magnaporthe oryzae*) were collected from Barishal and Rajshahi Division in Bangladesh. Sampling will be covered all of the administrative divisions of Bangladesh. Single spores were isolated from infected leaves or panicles incubated on moist filter paper in a petri dish at room temperature for 24 h in accordance with the protocols of JIRCAS. Colonies from single conidia were grown on water agar for 5 to 7 days; two or three cut pieces of single colony were then transferred to sterile filter paper placed on water agar medium. Finally, to enable repeated access to the original isolates, the fungi were grown on filter paper and 10 isolates were stored aseptically in filter paper at −20°C after the necessary drying for the study of morphological, molecular and pathogenocity test.

Morphological characterization of blast isolates in Bangladesh

Rice blast, which is caused by *Magnaporthe oryzae* is the major biotic factor that limits rice production globally.The disease has an impact on the crop at every stage.In Bangladesh,the average loss due to blast has been reported to be around 28-36%, and in certain areas yield losses could be as high as 80-100%. So, it is the potential threat for crop failure from this disease and owing to that it curtails to know the morphological features among the rice blast isolates in Bangladesh. Therefore, the present research work was conducted in order to understand the morphological differentiation of rice blast fungus present in Bangladesh. Nineteen *Magnaporthe oryzae* isolates were isolated from collected samples on PSA plates and used to analysis the morphological variation study. In this study, morphological differentiation of 19 *Magnaporthe oryzae* isolates was done initially based on the colony morphology such as colour of colony and margin of colony of different *Magnaporthe oryzae* isolates on PSA plates.A range of colour variation was observed among the 19 isolates. According to the isolates, the colony color varied. While some isolates have blackish grey with a concentric ring, whereas some isolates dark brownish with a black margin, ashy with a concentric ring, and so on.In addition, colony shape of 19 *Magnaporthe oryzae* isolates have also been considered in this study for the differentiation of *Magnaporthe oryzae* isolates and most of the isolates showed irregular, wavy margin on PSA plates, whereas the other have regular margin. In this study, differentiation of isolates was done based on colony growth variation in PSA plates. The radial mycelial growth of 19 *Magnaporthe* isolates were measured in cm and it was done until 13 DAI. Pure *Magnaporthe oryzae* block of each of the isolates placed in PSA plate and the radial mycelial growth variation was distinct for 19 isolates at 3,6, 9 and 13 DAI.However, the highest radial mycelial growth was observed at 13 DAI for the isolates Po-17, Po-6, Po-16, Po-18 and Po-11 and their respective radial mycelial growth were 8.0 cm, 8.0 cm, 7.9 cm, 7.8 cm and 7.7cm. On the other hand, the lowest radial mycelial growth was observed at 13 DAI for the isolates Po-5, Po-15, and Po-1 and their respective vegetative growth were 5.2 cm, 6.2 cm, and 6.6 cm. In this present study, the *Magnaporthe oryzae* isolates also differentiated based on their conidial shape. Five different types of conidial shaped such asFusoid with thick-ened wall at ends, Pyriform, Ovoid with acute ends, Ovoid conidium of *Hirsutella*-like synanamorph and Fusoid were observed among the isolates. In this research work, the selected 19 *Magnaporthe oryzae* isolates were also categorized based on their degree of sporulation (no. of conidia per ml). The result showed that the highest sporulation rate (5.12×10^5spores/ml) was observed in the Po-17 isolate, whereas the lowest sporulation rate (1.12×10^5spores/ml) was observed in the Po-5 isolate. The above results are indicating that quite morphological variation exists among the isolates used in this study.

Growing M_4 population of Chinigura and Kataribhog

This experiment was carried out with 43 M_4 rice mutants derived from aromatic rice landraces Chinigura (22 mutants) and Kataribhog (21 mutants) to assess the homozygosity, grain quality and yield performance. The experiment was conducted at BINA HQ farm, Mymensingh during Aman 2022-23. Each mutant was grown in 5 rows and each row contained 14 hills. The row-to-row and plant-to-plant distances were 20cm and 15cm, respectively. Parental lines were grown at every 10 mutants. Standard production practices for water and nutrition management, and disease and pest control were followed. Growth duration was calculated plot wise and plant height was measured from 5 randomly selected competitive plants. Grain yield was calculated from $1m^2$ plot and was converted to t/ha. Grain physical parameters such as length, breadth and length-breadth ratio were measured from 3 randomly selected decorticated grains. For the sensory test of decorticated grains, 1.7% KOH solution was used. One gram of stored decorticated grain was put into Petri dishes with 5 mL of 1.7% KOH solution at room temperature. After 30 minutes, the dishes were opened and immediately smelled. The presence or absence of aroma was scored. Wide range of variation was observed among the mutants of Chinigura for grain yield and quality related parameters (Fig 1). The Chinigura mutants took 95 to 120 days to mature with average growth duration of 109 days. The Chinigura required 119 days to complete its life cycle. The Chinigura was 155 cm in height while the mutants' plant height ranged between 80 to 180 cm with an average of 111 cm. The average grain yield of the Chinigura mutants was 468 gm/m^2. The grain of Chinigura was 4.57 mm long with a length-breadth ratio of 2.8 mm. Grain length and length-breadth ratio ranged from 3.97 mm to 7.63 mm and 2.23 mm to 4.25 mm, respectively. Among the 22 Chinigura mutants only 3 mutants *viz.* BN-R-2-250-3-1, BN-R-2-250-30-1 and BN-R-2-250-10-1 retained grain aroma. Moreover, the mutant BN-R-2-300-3-2 had red pericarp. Finally, based on grain yield (>500 gm/m^2), decorticated grain length-breadth ratio (> 3.5), grain aroma and pericarp color 10 mutants were selected for further evaluation in replicated trial.

Growing M_5 population of Black rice

Five M_5 populations of black rice were grown during Aman 2022-23 at BINA HQ, Mymensingh. Individual plants were selected based on plant height and grain filling rate.

Growing F_4, F_5, M_5 population of rice through field RGA

A total of 740 F_4 genotypes, 620 F_5 genotypes of different crosses and 5 M_5 genotypes of black rice were grown at BINA HQ, Mymensingh.

Growing F_3 population of aromatic rice

Kataribhog× Binadhan-17 derived ten F_2 populations were grown in Aman 2022-23 at BINA Hq, Mymensingh. A total of 22 plants were selected based on semi-dwarf (90-110cm) plant stature, leaf and grain aroma. For the sensory test of leaf and decorticated grains, 1.7% KOH solution was used. One gram of leaf or stored decorticated grain was put into Petri dishes with 5 mL of 1.7% KOH solution at room temperature. After 30 minutes, the dishes were opened and immediately smelled. The presence or absence of aroma was scored.

Screening of F_6 population of Binadhan-7 × Biroi crosses for higher yield and Biroi grain type

To select early, high yielding and Biroi grain type lines, an experiment was conducted during 2022-23 Aman Season, at BINA Headquarter's, Mymensingh by maintaining plant to plant and row to row distance of 15cm and 20cm respectively. The experiment was followed by non- replicated design. The size of the unit plots were 1.0 m × 2.0. It was observed that the

Biroi took higher time for maturity (140 days) while less time required for the P-2-38-1-4 line (127 days). Highest filled grain (135) was found in the P-2-38-1-14 line while minimum filled grain (59) was observed in P-2-38-1-7 line. Highest 100 grain weight (23.6) was obtained in Biroi whereas lowest yield was found in P-2-38-1-6 line (20). Considering yield and yield attributing characters, seven lines have been selected for the Observation Yield Trial (OYT).

Screening of M_4 lines derived from Tulsimala for higher yield

To select early, high yielding and Tulsimala grain type lines, an experiment was conducted during 2022-23 Aman Season, at BINA Headquarter's, Mymensingh by maintaining plant to plant and row to row distance of 15cm and 20cm respectively. The experiment was followed by non- replicated design. The size of the unit plots were 1.0 m × 2.0. Tulshimala produced comparatively lower tillers number (6.80) whereas the line T/150/P-5(1)-5 had greater tillers number (12.75) among all the lines. Maximum filled grain panicle^{-1} (152) was found in the T/150/P-2(1)-11 line while minimum filled grain (101.70) was observed in Tulsimala parent. Lowest unfilled grain (25) per panicle was found in Tulshimala but maximum unfilled grain (45) found in line T/150/P-2(1)-3. Considering yield contributing characters and Tulsimala grain type, seven lines have been selected for the M_5 generation.

Screening of rice mutants derived from deepwater rice

To select lines those are high yielding and having deep water characteristics, the local cultivar Sarsaria was irradiated with 150, 200, 250, 300 and 350Gy of gamma ray. This experiment was conducted in Aman season, 2022 at Deep Water Rice Screeing (DWRS) Tank, BINA Headquarter's farm, Mymensingh. In M_2 generation, 10 lines were selected based on stem elongation rate, aerial root number, knee capacity and awnless characters and grown the selected lines in subsequent M_3 and M_4 generation. Five lines were selected on the basis of high yielding and deep water characteristics in M_5 generation.

Growing of BC_1F_6 population to find out deepwater characteristics

To select lines those are high yielding and having deep water characteristics, the BC_1F_6 lines were grown in Aman season, 2022 at Deep Water Rice Screeing (DWRS) Tank, BINA Headquarter's farm, Mymensingh. The parents were also included in this experiment by maintaining plant to plant and row to row distance 15cm and 20cm respectively. The experiment was conducted by following non replicated design. Number of effective tillers was highest in the line RC-4-1-15-2-11(7.9) than the check variety Luxmidigha (7.5). The line RC-2-6-3-1-8-4 had significantly higher number of filled grains panicle^{-1} (135) than other lines. The line RC-4-1-15-2-11 had highest grain yield (22.6 g plant $^{-1}$) than the other lines and parent. According to the yield contributing and deep water characteristics, 8 lines have been selected for next trial.

Introgression of Biroi type trait to produce short duration, lodging resistant rice lines through hybridization

To select early, lodging resistant and Biroi type traits, all F_1 seeds are collected crossing between Biroi-250-2-6 line and Binadhan-17. This experiment was conducted in *Aman* season, 2022 at BINA Headquarters farm, Mymensingh.

Screening M_2 population derived from Baishmuri local landrace rice

Bulked seed collected from M_3 generation of Baishmuri that was irradiated with 200, 250, 300, 350 and 400 Gy of gamma ray. This experiment was conducted in *Aman* season, 2022 at BINA Headquarter farm, Mymensingh

Accelerating Genetic Gains in Rice: (AGGRi): using rapid cycle genomic selection to deliver annual genetic gains of 2% in rice

To increase the genetic grains of rice, an experiment was conducted by using a total of 51 IRRI breeding lines along with six international check varieties and five national check varieties were evaluated at Rangpur Substation of BINA during *Aman* 2022. The entries showed a wide range of variations in grain yield in this site. Yield range of the lines with check was 1.63 to 6.76 t/ha with growth duration ranges from 106-128 days. These lines could be used in the advanced yield trials prior to select candidates for variety release or use as parents in the breeding program.

Introgression of long slender grain trait in Binadhan-10

Binadhan-10 was crossed with a restorer line having long slender grain and crossed seeds were harvested.

Source Nursery

The source nursery was constructed with two CMS lines along with 25 restorers. A total of 33 test crosses were made. The test cross hybrids will be evaluated in the next Aman season.

Accelerating Genetic Gains in Rice: (AGGRi): using rapid cycle genomic selection to deliver annual genetic gains of 2% in rice

To increase the genetic grains of rice, an experiment was conducted by using a total of 53 IRRI breeding lines along with six international and five national check varieties in Alfa lattice design at Rangpur Substation of BINA during Boro 2022-23. The entries showed a wide range of variations in grain yield in this site. Yield range of the lines with check was 3.18 to 7.35 t/ha with growth duration ranges from 142-162 days. These lines could be used in the advanced yield trials prior to select candidates for variety release or use as parents in the breeding program.

Screening M_2 population derived from local landrace Kajalsail

To select early, high yielding and Kajalsail grain type lines**,** bulked seeds were collected from M_2 generation of Kajalsail mutants. This experiment was conducted in T. *Aman* season, 2022 at BINA Headquarter's farm, Mymensingh.

Improvement of aromatic rice through hybridization

To select early, high yielding and aromatic rice lines, all F_1 seeds were collected from crossing Binadhan-17 with BRRI dhan34 and BRRI dhan50; BINA dhan25 used as a recipient where BRRI dhan34 and BRRI dhan50 were donors parents. This experiment was conducted in T. *Aman* season, 2022 at BINA Headquarters farm, Mymensingh.

Screening of F_2 generation for earliness with high yielding characters

To select early, high yielding, and lodging resistant lines, fifty F_2 populations were selected during Boro season 2022-23. This experiment was conducted at BINA Headquarters farm, Mymensingh. The selected F_2 population was also put at Rapid Generation Advance (RGA) trail to develop F_3 and F_4 populations.

Induced mutation of Boro rice through physical & chemical mutagens

To select early and high yielding lines during Boro Season, M_1 seeds were collected from irradiation of selected genotypes with 150, 200, 250, 300 and 350 Gy and through chemical mutagen @ 0.5, 1.0, 1.5 & 2.0% EMS. This experiment was conducted in Boro season, 2022 at BINA Headquarter's farm, Mymensingh

Induced mutation of Aus rice through physical & chemical mutagens

To select early and high yielding lines during Aus season, the genotypes: BR26 and BRRI dhan55 was irradiated with 150, 200, 250, 300 and 350 Gy and through chemical mutagen @ 0.5, 1.0, 1.5 & 2.0% EMS. This experiment was conducted in Aman season, 2022 at BINA Headquarter farm, Mymensingh.

Field RGA of some crossing population growing at Boro Season

Seventy five F_4 populations were evolved from crossing between Binadhan-5 and Binadhan-17 and Binadhan-24 to select high yielding, short duration, and lodging resistant plant/progenies. This experiment was conducted Boro season, 2022 at BINA Headquarters farm, Mymensingh. The F_4 population was grown at Rapid Generation Advance (RGA) trail to develop F_5 and F_6 population

Generation advancement of parental lines having multi-stress genes (HRDC materials) with Restorer (R) and Maintainer (B) background

Six F_2 having multi-stress genes with restorer (R) and maintainer (B) backgrounds were grown at BINA HQ farm, Mymensingh. A total of 106 plants were selected from the six populations based on growth duration and plant architechture.

Growing M_2 generation of Binadhan-16 and Binadhan-17

The M_2 generation of Binadhan-16 and Binadhan-17 were grown at BINA HQ farm, Mymensingh. At maturity, a single panicle from each genotype was collected and will be grown in the next Aman season.

Preliminary yield trial of promising hybrids

This trial was carried out with five rice hybrids (HRDC materials) along with two yield check Suborna-3 and Mitali-4 to assess the yield performance at BINA HQ, Mymensingh during the Boro season of 2022-23. The trial followed the RCB design with three replications having the unit plot size of 4m × 3m. The row-to-row and plant-to-plant distances were 20cm and 15cm, respectively. Standard production practices for water and nutrition management, and disease and pest control were followed. Days to maturity ranged from 141 days (Suborna-3) to 154 days (IR139526H and Mitali-4). Mitali-4 had the shortest plants with an average plant height of 90 cm while the highest plant height was observed in case of the hybrid IR139526H (104 cm). Yield ranged from 6.68 t/ha (Suborna-3) to 8.02 t/ha (IR139526H). The heritability for days to maturity, plant height and yield was 0.98, 0.85 and 0.69, respectively.

Advanced yield trial of one high yielding wheat mutants

Drought is a significant abiotic stress that adversely affects wheat production, especially in regions like Bangladesh. The increasing temperatures and changing precipitation patterns amplify the incidence and severity of drought. Approximately 3.5 million ha of land in Bangladesh is vulnerable to reduced crop yields due to this stress, with wheat being a major crop at risk. Addressing this issue, the experiment was conducted at six locations to identify high-yielding drought-tolerant wheat lines. Using a Randomized Complete Block Design (RCBD) with three replications, seeds of the BWM-M-1-1 line and the check variety BARI Gom-28 were sown in plots measuring 4.0 m × 5.0 m. In a comparative analysis between the mutant line and the check variety, the mutant line displayed shorter

plant height, more effective tillers, longer spike length, more filled grains per spikelet, but a slightly lower 1000 grain weight. Moreover, BWM-M-1-1 also yielded (4.01 tha^{-1}) higher than the check variety. Given these promising results, BWM-M-1-1 will undergo further evaluation in the drought-prone Barind region.

Screening of BC_1F_3 generation for earliness and high yielding

The study aimed to select early-maturing lines with high yield attributes from the BC_1F_3 generation, developed from crosses between BARI Gom-33 × Bina-800-1-3 and Bina-800-1-3 × BARI Gom-33. These lines were conducted at BINA Headquarters farm in Mymensingh without replication. From the crosses, 40 lines were selected primarily for further selection in BC_1F_4 population. This selection process will be done in promoting early maturation and high yield in future wheat breeding programs.

Induced mutation of wheat through physical mutagen

This study aimed to induce genetic variation in wheat for earliness and heat tolerance using physical mutagenesis, seeds of 28 germplasm including four popular wheat varieties BARI gom-33, BWMRI gom-1, BWMRI gom-2 and Sonalika were irradiated with 150, 200, 300 and 400 Gy of gamma rays. Seeds were sown on 22 November 2022 at BINA Headquarters farm, Mymensingh. This experiment was followed by non-replicated design and sown separately (variety and dose wise). Finally, the survived plants produced seeds were harvested separately for growing M_2 population.

Hybridization of wheat for earliness and heat tolerance

The aim of this study is to create genetic variability for earliness and heat tolerance of wheat. The seeds were sown on 10 days interval of November 2022. In early morning the recipient parent was emasculated and pollinated by the respective donor parents followed by bagging and tagging. After few days seed setting spike was considered a success of cross. Maximum crosses were conducted between BARI Gom-33× Sonalika followed by BARI Gom-33× BWMRI-1 and success rate was higher in BARI Gom-33× BWMRI-2 65%. F_1 seeds were harvest separately for growing F_2 population.

Regional yield trial with M_7 rapeseed (*B. rapa* var. *toria*) mutants

The most popular but low yielding variety Tori-7 was irradiated with 700 Gy dose of gamma rays. Selection during M_2-M_7 has identified RT-35 and RT-39 for their short life cycle.In M_6 generation other two mutants performed better in regional yield trial. Three rapeseed (*B. rapa* var. *toria*) mutants (RT-35, RT-38 and RT-39) along with two check varieties Tori-7 and BARI Sarisha-15 were evaluated to assess overall performance for earliness and yield attributes. The trial was conducted at BINA Head quarters farm, Mymensingh and BINA Sub-station farms at Rangpur, Ishwardi and Magura. The experiment was laid out in a randomized complete block design with three replications. Seeds were sown on 3 November 2022 at all the locations. Unit plot size was $16m^2$ (4m × 4m) and line to line distance was 25cm. Recommended production packages i.e., application of fertilizers, weeding, thinning, etc. were followed to ensure normal plant growth and development. Data on plant height, branches $plant^{-1}$, siliquae $plant^{-1}$, siliqua length and seeds $siliqua^{-1}$ were taken from 10 randomly selected plants from each plot. Maturity period was counted when 90% siliquae were matured in a plot. Seed yield of each plot was recorded after harvest with proper drying and then converted into kg ha^{-1}. Appropriate statistical analyses were performed for comparison of mean of each character.

Results obtained from the trial of individual location and combined means over locations for all the characters are presented in the Table 73. Significant variation was observed among the

lines and check varieties for most of the characters in each location and combined over all locations. Average maturity period ranged from 80 to 86 days. BARI sarisha-17 required longest maturity period of 86 days and RT-38 required the earliest 80 days, whereas Tori-7 required 85 days. In case of plant height, RT-38 produced the tallest plant (110.17cm) followed by RT-35 (104.83cm) and RT-39 (100.61cm). RT-35 and RT-38 produced the highest number of branches plant^{-1} (6) and other genotypes had similar number of branches plant^{-1} (4-5). RT-38 produced the highest number of siliquae plant^{-1} (146) followed by RT-39 (142). Numbers of seeds siliquae^{-1} and siliquae length are good traits that contribute to seed yield. Seeds siliquae^{-1} and siliquae length of all the genotype significantly differed from each other. The longest siliquae was found in RT-35 (5.17cm) whereas; the shortest (3.42cm) was in Tori-7. Among the genotypes, line RT-39 produced highest seed yield 1311 kg ha^{-1} followed by RT-38 (1301 kg ha^{-1}) which was statistically from seed yield of check variety Tori-7 (1163 kg ha^{-1}). Higher seed yielding lines RT-38 and RT-39 have been selected for future trial on the basis of their yield stability and other agronomic traits.

Among the genotypes, line RT-39 produced highest seed yield 1311 kg ha^{-1} followed by RT-38 (1301 kg ha^{-1}) which was statistically different from seed yield of check variety Tori-7 (1163 kg ha^{-1}). Higher seed yielded lines RT-38 and RT-39 was selected for future trial on the basis of their yield stability and other agronomic traits.

Preliminary yield trial with M_6 rapeseed (*B. napus*) mutant in drought and saline prone areas

Seven rapeseed mutants (RM-27, RM-28, RM-32, RM-33, RM-34, RM-35 and RM-39) along with the two check varieties Binasharisha-4 and Binasharisha-9 were taken in the present investigation. This trial was conducted at BINA HQS farm, Mymensingh and BINA substation farms at Satkhira, Noakhali and Ishwardi. The experiment was laid out in a randomized complete block design with three replications. Seeds were sown on 3 November 2022 at all locations. Unit plot size was 4m^2 (2m×2m) and line to line distance was 25cm. Production packages, data recording and statistical analysis were the same as followed in the first experiment.

Results obtained from the trial of individual location and combined over location revealed significant variations among the lines and checks variety for most of the characters in both of the three individual locations and combined over all locations. On average, the maturity period ranged from 79 to 96 days. Check variety Binasharisha-4 required the longest maturity period of 96 days and RM-27 required the shortest maturity period of 79 days. RM-34 (93cm) and Binasharisha-4 (92cm) had the tallest plant height followed by RM-32 (89cm). The other check variety Binasharisha-9 (80cm) was comparatively dwarf in height. The mutants RM-28, RM-35 and RM-39 produced a similar number of branches (5) which is higher than all other genotypes and check varieties. RM-39 produced the highest number of siliquae plant^{-1} (67) followed by RM-34 and RM-32 which produced 63 and 62 siliqua plant^{-1}, respectively. Numbers of seeds siliquae^{-1} and siliquae length are good yield contributing characters. Higher seed yielding lines RM-32 (1435 kg ha^{-1}) and RM-34 (1357 1435 kg ha^{-1}) have been selected for future trial on the basis of their yield stability and other agronomic traits.

Screening mustard mutants for salinity tolerance at reproductive stage in hydroponic culture

Climate change is no longer a future issue. Salinity is an ever present threat to crop yield. Developing a salt tolerant variety, screening is an ultimate way to select tolerant genotypes to

be used in the future breeding program. The objective of this study was to identify mustard genotypes for salinity tolerance. Screening of salinity from a vast number of collected genotypes under field condition is quite difficult. It is also difficult to maintain accurate salinity levels in soil media at different treatments. In hydroponic culture solutions, it is easy to maintain the accuracy of salinity in respective treatments. Thus, this study was aimed at finding the salt tolerant genotypes using hydroponic screening technique. Uniform seeds of RL-13, RL-14, RL-17 and Tori-7 were used in the present investigation. Salinity treatment (6, 8 and 10 dSm^{-1}) was applied after every seven days when the entire seedling was established in hydroponic culture. Data on various characters such as plant height, leaf number, leaf area, shoot and root dry weight were taken from five randomly selected plants of each tray at reproductive stage.

Maximum, minimum and mean values of different plant characters of four rapeseed genotypes grown under different levels of saline conditions revealed visual injury at reproductive stage. All the characters were sharply decreased due to salt injury. The plant height ranged from 35.3 to 52.9cm with a mean of 45.1cm in the control plants. However, at 8 dSm^{-1} salinity, the plant height ranged from 26.63 to 41.6cm with a mean of 32.8cm. Number of leaves per plant ranged from 14.3 to 19.1 with a mean of 15.71 in the control plants. At 8 dS m^{-1} salinity, that was reduced and found from 9.0 to 22.0 with a mean of 15.33; and 31.3-48.2 with a mean of 29.4 for leaf area (cm^2 $plant^{-1}$). Like other traits root and shoot dry weight also decreased due to salinity effect. Among the different plant characters, leaf number as well as leaf area was more sensitive to salinity than others. RL-13 and RL-14 were found moderately salt tolerant than other genotypes and these two genotypes can be used as a breeding material for developing salt tolerant varieties in near future (Table 75).

Molecular marker based selection of rapeseed mutants for low erucic acid content against *FAE1* gene

High erucic acid has negative effect on health. It is essential to determine low erucic acid content mutants. This work might play an important role for canola type breeding program. Seven mutants (RM-12, RM-13, RM-14, RM-15, RM-17, RM-18 & RM-19) and one check (BARI Sarisha-18) were evaluated in this trial. The trial was conducted at BINA Head quarter farm, Mymeningh and BINA Sub-station farm at Nalitabari. This experiment was laid out in a randomized complete block design with three replications. Seeds were sown on 3 November 2022. Unit plot size was $16m^2$ (4m × 4m) and line to line spacing was 25cm. Production packages, data recording and statistical analysis were the same as followed in the first experiment.

Results obtained from the trial of individual location and combined over location for all the characters are presented in the Table 77. Significant variation was observed among the lines and check varieties for most of the characters in both of individual location and combined over location. Average maturity period ranged from 79 to 110 days. Check variety BARI sharisha-18 required the longest maturity period of 110 days while RM-12 required the shortest maturity period of 79 days. RM-17 (93cm) and BARI Sarisha-18 (126cm) had produced the tallest plant followed by RM-14 (89cm). The mutants RM-13, RM-18 and RM-19 produced similar number of branches (5) which were the highest mutants of all genotypes and check varieties. RM-19 produced the highest number of siliquae $plant^{-1}$ (67) followed by RM-17 and RM-14 which produced 63 and 62 siliqua $plant^{-1}$, respectively.

Two most important characters seeds $siliqua^{-1}$ and siliqua length contribute to seed yield of rapeseed showed significant variations among the genotypes. BARI Sarisha-18 produced the highest seed yield (2030 Kg ha^{-1}) which was significantly different compared to the mutants

with 100 days for maturity. Considering growth duration, agronomic performances and yield, RM-14 and RM-18 were selected as promising mutants for further breeding program of rapeseed.

Screening of segregating population of RM-005

Mutant RM-005 is an advanced rapeseed mutant having only 26% erucic acid. It is the lowest erucic acid content rapeseed-mustard advance line in Bangladesh than any other rapeseed-mustard cultivated variety. Due to the indeterminate nature of rapeseed still it has some heterogeneity regarding plant height at maturity period. The objective of this study was to bring homogeneity of this mutant with desirable yield attributes. It was done successfully and last January 2023 released a new variety named as BINA Sarisha12.

Screening M_6 generation of rapeseed

Six rapeseeds (*B. rapa var. toria*) mutants having heterogeneity regarding plant height, branches plant^{-1} and maturity period. For the advancement of breeding materials homogeneity is the ultimate facts of nature for advanced lines. Six rapeseed mutants (RMT-13, RMT-14, RMT-22, RMT-23, RMT-24 and RMT-25) along with two check varieties Tori-7 and Binasharisha-11 were taken in the present investigation. This trial was conducted at BINA HQ farm, Mymensingh. The experiment was laid out in a non-replicated design. Seeds were sown on 4 November 2022 at BINA HQ farm, Mymensingh. Plot size was 150m^2 and line to line distance was 25cm. Recommended production packages i.e., application of fertilizers, irrigation and pesticide, weeding, thinning, etc. were followed to ensure normal plant growth and development. Data on plant height (cm), no. of branch plant^{-1}, siliqua length (cm), no. of silique plant^{-1}, no. of seed silique^{-1}, seed yield (kg ha^{-1}), 1000 seed weight (gm), days to flowering and days to maturity were taken from 5 randomly selected plants from each plot. Maturity period was counted when 90% siliqua was matured in a plot. Seed yield of each plot was recorded after harvest and proper drying and then converted into kg ha^{-1}. Appropriate statistical analyses were performed for comparison of the mean of each character. Results obtained from BINA HQ farm, Mymensingh for all the characters showed significant variation among the lines and check variety for most of the characters at BINA HQ farm, Mymensingh. On average, the maturity period ranged from 81 to 92 days. RMT-14 required the longest maturity period of 92 days and RMT-26 required the shortest maturity period of 81 days. RMT-24 (117cm) and RMT-23 (113cm) had the tallest plant followed by RMT-22 (112cm) and RMT-14 (87cm) had comparatively dwarfed plants. The mutants RMT-22, RMT-23 and RMT-26 produced similar number of branches (6) which was the highest of all genotypes and check varieties. RMT-22 and Tori-7 produced the highest number of siliqua plant^{-1} (135) followed by RMT-23 which produced 126 siliqua plant^{-1}. Number of seeds siliqua^{-1} and siliqua length is a good indicator contributing to seed yields**.** Maximum seeds siliquae^{-1} and siliquae length was obtained from RMT-13, RMT-22 and RMT-25 that was significantly differ from other mutants and check. Among the genotypes, line RMT-22 produced higher seed yield of 1348 kg ha^{-1} which was statistically similar to seed yield of RMT-25 and RMT-23 (1122 kg ha^{-1}& 1095 kg ha-^{1}). Better yield performance at southern area of RMT-13, RMT-22 and RMT-25 have been selected for future trial.

Growing of F_5 to F_2 population of rapeseed generation

Rapeseeds (*B. rapa var. yellow sarson*) lines having heterogeneity in plant height, branches plant^{-1} and maturity period were screened with the objective to select desirable populations. A large number of F_5, F_4, F_3 and F_2 variants were developed from various cross between Binasarisha-9×BARI Sarisha-14, Binasarisha-9×Tori-7, Binasarisha-9×BARI Sarisha-18, Tori-7×BARI Sarisha-18 were grown at BINA Head Quarter farm, Mymensingh. The seeds

were sown during 4-6 November 2022. All the seeds were planted in 3m long five rows with 30cm row spacing. Recommended fertilizer was applied and necessary actions were taken to grow the crop uniformly. Total 49 segregating populations were evaluated for yield and yield contributing characters. Among them 12 were segregating families and other 25 were single plant. All the segregating populations were obtained from earlier generations that have been selected from previous trials, whereas single plant populations were from earlier generation of F_4 to F_2. Five populations from F_5 and 12 from F_4 were selected for future generation advancement. The selection considered the early maturity period (79-82 days) with other yield contributing characters. From various early generation single plants were also selected considering maturity period, seed color, no. of siliqua and other agronomic traits. Thirty-four single plants have been selected and harvested separately for future utilization of varietal improvement program. A total of 25 true breeding lines have been selected primarily for further selection that will be grown irrespective of advance generation on the basis of their agronomic performances.

Growing of M_5 to M_2 generation of rapeseed mutants

Fifteen rapeseeds (*B. rapa var. toria*) lines having heterogeneity in plant height, branches plant^{-1} and maturity period, a large number of M_5, M_4, M_3 and M_2 variants was developed from different irradiated materials were grown for selecting desirable mutant at BINA Head Quarter farm, Mymensingh. The seeds were sown during 4-6 November 2022. All the seeds were space planted in 3m long five rows with 30cm row spacing. Recommended fertilizer was applied and necessary steps were taken to grow the crop uniformly. Total 124 segregating population (Table 7) was evaluated for yield and yield contributing characters. Among these, 44 segregating families (M_5& M_4) and others were (68) single plant. All these segregating populations were obtained from earlier generation, that have been selected from previous trials, whereas, single plant population was from earlier generation of M_4, M_3 and M_2. Total eight populations from M_5 and ten from M_4 were selected for future advancement of generation. The basis of the selection was the maturity period (78-83 days) with other yield contributing characters. The single plants were selected considering maturity period, seed color, no. of siliqua and other agronomic traits. Fifty-eight single plants also selected and harvested separately for future utilization in varietal improvement program. From these variants a total of 68 true breeding mutants have been selected primarily for further selection.

Growing of M_1 generation of rapeseed

Binasarisha-9 is one of the most popular rapeseed variety in Bangladesh. It requires near about 85 days mature, is one of the drawbacks for wide use of this variety in existing cropping pattern. Induced mutation is widely acceptable techniques for creating genetic variability. The well dried seed of BARI Sarisha-18, Binasarisha-11, Binasarisha-9 and Tori-7 were used. Thirty seeds were exposed to four doses of gamma rays (500, 600, 700, and 800 Gy). Prior to mutagenic treatment, seeds were kept in desiccators for moisture equilibration. The seeds were irradiated by gamma rays (^{60}Co irradiator) at BINA Mymensingh. The response variables, percent germination and survival rate were counted after 21 days of sowing.

Hybridization of Binasarisha-9 and BARI Sarisha-14, BARI Sarisha-17 & BARI Sarisha-18

The aim of this study was to create genetic variability for higher seed yield, low erucic acid content and early maturity of rapeseeds. Binasarisha-9 was crossed with BARI Sarisha-14, BARI Sarisha-17 and BARI Sarisha-18. The seeds were sown on 10 days' interval from 4-13 November 2022. In early morning the recipient parent was emasculated and pollinated by the

respective donor parents followed by bagging and tagging. After 3-5 days the bag was removed and seed setting siliqua was considered as success of cross. Maximum crossing were conducted between Binasarisha-9×BARI Sarisha-18 followed by Binasarisha-9×BARI Sarisha-14 and success rate was higher in Binasarisha-9×BARI Sarisha-18, (50%). F_1 seeds were harvest separately for growing F_2 population.

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

On-farm and on-station trials were carried out during the Kharif-II season of 2022 to assess the performance of four groundnut mutants with a check variety, Binachinabadam-4, across eight locations. Using a randomized complete block (RCB) design with three replications, data were collected on plant height, pod number, pod yield plant^{-1}, 100-pod and kernel weight from random selections. Significant variations were observed among the tested lines and the check variety in yield and associated characteristics. The mutant B6/282/80 consistently performed better (2.04 tha^{-1}) than other mutants and the check variety (1.96tha^{-1}) in yield across most locations. In terms of height, RG-KHA-19-1 was the tallest (75.36cm), while for pod and kernel weight, B6/282/80 showed superiority over Binachinabadam-4. The shelling percentage of B6/282/80 was 73.26, also found to be significantly higher. Based on its promising yield, enhanced shelling percentage, and larger kernel size, the B6/282/80 mutant was registered as a new groundnut variety, BINA Chinabadam11, suitable for both Rabi and Kharif seasons across Bangladesh's groundnut growing areas.

Regional yield trial with bold seeded mutants of groundnut

Regional yield trial was carried out to identify highyielding, bold-seeded mutant lines of groundnut with an emphasis on superior yield and quality attributes over existing varieties, Binachinabadam-4 and BARI Chinabadam-8. Trials were conducted at multiple locations using five mutant lines in a randomized complete block design (RCBD) with three replications. Evaluations focused on yield. Significant variations showed among the tested mutants and check varieties. The mutant BCB-4-2-2 demonstrated superior yield (2.67tha^{-1}) and a high shelling percentage (68.77). Furthermore, fatty acid content analysis, particularly Oleic and Linoleic acids, revealed significant variations among the genotypes. The study also emphasized the importance of both unsaturated and saturated fatty acids in determining the nutritional and storage characteristics of groundnut oil. BCB 3-1-3 exhibited the highest oleic acid content (31.56%), while BCB 4-2-2 had the lowest oil content (22.06%). Given the promising yield and oil quality attributes, a zonal trial for the mutant is recommended for the Kharif-II season.

Advanced yield trial with bold seeded mutants of groundnut

Advanced yield trial was carried out to assess the adaptability of groundnut in Bangladesh by evaluating genotype, environmental effects, and genotype by environment interactions concerning pod yield. The Trial was conducted at four seperate locations using a randomized complete block design over three replications. Seeds were spaced 15 cm apart in 30 cm rows. Evaluations focused on various growth parameters and yield attributes. Significant variations showed among the mutants and check varieties across different environments. Mutant BCB-4-2-2 consistently exhibited superior characteristics, including yield 2.11tha^{-1} and shelling percentage 72.40, compared to other lines. The findings suggest BCB-4-2-2 is a suitable genotype for widespread cultivation in Bangladesh, whereas other genotypes might be more environment specific.

Screening of F_5 populations for long and bigger pods with 3-4 kernels

The study screened F5 populations of groundnut for longer pods containing 3-4 kernels using a 4 × 4 intra-specific diallel cross with diverse parent genotype. Four parent genotypes, GC-1,

Binachinabadam-4, Morocco, and Myanmar Badam, were crossed, and the experiment was carried out at the Bangladesh Institute of Nuclear Agriculture (BINA) farm, Mymensingh, from January to June 2023. Groundnuts were grown under a randomized complete block design (RCBD) with three replicates in 1.0 m × 2.0 m plots. Standard planting spacing and agronomic practices were followed, and no irrigation was applied due to sufficient rainfall. Various plant and yield metrics were recorded from 10 randomly selected mature plants per plot. Data analysis revealed significant variations among cross combinations and the parent genotypes. The cross BCB-BB-GC-1-19 displayed the highest plant height of 74.93cm. Notably, BCB-GC-MY-9 and BCB-BB-B4-7 produced higher pods per plant at 14.2. The mutant BCB-M-MY-5 exhibited the highest pod (79.07 g) and kernel weights (56.67 g), which was higher than the parent genotypes. Furthermore, BCB-M-MY-5 demonstrated the highest yield 3.48 tha^{-1}, as a suitable line for further breeding efforts for longer pods with 3-4 kernels.

Screening of F_4 populations for long and bigger pods with 3-4 kernels

Using a 4 × 4 intraspecific diallel cross of groundnut, four groundnut parent genotypes viz., GC-1, Binachinabadam-4, Morocco and Myanmar Badam, having diverse origin. The experiment was conducted at the field experimental plot of Bangladesh Institute of Nuclear Agriculture (BINA), Mymensingh, Bangladesh during the period of August 2022 to December 2022. From 21 lines a total of 13 lines have been selected primarily for future selection in F_5 generation.

Induced mutation of groundnut through Gamma irradiation

To create genetic variability, seeds of five groundnut variety Lory, Binachinabadam-9, BARI Chinabadam-11 and GC-1were irradiated with physical (150, 180, 200 and 250 Gy) mutagen. Seed were sown on 22 November 2022 at BINA HQSs farm, Mymensingh. The experiment followed non- replicated design and sown separately (variety and dose wise). Survived plants produced seeds were harvested separately for growing M_2 generation

Maintenance of groundnut mutant germplasm

Fifty five germplasm were grown at BINA Headquaters farm, Mymensingh. After harvest, seeds of all germplasm were collected and preserved as breeding materials.

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

Two promising mutants along with two check varieties Binatil-1 and BARI Til-4 were evaluated last six years through this trial. Further trials will be needed to confirm the results of selected promising mutants. Two promising mutants SM-25 & SM-26 along with two check varieties Binatil-1 and BARI Til-4 were evaluated through this trial. This experiment was conducted at BINA HQ's farm, Mymensingh and BINA sub-station farms at Ishurdi, Magura & farmer's field at Ishurdi, Cumilla and Magura during March to June 2023.The mutants and the check varieties were laid out in a randomized complete block design with three replications. Unit plot size was $20m^2$ (4m × 5m) and line to line spacing was maintained 25cm. Seeds were sown on March 2023. Recommended production packages like application of recommended doses of fertilizers, irrigation, weeding, thinning, etc. were followed to ensure normal plant growth and development. Data were taken on plant height, number of branches $plant^{-1}$, number of capsules $plant^{-1}$ and number of seeds $capsule^{-1}$ from 10 randomly selected plants of each plot. Maturity period was counted when 80% capsules were matured and most of the plants turned into straw or yellowish color in each plot. Seed yield of each plot was converted into kg ha^{-1}. Appropriate statistical analyses were performed for comparison of means. Results obtained from the trial of individual location and combined

over locations for all the characters showed significant variations among the mutants and the check varieties for most of the characters in both of individual locations and combined over locations. No-significant variation was observed for days to maturity, branches plant^{-1} and capsule length. On an average, days to maturity ranged from 84 to 88 days. The mutant SM-25 & SM-26 matured earlier (84 days) than the check varieties Binatil-1 (87 days) and BARI Til-4 (88 days). Binatil-1 produced the tallest (102cm) plant and mutant SM-26 produced the shortest plant height of 93cm followed by BARI Til-4 (94) and the mutant SM-25 (95cm). BARI Til-4 produced 3 branches where the mutant SM-26 bear 2 branches but the mutant SM-25 and the check variety Binatil-1 were uniculm type. BARI Til-4produced significantly higher number of capsules plant^{-1} (56) followed by the mutant SM-26 (47) and SM-25 (46cm). BARI Til- 4 produced only 38 number of capsules plant^{-1}. The mutant SM-26 had the highest number of seeds capsaules^{-1} (71) with long capsule (3.41cm) size followed by BARI Til-4 (70). The mutant SM-25 had 67 number of seeds capsaules^{-1} with 3.02cm long where as Binalit-1 had 66 numbers of seeds capsaules^{-1} with 3.49cm capsule length. On an average, SM-26 produced the highest seed yield of 1357 kg ha^{-1} followed by the check variety BARI Til-4 (1279 kg ha^{-1}) and the mutant SM-25 produced the lowest seed yield of 1153 kg ha^{-1}. Location-wise performance showed that the highest seed yield was produced at BINA sub-station field, Ishurdi (1378 kg ha^{-1}) followed by farmer's Field Ishurdi (1301 kg ha^{-1}). From this trial it was observed that, SM-26 was the best mutant among the mutants and check varieties. Application will be made to NSB for registering this mutant as a variety.

Regional yield trial with M_7 sesame mutants

Four promising mutants along with two check varieties Binatil-4 & BARI til-4 were evaluated through this experiment at BINA HQs farm, Mymensingh and BINA Sub-station's farm at Ishurdi, Magura and Jamalpur during March to June 2023. The mutants and the check varieties were laid out in a randomized complete block design with three replications. Unit plot size was 20m^2 (4m × 5m) and line to line spacing was maintained 25cm. Seeds were sown on March 2023. Recommended production packages like application of recommended doses of fertilizers, irrigation, weeding, thinning, etc. were followed to ensure normal plant growth and development. Data were taken on plant height, number of branches plant^{-1}, number of capsules plant^{-1} and number seeds capsule^{-1} from 10 randomly selected plants from each plot. Maturity period was counted when 80% capsules were matured and most of the plants turned into straw or yellowish color in each plot. Seed yield of each plot was converted into kg ha^{-1}. Appropriate statistical analyses were performed for comparison of means of each character. Results obtained from the trial of individual location and combined over locations for all the characters showed significant variations among the mutants and two check varieties for most of the characters in both individual locations and combined over locations. Days to maturity ranged from 83 to 96 days in different locations. The plant heights of the mutants were shorter (106-107 cm) than the check varieties (111-116 cm) except the mutant ESE-03 (111 cm). The mutant ESE-03 produced maximum (3.03) branches plant^{-1} followed by the other mutants and check varieties (2.92) whereas the lowest was in ESE-01 (2.38). Binatil-4 produced significantly higher number of capsules plant^{-1} (61) which was statistically different from ESE-01 (46). All other mutants and check BARI til-4 produced almost similar number of capsules plant-^{1} (53-56). Check variety BARI til-4 produced the highest number of seeds capsaule^{-1} (99) followed by the mutant ESE-03 (89). Binatil-4 had long capsule length (2.69cm) and ESE-01 also had long capsule length (2.55cm) than others. Highest thousand seed weight (3.03g) in ESE-01, which was statistically identical from others.On an average, Mutants ESE-04 and ESE-06 produced the highest seed yield of (1295 kg ha^{-1}) and (1314 kg ha^{-1}), respectively followed by check varieties Binatil-4 (1270 kg ha^{-1}) and BARI til-4 (1276 kg ha^{-1}). Location-wise performance

showed that the highest seed yield was produced at BINA sub-station, Jamalpur (1260 kg ha^{-1}) followed by BINA HQs farm, Mymensingh (1231 kg ha^{-1}) and BINA sub-station Magura (1229 kg ha^{-1}). From this result, it was concluded that mutant's ESE-03, ESE-04 and ESE-06 performed better in yield and other yield contributing characters. Further trials will be needed to confirm this result.

Preliminary yield trial with promising M_6 sesame mutants

Five promising mutants (SES-05, SES-07, SES-08. SES-09, SES-10 & SES-11) along with two check varieties Binatil-4 & BARI til-4 were evaluated through this trial. This experiment was conducted at BINA Sub-station's farm at Ishurdi and Magura during March to June 2023. The mutants and the check variety were laid out in a randomized complete block design with three replications. Unit plot size was $12m^2$ (4m × 3m) and line to line spacing was maintained 25cm. Seeds were sown on 06 March 2023. Recommended production packages like application of recommended doses of fertilizers, irrigation, weeding, thinning, etc. were followed to ensure normal plant growth and development. Data were taken on plant height, number of branches $plant^{-1}$, number of capsules $plant^{-1}$ and number seeds $capsule^{-1}$ from 10 randomly selected plants from each plot. Maturity period was counted when 80% capsules were matured and most of the plants turned into straw or yellowish color in each plot. Seed yield of each plot was converted into kg ha^{-1}. Appropriate statistical analyses were performed for comparison of means of each character. Results of individual location and combined over locations for all the characters revealed significant variations among the mutants and check for most of the characters at individual location and combined over locations. Days to maturity ranged from 86 days (SES-08) to 91 days (SES-11). Mutants SES-09 produced the tallest plant (122cm) whereas mutant SES-09 produced the shortest plant height (105cm). The mutant SES-08 is unicalm but the other mutants and check varieties had more branches with SES-11 having the maximum (3.3) branches $plant^{-1}$ followed by the mutant SES-07 (3.1). Mutant SES-11 produced significantly higher number of capsules $plant^{-1}$ (58) which was statistically different from others. Lowest number of capsules $plant^{-1}$ (38) was obtained from SES-08. Mutant SES-08 produced highest number of seeds $capsaule^{-1}$ (95) followed by the mutant SES-05 (91) and SES-11 (90). Mutant SES-08 had long capsule length (2.44cm) and highest thousand seed weight (3.29g) in SES-11, which was statistically identical with others. On an average, Mutants SES-11 produced the highest seed yield of (1403 kg ha^{-1}) followed by mutants SES-10 (1352kg ha^{-1}) and SES-05 (1337kg ha^{-1}). Location-wise performance showed that the highest seed yield was produced at BINA HQ farm, Mymensingh (1312kg ha^{-1}) followed by BINA sub-station farm, Ishurdi (1302kg ha^{-1}).

Growing of M_6 to M_2 generation of sesame mutants

One hundred and six mutant populations (28) / single plants (78) selected based on maturing period, yield and other yield contributing characters in M2-M6 generations. A large number of M_6, M_5, M_4, M_3 and M_2 variants was developed from different irradiated materials were grown for selecting desirable mutant at BINA Head Quarter farm, Mymensingh. The seeds were sown during March 2023. All the seeds were space planted in five rows of 3m long with 25cm row spacing. Recommended fertilizer was applied and necessary steps were taken to grow the crop uniformly. Total 106 segregating population were evaluated for yield and yield contributing characters. Among these, 28 segregating families (M_6 & M_5) and others were (78) single plant. All of these segregating populations were obtained from earlier generation, that have been selected from previous trials, whereas, single plant population was from earlier generation of M_4, M_3 and M_2. Total six populations from M_6 and 10 from M_5 were selected for future advancement of generation. The basis of the selection considered the

maturity period (84-95 days) with other yield contributing characters. From various early generation single plant also selected considering maturity period, seed color, no. of capsule and other agronomic traits. Forty-four single plants also selected and harvested separately for future utilization of varietal improvement program. From all of these variants a total of 60 true breeding mutants have been selected primarily for further selection in the following generation on the basis of their agronomic performances.

Growing of M_1 population

To select early maturing lines with desirable yield attributespromising mutants will be grown for subsequent generation. To create genetic variability, seeds of popular sesame varieties Binatil-1, Binatil-2, Binatil-4 and BARI til-5 were irradiated with 600, 700 and 800Gy of gamma rays. Seeds were sown on 04 April 2023 at BINA HQ farm, Mymensingh. This experiment was followed non-replicated design and sown separately (variety and dose wise). Finally, the survived plants that produced seeds were harvested separately for growing M_2 population.

On-station and on-farm yield trial with selected M_7 soybean mutants

Three promising mutants SBM-22, SBM-23 and SBM-26 along with two check varieties Binasoybean-5 and BARI Soybean-6 were evaluated through this trial at BINA HQs farm, Mymensingh and BINA sub-station farms at Barishal and farmers' field at Subornochor, Kamalnagar, Haimchar and Barishal during January to April 2023. This experiment was laid out in a randomized complete block design with three replications. Sowing was done within first week of January. Spacing between rows was 30cm and 5-8cm between plants in a row. Unit plot size was $20m^2$ (5m × 4m). Recommended management practices were followed to ensure proper growth and development of plants. Data on various characters such as plant height, number of branches $plant^{-1}$, pods $plant^{-1}$ and seeds pod^{-1} were taken from 10 randomly selected plants of each plot. Maturity period was counted when the plant and pods of each plot turned into yellowish brown color and almost all the leaves spill. Seed yield of each plot was recorded and converted into kg ha^{-1}. Data recorded from the experiment was analyzed following appropriate statistical analysis. Results obtained from this trial of individual location and combined over locations for all the characters showed significant variations among the mutants and check varieties for most of the characters in both individual location and combined over locations. On an average, maturity period ranged from 106 to 129 days and there were no statistical differences among the mutants and check varieties. The mutant SBM-23 matured earlier than other and it required 106 days to mature where the mutants SBM-26 & SBM-22 required 129 & 128 days to mature, respectively. BARI Soybean-6 & Binasoybean-5 require 111 & 110 days to matured respectively. Plant height ranged from 46cm in SBM-23 to 99cm in SBM-22. There were no significant differences for Branches $plant^{-1}$ among the mutants and check varieties. The mutants SBM-22 produced the highest number of branches $plant^{-1}$ (5) and highest number of pods $plant^{-1}$ (84), seeds pod^{-1} (3). The mutant SBM-26 produced 73 numbers of pods $plant^{-1}$ and two check varieties BARI Soybean-6 and Binasoybean-5 produced 74 & 70 pods $plant^{-1}$, respectively. Pod length ranged from 3.32cm (BARI Soybean-6) to 2.58cm in SBM-23. The highest hundred seed weight was found in the mutant SBM-23 (14.00g) followed by SBM-22 (13.24g). Mutant SBM-22 produced the highest seed yield of 3094 kg ha^{-1} followed by two check varieties Binasoybean-5 (2874 kg ha^{-1}) and BARI Soybean-6 (2891 kg ha^{-1}). Among the locations the highest seed yield of 2878 kg ha^{-1} was obtained from farmer's field at Kamalnagar followed by BINA sub-station farm at Barishal (2830 kg ha^{-1}) & BINA HQs farm, Mymensingh (2804 kg ha^{-1}). From this trial, it was observed that SBM-22 and SBM-26 showed better yield performance than other mutant and check varieties.

Preliminary yield trial with selected M_5 soybean mutants

Five promising mutants SCM-5, SCM-8, SCM-11, SCM-15 and SCM-17 along with a check variety Lokon were evaluated through this trial at BINA HQ farm, Mymensingh and BINA Sub-station farms at Satkhira during January to April 2023. This experiment was laid out in randomized complete block design with three replications. Sowing was done on 14 January 2023. Spacing between rows was 30cm and 7-10cm between plants in a row. Unit plot size was $12m^2$ (4m × 3m). Recommended management practices were followed to ensure proper growth and development of plants. Data on various characters such as plant height, number of branches $plant^{-1}$, pods $plant^{-1}$ and seeds pod^{-1} were taken from 10 randomly selected plants of each plot. Maturity period was counted when the plant and pods of each plot turned into yellowish brown color and almost all the leaves shed. Seed yield of each plot was recorded and converted into kg ha^{-1}. Data recorded from the experiment were analyzed following appropriate statistical design. On an average, maturity period ranged from 116 days (SCM-5) to 136 days (SCM-08 &Lokon). Plant height ranged from 32cm (SCM-11) to 105cm (Lokon) and branches $plant^{-1}$ ranged from 1 (SCM-15 & SCM-17) to 4 (SCM-8 &Lokon). The check variety, Lokon produced the highest number of pods $plant^{-1}$ (64); whereas, the mutant SCM-8 produced 43 pods $plant^{-1}$ and the mutants SCM-5 & SCM-11 produced 26 pods $plant^{-1}$. The lowest number of pods $plant^{-1}$ was produced by the mutants SCM-15 (17) and SCM-17 (16). Lokon produced the highest number of seeds pod^{-1} (3.90) followed by SCM-17 (3.82). Lokon had the highest pod length (2.67) followed by SCM-5 (2.33) and the rest four mutants had the similar pod length (2.17). Hundred seed weight was higher in SCM-11 (15.96g) and lower hundred seed weight was obtained from Lokon (10.96g). Seed yield obtain from the mutants and check varities significantly differs from each other. Mutant SCM-5 produced the highest seed yield of 2517 kg ha^{-1} followed by SCM-11 (2353 kg ha^{-1}) and the check variety Lokon produced 2169 kg ha^{-1}. Among the locations the highest seed yield was obtained from BINA HQ farm Mymensingh (2093 kg ha^{-1}) followed by BINA sub-station farm at Satkhira (1968 kg ha^{-1}). From this experiment, it was concluded that SCM-5 and SCM-11 performed better among the mutants and the check variety. Further trials will be needed to confirm the result.

Screening soybean mutants for salinity tolerance at reproductive stage in hydroponic culture

Three promising soybean mutants SBM-22, SBM-25 and SBM-26 along with three soybean varieties Binasoybean-2 (Parent), Binasoybean-6 and Lokon were evaluated to investigate the performance under saline condition at reproductive stage in hydroponic culture. The experiment was conducted at BINA HQs, Mymensingh during July to October 2022, and laid out in a completely randomized design (CRD) with three replications. After completion of seedling and vegetative stages in normal condition, artificial salinity was created with NaCl and maintained 8 dS m^{-1}, 10 dS m^{-1} and 12 dS m^{-1} in each tray in hydroponic culture solution. Data on visual injury and pod setting rate was recorded from five randomly selected plants of each doses. Comparing with imposed salinity level and time, pods $plant^{-1}$ and seeds pod^{-1} was decreased gradually day by day. All the genotypes completed flowering stage at 8 dS m^{-1} in 45-55 days and also showed moderately tolerant reactions. After 55 days the mutants showed moderately tolerant at 8 dS m^{-1} but after 65 days' mutants are unable to set pod formation. Furthermore, Binasoybean-2 & Binasoybean-6 showed moderately tolerant and Lokon performed highly tolerant up to maturity stage. From the visual salt injury score it was concluded that the mutants SBM-22, SBM-25 and SBM-26 was susceptible for salinity at reproductive stage. Whereas, Binasoybean-2 and Binasoybean-6 showed moderately tolerant and Lokon performed tolerant for all stages. Moderately tolerant and tolerant varieties could be used as parent material of salinity stress breeding program.

Screening salt tolerant soybean genotypes in pot culture

Ten genotypes (nine promising soybean mutants SBM-22, SBM-23, SBM-25, SBM-26, SCM-5, SCM-8, SCM-11, SCM-15 and SCM-17 along with one soybean variety Lokon) were evaluated to investigate the performance in saline condition at reproductive stage.The experiment was conducted at BINA HQ, Mymensingh during Jan to April 2023, and laid out in a completely randomized design (CRD) with three replications. Before seed sowing, salinity was created artificially with NaCl and maintained 4 dS m^{-1}, 6 dS m^{-1} and 8 dS m^{-1} in each pot (10 kg soil in each pot). Data on various characters such as plant height, number of leaves $plant^{-1}$, leaf area and chlorophyll content (SPAD meter) was recorded from five randomly selected plants of each doses. Comparing with imposed salinity level and time, plant height as well as leaf number/area was decreased. All the germinated genotypes survived at 4 dS m^{-1} until 21 days (Table 16). All the mutants showed moderately tolerant at 6 dS m^{-1} up to 7 days after sowing. Check variety Lokon performed well with the advancement of time. Total chlorophyll content was shapely decreased at saline condition. The decreased rate was lower at Lokon than other indicating its salt tolerance potentiality. Total chlorophyll content was relatively higher for the mutants SBM-22 and lower for SBM-26. From the visual salt injury score and chlorophyll content it was concluded that all the mutants were susceptible for salinity except SCM-8, SCM-17 and Lokon performed well and could be selected for further evaluation.

Screening drought tolerant soybean genotypes under hydroponic culture

Due to climatic change drought prone areas in Bangladesh increasing day by day. Screening of the selected drought tolerant soybean genotypes will be used for the future breeding program. Nine promising soybean mutants SBM-22, SBM-23, SBM-25, SBM-26, SCM-5, SCM-8, SCM-11, SCM-15 and SCM-17 along with one soybean variety Binasoybean-2were evaluated to investigate the performance in drought condition. The experiment was conducted at BINA HQ, Mymensingh during July to October 2022, and laid out in a completely randomized design (CRD) with three replications. Seeds are sowing in normal condition, artificial drought stress was created with 10%, 15% and 20% of PEG in each tray in hydroponic culture solution. Data on visual injury and pod setting rate was recorded from five randomly selected plants of each doses. Comparing with imposed drought level and time, pods $plant^{-1}$ and seeds pod^{-1} was decreased day by day. All the genotypes were not completed the flowering stage and some are showed moderately tolerant. After completion of all treated drought imposed stages five mutants are unable to set pod formation. Furthermore, SBM-23, SBM-26, SCM-11, SCM-17 and Binasoybean-2 showed moderately tolerant up to maturity stage. From the visual drought injury score it was concluded that five mutants viz., SBM-22, SBM-25, SCM-5, SCM-8 and SCM-15 was susceptible; whereas, SBM-23, SBM-26, SCM-11, SCM-17 and Binasoybean-2 showed moderately tolerant against drought. Moderately tolerant mutants could be used for further evaluation.

Screening of M_4 &M_5 population

Homogeneity is the prime focus for advanced mutants. There are nine mutants of M_4 population and seven mutants of M_5 population were evaluated last three and four years through this trial. Further trials will be needed to confirm the results of selected promising mutants. A large number of M_5 populations from BU-2, AVRDC-250, AVRDC-266 and AVRDC-262 were grown in plant progeny-rows for selecting desirable mutants at BINA HQ farm, Mymensingh. Sowing was done on 11 December 2022. Spacing between rows was 30cm and 7-10cm between plants in a row. Recommended production packages like application of recommended doses of fertilizers, irrigation, weeding, thinning, etc. were followed to ensure normal plant growth and development. Data were considered for plant

height, number of branches plant^{-1}, number of pods plant^{-1} and number seeds pod^{-1}. From them primarily, a total offivemutants have been selected based on their agronomic performances for subsequent generations.

Growing of M_4 population

To select desirable mutants in respect of early maturity, bold seeded with higher yield. A large number of M_4 populations from AVRDC-366, CMLL-0.3 were grown in plant progeny-rows for selecting desirable mutants at BINA HQ farm, Mymensingh. Sowing was done on 12 December 2022. Spacing between rows was 30cm and 7-10cm between plants in a row. Recommended production packages like application of recommended doses of fertilizers, irrigation, weeding, thinning, etc. were followed to ensure normal plant growth and development. Data were considered for plant height, number of branches plant^{-1}, number of pods plant^{-1} and number seeds pod^{-1}. From them primarily, a total of ten mutants have been selected based on their agronomic performances for subsequent generations.

Growing of M_3 population

To select desirable mutants in respect of early maturity, bold seeded with higher yield. A large number of M_3 populations from AVRDC-366, BU soybean-2, YESOY-4, PK-416, LG-92p-1139 and PM-78 were grown in plant progeny-row for selecting desirable mutants at BINA HQ farm, Mymensingh. Sowing was done on 12 December 2022. Spacing between rows was 30cm and 7-10cm between plants in a row. Recommended production packages like application of recommended doses of fertilizers, irrigation, weeding, thinning, etc. were followed to ensure normal plant growth and development. Data were considered for plant height, number of branches plant^{-1}, number of pods plant^{-1} and number seeds pod^{-1}. From them primarily a total of 15 mutant variants have been selected based on their agronomic performances for subsequent generation.

Growing of M_2 population

To select desirable mutants in respect of nodules. Nine bulk population (150, 250 and 300Gy of gamma rays using) of Lokon, YESOY-4 and HIS-WIHS were grown in plant progeny-rows for selecting desirable mutants at BINA HQ farm, Mymensingh. Sowing was done on 12 December 2022. Spacing between rows was 30cm and 7-10cm between plants in a row. Recommended production packages like application of recommended doses of fertilizers, irrigation, weeding, thinning, etc. were followed to ensure normal plant growth and development. Data were considered for plant height, number of branches plant^{-1}, number of pods plant^{-1} and number seeds pod^{-1}. From them primarily a total of 20 mutant variants have been selected based on their agronomic performances for subsequent generations.

Growing of M_1 population

Soybean is one of the important oil crops in Bangladesh. There is an urgent demand for high yielding soybean cultivars to reduce the importation of edible oil from other countries. Early maturing, dwarf type soybean variety will be needed to avoid logging problem. So, irradiation of experimental materials is essential for creation of genetic variations. To create genetic variability, seeds of soybean variety AVRDC-262 and BU-2 was irradiated with 150, 200, 250, 300 and 350Gy of gamma rays with 19% & moisture content in seeds. Seeds were sown on 12 December 2022 at BINA HQ farm, Mymensingh. This experiment was followed non-replicated design and sown separately (variety and dose wise). At maturity stage the survived plants produced seeds were harvested separately for growing M_2 population.

Maintenance of germplasm (mutants, local and exotic collections)

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

Project-4: Varietal improvement of sunflower through induced mutations

Evaluation of sunflower line for synthetic and composite variety development

To assess earliness, higher seed yield and other morpho-physiological attributes. Ten sunflower genotypes were grown in plant progeny-rows at BINA HQs farm, Mymensingh on 12 December 2022. The experiment was conducted in a non-replicated design and unit plot size was $24m^2$ (4m × 6m) with 50cm line to line spacing and 25cm between within a row. Recommended production packages i.e., application of fertilizers, irrigation, weeding, thinning etc. were followed to ensure normal plant growth and development. Data on plant height (cm), head diameter (cm) and seeds/head were taken from 5 randomly selected plants from each plot. Maturity period was counted when 90% heads were matured in a plot. Appropriate statistical analysis was performed for comparison of mean of each character. Data was recorded on average plant height (cm), head diameter (cm) and seeds/head from 5 randomly selected plants of each plot. Recorded data were subjected to proper statistical analyses. On an average, maturity period ranged from 98-125 days. BD9328 and BD9358 required shortest maturity period of 98 days while BD9382 required the longest maturity period of 125 days. Plant height ranged from 122 to 204cm. BD9385 produced the tallest plant (204cm) followed by BD9382 (172cm). BD9359 were comparatively dwarf having 122cm plant height. Head Diameter (cm) is one of the major yield contributing characters of sunflower, it ranged from between 11.5-18.0cm. Among the genotypes, BD9382 produced the highest number of seeds $head^{-1}$ (441) followed by BD9349 and BD9401 (408). Considering yield contributing traits further trials will be needed to confirm the results of selected promising lines.

Preliminary yield trial with promising M_5 sunflower mutants

Seven sunflower mutants: SFM-01, SFM -02, SFM -03, SFM -04, SFM -05, SFM -06 & SFM -07 and one check variety BARI Surjomukhi-2 were grown in plant progeny-rows at BINA HQ farm, Mymensingh and BINA sub-station farms at Jamalpur and Nalitabari on 13 December 2022. The experiment was conducted in a non-replicated design and unit plot size was $24m^2$ (4m × 6m) with 50cm line to line spacing and 25cm between plant to plant within a line. Recommended production packages i.e., application of fertilizers, irrigation, weeding, thinning etc. were followed to ensure normal plant growth and development. Data on plant height (cm), head diameter (cm) and seeds/head were taken from 5 randomly selected plants from each plot. Maturity period was counted when 90% heads were matured in a plot. Appropriate statistical analysis was performed for comparison of mean of each character. Data was recorded on average plant height (cm), head diameter (cm) and seeds/head from 5 randomly selected plants of each plot. Recorded data were subjected to proper statistical analyses and presented in the Table 18. On an average, maturity period ranged from 100-112 days. SFM-02 and SFM-07 required shorter maturity period of 100-104 days while SFM-03 required the longest maturity period of 112 days. Plant height ranged from 143.9-184.6cm. BARI Surjomukhi-2 had the tallest plant (184.6cm) followed by SFM-06 (184.3cm). SFM-02 was comparatively dwarf having 143.9cm plant height. Head Diameter (cm) ranged from 17.3-21.1cm. Among the genotypes, SFM-02 produced highest number of seeds $head^{-1}$ (380) followed by SFM-04 and SFM-07 (360). These mutants will be furthur evaluated in the subsequent generation based on plant hight and head diameter.

Development of dwarf inbred line of sunflower having *GA2oX1* gene

To select mutants for earliness and dwarf with higher seed yield. Five mutants (SDM-01, SDM-02, SDM-03, SDM-04 & SDM-05) and check (BARI Surjomukhi-3) were used in this experiment for earliness and dwarf with higher seed yield. Seeds were grown in plant progeny-rows at BINA HQ farm, Mymensingh and BINA sub-station farm at Ishurdi&Khagrasori on 12 December 2022. The experiment was conducted in a non-replicated design and unit plot size was $24m^2$ (4m × 6m) with 50cm line to line spacing and 25cm from plant to plant within a line. Recommended production packages i.e., application of fertilizers, irrigation, weeding, thinning etc. were followed to ensure normal plant growth and development. Data on plant height (cm), head diameter (cm) and seeds/head were taken from 5 randomly selected plants from each plot. Maturity period was counted when 90% heads were matured in a plot. Appropriate statistical analysis was performed for comparison of mean of each character. Data was recorded on average plant height (cm), head diameter (cm) and seeds/head from 5 randomly selected plants of each plot. Recorded data were subjected to proper statistical analyses and presented in the Table 19. On an average, maturity period ranged from 106-111 days. SDM-03 required shortest maturity period of 106 days and SDM-05 required the longest maturity period of 111 days. Plant height ranged from 75.14-85.87cm. BARI Surjomukhi-3 produced the tallest plant (85.87cm) followed by SDM-01 (85.60cm). Head Diameter ranged from 18.03-22.66cm. Among the genotypes, SDM-02 produced the highest number of seeds $head^{-1}$ (580) followed by SDM-03 and SFM-07 (550). Further trials will be needed to confirm the results of selected promising mutants. All the mutants were sown in a non-replicated design and unit plot size was $24m^2$ (4m × 6m) with 50cm line to line spacing and 25cm from plant to plant within a line. Recommended production packages i.e., application of fertilizers, irrigation, weeding, thinning etc. were followed to ensure normal plant growth and development. Data on plant height (cm), head diameter (cm) and seeds/head were taken from five randomly selected plants from each plot. Maturity period was counted when 90% heads were matured in a plot. Percent protein content was determined on the basis of total nitrogen content (from soil science division). Appropriate statistical analysis was performed for comparison of mean of each character. The key yield contributing characteristics of sunflowers are plant height, Head diameters, hundred seed weight, and seeds $plant^{-1}$.

Growing of M_4 to M_1 generation of sunflower mutants

To select early maturing mutantswith shorter plants having droopy heads and desirable yield attributes. A large number of M_4, M_3, M_2 and M_1 variants developed by irradiating materials with three checks BARI Surjomukhi-2, BARI Surjomukhi-3 and BD9850 were grown for selecting desirable mutants at BINA Head Quarters farm, Mymensingh following augmented block design. The seeds were sown on 12-14 December 2022. All the mutants were grown in a augmented design and unit plot size was $24m^2$ (4m × 6m) with 50cm line to line spacing and 25cm from plant to plant within a line. Recommended fertilizer was applied and necessary steps were taken to grow the crop uniformly. Total 82 segregating population was evaluated for yield and yield contributing characters. Among them 62 was segregating families and other 20 was single plant. All of the segregating populations were obtained from different mutant population that have been selected from previous trials, whereas single plant population was from earlier M_1 population. A total of two families from M_4, three families from M_3 and five families from M_2 were selected and massed for future generation advancement. The selection considered the maturity period (90-115 days) with other yield contributing characters. From various early generation single plant also selected considering maturity period, seed color, no. of seeds $head^{-1}$, head diameter and other agronomic traits. Fourty single plant have been selected and harvested separately for future utilization of

varietal improvement program. From the variant population a total of 30 true breeding mutants have been selected primarily for further selection.

Regional yield trail with two M_8 mutants derived from JRO-524

This research aimed at assessing the yield potential and specific plant characteristics of two M8 mutants derived from JRO-524 across different locations in Bangladesh. Regional yield trials were conducted across seven diverse locations for testing two M_8 mutants, their parent (JRO-524), and a check variety, BJRI Tosa Pat-8. A 4.0 m × 3.0 m plot size was used, with plants spaced at 5-7 cm within rows 30 cm apart. Standard fertilizer and intercultural practices were applied. Plant height, base diameter, fiber weight, and stick weight were recorded from randomly ten selected plants. Statistical analysis showed significant variations in traits between the mutants and the check variety across different locations. While overall plant height was consistent at certain locations like Magura and Rangpur revealed significant differences. Both mutants, BJM-10-1-3 and BJM-10-1-5, exhibited a broader base diameter (1.55 cm and 1.56cm respectively) than the parent and check variety. Mutants BJM-10-1-3 and BJM-10-1-5 performed better than the parent JRO-524 in terms of fiber weight (0.34 kg and 0.34 kg respectively) and stick yield (0.66 kg and 0.68 kg respectively). Finally, the mutants BJM-10-1-3 and BJM-10-1-5 which were produced higher base diameter with leaves, fiber weight, and stick weight compare to parent JRO-524.

Growing of M1 generation of jute species

The study aimed at evaluating the effect of different concentrations of Ethyl Methane Sulfonate (EMS) on seed germination and early growth of several jute and kenaf varieties. Healthy seeds of jute varieties O-9897, O-795, O-72, kenaf HC-95, Mestapat-1 and BJRI deshi patshak-1, were treated with 0.5%, 0.75%, 1.0%, and 1.5% of EMS across exposure times ranging from 2 to 6 hours. Control seeds were incubated in distilled water under identical conditions. After treatment, the seeds were rigorously washed with tap water and were sown in both controlled Petri dish environments and field conditions at BINA HQs farm, Mymensingh. Control seeds of kenaf (HC-95) and jute (O-9897) recorded the highest germination rate (100%). However, germination rates declined with increased EMS concentrations, with the lowest observed in Mestapat-1 at 1.5% EMS (30%). This observation suggested that increased mutagenic doses lead to decreased germination. Seedling growth was also significantly affected. For root growth, maximum lengths were observed in Mestapat-1 (14 cm) and kenaf (HC-95) at control conditions, with reduced lengths in increased EMS treatments. Shoot growth showed a similar trend; the kenaf variety HC-95 exhibited the highest shoot length at control conditions (44.3 cm), while jute variety O-72 showed the shortest length at 0.75% EMS (24.5 cm). EMS treatments exhibited a dose-dependent inhibition of germination and seedling growth in jute and kenaf varieties. These findings are integral for understanding mutagenic impacts in mutation breeding processes for these crops.

Zonal yield trial of summer mungbean lines

Despite the importance of synchronous maturity, mungbean pod ripening is not synchronous. Uneven pod maturity leads to low yield and low harvesting index (HI) in mungbean. The objective of this experiment was to investigate the synchrony in pod maturity with the highest yield potential of mungbean. With a view to identify mutants with earliness, synchronous pod maturity, disease tolerance and higher yield, two mutants MB-03, MB-07 along with one check variety Binamoog-8 were sown at BINA sub-station farm at Barishal, Magura, Ishwardi and Chapainawabganj. The experiment was conducted in RCBD design with three replications. The size of the unit plots were 4.0 m × 5.0 m. The mutant MB-03 and MB-07

had shorter duration (63 days and 67 days respectively) than the variety Binamoog-8 (70 days). The mutant MB-03 showed the shortest plant height (44.88 cm) but the variety Binamoog-8 (45.99 cm) and the mutant MB-07 (48.95 cm) had longer plant height. The highest pod plant^{-1} was observed in the check variety Binamoog-8 (17.76) compared to the mutants MB-03 (15.34) and MB-07 (17.75). Pod length was the longest in the variety Binamoog-8 (7.83 cm) folowed by the mutants MB-07 (7.81 cm) and MB-03 (7.75 cm). Maximum seeds pod^{-1} was found in the mutant MB-07 (11.85) with the check variety Binamoog-8 and mutant MB-03 had 11.70 and 11.15 seeds pod^{-1} respectively. The highest 100 seed weight (5.20 g) was found in the mutant MB-07 but Binamoog-8 and MB-03 had 3.80 and 4.54g, respectively. The highest yield was obtained from the mutant MB-07 (1.56 t/ha) while the check variety Binamoog-8 produced 1.51 t/ha. Considering earliness, synchronous pod maturity and yield performance of the mutants MB-07 and MB-03 will be evaluated at the next PVT trial in the Kharif-I season in the Mungbean growing region.

On-farm and on-station yield trial of promising summer mungbean mutant

The mungbean (*Vigna radiata L.*), commonly known as green gram, is a long-cultivated pulse crop that originated in South East Asia and is a member of the Papilionoideae family. Mung beans are primarily farmed for human consumption. It can be eaten as a vegetable or as cooked. It has great value as food and fodder. It is a cheap source of protein for human consumption. Mungbean has special features such as its earliness in maturity, supply of good yield, drought-resilient property that makes it highly responsive in scanty rainfall area. Moreover, due to short duration, it can fit well in cropping pattern. The objectives of this research were to evaluate the overall performance of the mutant for earliness, disease tolerance and seed yield.

For this experiment, the mutant line MBM-656-51-2 with the check variety BARI Mung-6 were used during Kharif-I season of 2022 at different locations BINA sub-stations farm at Ishwardi and Magura and farmer's field at Natore and Magura. The experiment followed RCB design with three replications. The size of unit plot was 5.0 m × 6.0 m. Row to row and plant to plant distances were 40 and 10-15 cm, respectively. Data on days to maturity, plant height, pods plant^{-1}, pod length, seeds pod^{-1} and seed yield were recorded. Maturity was assessed plot basis. The data for the characters under study were statistically analyzed wherever applicable. Data were analyzed using Minitab statistical package.

Results revealed that significant variations among the mutant and the check variety at different locations. It was observed that, MBM-656-51-2 had shorter plant height than the check varieties at all the locations. From mean over locations, the tested mutant MBM-656-51-2 took only 62.5 days for maturity while the check variety BARIMung-6 took 66.33 days. The highest number of pods plant^{-1} (17.19) was found in MBM-656-51-2. In respect of seed yield, this mutant produced the highest seed yield of 1.75 t/ha followed by BARI Mung-6 (1.48 t/ha). It will be applied to National Seed Board for releasing this mutant MBM-656-51-2 as a variety.

Experiment-150: Zonal yield trial of summer mungbean mutants

Despite the importance of synchronous maturity, mungbean pod ripening is not synchronous (Yeates et al, 2000). Uneven pod maturity leads to low yield and low harvesting index (HI) inmungbean (Bushby & Lawn, 1992; Egli & Bruening, 2006). A high harvest index means high proportion of total biomass production. Thus in order to increase the seed yield, selection of higher harvest index genotypes could be achieved through synchronous maturity. The inverse effects on seed yield due to high leafiness and asynchronous flowering have been observed (Bisht et al, 1998 & 2005). Opportunities further exist to investigate potential synchronously maturing mutants in mungbean through induced mutagenesis. The objective of

this experiment was to investigate the synchrony in pod maturity with highest yield potential of mungbean. With a view to identify earliness, synchronous pod maturity, disease tolerant and higher yielding mutant(s) MB-03, MB-07 and one check variety (Binamoog-8) were sown at BINA sub-station farm, Barishal, Magura, Ishwardi and Chapainawabganj. The experiment was conducted in RCBD design with three replications. The size of the unit plots were 4.0 m × 5.0 m. Recommended doses of nitrogen, phosphorus, potassium, sulphur and zinc were applied form Urea, TSP, MoP, Gypsum and Zinc Sulphate. Intercultural practices were followed as and when necessitated. The mutant MB-03 and MB-07 had shorter duration (63 days and 67 days, respectively) than the variety Binamoog-8 (70 days). The mutant MB-03 showed the lowest plant height (44.88 cm) than the variety Binamoog-8 (45.99 cm) and the mutant MB-07 (48.95 cm). Highest pod plant^{-1} was observed in the check variety Binamoog-8 (17.76) compared to the mutants MB-03 and MB-07 had 15.34 and 17.75, respectively. Pod length was longer in the variety Binamoog-8 (7.83 cm) compared to the mutants MB-07 (7.81 cm) and MB-03 (7.75 cm). Maximum seeds pod^{-1} was found in the mutant MB-07 (11.85) but the check variety Binamoog-8 and mutant MB-03 had 11.70, and 11.15, respectively. Higher 100 seed weight (5.20 g) was found in the mutant MB-07 compare to the Binamoog-8 and MB-03 (3.80 and 4.54 respectively). Higher yield was obtained from the mutant MB-07 (1.56 t/ha)

Considering the earliness, synchronous pod maturity and yield performance of the mutant MB-07 and MB-03 will be evaluated in the next PVT trial in the Kharif-I season in mungbean growing region. This research was supported by the project 'Development of climate resilient crop varieties and profitable crop management technology through nuclear techniques and enhance crop production through increasing cropping intensity and their adaptation in Haor, Charland, Saline and Hilly areas project under the Ministry of Agriculture. The authors are grateful to the Bangladesh Climate Change Trust (BCCT) under the Ministry of Environment, Forest and Climate Change and Bangladesh Institute of Nuclear agriculture (BINA), Bangladesh for providing laboratory and field facility throughout the experimental period.

Growing of M_4 generation of mungbean for synchronous pod maturity

To select desirable mutants for synchronous pod maturity with higher seed yield seeds of Binamoog-8 were irradiated with ^{60}Co gamma rays from the ^{60}Co source of BINA. Asynchronous habit of mungbean variety is difficult to harvest. Mutants that are synchronous in maturity, high yielding will address the problem effectively. Irradiation doses were 10, 20, 40, 60 and 80Gy. A large number of M_4 population were grown following plant progeny rows for selecting desirable mutant at BINA sub-station farm atIshwardi during Kharif-I season 2022. A total of 10 mutant variants have been selected on the basis of synchronous pod maturity with higher seed yield primarily for next generation.

Experiment-154: Growing of M_1 generation of mungbean for synchronous pod maturity

To create genetic variability for earliness, higher seed yield and insect tolerance, seeds of four popular mungbean varieties Binamoog-5, Binamoog-8, and Binamoog-9 & Binamoog-10 were irradiated.Several insect pests have been reported to infest mungbean and damage the seedlings, leaves, stems, flowers, buds, pods causing considerable losses. This program will help to develop new promising lines. Seeds were irradiated with ^{60}Co gamma rays from the ^{60}Co source of BINA at 300, 350, 400 & 450Gy doses. Seeds were sown at BINA HQs farm, Mymensingh during Kharif-I season 2022. The experiment was followed by non-replicated design and sown separately (variety and dose wise). Dose wise seeds were collected as bulk. Further experiment will be conducted in next season.

Preliminary yield trial of some selected mutants of Chickpea

An experiment was conducted with seven mutants (CIEN SA-15, CIEN SSA-6-10, CIEN SSA-15-41, CIEN SSA-32-26, CAT-23-29, CIEN SA-33 andCAT-29-38) and one check variety Binasola-8 at BINA sub-station farm Magura during 2022-23 for selecting mutants with high yield, earliness and tolerant to diseas.. The experiment was single factor as mutants and seeds were sown in randomized complete block design with three replications. Data on days to maturity, plant height, number of primary branches, pods plant^{-1} were recorded from 10 randomly selected plants. In the location of BINA sub-station farm Magura CIEN-SSA-(32-26) mutant showed the highest seed yield (2.15 tha^{-1}) and pods plant^{-1} (97.00). Besides this CIEN-SA-15 mutant showed earliest in maturity (127 days). Further experiment will be conducted in the next season at different chickpea growing areas.

Growing of M_1 generation of Chickpea

To create genetic variability for earliness, higher seed yield and disease tolerance an experiment was set up at BINA Substation farm Ishwardi during Rabi 2022-23. Seeds of Binasola-6& BARI Sola-11 were irradiated with ^{60}Co from source of BINA 200, 250, 300 & 350 Gy doses of gamma rays. The non-irradiated seeds were kept as control of parents.. Dose wise seeds were collected as bulk.

Screening of exotic chickpea lines for early maturity, disease tolerance and higher seed yield

To select desirable lines with early maturity, high yield and tolerance to diseases, an experiment was set up at BINA sub-station, Magura during Rabi 2022-2023 with twenty nine linescollected from ICARDA. Among 29 exotic chickpea lines and 1 check variety Binasola-8, maximum and minimum yield was observed in exotic line CAT-9-30 (30.2gm/plant) & CAT-7-51 (3g/plant), respectively. Average yield was 13.8 g/plant. Days to maturity ranged from 119-128 days. Three lines (CIEN-SA-32, CIEN MED-32&CAT-9-30) performed better than the check Binasola-8 in termS of yield and other nine lines had yield more than average. Better performed exotic lines with yield and days to maturity can be used for further varietal improvement programs.

Growing of M_4 generation of pigeon pea

The pigeon pea (*Cajanus cajan*) is a perennial legume from the family Fabaceae native to the old world. Seeds of three local pigeon pea germplasms were irradiated with 15, 20, 25 and 30Gy doses of gamma rays from the ^{60}Co source of BINA. Dose wise seventeen mutants were grown at BINA Headquarter farm during July 2022. Ten mutant variants were selected based on shorter plant height, higher seed yield and disease tolerance for further evaluation. M_3-P-33(1) showed early maturity (161 days) than other mutants and M_3-P-15(1) showed the highest number of pods (1703) per plant. Further experiment will be conducted in the next season.

Project: Varietal improvement of garden pea using mutation breeding techniques

Growing of M_3 generation of garden pea

Garden Pea (*Pisum sativum*) is a species of annual herb in the family legumes**.** To select desirable mutants for earliness, higher seed yield and disease tolerance this experiment was done. Application of different doses radiation might change the genetic makeup of garden pea (BARI Motor-3). Seeds of BARI Motor-3 were irradiated with 20, 40, 60 and 80Gy doses of gamma rays from the ^{60}Co source of BINA. Ten mutants were selected based on bolder seed size, days to maturity and higher seed yield and disease tolerance for further evaluation. Among all mutants, Motorshuti (40 Gy)-1(1)/P-1showed the highest number of pods (9) per

plant and N. Motorshuti (60 Gy)-4/P-1was the earliest (51 days) than others. Further evaluation will be conducted in the next season.

Varietal improvement of lentil through induced mutation and advanced breeding techniques

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

Food legumes are a nutrient-dense staple that is extensively consumed around the world. Lentils are one of the most widely produced legumes, with major global trade. Lentils are a good source of protein (approximately 25%) and some micronutrients, such as minerals (calcium, iron, potassium, and zinc) and vitamins (vitamin A, C, and niacin).The purpose of this study is to evaluate the yield potential of the lines over locations. On-station yield trials were conducted with four mutant lines along with a check variety, BARI Mashur-8, at BINA sub-stations farms at Magura, Ishurdi, and BINA HQs Mymensigh farm during the Rabi season of 2022. On the other hand, on-farm yield trials were conducted at farmers' field at Magura, Ishurdi, and Chapainawabganj during 2022. The experiment was laid out in a randomized complete block design with three replications. The unit plot size was 12 m^2 (4 m × 3 m) with 30 cm line to line distance. Data on days to maturity, plant height, number of primary branches $plant^{-1}$ and pods $plant^{-1}$ were recorded from 10 randomly selected plants.Results revealed significant variations among the mutants and the check variety for days to maturity, pods per $plant^{-1}$, 100-seed weight, and seed yield at the three locations. On average, the maturity period varied from 105 days to 110 days. LM-99-8 produced the highest number of pods $plant^{-1}$ at all locations but LM-20-4 produced the highest seed yield (1735 kg ha^{-1}) followed by LM-99-8 with 1700 kg ha^{-1} at Ishurdi.In the case of 100-seed weight, a higher weight was also found in LM-20-4, followed by LM-88-9 at the same location. When combined over the three locations, the line LM-20-4 (1715kg ha^{-1}) produced the highest seed yield followed by the mutant LM-99-8 (1678 kg ha^{-1}). Further trials will be conducted in the next season.

b) Advanced yield trial with some selected mutants of lentil

An experiment was conducted with four mutants along with a check variety, BARI Mashur-8, at Mymensingh during the Rabi season of 2022Seeds were sown in randomized complete block design with three replications. The unit plot size was 3m x 2m, and rows were 30cm apart. Normal cultural practices were followed. Data on days to maturity, plant height, number of primary branches and pods $plant^{-1}$ were recorded from 10 randomly selected plants from each plot. Plot seed yield was converted into $kgha^{-1}$. Results revealed that significant variations among the mutants and the check variety for most of the characters except number of primary branches per plant. On average, the maturity period varied from 92 days to 96 days, with the mutant LM-250 being the earliest. The mutants LM-300 and LM-150 produced the highest number of pods $plant^{-1}$ followed by LM-250, and the highest seed yield was produced by LM-300 (1678 $kgha^{-1}$) followed by LM-150 (1634 $kgha^{-1}$). Further trials will be conducted in the next season in different lentil-growing areas.

Varietal improvement of blackgram through induced mutation

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

Pulses are more important in agriculture because they provide more protein (17-25%) than cereals (6-10%). Pulses provide a significant amount of protein, vital amino acids, and

improve soil fertility through symbiotic N fixation. It promotes proper human growth, development, and health. Among the pulses, Blackgram is a popular pulse in Bangladesh, ranking third in terms of consumption and total area under cultivation. Blackgram is extremely nutritious due to its high protein content. Hence, the farmers need a high yielding variety with synchronized maturity of blackgram. For this reason, a study was taken to evaluate the yield potential of the lines over different locations. On-station yield trials were conducted withtwo promising blackgram mutants along with a check variety, BARI Mash-3 at BINA substation farms at Magura, Chapainawabganj, Gopalganj, and BINA HQs farm at Mymensingh during Kharif-2 season of 2022. On the other hand, on-farm yield trials were conducted at three locations, Mymensingh, Magura, and Faridpur. The experiment was laid out in a randomized complete block design with three replications. The unit plot size was 12 m^2(4 m × 3 m). Plant to plant distance was from 5 to 6 cm in a row while line to line distance was 40 cm. Data on various characters such as plant height, number of primary branches $plant^{-1}$, pods $plant^{-1}$, number of seeds pod^{-1}, 100-seed weight were recorded from 10 randomly selected plants in each plot. Seed yield $plot^{-1}$ was recorded and converted into kg ha^{-1}. Results revealed significant differences among the mutants and check variety for most of the characters except the number of primary branches at Magura. BM-4 was the shortest of all the mutants and check at Magura, Mymensingh, Chapainwabganj, and Gopalganj. In terms of primary branches per plant, BM-4 had the highest number of branches, seeds pod^{-1} and 100-seed weight among the check variety, BARI Mash-3. Combined over the three locations, the highest seed yield was recorded for BM-4 (1763 kg/ha) because of its bigger seed size and higher number of pods $plant^{-1}$. Applications will be made to register this mutant line as a variety soon.

b) Advanced yield trial with five promising blackgram mutants

A study was conducted to assess the yield potential of the mutant's lines.The trials were conducted with five promising blackgram mutants along with a check variety, BARI Mash-3 at Chapainwabganj. The experiment laid out in a randomized complete block design with three replications. Unit plot size was 2 m × 1.6 m. Plant to plant distance was from 5 to 6 cm in a row while line to line distance was 40 cm. Intercultural operations like weeding, thinning, application of pesticides, etc., were done for the proper growth and development of plants in each plot. Harvesting was done depending on the maturity of the lines. Data on various characters such as plant height, number of primary branches $plant^{-1}$, number of seeds pod^{-1}, 100-seed weight were recorded from 10 randomly selected plants in each plot. Seed yield $plot^{-1}$ was recorded and converted into kg ha^{-1}. Results revealed significant differences among the mutants and check variety for most of the characters except the number of branches per plant. The check variety, BARI Mash-3, was the tallest among the mutants. In terms of the number of pods $plant^{-1}$ BM-235 and BM-46 had the highest number of pods $plant^{-1}$. The highest number of seeds pod^{-1} was observed in BM-46, whereas 100-seed weight was observed in BM-43, followed by BM-235. The highest seed yield was recorded in BM-46 followed by BM-235, because of their higher number of pods $plant^{-1}$ and seeds pod^{-1}. Further trials will be done with the three selected mutants, BM-235, BM-46, and BM-43.

Varietal improvement of grasspea through induced mutation

a) **On-station and on-farm yield trial with three promising grasspea mutants along with the two check varieties**

Grasspea is recognised as a versatile crop with high nutritional value and one of the future's climate-smart choices, and it has earned the title of multifunctional legume.Experiments were carried out to analyse the yield potential of the lines over locations in order to develop new and superior cultivars. Theon-station yield trials were carried out with three selected mutants

along with two check varieties Binakheshari-1 and BARI khasari-2 at BINA sub-station farm Magura and Barishal during the Rabi season of 2022. On the other hand, theon-farm yield trials were carried out at farmers' field, Ishurd, Magura, and Barishal during the Rabi season of 2022. The experiment conducted in randomized complete block design with three replications. The unit plot size was 3 m × 2 m with 40 cm row to row distance. Normal cultural practices were followed. Data on days to maturity, plant height, primary branches plant^{-1}, pods plant^{-1} and 100-seed weight were recorded from 10 randomly selected plants from each plot. Plot seed yield was converted into kgha^{-1}.Results revealed significant variations among all the mutants and check variety for all the characters except number of primary branches plant^{-1}. It was observed that mutant GM-4 was the earliest of all , but mutant GM-1 produced the highest number of pods and highest seed yield, followed by mutant GM-3 all over the locations. Combined over the three locations, the highest seed yield was recorded in mutant GM-1 (1761 kg ha^{-1}) followed by GM-4 (1664 kg ha^{-1}) and GM-3 (1625 kg ha^{-1}),. The mutant GM-1 will be applied to the NSB for release as a new variety soon.

b) Regional yield trial with six promising grasspea mutants along with two check varieties

To find out the suitable line, an experiment was carried out with six selected mutants along with a check variety BARI khasari-2 at BINA HQs farm, Mymensingh during the Rabi season of 2022. The experiment conducted in a randomized complete block design with three replications. The unit plot size was 3 m × 2 m with 40 cm row to row distance. Normal cultural practices were followed. Data on days to maturity, plant height, primary branches plant^{-1}, pods plant^{-1} and 100-seed weight were recorded from 10 randomly selected plants from each plot. Plot seed yield was converted into kgha^{-1}.Results revealed significant variations among all the mutants and check variety for all the characters except the number of primary branches plant^{-1}. It was observed that mutant GM-304 was the earliest for maturity (1035 days) and it was the shortest in height . The mutant GM-304 produced the highest number of pods and highest seed yield followed by the mutant GM-309, GM-326, and GM-305. The three mutants, GM-309, GM-326 and GM-305will be evaluated in the next growing season.

Screening of Advanced Rice lines for salinity stress tolerance at the reproductive stage

Salinity screening salt-tolerant rice genotype is important to develop salt-tolerant high-yielding varieties. In this research, eighteen better-performing salt-tolerant rice genotypes were further screened to assess the effects of salt by analyzing biomolecular and morphological responses compared with established checks. Standard protocols were followed for salinity tolerance screening of rice developed by the International Rice Research Institute (IRRI) at reproductive stage. The experiment was conducted with a completely randomized design (CRD) with three replications. When flag leaves appeared or were at the booting stage, rice genotypes were exposed to different levels of salt treatments (electrical conductivity: 6 dS m^{-1} and 10 dS m^{-1}) and control set up to fourteen days. Afterward, the genotypes were grown with regular water until harvesting. Most of the genotypes showed better performance (tolerant and moderately tolerant) at the reproductive stage under EC: 6-10 dS m-1. At 6 dSm^{-1} salinity, eight (8) genotypes (SALN-38, SALN-54, SALN-52, SL-23, SAL-52, BRRI dhan99, BRRI dhan97 and Binadhan-10) showed tolerance but four (4) of them (SALN-54, SALN-52, BRRI dhan97 and Binadhan-10) could show tolerance upto 10 dSm^{-1} salinity. Similarly ten (10) genotypes (SALN-40, SALN-25, SALN-44, SALN-05, SL-44, SL-21, SL-10, SAL-73, SAL-44 and BRRI dhan29) were moderately tolerant at 6 dSm^{-1} salinity but became susceptible at 10 dSm^{-1}. The rest of the genotypes were susceptible at

both the conditions based on salt injury with significant variations. The genotypes were also grouped into four major clusters for ten microsatellite markers (RM336, RM493, RM472, RM562, RM152, RM25, RM10793, RM10694, RM10825, and RM2412b) based on the method Unweighted Pair Group Method of Arithmetic Means (UPGMA) is linked to *saltol* QTL and identified as salt tolerant. The SSR analysis found an average number of 9.8 alleles per locus was detected with polymorphism information content (PIC) values ranging from 0.7531 (RM10825) to 0.9140 (RM493). The highest gene diversity was observed in loci RM493 and the lowest in loci RM10825 with a mean diversity of 0.8483. Therefore, the present study revealed some lines of rice that showed salinity tolerances; these were: SALN-54, SALN-52, and SL-21, and moderately tolerant were: SAL-52 and SL-23 for both the morphological and molecular screening. Based on a modified standard evaluation system (SES), morphological characters, biochemical responses, and molecular characterization revealed SALN-54, SALN-52, SALN-38, SL-21, SL-23, SAL-52, BRRI dhan99, BRRI dhan97, and Binadhan-10 as salt-tolerant rice genotypes at 10 dSm^{-1} at the reproductive stage. These lines could help to improve future rice breeding programs and a potential germplasm source of *saltol* QTL for developing salt-tolerant high-yielding rice genotypes.

Plant Genetic Resources:

Project: Collection, Conservation and Characterization of Plant Genetic Resources of Different crops

Objective(s): Exploration, Collection, Multiplication, Conservation, Characterization and promoting utilization of germplasm for the benefit of present and future generation.

Experiment: Growing of collected and preserved germplasm of different crops for seed multiplication and conservations

Objective(s): Preservation and Multiplication of PGR materials

Results: Two hundred and ten germplasms of different crops were collected and 400 rice germplasms were regenerated. Germplasm have been preserved with accession number in short term storage.

Experiment: Morphological characterizationoflocalrice landraces for *Aus season*

Objective(s): To characterize the rice germplasm for *Aus* season

Materials and Methods: Thirty-seven collected local rice germplasm were used. The experiment was conducted OF BINA Sub-station farm CUmilla followed RCBD with 2 replications.

Findings: Some promising germplasm (Chengrimurali, Surjamukhi, Gofra) were identified and these germplasms would be used for varietal development.

BIOTECHNOLOGY DIVISION

Research Highlights of Biotechnology Division

Genetic Engineering and Tissue Culture

- To assess the effect of salt and submergence on the expression of *OsMGD g*ene, total RNA was isolated and the expression levels of the gene were evaluated by RT-qPCR. The results indicated that expressions of *OsMGD* was higher in salinity stress at 36 hours followed by 18 hours and 72 hours and in submergence stress higher expression was found in 5 days followed by7days and 2days.
- The *OsMGD* gene was amplified by PCR using Q5 High Fidelity DNA polymerase with gene-specific primers (PCR1) and subsequently with Gateway adapter primers (PCR2). The actual size of *OsMGD* gene is 1076bp but amplification size was relatively small (~ 600bp). In order to get the actual size of the gene, optimization of PCR protocol and conditions are needed.
- The study demonstrates that silicon treatment can modify defense signaling pathways in *Arabidopsis thaliana*, potentially enhancing plant defense mechanisms against *Myzus persicae* infestation.
- The callus induction and regeneration ability of the three indica advance rice lines were evaluated and observed the highest callus induction were found in advance rice line Bina(bio)-BC2-5-2-11-27 (90%) followed by Bina(bio)-BC2-5-2-3-14 (82%) and Bina(bio)-BC2-5-2-3-42 (70%), respectively.
- Established a comprehensive protocol for callus induction and regeneration in BRRI dhan29 rice, with optimal concentrations of 2,4-D, NAA, and kinetin, and successful acclimatization of *in vitro* grown shoots, facilitating further growth and development for genetic improvement efforts and disease resistance enhancement. Additionally, the LD50% of EMS on BRRI dhan29 calli is determined as 0.31%, highlighting its potential as a mutagen for inducing genetic variations in this important rice variety.
- Induce genetic variability in rice varieties (BRRI dhan89, BRRI dhan29, and Fatema) by treating their calli with 0.2% EMS followed by selection of plants based on duration, height and yield parameters, which will be further evaluated and multiplied in subsequent generations based on the above mentioned parameters.
- A total of 19 irradiated plants were selected out of which seven were somaclonal, five were 12Gy and seven were 6Gy irradiated. The selected somaclonal and irradiated plant DNA was isolated and PCR was carried out. The PCR amplified band showed some difference with the parent (control).
- *In vitro* callus induction and plant regeneration of *Brassica napus* was optimized. Gamma radiation doses up to 800 Gy enhanced callus and shoot initiation, while higher doses resulted in suppressed shoot formation. The results indicated the potential of gamma radiation for generating variability in *Brassica napus*.
- Establishment an efficient *In vitro* regeneration protocol for *Brassica napus* varieties, BARI Sharisha14 and Binasharisha-9, through Agrobacterium mediated transformation using hypocotyl explants. The results demonstrated varietal differences in callus and shoot initiation, with BARI Sharisha-14 having higher rates. However, bacterial overgrowth posed challenges during the transformation process, requiring further optimization for successful transformation and control of bacterial contamination.

Marker Assisted Selection:

- In Boro, 2022-23 at BINA HQs, Mymensingh 11 advance rice lines were selected depending on the duration, plant height and comparable yield with the checks for further evaluation. The tested lines and the check differed significantly for grain yield, plant height and also maturity. The line Bina(bio)-BC2-5-2-3-42 produced the highest yield (9.21 t/ha) followed by Bina(bio)-BC2-5-2-3-28 (9.05 t/ha) and Bina(bio)-BC2-5-2-3-14 (8.74 t/ha).

Microbial-Biotechnology:

- Specific combinations of Plant Growth-Promoting Rhizobacteria (PGPR) strains, such as CD1A with 70% of recommended fertilizer dose, resulted in significantly improved growth parameters and yield, indicating the potential of PGPR for enhancing rice productivity in combination with appropriate fertilizer management.
- Isolated and characterized 30 rhizobial strains from Faba bean nodules, revealed the predominance of *Rhizobium binae* as the main symbiont in Bangladesh. Genetic analysis of housekeeping and nodulation genes provided further insights into the diversity and identification of these strains, highlighting the importance of sequencing additional housekeeping genes for precise species identification in faba bean rhizobia.
- Isolated and evaluated 10 rhizobial strains from chickpea root nodules, revealing variations in colony morphology, growth rates, acid production, nodulation ability, salt tolerance, acidity and temperature tolerances among the strains. The findings provided valuable insights into the characteristics of the strains, including their symbiotic associations with chickpea, salt tolerance capacity, and limitations in acidic environments, which can contribute to the selection of suitable strains for improved chickpea cultivation and nitrogen fixation efficiency.

PROGRAM AREA I: GENETIC ENGINEERING AND TISSUE CULTURE

Expression and detection of salinity and drought induced genes through Real Time qPCR

The rice cultivar FR13A was used in this study. The seedling was sowed in two sets one for salinity and the other for submergence. Afterwards, for salinity stress the plants were stressed by adding NaCl at a final concentration of 150 mM and for submergence sample were kept under 20cm below standing water in a plastic container. The sample was collected at different time points. In case of salinity stress, e.g. control (0)h, (1)h, (6)h, (12)h, (18)h, (24)h and (72)h and for submergence stress control (0)d, (1)d, (3)d, (5)d, (6)d and (7) days samples were collected. All samples were stored in -80^{0}C freezer until RNA isolation. Total RNA was extracted from shoots and leaves using RNAiso Plus total RNA extraction reagent (TAKARA, Japan) for both sets of stress treatments according to the manufacturer's protocol. Total RNA extracted from treated and non-treated leaves and shoot tissues was converted to complementary DNA (cDNA). A Reverse Transcription System was employed for carrying out first-strand cDNA synthesis using Superscript III 1st strand cDNA synthesis kit (Invitrogen, USA) according to manufacturer's protocol (Model: 7500 Fast, Applied Biosystems, Thermo Fisher Scientific, USA). PCR of *OsMGD g*ene was carried out using specific primers for amplification of PCR products around 180–300 bp length. Actin gene was used as an internal reference in PCR reactions. The PCR products (10µl) were analyzed through 1.5 % agarose gel electrophoresis with the use of ethidium bromide. To assess the effect of salt and submergence on the expression of *OsMGD g*ene, total RNA was isolated from tissues of stressed FR13A. The expression levels of the gene in tissues were evaluated

using RT-qPCR. The results indicated that expressions of *OsMGD g*ene was up and down regulated until 72h at salinity stress and 7d at submergence stress (Fig: 1a and 2a) . In salinity stress higher expression were found 36h followed by 18h and 72h. On the other hand, in submergence stress higher expression was found at 5d flowed by 7d and 2d. The *OsMGD* gene maintained chloroplast integrity in high salt and drought stress condition. The results of *OsMGD* gene expression under stress detected RT-qPCR will be help in future gene amplification, cloning and genetic transformation.

Cloning of one salinity and drought tolerant genes *OsMGD* from FR13A through Gateway technology

Three weeks old FR13A rice seedlings were submerged completely at 50 cm under the water surface (at 25–30˚C) for 1–7 days in a tank, in a glass house. Seedlings of the same age were either irrigated with high salt (irrigated with 250mM NaCl), drought (not irrigated) for 7 days or exposed to cold (4˚C) for 1 day. The healthy rice leaves grown under different conditions were harvested, frozen in liquid nitrogen and stored at –80˚C. Total RNA extracted from treated and non-treated leaves and shoot tissues was converted to complementary DNA (cDNA). A Reverse Transcription System was employed for carrying out first-strand cDNA synthesis by using Superscript III 1st strand cDNA synthesis kit (Invitrogen, USA) according to manufacturer's protocol. The cDNA containing the *OsMGD* gene was amplified by PCR using Q5 High Fidelity DNA polymerase (NEB, USA) with gene specific primers (PCR1) and subsequently with Gateway adapter primres (PCR2). The *OsMGD* gene actual size is 1076bp. During the research period relatively small size (~ 600bp) amplification was found. In order to get the actual size of the gene, optimization of PCR protocol and conditions are needed.

Silicon-Mediated modulation of defense signaling pathways in *Arabidopsis thaliana* in response to *Myzus persicae* infestation by qRT-PCT

The peach potato aphid (*Myzus persicae*) poses significant threat to global agriculture by transmitting over 100 viruses to more than 30 plant families and displaying resistance to conventional insecticides. This study aimed to investigate the potential of silicon (Si) in enhancing plant defense against aphids and understand its impact on the salicylic acid (SA), jasmonic acid (JA), and ethylene (ET) signaling pathways in *Arabidopsis thaliana*. *Arabidopsis thaliana*, a model plant, and *Myzus persicae*, a generalist aphid pest, were utilized. Silicon treatment involved applying a 2mM concentration of potassium silicate. Transcript levels of three key genes, *PR1* (Salicylic acid pathway), *BGL1* (Jasmonic acid), and *EIN2* (Ethylene pathway) were quantified using RT-qPCR. The study unveiled distinct changes in gene expression following *Myzus persicae* infestation and silicon treatment. Aphid infestation activated the SA pathway, as evidenced by increased *PR1* expression. Surprisingly, silicon treatment led to lower *PR1* induction due to the overexpression of *BGL1,* indicating silicon's potential to modulate the SA pathway and possibly weaken the plant's response to aphids. Aphid feeding suppressed the JA pathway, as shown by reduced *BGL1* expression. In contrast, silicon treatment in infested plants increased *BGL1* expression, suggesting silicon's capacity to enhance the JA pathway and improve defense against aphids. Aphid infestation had minimal impact on the ET pathway, with unchanged *EIN2* expression. Unexpectedly, silicon treatment in aphid-infested plants reduced *EIN2* expression, indicating a potential dampening effect of silicon on the ET pathway. The relationship between silicon treatment, aphid infestation, and plant defense signaling pathways is explained by this study. Application of silicon seems to alter the SA and JA pathways, possibly enhancing plant defenses against *Myzus persicae*. Further research is warranted to unravel the precise mechanisms behind silicon-mediated defense responses and assess their practicality in crop

protection strategies against aphid pests, contributing to sustainable and ecologically sound pest management in agriculture.

Expression and cloning of *CaChiVI$_2$* gene in *Capsicum annuum L.* for resistance against heat stress

The genus *Capsicum* is recalcitrant regarding its *in vitro* regeneration potential, which makes it difficult or efficient to apply recombinant DNA technologies via genetic transformation aimed at genetic improvement. So, before initiating the cloning program, optimization of regeneration protocol is pivotal. A number of studies have been carried out on the regeneration of sweet pepper globally and in Bangladesh. But the effectiveness of plant regeneration in different species of pepper (*Capsicum* spp.) varies depending on the plant genotype, the type of initial explants, and the factors and conditions of *in vitro* cultures. To overcome the major constraints of recalcitrant response of sweet pepper (*C. annuum*), the present investigation was started to carry out. This work intended to present an efficient and reproducible *in vitro* regeneration protocol for two selected lines (CKN-1 and CKN-8) of sweet pepper which could be followed for the main project of cloning and genetic transformation with useful candidate genes. The two lines CKN-1 and CKN-8 were selected from 11 extotic sweet pepper lines through a phenotypic study of Biotechnology Division, BINA. Then the seeds of CKN-1 and CKN-8 were used for germinating plantlets which were further used as explants. The cotyledonary leaves were used as explants. The seeds were primarily washed with distilled water and then sterilization was carried out with 70% (v/v) ethanol for 1 min, followed by mild detergent (Tween-20), 0.1% $HgCl_2$ through gentle shaking for 5 min and rinsed three times with autoclaved distilled water. Then the seeds were cultured on full strength MS media containing plant growth regulators (PGRs) such as BAP, NAA and IAA in combinations for callus formation. For induction and development of root, about 3 - 4 cm long shoots were separated and cultured on freshly prepared full and half strength of MS with different concentrations (0.25 - 1.0 mg/l) of IBA. Both media contained 3% sucrose and 0.8% agar with 5.8pH adjusted before autoclaving. All cultures were maintained in 16 hrs photoperiod at 25 ± 2ºC. As the expected response towards shoot initiation from the explants was not found, the experiment will continue to next year.

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

Most of the *indica* rice genotypes, the world's most cultivated rice types, still remain less amenable to genetic modifications due to their poor regeneration potential. Considering the significance of genetic transformation in functional genomics and crop improvement the need of the hour is to develop an easy, rapid, reproducible, widely applicable and highly efficient transformation and regeneration protocol for various *indica* rice genotypes. In the present study, we have followed a highly efficient and reproducible *A. tumefaciens* mediated transformation protocol using mature seeds as explants. Mature, healthy and disease free dehusked rice seeds were used as a explant of this study. *Agrobacterium tumefaciens* strain GV3101 harboring *OsCAL* gene which was used for rice transformation. The expression of the gene of interest was under the control of the double constitutive CaMV35S promoter. The plant expression vector pB2WG7 incorporated the genes of interest *OsCAL* and *Bar* gene for selection. The engineering strain was grown in 50ml of YEM medium, containing 50mgl^{-1} streptomycin and 50mgl^{-1}rifampicin in a 28^{0}C shaker at 200rpm for 16h. The bacterial suspension was centrifuged and the bacteria was re-suspended in the MS re-suspended medium to optical density (OD_{600}) of 0.6 to 1.0, and used for bacterial infection. The 4 days sub cultured embryogenic calli were collected and *Agrobacterium* infected by immersing them in the *Agrobacterium* culture (GV3101) for 20-25 min with intermittent gentle shaking

at 50 rpm. The *Agro* infected calli were dried on sterile Whatman No. 3 filter paper for 5 min. Calli were then transferred to the co-cultivation medium (MCCM)-MCI containing 10 g/l glucose, pH 5.2, 150µM acetosyringone and incubated at 27 ± 1°C in the dark for around 48 hours. Once slight growth of *Agrobacterium* appeared around most of the calli. The calli were rinsed 8-10 times with 250 mg/l cefotaxime in sterile distilled water, dried on sterile Whatman No. 3 filter paper and transferred onto first selection medium-MSM (MCI containing 250 mg/lcefotaxime) and incubated for 12 days at 27 ± 1°C in dark. After the first selection, brown or black calli were removed and only creamish healthy calli were shifted to the fresh MSM media for second selection and maintained at 27 ± 1°C in dark. After second selection for 10 days, microcalli were observed which were finally transferred to fresh MSM media for third selection and allowed to proliferate for 5 days at 27 ± 1°C in dark. After third selection, black or brown microcalli were discarded and only granular 'macro calli' were transferred into regeneration medium containing either two or three growth regulators comprised of MS salts, 30 gl^{-1} maltose, 2 mgl^{-1} kinetin,0.2 mgl^{-1} naphthalene acetic acid (NAA), pH 5.8; gelled with 6.0 gl^{-1} and 250 mgl^{-1} cefotaxime added after autoclaving. These microcalli were incubated at 27 ± 1°C in dark for 7 days for the first phase of regeneration. During the second phase of regeneration, these were shifted to fresh regeneration medium and incubated in light for 4 days. For development of roots, the regenerated shoots were shifted to test tube (100ml) containing rooting medium MROM (comprising half strength MS salts, 30gl^{-1}sucrose, 3.0 gl^{-1}phytagel, pH 5.8 and cefotaxime 250 mgl^{-1}. During the research period a number of embryogenic calli were infected by *OsCAL* gene through A*grobacterium* mediated gene transformation. The research work has been done several times. The transformed calli were shown bacterial over growth in selection and also in regenerated stage. This work is continuing on and optimization will be needed for control the bacterial over growth for infected transformed calli.

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

The rice *Waxy* (*Wx*) gene plays a major role in seed amylose synthesis and consequently controls grain amylose content. The *Wx* gene expression is highly regulated at the post-transcriptional level. In particular, the GT/TT polymorphism at the 5′splicing site of its 1st intron greatly affects this intron's splicing efficiency. The *Wx* gene is a major gene controlling amylose content in rice endosperm and plays a decisive role in rice cooking and eating quality (ECQ). During the research periods for this program, three advanced rice lines were selected namely, Bina (bio)-BC2-5-2-3-14, Bina (bio)-BC2-5-2-3-42 and Bina (bio)-BC2-5-2-11-27. The selected lines have high yield potentials (>8.0 t/ha), short duration and semi dwarf type but amylose content is low (<22.0%). Before starting the genome editing research program to find out the callus induction and regeneration ability of the three indica advanced rice line is needed. The highest callus induction was observed in Bina (bio)-BC2-5-2-11-27 (90%) followed by Bina (bio)-BC2-5-2-3-14 (82%) and Bina (bio)-BC2-5-2-3-42 (70%). Finally, the embryogenic calli were transferred to sub-culture media for shooting and survived calli were transferred to rooting media. According to callus production ability three advanced lines observed better. So, all three lines will be used in the genome editing program. Before constructing an editing vector, we employed the online software CHOPCHOP (http://chopchop.cbu.uib.no) to identify proper editing target sites using the Nipponbare *Wx* gene (LOC_Os06g04200) as a reference. Two target sites located within the 1st intron but close to the 5′ or 3′ splicing site were selected. To confirm whether these two targeted sequences were suitable for editing the *Wx* gene of all 3 inbred advance lines, we amplified and sequenced fragments including the targeted sequences and their flanking sequences from genomic DNA of all three advance inbred lines, using primer sets

WxP1_F/WxP1_R (for Target1) and WxP2_F/WxP2_F-R (for Target2). The CRISPR/*Cas9* vector pRGEB31 targeting the first intron of the *Wx* was selected for construction. The vector used in this study was based on the vector pCambia1300 backbone. The editing vector pRGEB31 contained a Cas9 expression cassette driven by the Rice snRNA U3 and dual 35S promoter and two sgRNA expression cassettes driven by the rice U3 or U6 snRNA promoters. The editing vector pRGEB31will be transferred into *Agrobacterium tumefaciens* strain GV3101 by heat-shock and consequently delivered into three selected materials cells via *Agrobacterium* mediated transformation.

Callus induction and regeneration efficiency in BRRI dhan29 and determination of lethal dose of EMS

BRRI dhan29, an important rice variety susceptible to disease and pests, posses challenges to rice production. This study aimed to develop a comprehensive protocol for enhancing yield, disease resistance and genetic variability in BRRI dhan29 by optimizing callus induction and regeneration as well as determining the LD50% of EMS (ethyl methanesulfonate) for mutagenesis. Mature embryos of BRRI dhan29 were used for callus induction, employing varying concentrations of 2,4-D. Optimal concentrations of 2.0 mg/L 2,4-D and a combination of 10 µg/L NAA and 2.0 mg/L kinetin were identified for efficient callus induction and subsequent plant regeneration, respectively. The acclimatization of in vitro-grown shoots was also conducted. The LD50% of EMS on BRRI dhan29 calli was determined. High concentrations of 2,4-D inhibited callus induction, with the best efficiency (87%) achieved at 2.0 mg/L 2,4-D. NAA and kinetin were crucial for cell division, callus formation, and shoot induction. The combination of 10µg/L NAA and 2.0 mg/L kinetin led to the highest regeneration rate (74%). *In vitro* grown shoots exhibited robust growth during acclimatization, with a high survival rate of approximately 75%. They successfully developed roots were adapted to their new environment. The LD50% of EMS on BRRI dhan29 calli was 0.31%, indicating its potential as a mutagen for creating genetic variations. This study established a successful protocol for callus induction and regeneration in BRRI dhan29 rice, with *in vitro* grown shoots adapting well during acclimatization. These finding contribute valuable insights to tissue culture based studies and genetic improvement programs for BRRI dhan29, offering the potential to enhance rice crops and bolster resistance against diseases.

Growing of T_2 –T_4 generation of rice lines developed through tissue culture and chemical mutagenesis

To create the genetic variability in the rice varieties/land races the callus of BRRI dhan89, BRRI dhan29 and Fatema were treated with 0.2% EMS (Ethyl Methanesulfonate) for two hours. The treated calli of these rice varieties were subsequently grown in pot and field conditions. After appropriate growth and development, eight plants from T_3 generation were harvested from BRRI dhan89, 17 plants from T_2 generation were selected and harvested from BRRI dhan29 and 25 plants from T_4 generation were harvested from Fatema. Selection criteria were duration, height and yield. High-yielding plants with robust productivity were selected for further evaluation. The most promising individuals showing desirable traits will be selected after further evaluation and multiplication in the next generation.

Development of lodging resistance and high yield premium quality rice variety through irradiation on embryogenic callus

Tissue culture techniques offer the great possibilities for selection of mutants through the use of new and expanded genetic variability. Induced mutagenesis serves a source of variability for better selection. Many researchers have attempted to exploit somaclonal variation for crop improvement particularly treated with gamma radiation. Considerable work has been done on induced mutation in rice by applying low doses of gamma rays to callus of rice. The present

study was undertaken to investigate the extent of variability on callus production and plant regeneration of Kataribhog rice cultivar at different doses of gamma radiation. In previous tissue culture program 19 irradiated plants were selected out of which seven were somaclonal, five were from 12Gy irradiated population, and seven were from 6Gy irradiated T_2 plant. The selected somaclonal and irradiated plants seeds and leaf samples were collected and preserved. DNA was isolation from the collected leaves sample and PCR was also done. The PCR amplified band showed some difference with the parent (control). The harvested sample will be sown in T aman, 2023 for further evaluation.

Effect of gamma radiations on *in vitro* regeneration in *Brassica Napus*

Brassica napus L. belongs to family Brassicaceae (Cruciferae) commonly known as rapeseed. The objective of the study is to initiate *in vitro* culture of *Brassica napus* variety using seeds with and without gamma-radiations and optimize conditions for efficient callus induction and plant regeneration. For radiobiological studies, the dry and uniform sized seeds of variety Binasarisha-4, Binashaisha-9 and BARI Sasrisha-14 were exposed to 500, 600, 700, 800, 900, 1000 and 1100 Gy of gamma irradiations. The callus and shoot potential were increased with the increase of radiation doses up to 800 Gy and afterwards started decreasing with the increase of doses. The percentage of shoot formation were decreased gradually with the increase of radiation dose up to 1000 Gy and the small, less vigorous with retarded growth and yellowish color shoots were developed. Total suppression of shoot formation was observed in cultures derived from seeds treated with 11000 Gy dose.

Transfer of *$OsNHX_2$/ Os HKT_8* genes into rapeseed cultivar through agrobacterium mediated gene transformation

Brassica napus is an important oilseed crop, ranking as the second most important crop for oilseed production worldwide. Two rapeseed varieties i.e BARI Sharisha-14 and Binasharisha-9 were used. *Agrobacterium tumefaciens* strain GV3101 harboring *$OsNHX_2$* gene for transformation. The plant expression vector pB2WG7 incorporated the genes of interest *$OsNHX_2$* for selection. The 6 days old sub-cultured hypocotyls were collected and *Agrobacterium* infected by immersing them in the *Agrobacterium* culture (GV3101). Hypocotyls were then transferred to the co-cultivation medium. After third selection, hypocotyls were transferred onto regeneration medium. For development of shoots, the regenerated shoots were shifted to 500 ml jar containing shooting medium. The callus and shoot initiation are found higher BARI Sarisha-14 (57.99% and 52.46%) followed by Binasarisha-9 (66.78 %and 63.84%). These callus and shoot initiation were gently separated from the mother callus and shoot transferred to fresh MS selection medium for the third selection. During the research period a number of hypocotyls were infected by *$OsNH_2$* gene through *agrobacterium* mediated gene transformation. The research work has been done several times. Unfortunately, the transformed callus and shoot were suffered from bacterial over growth in some time of selection and some of time regenerated stage. This work is going on and optimization will be needed for control the bacterial over growth for infected transformed callus and shoot initiation. This speedy, yet less labor-intensive, protocol overcomes major limitations associated with genetic manipulation in rapeseed. Moreover, this protocol uses hypocotyl as the explants, which can easily be obtained in quantity throughout the year and kept viable for a long time.

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

Regional yield trial with high yielding and short duration rice lines

Recent studies by several groups have shown that despite its inferior agronomic performance, a wild rice, an accession of *Oryza rufipogon*, is likely to contain genetic factors that can increase the yield of modern varieties. It was reported that *Oryza rufipogon* allele at two QTL loci on chromosome 1 and 2 were associated with an 18 and 17% increase in grain yield per plant, respectively, without delaying maturity or increasing plant height. Therefore, the proposed study is set to increase yield or break down the yield ceiling of Binadhan-16 (a short duration and medium high yielding rice mutant variety) to introgress useful genes from accessions of *O. rufipogon*. In Boro, 2022-23 a total eighteen advance rice lines were grown with three standard check varieties viz Binadhan-16, BRRI dhan96 and Binadhan-17. The design of the experiment was RCBD with three replications at BINA Head Quarters, Mymensingh. During the Boro, 2022-23 at BINA HQs, Mymensingh 11 advance rice lines were selected depending on the duration, plant height and comparable yield with the checks for further evaluation. The tested lines and the check varieties differed significantly for grain yield, plant height and also maturity. The line Bina(bio)-BC2-5-2-3-42 produced the higher yield (9.21 t/ha) followed by line Bina(bio)-BC2-5-2-3-28 (9.05 t/ha) and line Bina(bio)-BC2-5-2-3-14 (8.74 t/ha). Highest plant height was found line Bina(bio)-BC2-5-2-3-6-39 (138cm) followed by line Bina(bio)-BC2-5-2-3-20 (137cm) and the lowest was BRRI dhan96 (98cm) followed by Bina(bio)-BC2-5-2-3-14 (109cm). The yield of the selected lines and other agronomic characters need further evaluation. So, selected lines will be transplanted in the next season.

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

The aromatic rice variety Kataribhog is medium long type, fine grained and highly scented and high priced. But the cultivar has weak stem, highly susceptible to lodging, very long growth duration, low grain weight and poor yield. Binadhan-13 is another aromatic rice variety, but this variety has same problem. Farmers mainly grow these varieties for their own consumption and ceremonial purposes. Under these circumstances, a program was taken to improve these varieties for yield potential and lodging resistance through hybridization with *Oryza rufipogon* and BR5. In T. aman 2022 about 35 F_4 plants were selected from 68 segregating F_3 populations (Kataribhog x *Oryza rufipogon*)) based on better plant types compare to the parents. The molecular work was done for testing the presence of fragrance gene (*BADH2*) in the selected lines. On the other hand only 19 F_4 plants/lines were selected in T. aman 2022 from the 119 (Binadhan-13x BR5) F_3 populations. The seeds of selected plants were harvested and stored for evaluation in the next season.

ROGRAMME AREA III: MICROBIAL BIOTECHNOLOGY

Evaluation of PGPR bacterial strains for enhancing growth and yield of rice

This study aimed at assessing the impact of various Plant growth promoting Rhizobacteria (PGPR) strains on the growth and yield of Binadhan-22 rice during the 2022-2023 T. aman season. The objective was to identify potential candidates for sustainable agricultural practices to enhance rice production. The experiment involved seven treatments, including different PGPR bacterial strains, their combinations with 70% of the recommended fertilizer dose, fertilizer alone, and zero fertilizer. Various parameters, such as plant height, effective tillers per plant, panicle length, filled and unfilled grains per panicle, and crop yield, were measured. The experiment was conducted with seven treatments and three replications. Treatment T_5 (100% recommended fertilizer dose) exhibited the tallest plants, averaging 98 cm, while the shortest plants were observed in T_7 (no fertilizer) at an average of 92.3 cm. T_5

had the highest number of effective tillers per plant, averaging 11.7, whereas T_7 had the lowest, with an average of 7. No significant variations were observed in panicle length across treatments, with consistent results. T_1 (PGPR strain CD1A + 70% of recommended fertilizer dose) showed the highest number of filled grains per panicle, averaging 133.7. T_4 (70% fertilizer) and T_6 (Mix of PGPR and 70% RFD) also had high filled grain counts, averaging 121 per panicle. T_7 (no fertilizer) had the most unfilled grains per panicle, averaging 39, indicating poor grain filling. Conversely, T_6 showed the fewest unfilled grains, averaging 29 per panicle. T_1 produced the highest yield at 5.2 ton/ha, followed closely by T_5 with an average of 5 ton/ha. T_6 also yielded well, averaging 4.8 ton/ha. The lowest yield was recorded in T_7 at an average of 3.5 ton/ha. The results of this study showed considerable influence of PGPR bacterial strains on the yield and growth of Binadhan-22 rice. Treatments combining specific bacterial strains, like CD1A, with 70% of the recommended fertilizer dose (T_1) resulted the highest yield, while treatments without fertilizer (T_7) yielded the lowest. These findings indicated the potential of PGPR bacterial strains to enhance rice productivity and underscore the importance of proper fertilizer management for optimal rice growth, contributing to sustainable and improved rice production technologies.

Genetic diversity analysis of *Rhizobium* bacteria from faba bean (*Vicia faba*) nodules

The genetic diversity of *Rhizobium* bacteria in Faba bean nodules is crucial for optimizing the efficiency of nitrogen fixation, ensuring adaptability to diverse environmental conditions, and maintaining the specificity of symbiotic relationships with Faba bean plants. Previous morphological characterization had been conducted, and this reporting year focused on genetic diversity assessment using sequencing of two housekeeping genes (*recA* and *atpD*) and one nodulation gene (*nodC*). The research involved the isolation of rhizobial strains from Faba bean nodules and subsequent morphological characterization. In this reporting year, genetic diversity was further explored by sequencing three specific genes: *recA*, *atpD*, and *nodC*. Phylogenetic analyses were performed to identify the strains at the species level. Phylogenetic analysis of the *recA* and *atpD* genes revealed that most of the isolated strains belonged to the species *Rhizobium binae*. This marked the first report of *Rhizobium binae* being associated with faba bean nodules. Analysis of the *nodC* gene indicated that the nodules were similar to those formed by the symbiovar viciae. The study underscore of the presence of diverse rhizobial strains associated with faba bean nodules. It highlighted the limitations of using the *16S* rRNA gene for species-level identification, as partial sequencing of this gene cannot reliably differentiate between different species. However, it remains valuable for identifying and classifying organisms at the genus level. Notably, the research identified *Rhizobium binae* (R) as the primary symbiont of faba beans in Bangladesh. To achieve more precise species identification, future studies should consider sequencing additional housekeeping genes. This study provides essential insights into the genetic diversity of faba bean rhizobia, laying the foundation for further research on optimizing faba bean symbiosis and agricultural practice.

SOIL SCIENCE DIVISION

Research Highlights:

1. Among the IPNS approaches, the vermicompost with reduced rate of fertilizer (100 kg N ha^{-1} + vermicompost @2 t ha^{-1}) showed the highest yield, nitrogen uptake and nitrogen use efficiency in Mustard-Boro-T. Aman cropping pattern.
2. Considerable differences in the pH, EC, heavy metal concentration, total N (%), OC (%), NH_4^+ and NO_3^- were found in sediment and water samples from various sites. Use of the river waste water for irrigation might be detrimental for crop and human health.
3. The application of cowdung (CD), vermicompost (VC) and eco-compost (EC) increased the carbon content in soil. The recommended dose of chemical fertilizer along with the manure increased soil carbon and produced higher crop yield.
4. The lime, poultry manure and biochar increased the soil pH. Repeated application of single poultry manure could also increased the soil pH as well as organic matter.
5. The economic dose for lentil cultivation at Ishurdi area could be recommended as $N_{20}P_{32}K_{17}S_{14}Zn_2B_1$ kg ha^{-1}.
6. The use of Khamari apps for fertilizer doses in a specific location performed better than that of farmer's practices.
7. Among the studied brick kiln areas, lead (Pb), chromium (Cr), iron (Fe) and mangenese (Mn) were found within the permissible level with the exception of Ni which was exceeded the permissible limit.
8. The use of ash and rice straw reduced the salinity level and increased rice yield.
9. Fifty percent (50%) K fertilizer could be saved with the application of K-rich vermicompost in T. aman rice.
10. About 100% P fertilizer and 33% K fertilizer could be saved with the application of PK-rich vermicompost in Boro rice.
11. Fourty percent (40%) K from vermicompost + 60% K from chemical fertilzer + 100% NPS (Non IPNS) could be recommended for maximum yield for the cultivation of cabbage in Rangpur and Ishwardi.
12. Earlier sowing of mustard in zero tillage system is good option for minimize the sowing time of mustard than conventional tillage system. Fertilizer doses of N_{139} $P_{26}K_{79}$ S_{24} kgha^{-1} for Ishwardi and Barishal could be used in the cultivation of mustard under zero tillage system.
13. Fertilizer doses of N_{167} $P_{21}K_{63}$ S_{19} Zn_2B_2 for Narshingdi area could be adopted in the cultivation of mustard for getting maximum seed yield under zero tillage system.
14. Crop yield of wheat was lower in zero tillage system but earlier sowing of wheat in zero tillage system is good option for minimizing the sowing time of wheat than conventional tillage system and fertilizer doses of $N_{139}P_{17}K_{73}S_{12}$ kg ha^{-1} for Ishwardi and $N_{145}P_{24}K_{74}S_{10}$ kg $ha^{-1}$for Gopalgonj and Shatkhira could be used in the cultivation of wheat under zero tillage system.
15. The optimum fertilizer doses of boro mutants (BLB-P-O-44, BN-P-120, MEF-27, BN-P-115, and BLB-042) were 470-144-182-80-7.7 kg ha^{-1} as Urea-TSP-MoP-Gypsum-Zinc for boro mutants, respectively. On the other hand, 234-60-120-27-5.4 kg ha^{-1} as Urea-TSP-MoP-Gypsum-Zinc for T. aman mutants (BSB-24, MEF-10, MEF-27, and MPQR-62), respectively.
16. Soil characterization of BINA HQs farm, Mymensingh was done from the different blocks after T.aman harvest. Soil pH, OC%, total N%, available P, S, (ppm) and exchangeable K (meq %) was found low to medium.
17. The highest yield of Boro rice was found with the application of 75% RDF + 2.0 t ha^{-1} PM + 1.0 t ha^{-1} Biochar.
18. Either Zn @ 4 kg $ha^{-1}$and B @ 2 kg ha^{-1} to the first crop or, Zn @ 2 kg ha^{-1} and B @ 2 kg ha^{-1} to the first crop and again in the second crop gave maximum grain yield in a rice – rice cropping pattern.
19. The inocluant FBR-1 gave the maximum green pod yield as vegetables of french bean. The rhizobial inoculant FBR-1 could be used for the production of biofertilizer for the cultivation of french bean.
20. About 902 kg biofertilizers were produced and distributed in different stakeholders.

Project-1: Integrated Plant Nutrition System (IPNS) for soil fertility management and increased crop production

Experiment-1: Integrated nutrient management for increased crop production and fertilizer use efficiency (FUE) in Mustard-Boro-T.Aman rice cropping pattern

An experiment was conducted at the farmer's field, Char Nilokkhia, Sadar, Mymensingh using the cropping pattern Mustard- Boro- T. Aman rice during November 2021 to October 2022 to identify the suitable combination of IPNS using organic amendments & inorganic fertilizer for maximizing crop yield and to investigate the effects of organic amendments with chemical fertilizers on N nutrient uptake, NFUE (%) and soil fertility. The experiment was carried out with five treatments for all the three crops. The experiment was laid out in a Randomized Complete Block Design with three replications. The treatment combinations were T_1: Control (without N) (basal $P_{30}K_{75}S_{25}Zn_2B_1$), T_2: N @120 kg ha^{-1} on STB, T_3: N @110 kg ha^{-1}+ Rice Straw @5 t ha^{-1} with IPNS, T_4: N @105 kg ha^{-1} + Cow dung @3 t ha^{-1} with IPNS and T_5: N @100 kg ha^{-1} + Vermicompost (2 t ha^{-1}) with IPNS for mustard, T_1: Control (without N), T_2: RFD based on STB, T_3: RFD based on STB + Residual Rice Straw, T_4: RFD based on STB + Residual Cow dung and T_5: RFD based on STB + Residual vermicompost for boro rice and T_1: Control (without N), T_2: RFD based on STB, T_3: 85% RFD based on STB + residual RS, T_4: 85% RFD based on STB + residual CD and T_5: 85% RFD based on STB + residual VC for T. Aman rice. In first crop (mustard), the yield attributes and the grain and straw yields responded significantly due to the application of inorganic fertilizers with organic amendments. The highest grain yield, straw yield, N uptake by grain and straw and nitrogen use efficiency were obtained in treatment T_5: N @100 kg N ha^{-1} + vermicompost (2 t ha^{-1}) with IPNS. In second crop (boro rice) the grain yield, straw yield and N uptake also responded significantly due to the application of STB based fertilizer and the residual effects of organic amendments applied in previous crop. The highest grain yield, straw yield, N uptake & use efficiency by grain and straw were observed in treatment T_5: RFD based on STB + Residual Vermicompost. In third crop (T. Aman rice) the highest grain yield, straw yield, N uptake & use efficiency by grain and straw were observed in combined T_2: RFD based on STB and T_5: 85% RFD based on STB + residual VC. The results indicated that the use of N @ 100 kg N ha^{-1} + vermicompost (2 t ha^{-1}) with IPNS for mustard and T_5: RFD on STB + residual vermicompost for Boro rice and T_2: RFD based on STB and/or T_5: 85% RFD based on STB + residual VC for T. Aman rice were found to be more effective and beneficial for the enhancement of crop production, N nutrient uptake and FUE (%) by the crop.

Experiment-2: Effect of organic and inorganic fertilizers on carbon content in soil and increased of yield under rice–rice cropping pattern

The experiment was conducted to increase fertility with carbon stock pool in soil and sustainable crop production in rice-rice cropping system at BINA HQs farm, Mymensingh during 2022-23. There were five treatments (Viz. T_1: Control, T_2: Chemical fertilizer (T. aman: $N_{90}P_{25}K_{50}S_{16}$ and Boro $N_{120}P_{35}K_{80}S_{20}$), T_3: Chemical fertilizer + cowdung @ 3 t ha^{-1}, T_4: Chemical fertilizer + vermi-compost @ 2 t ha^{-1} and T_5: Chemical fertilizer + Eco-compost @ 3 t ha^{-1} with RCBD design and three replications. In this trials Binadhan-24 were used as rice variety for Boro season and Binadhan-17 were used in T.aman season. Yields and yield contributing characters of T. aman rice were significantly influenced with the different fertilizer combination. The highest yield was produced from the treatment T_5 (4.95 t ha^{-1}) although the treatments T_4 and T_3 produced statistically similar yield. The highest straw yield (6.57 t ha^{-1}) was produced from the treatment T_4 and the treatments T_5 and T_3 produced which were statistically similar. The application of organic and inorganic fertilizer influenced significantly the yield and yield contributing characters of Boro rice (Binadhan-24). The highest yield was produced from the treatment T_5 (6.85 t ha^{-1}) along with similar yield statistically from the treatments T_3 and T_4 respectively. The treatment T_2 (7.03 t ha^{-1}) gave the highest straw yield followed by treatments T_3, T_4 and T_5. The results revealed that substantial amount of N, P, K and S fertilizers could be saved with the integrated use of organic manure in rice-rice cropping system. The application of organic carbon through cowdung (CD), vermi-compost (VC) and eco-compost (EC) influences in increasing carbon

content in the soil. From the results it may be concluded that recommended dose of nutrients combination along with the organic manure performed better and found suitable for higher crop production.

Experiment-3: Effect of different sources manure and lime (poultry manure, biochar) for increased soil pH and crop production

The soil reaction of the northern areas of Bangladesh is going down to 4.5 which is alarming for the agricultural crop production. To increase the soil pH, an experiment was conducted in the low pH soil at BINA substation, Rangpur. There were seven treatments for the study (T_1: Control Recommended chemical fertilizer (RCF), T_2: RCF + lime @ 2 t ha^{-1}, T_3: RCF + poultry manure @ 3 t ha^{-1}, T_4: RCF + biochar @ 2 t ha^{-1}, T_5: RCF + lime @ 1 t ha^{-1} + poultry manure @ 1.5 t ha^{-1}, T_6: RCF + lime @ 1 t ha^{-1} + biochar @ 1 t ha^{-1} and T_7: RCF + biochar @ 1 t ha^{-1} + poultry manure @ 1.5 t ha^{-1}) and was randomized complete block design with three replication. The sesame variety BINA Til2 was used as a test crop in this study. It is observed that due to the treatments there are some positives changes that effects on the yield and yield contributing characters positively. Observing with the treatments effect, considering the seed yield the highest yield was produced from treatment T_6 (RCF + lime @ 1 t ha^{-1} + biochar @ 1 t ha^{-1}) which is combination with the lime and biochar application never-the-less all the treatments combination has significant different from treatment T_1 which received only chemical fertilizers. The initial pH value was 4.8 in the experiment site and has increased due to the different treatments to 5.8 which are very noticeable. The mean organic matter ranged from 1.04-1.21 and there are decrease trend in organic matter after the crop cultivation. The nitrogen percentage of experimental site was low to very low and became lower after one year cropping. The phosphorus content at initial and post-harvest soil is almost similar at the experiment site. The potassium content reduced at the experiment site with a very similar amount after one year of crop cultivation. The result showed that potassium depletion take place in the cropping and the recommendation for potassium need to re-adjust again in that soil. The amount of sulphur in post-harvest soil is similar compared to the initial soil.

Experiment-4: Determination of optimum and economic doses of nutrients for advance lentil mutant line at BINA substation Ishurdi

Soil fertility is a dynamic property which varies with crops, cropping intensity and input uses. Therefore, to develop an optimum and economically suitable combination of fertilizers for sustaining soil fertility with higher crop productivity field trial of advanced mutant line of lentil was conducted at BINA substation Ishurdi 2022-23 to determine the amount of fertilizer require for higher crop production. There were four levels of N, P, K and S nutrients used. The yield of lentil mutant line affects significantly due to treatment combinations of different nutrients. Considering the nitrogen nutrients, the highest yield (1.485 t ha^{-1}) was produced from treatment T_3 (N- 20) as well as the response curve indicated the same requirement of nitrogen fertilizer. And the highest straw (2.668 t ha^{-1}) yield was obtained from treatment T_4. The lowest grain and straw yield was obtained from T_1 (control) treatment. Considering the phosphorus nutrients, the highest yield (1.471 t ha^{-1}) was produced from treatment T_8 (P- 35) but the response curve indicated that the phosphorus requirement is 32 kg ha^{-1} which produced highest yield. The highest straw (2.954 t ha^{-1}) yield was obtained from treatment T_8 as well. The lowest grain and straw yield was obtained from T_5 (control) treatment. Considering the potassium nutrients, the highest yield (1.675 t ha^{-1}) was produced from treatment T_{10} (K- 15) and the response curve indicated that the potassium requirement is 17 kg ha^{-1} which produced highest yield. The highest straw (3.261 t ha^{-1}) yield was obtained from treatment T_{10} as well. The lowest grain and straw yield was obtained from T_1 (control) treatment. Considering the sulphur nutrients, the highest yield (1.468 t ha^{-1}) was produced from treatment T_{14} (S- 14) as well as the response curve indicated the same requirement of Sulphur fertilizer. The highest straw (3.522 t ha^{-1}) yield was obtained from treatment T_{14}. The lowest grain and straw yield was obtained from T_1 (control) treatment. Results demonstrated that the economic doses for optimum crop production for

lentil at Ishurdi area showed remarkable yield variation due to lower doses ($N_{100}P_{18}K_{50}S_{12}Zn_2B_1$) of fertilizer applied compared to higher doses ($N_{25}P_{35}K_{25}S_{16}Zn_2B_1$) of fertilizer application. The optimum and economic doses of nutrients may be recommended as $N_{20}P_{32}K_{17}S_{14}Zn_2B_1$ kg ha^{-1} respectively.

Project 2: Development of Upazila Land Suitability Assessment and Crop Zoning System of Bangladesh (Phase-II- KGF Project)

Experiment 5: Validation of Khamari apps fertilizer recommendation at different locations of Bangladesh (Phase-II- KGF Project)

Three experiments were conducted at Mymensingh, Magura and Chapainawabgonj districts of farmer's field to validate fertilizer recommendation at farm level with the help of NARS Institute and DAE. The experiments were conducted to evaluate the Khamari apps fertilizer recommendation compared to the farmer's practices with two treatments as T_1: Khamari apps and T_2: Farmers practices. The tested variety was Binasharisha-9 in Mymensingh and was sown in 23-11-2022 and harvested at full maturity on 18/02/2023. The yield of mustard at Mymensingh has been influenced by the fertilizer doses of Khamari apps. All the yield contributing characters and yield were found higher in treatment T_1 than T_2. The application of the Khamari apps fertilizer doses produced higher seed yield (1.86 t ha^{-1}) over the fertilizer used by the farmer's practices (1.51 t ha^{-1}). The highest gross marginal income for mustard was Tk. 125940/-, which was obtained from the treatment T_1 (Khamari apps) and the percent yield increase over farmer's practices fertilizer dose was 23.2%. Result indicated that the Khamari apps based fertilizer dose produced higher yield compared to the fertilizer dose of farmer's practices. The tested variety was Binamasur-9 in Magura and was sown on 11-11-2022 and harvested at full maturity on 06/03/2023. The yield of lentil at Magura has been influenced by the fertilizer dose of Khamari apps. All the yield contributing characters and yield were found higher in treatment T_1 than T_2. The application of the Khamari apps fertilizer doses produced higher seed yield (2.10 t ha^{-1}) over the fertilizer used by the farmer's practices (1.87 t ha^{-1}). The straw is also produce higher in Khamari apps than farmer's practices.The highest gross margin for mustard was Tk. 207658/-, which is obtained from treatment T_1 (Khamari Apps) and the percent yield increase from farmer's practices fertilizer dose was 12.2%. The total fertilizer cost is higher in Khamari apps fertilizer dose than farmer's practices but the yield is higher in T_1 treatment. Result indicated that the Khamari apps based fertilizer dose produced higher yield compared to the fertilizer dose of farmer's practices. The tested variety was Binamasur-8 in Chapainawabganj and was sown on 13-11-2022 and harvested at full maturity on 09/03/2023. The yield of lentil at Chapainawabganj has been influenced by the fertilizer dose of Khamari apps. All the yield contributing characters and yield were found higher in treatment T_1 than T_2. The application of the Khamari apps fertilizer doses produced higher seed yield (2.10 t ha^{-1}) over the fertilizer used by the farmer's practices (2.00 t ha^{-1}). The highest gross margin for lentil was Tk. 207502/-, which was obtained from treatment T_1 (Khamari Apps) and the percent yield increase from farmer's practices fertilizer dose was 5.0%. The total fertilizer cost is lower in Khamari apps fertilizer dose than farmer's practices but the yield is higher in T_1 treatment. Result indicated that the Khamari apps based fertilizer dose produced higher yield compared to the fertilizer dose of farmer's practices.

Experiment-6: Effect of organic amendments for rice production in saline soil

Most distressing ecological stress is salinity that reduced agrarian production. One of the main adaptation processes for plants to tolerate salinity is the accumulation of organic compounds. The main 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 of the farmer' of the coastal saline areas of Bangladesh. The field experiment was conducted at the farmer's fields of Tala upazilla under Satkhira district with BINA dhan10, 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}). In different treatments, application of organic amendments reduced the salinity which favors the growth and development of rice plant. The initial soil salinity was 6.75 dS/m in the main plot in which the rice seedlings were transplanted. The cumulative effect of different organic amendments reflected in the yield contributing feathers and grain yield of rice. The highest yield was produced (5.81 t ha^{-1}) from T_2 (ash + rice straw) treatment although other treatments produced similar grain yield except T_3 and T_1. Apart from the study, the soil analysis 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 saline prone regions, which is advantageous for Bangladeshi farmers. Soil reaction values (pH) range from 7.1-7.5. The top soil organic matter ranged from 1.58 to 1.71%. The total N content of the soils are generally low and mostly around 0.10-0.13%. The available P and S status of the soils ranged from 12.11-13.5 ppm and 12.96-14.23 ppm respectively. The potassium content ranged from 0.17-0.20 cmol (+)/kg. The changes in soil pH, organic matter, total N, available P and S and exchangeable K content was very low due to the treatments and one season cultivation. Salt stress caused a significant decrease in growth and yield of rice and organic matters of ash, rice husk and rice straw improve salinity condition that reflect the growth and yield of rice by minimizing the inhibitory effects of salinity stress. Application of different sources of ash and rice straw produced higher yield of rice in saline area.

Project-3: Impact of Brick Kilns emission on soil quality of agricultural field

Experiment-7: Effect on soil quality due to brick kilns emission around the agricultural land

The study was conducted at Mymensingh Sadar and Fulbaria upzilla of Mymensingh district, during the period from January to April 2023 in dry season to estimate the soil degradation at 16 different brick kilns. The climate is typically tropical; mild winter (October to March); hot, humid summer (March to June); humid, warm rainy monsoon (June to October). There are sixteen soil samples were collected from different sixteen brick kilns from 50-100 meter distances. The samples were collected from the depth of 0-15 cm by auger from each point and mixed thoroughly to make composite sample. The pH values of the samples of surface soil (0-15 cm) ranged from 5.02 to 7.07 in the burnt soils and from 5.02 to 7.07 with a mean value is 6.42. The organic carbon (%OC), it ranged from 0.56 to 3.02 with an average value is 1.55 which expressed indiscriminate OC value in different sample. The nitrogen is low to very low in status among the brick kiln study areas and the average nitrogen value is 0.17%. The phosphorus status is wide range with 4.21 to 16.40 ppm. The potassium content is ranged from 0.12 to 0.78 cmol (+)/kg which is very wide range and the mean value is 0.25 cmol(+)/kg. The sulphur content is seems to be medium to higher with a range from 11.28 to 110.76 ppm.This study reported that heavy metals in excessive amounts in soil, water, and air. The Ni content ranged from 0.306 to 2.423 ppm among the tested brick kiln areas. The Mn content ranged from 5.64 to 189.91ppm among the tested brick kiln areas. The study results showed that the Cd concentration in farm soil ranged from 0.015 to 0.111 ppm. The results of this study indicated that all of the farm soil samples contained Cd concentration within the range (3.00 ppm) for the uncontaminated soil range. The results showed that the Pb concentration in farm soil ranged from 1.77 to 7.28 ppm in the study areas. A report showed that the Pb status of the soils was maximum acceptable limit of 100 ppm for crop production. The results showed that the iron (Fe) concentration in farm soil ranged from 12.03 to 55.24 ppm in study areas. The extreme heat produced during brick-making operations may cause soil burning and textural disruption in the surrounding areas.

Project-4: Assessing and Mitigating Agro-Contaminants to Improve Water Quality using Integrated Isotopic Approaches (IAEA/RCA RAS5091)

Experiment-8: Assessment and monitoring of the water quality of Turag, Buriganga and Sitalakhyaa River

Rivers located besides the most important industrial areas and capital city of Bangladesh have become highly polluted due to massive industrialization, urbanization and domestic sewage. Therefore, the current study has been undertaken to assess & monitor the water quality of the sites to find out the possible sources of contamination and also hazardous metals, compounds in the water and sediment. Water samples have been collected from eleven different points of Turag, Buriganga and Sitalakhya River adjacent to Dhaka and Narayanganj's urban & industrial area and analyzed for various water quality parameters e.g. pH, EC, heavy metals, NH_4^+ (ppm), NO_3^- (ppm), OC%, %N etc. during pre-monsoon, monsoon and post-monsoon seasons. In the collected samples from different point of Turag, Buriganga and Sitalakhya rivers Zn levels in water samples ranged from 0.87 to 3.45 ppm, the lead (Pb) in the water ranged from 0.0052 to 0.0139 ppm. The highest and lowest values were reported at site S_1 and S_5 during the pre-monsoon and monsoon seasons, respectively. Cd levels in the collected water samples from different sites ranged from 0.0007 to 0.0040 ppm. The lowest and highest concentrations were measured at sites S_6 and S_2. High levels of Cd mainly fall into river from the industrial waste disposal. The Cd concentration found in this study is lower than the Bangladesh EQS value. The higher heavy metals in surface water caused by the combined effect of greater vaporizations and lower rainfall during the pre monsoon season. Again, the opposite result was recorded during the rainy season, which could be related to the rainfall effect, which increased the dilution process and continued the dilution of heavy metals throughout the rainy season. The dry season (pre-monsoon and post-monsoon) had significantly higher contamination loads and dissolved metals in the water samples, which were decreased during the wet season (monsoon), as the river was found to be highly turbid in wet season. To conclude, the variation in river water flow during different seasons and the anthropogenic activities were the main reasons for this water pollution of Turag River. This could happen due to the discharge of untreated industrial wastes, oils, and municipal wastes, among other things. Therefore, it is high time to take initiatives to save the river from further pollution.

Project-5: Evaluation of different organic wastes for the production of vermicompost and its effect on crop yields and soil fertility using nuclear techniques

Experiment-9: Integrated effects of potassium rich vermicompost with chemical fertilizer on T. aman rice

Field experiment was conducted to reduce the chemical fertilizers with the integrated use of potassium rich -vermicompost (K-rich VC) with chemical fertilizers (CF) in T. aman rice (BINA dhan-17) at the BINA farm, Mymensingh during 2022-23. Six treatments were used in the experiment which were as follows: T_1: Native soil fertility, T_2: 100% NPKS chemical fertilizer, T_3: 50% K from VC+ 50% K from CF+ 100%NPS (IPNS), T_4: 100% K from VC + 100%NPS from CF (IPNS), T_5: 100% K from VC+100%NPS (non-IPNS) and T_6: 100%NPS.The experiment was conducted in a Randomized Complete Block Design with three replications. T. Aman rice (var. Binadhan-17) was transplanted on 4th August 2022 and harvested on the 8th November, 2022. Fertilizer rates were applied on the basis of soil test. In case of manure treatments, IPNS was followed i.e. chemical fertilizer N, P, K and S were balanced according to nutrients supply from organic manures in respective cases. Therefore, N, P, K and S were also reduced from CF treatments in T. aman rice.

Nutrient contents of K-rich vermicompost were analysed. K-rich vermicompost and all chemical fertilizers (TSP, MOP and gypsum) were applied during final land preparation except urea. Urea was applied in three equal splits. Yields and yield contributing characters of T. aman rice were significantly influenced with the application of K-rich vermicompost and chemical fertilizers except panicle length. The treatment T_3 (5.5 t ha^{-1}) gave maximum grain yield of T. aman rice followed by the treatment T_2 and T_5 (5.1 t ha^{-1}). The result indicated that reduced rate of chemical fertilizer with incorporation of K rich vermicompost gave statistically similar yields to the sole application of 100% CF. The treatment T_1 (Native soil fertility) gave significantly minimum grain yield (3 t ha^{-1}) of T. aman rice. The results also revealed that 50% reduced rate of K fertilizer and IPNS from K-rich vermicompost or chemical fertilizer might be good option (i.e.50% K from VC + 50% K from CF + 100% NPS with IPNS) for the cultivation of T. aman rice. Recorded all the yield contributing characters were maximum in the treatment T_3 except straw yield and unfilled grain $panicle^{-1}$. Hence, 50% K could be met up with the application of K-rich vermicompost @ 1 t ha^{-1} with IPNS chemical fertilizers (NPS) which was sufficient for attaining the comparable grain yield of T. aman rice to the 100% NPKS. Therefore 50% K fertilizer could be saved with the application of K-rich vermicompost for the cultivation of T. aman rice.

Experiment-10: Integrated effects of phosphorus and potassium rich vermicompost (PK rich VC) with inorganic fertilizer on Boro rice

Field experiment was conducted to reduce the chemical fertilizers with the integrated use of phosphorus and potassium rich -vermicompost (PK-rich VC) with the chemical fertilizers (CF) in Boro rice (BINA dhan-25) at the BINA farm, Mymensingh during 2022-23. Six treatments were used in the experiment which were as follows: T_1: 100% NS, T_2: 100% NPKS from chemical fertilizer (CF), T_3: 100% P from PK-VC+ 100% NKS from CF (IPNS), T_4: 100% P from PK-VC +100% NKS from CF (non-IPNS), T_5: 50% K from PK-VC +50% K from CF+ 100% NPS from CF (IPNS), T_6: 50%K from PK-VC +50% K from CF+ 100% NPS from CF (Non-IPNS). The experiment was conducted in a Randomized Complete Block Design with three replications. Boro rice (var. Binadhan-25) was transplanted on 12th January 2023 and harvested on the 30th April, 2023. Fertilizer rates were applied on the basis of soil test. In case of manure treatments, IPNS was followed i.e. chemical fertilizer N, P, K and S were balanced according to nutrients supply from organic manures in respective cases. Therefore, N, P, K and S were also reduced from CF treatments in boro rice. Nutrient contents of PK-rich vermicompost were analysed. PK-rich vermicompost and all chemical fertilizers (TSP, MOP and gypsum) were applied during final land preparation except urea. Urea was applied in three equal splits. Yield and yield contributing characters such as grain yield, effective tiller/hill and unfilled grain of boro rice were significantly influenced with the application of PK-rich vermicompost and inorganic fertilizers. The treatment T_3 (6.3 t ha^{-1}) gave maximum grain yield of Boro rice followed by the treatment T_5 (6.2 t ha^{-1}). The result indicated that reduced rate of chemical fertilizers with incorporation of PK rich vermicompost gave higher yields than the sole application of 100% CF. The treatment T_1 gave significantly minimum grain yield (4.3 t ha^{-1}) of Boro rice. The results revealed that 100% reduced rate of P from CF and 33% reduced rate of K (calculated) from CF through IPNS from PK-rich vermicompost (Table 42) or chemical fertilizer might be good option (i.e.100% P from PK-VC + 100% NKS from CF (IPNS)) for the cultivation of Boro rice. Recorded all the yield contributing characters were maximum in the treatment T_3 with except plant height and unfilled grain. Hence, 100% P and 33% K could be met up with the application of PK-rich vermicompost @ 0.88 t ha^{-1} with IPNS chemical fertilizers (NPS) which was sufficient for attaining the comparable grain yield of Boro rice to the 100% NPKS chemical fertilizers. Therefore 100% P and 33% K fertilizer could be saved with the application of PK-rich vermicompost for the cultivation of Boro rice.

Experiment-11: Integrated effect of prepared K rich vermicompost with inorganic fertilizer on cabbage

Field experiments were conducted in two agroecological zones (AEZ) at the BINA sub-station, Rangpur (AEZ-3) and BINA sub-station, Ishurdi (AEZ-11) to investigate the integrated effect of prepared K rich vermicompost with inorganic fertilizer on cabbage yield during 2022-23. The experiments were carried out with seven treatments and three replications in Randomized Complete Block Design (RCBD). The treatments were T_1: Native soil fertility, T_2: 100% NPKS from chemical fertilizer (CF), T_3: 40% K from Vermicompost (VC) + 60%K from CF + 100%NPS (IPNS), T_4: 40% K from VC + 60%K from CF + 100% NPS (Non IPNS), T_5: 20% K from VC + 80% K from CF + 100% NPS (IPNS), T_6: 20% K from VC+80% K from CF + 100% NPS (Non IPNS) and T_7: 100% NPS from CF. Local variety of cabbage was used in the experiment at Ishwardi where three weeks old seedlings was transplanted on 18 November 2022. At Rangpur, cabbage (cv: Green-60) was transplanted at 13 November 2022. The distance between plant to plant was 40 cm. The unit plot size was 4 m × 3 m. The whole amount of vermicompost, TSP, MoP, Gypsum, Zinc sulphate and Solubor boron were broadcast at the time of final land preparation and urea was top dressed in three equal splits at 10, 25 and 45 days after transplanting. Fertilizers were applied on the basis of soil test. Nutrient contents in K rich vermicompost were analyzed. Weeding, irrigation and other intercultural operations were done as and when necessary. The cabbage was harvested on 24 February 2023 at Ishwardi and 27 February, 2023 at Rangpur. Yield and yield contributing characteristics of cabbage were significantly influenced with the different treatments at Rangpur and Ishwardi during 2022-23. Maximum edible yield of cabbage (78 t ha^{-1}) was obtained in the treatment T_4 (40% K from VC + 60% K from CF + 100% NPS (Non IPNS) followed by the treatment T_2 (76 t ha^{-1}) at BINA Sub-Station Rangpur. In case of BINA Sub-Station Ishwardi, the treatment T_4 (40% K from VC + 60% K from CF + 100% NPS (Non IPNS) produced the highest edible yield (68.7 t ha^{-1}). In both locations the lowest edible yield of cabbage was recorded in the control treatment T_1 where no fertilizer was applied. Yield contributing characters of cabbage were also significantly influenced with the combined use of chemical fertilizer and K- rich vermicompost. The treatments T_4 gave the highest results regarding yield contributing characters of cabbage such as plant height, fresh weight and edible weight in both the locations. The results revealed that 40% K from VC + 60% K from CF + 100% NPS with Non IPNS system enhanced more crop growth which influenced the fresh as well as edible yield of cabbage in field condition. However, considering of maximum yield, the treatments T_4 (40% K from VC + 60% K from CF + 100% NPS (Non IPNS) could be recommended for maximum yield for the cultivation of cabbage.

Project-6: Fertilizer management for relay cropping system

Experiment-12: Comparative study of zero tillage and conventional tillage systems with different doses of fertilizer on yield of mustard

Field experiments were conducted at BINA Sub-Station Ishwardi and BINA Sub-Station Barishal to investigate the effect of zero tillage and conventional tillage systems with different doses of fertilizer on Mustard. The experiments were set side by side with zero tillage and conventional tillage systems with five fertilizer treatments for each system. The fertilizer treatments for both the systems were T_1: Native soil fertility only, T_2 : 100% NPKS, T_3 : 75% NPKS , T_4 : 125% NPKS and T_5 : 150% N + 100% PKS. The experiments were carried out in a RCB design with three replications. Fertilizers applied on the basis of soil test (STB) and requirement of the crop. At sowing time, soil moisture in the zero-tillage system was around 40 - 45% at those locations where in the conventional tillage system seeds were sown in the field capacity after preparation of land with power tiller. Seeds of mustard (Binashrisha-9) were sown on 11th November 2022 in the zero-tillage system where in the conventional tillage system seeds were sown on the 26th November 2022 at BINA substation,

Ishwardi and Barishal. The unit plot size was 4 m × 3 m at both the locations. Fertilizers were applied on the basis of soil test and the rates of fertilizer have been given in the Table 51. The whole amount of TSP, MoP, Gypsum, Boric acid and Zinc sulphate (Mono hydrate) were applied before sowing in the zero-tillage system where those fertilizers were applied at the time of final land preparation in the conventional tillage system. Urea was applied in three splits. First split was applied at 12 days after sowing (DAS) and 2nd and 3rd splits were applied at 25 DAS and 40 DAS. Weeding, irrigation and other intercultural operation were done as and when necessary. The mustard was harvested on 19th February 2023 in case of Zero tillage condition and 28th February, 2023 in case of conventional tillage condition. Yield and yield contributing characters were recorded during harvest. Yield contributing characters of mustard were significantly influenced with the use of chemical fertilizer in two tillage systems at BINA substation, Ishwardi and Barishal. The treatment T_4 (125% NPKS) gave the highest results on yield contributing characters of mustard at zero and conventional tillage system. Maximum grain yield (1.66 t ha^{-1} and 1.47 t ha^{-1} respectively) was recorded in the treatment T_4 in zero tillage system at both locations where the treatment T_4 gave maximum grain yield (1.53tha^{-1} and 1.14 tha^{-1} respectively) in the conventional tillage system at Ishwardi Sub-station and Barishal Sub-station. The treatment T_1 gave the lowest grain yield of mustard (0.20 t ha^{-1} and 0.55 t ha^{-1}) respectively at Ishwardi Sub-station and Barishal Sub-station at zero tillage system where no fertilizer was applied. 125% NPKS gave maximum grain yield (1.66 t ha^{-1} and 1.47 t ha^{-1} respectively) of mustard at zero tillage system. Zero tillage system produced higher grain yield than the conventional tillage system because it offers earlier sowing than conventional tillage system. Sowing times were delay due to land preparation in the conventional tillage system which affected the growth of mustard and ultimately lower yield was obtained in the conventional tillage than the zero tillage system. The results indicated that earlier sowing of mustard in zero tillage system is good option for minimizing the sowing time of mustard than conventional tillage system and 125%NPKS fertilizer doses could be used for the zero tillage system in the cultivation of mustard. Therefore, fertilizer doses of $N_{139}P_{26}K_{79}S_{24}$ kg ha^{-1} for Ishurdi and Barishal could be used in the cultivation of mustard under zero tillage system.

Experiment-13: Effects of selected doses of fertilizers on mustard under zero tillage at farmer's field

Field experiments were conducted at the farmer's field of Mojlishpur, Narsingdi during 2022-23 to observe the effects of various fertilizer doses on mustard under zero tillage system. Four treatments combination were used in this experiment, which were T_1: 100%NPKS, T_2: 75%NPKS, T_3: 125% NPKS and T_4: 150%N +100%PKS. The experiments were conducted in RCBD with three replications. At sowing time the soil moisture was 45 -50%. So, the condition of germination for seed of mustard was well in zero tillage system. Seeds of mustard (Binashrisha-9) were sown in zero tillage system on 23th Nov. 2022. Fertilizers were applied on the basis of soil test. TSP, MoP, gypsum, zinc (2.0 kg^{-1}) and boron (2.0 kg ha^{-1}) were applied before the sowing of mustard seeds. Urea was top dressed in two equal splits. First split was applied 12 days after sowing (DAS) and second split was applied 30 DAS. Weeding, irrigation and other intercultural operation were done as and when necessary. The mustard crop was harvested on the 28th February 2023. Yield and yield contributing characters were recorded after harvesting. Maximum seed yield (1.72 t ha^{-1}) was recorded with the treatment T_4 (150%N +100%PKS) which was significantly differed from other treatments. The result indicated that the application of all kinds of fertilizers with increasing rates have tremendous influence on seed yield of mustard in zero tillage system. The lowest seed yield (1.28 t ha^{-1}) was recorded in the treatment T_2 where 75% NPKS fertilizer was applied. Straw yield of mustard was not significantly affected with the different treatments. Yield contributing characters like plant height, no. of pods $plant^{-1}$ and seeds pod^{-1} were not significantly influenced with the different treatments. The results revealed that 150% N + 100%PKS fertilizer doses enhanced more crop growth which influenced to obtain maximum seed yield of mustard under zero tillage systems. Therefore, fertilizer doses of N_{167} $P_{21}K_{63}$ S_{19} Zn_2B_2 for Narsingdi area could be adopted in the cultivation of mustard for getting maximum seed yields under zero tillage system.

Experiment-14: Comparative study of zero tillage and conventional tillage systems with different doses of fertilizer on the growth and yield of wheat

Field experiments were conducted at BINA Sub-Station, Ishwardi, Gopalgonj and Shatkhira to investigate the effect of zero tillage and conventional tillage systems with different doses of fertilizer on wheat. The experiments were set side by side with zero tillage and conventional tillage systems with six fertilizer treatments for each system. The fertilizer treatments for both the systems were T_1: Native soil fertility only, T_2: 100% NPKS, T_3: 75% NPKS, T_4: 50% NPKS, T_5: 125% NPKS and T_6: 150% NPKS + 75%PKS. The experiments were carried out in a RCB design with three replications. Fertilizers applied on the basis of soil test (STB) and requirement of the crop. At sowing time, soil moisture in the zero tillage system was around 40 - 45% at three locations where in the conventional tillage system seeds were sown in the field capacity after preparation of land with power tiller. Seeds of wheat (Binagom-1) were sown on 15th Nov. 2022 in the zero tillage system where in the conventional tillage system seeds were sown on the 29th November 2022 at BINA substation, Gopalgonj and Shatkhira. At BINA substation, Ishwardi seeds of wheat (Binagom-1) were sown on 13th November 2022 in the zero-tillage system where in the conventional system seeds were sown on the 1st December 2022. The unit plot size was 4 m × 3 m at three locations. The whole amount of TSP, MoP, Gypsum, Boric acid and Zinc sulphate (Mono hydrate) were applied before sowing in the zero-tillage system where those fertilizers were applied at the time of final land preparation in the conventional tillage system. Urea was applied in three splits. First split was applied at 12 days after sowing (DAS) and 2nd and 3rd splits were applied at 25 DAS and 40 DAS. Weeding, irrigation and other intercultural operations were done as and when necessary. In case of zero tillage, wheat was harvested on 10th March 2023 at Ishwardi and 13th March 2023 at Gopalgonj and Shatkhira. But the date of harvesting was 10 days later in case of conventional tillage in all the three locations. Yield and yield contributing characters were recorded during harvest.

Yields of wheat were significantly influenced with the different treatments at three locations. Yields of wheat were significantly influenced with the use of chemical fertilizer in two tillage systems in every location. The treatment T_5 (125% NPKS) gave the highest results on grain yields of wheat at zero and conventional tillage system in three locations except Shatkhira. At three locations grain yields and straw yields of wheat in conventional tillage were higher than zero tillage. Maximum grain yield (3.7 t ha^{-1}) was recorded in the treatment T_5 in conventional tillage system in Gopalganj Sub-Station. The treatment T_1 gave the lowest grain yield of wheat in three locations where no fertilizer was applied. 125% NPKS gave maximum grain and straw yield of wheat in three locations at conventional tillage system. Zero tillage system produced slightly lower grain yield than the conventional tillage system but it offers earlier sowing than conventional tillage system. Sowing times were delay due to land preparation in the conventional tillage system which delay the harvesting time of wheat and ultimately affect next crops. The results indicated that earlier sowing of wheat in zero tillage system is good option for minimizing the sowing time of wheat than conventional tillage system and 125%NPKS fertilizer doses could be used for the system in the cultivation of wheat. Therefore, fertilizer doses of $N_{139.4}P_{17.5}K_{73.3}S_{12.3}$ kg ha^{-1} for Ishurdi and $N_{145}P_{24.1}K_{74.6}S_{10.1}$ kg ha^{-1}for Gopalgonj and Shatkhira could be used in the cultivation of wheat under zero tillage system.

Project-7: Fertilizer recommendation for elite mutants/variety developed at BINA

Experiment-15: Evalution of different Boro and T. aman rice mutants against different doses of fertilizers

Five mutants for each Boro and T. aman were assessed for the optimum fertilizer dose at BINA Headquarters in Mymensingh during 2022–2023. Treatment combinations were T_1 = 80% of recommended chemical fertilizers (RCF), T_2 = 100% RCF, and T_3 = 120% of RCF in a RCBD with three replications. Mutants of Boro and T. aman rice (M1, M2, M3, M4, and M5) produced 5.76, 6.80, 5.25, 6.51, and 5.38 t ha^{-1}, as well as 3.79, 4.00, 5.05, 4.59, and 5.77 t ha^{-1} in T_3 treatment, respectively. It may be concluded that urea-TSP-MoP-gypsum-zinc fertilizers such as 470-144-182-80-7.7 kg ha^{-1} for Boro and 234-60-120-27-5.4 kg ha^{-1} for T. aman are suitable for all the mutants to increase rice production.

Project-8: Carbon sequestration in soils of Bangladesh using stable tracer techniques

Experiment-16: Effect of organic and inorganic fertilizers on yield and yield contributing characters of rice under rice-rice cropping system

A field experiment was conducted to evaluate the performance organic and inorganic fertilizer on yield and yield attributing characters of rice. Two crop residue levels viz., crop residue (6-7 cm height), and no crop residue were verified with different organic and inorganic combinations such as 100% recommended dose of chemical fertilizers (RDF), 75% RDF +3.0 t ha^{-1}poultry manure (PM), 75% RDF +2.0 t ha^{-1} PM + 1.0 t ha^{-1}biochar (BC) and 100% RDF + 2.0 t ha^{-1} BC including control. Factorial experiment was laid out in a randomized complete block design, with five treatments with three replications. The plot size was 3.0m × 4.0m = 12 m^2. Rice (BINAdhan-24) was the test crop. Available N, P, and K nutrient contents were analyzed following standard methods. After harvesting the crop, data on plant height, panicle length, effective tiller, grain yield, straw yield and nitrogen content were collected.The yield of Boro rice was significantly influenced by the different treatment combinations. The grain yield ranged from 3.76 to 5.76 t ha^{-1}. The highest yield (5.76 t ha^{-1}) wasfound in the treatment combination of 75% RDF +2.0 t ha^{-1} PM + 1.0 t ha^{-1}biochar and the lowest yield (3.02 t ha^{-1}) was observed in the control treatment. The straw yield ranged from 4.70 to 6.82 t ha^{-1}. The highest straw yield (6.82 t ha^{-1}) was recorded in the treatment combination of 75% RDF +2.0 t ha^{-1} PM + 1.0 t ha^{-1} biochar and the lowest was obtained from the control treatment. For the grain and straw yield, all the treatments were identical exceptcontrol. The treatment, 100% RDF shows similar result. Crop residue significantly increased grain and straw yield of rice.

Experiment-17: Soil characterization of BINA HQs farm, Mymensingh 2023

Different soil and crop management practices play an important role in distribution of organic matter throughout the soil profile, soil biological properties, soil carbon and nitrogen dynamics. Soil characterization of BINA Headquarters farm, Mymensingh was done to evaluate the physico-chemical characteristics of the soil from different blocks of the farm area. Composite soils from different blocks of the farm area were collected after harvesting the T-Aman in 2022. The pH of the farm area is slightly acidic to neutral. The OC% of the soils are low to medium. Total nitrogen contents are low in soil. Available phosphorus content is medium in range. Exchangeable K (meq %) contents are very low to low in range. Available sulphur (ppm) content is low to medium in range.

Soil Micronutrients and Heavy Metals:

Project-9: Soil fertility status of some intensive crop growing areas under major AEZs and balanced fertilization

Experiment-18: Requirement of Zinc and Boron application for Rice-Rice Cropping Pattern

Intensification of agricultural land use coupled with cultivation of modern varieties has remarkably increased in Bangladesh. This in turn has resulted in deterioration of soil fertility, with emergence of macro and micro-nutrient deficiency of crops. With this point in view, a study was undertaken to evaluate the effect of Zn and B application on the yield of T. Aman and Boro rice to find out the optimum rates of Zn and B for the T. Aman - Boro rice cropping pattern in AEZ 9. The experimental soil samples were collected and analysed for some basic properties of soils included pH and organic matter contents, macronutrients included (N, P, K, S) contents and micronutrients included (Zn and B) contents. All analysis was done following standard methods. There were four treatments for the T. Aman (T_1: Zn_0B_0, T_2: $Zn_2B_{1.5}$, T_3: Zn_4B_2, T_4: Zn_6B_3, and six treatments for Boro rice as $T_{1.1}$ (Zn_0B_0), $T_{2.1}$ (Zn_2B_2), $T_{2.2}$ (Zn_0B_0), $T_{3.1}$ (Zn_4B_2), $T_{3.2}$ (Zn_0B_0), $T_{4.1}$ (Zn_0B_0). Subscripts of Zn and B represent kg ha^{-1}. Each treatment replicated three times. Nitrogen, P, K, S were applied as recommended rates in all plots. The Zn-B treatments were imposed on the first and second crop, as shown above. The Zn was added as $ZnSO_4$ and B was as H_3BO_3. The results show that Zn @ 4 kg $ha^{-1}$and B application @ 2 kg ha^{-1} to the first crop or, Zn @ 2 kg ha^{-1} and B application @ 2 kg ha^{-1} to the first and again in the second rice crop can give maximum grain yield in rice - rice cropping pattern.

Soil Microbiology:

Project-10: Development of efficient and climate smart biofertilizers for pulse, oilseed and vegetable production using microbiological, molecular and nuclear techniques

Experiment-19: Effects of Rhizobial strain on growth, nodulation and Yield of French bean

A field experiment was conducted to select the rhizobial inoculants/strains to produce efficient biofertilizer for the cultivation of french bean at Sutiakhali, Mymensingh during 2022-23. There were seven treatments viz. Inoculants FBR-1, FBR-2, FBR-3, FBR-4 along with two nitrogen dose viz N_{15} kg ha^{-1} and N_{30} kg ha^{-1} and one uninoculated control. The experiment was conducted in a Randomized Complete Block Design with three replications. Plot size was $4m^2$ (2m×2m). Phosphorus, Potassium and Sulphur were applied as basal application @ 20 kg ha^{-1}, 40 kg ha^{-1}, 10 kg ha^{-1}. Irrigation and weeding were done as and when necessary. Nodulation data were recorded at vegetative stage. Data on grain yield was recorded at maturity stage. Yield attributing parameters were recorded after harvest of crop. Results showed significant increase in nodulation, plant height and yield with inoculated treatments over uninoculated ones. At 40 DAS, different growth parameters of french bean were collected. The highest shoot length (cm) and nodule fresh wt. $plant^{-1}$ were recorded in the treatment T_2 whereas effective nodule $plant^{-1}$ was highest in the treatment T_4. Total pod $plant^{-1}$, total green pod yield (t ha^{-1}) were noted in the treatment T_2. Mazimum yield was observed over control. Among four *Rhizobium* inoculants/strains (FBR-1, FBR-2, FBR-3, FBR-4), the FBR-1 strain showed over all good performene providing the maximum green pod yield (9.58 t ha^{-1}) as vegetables of french bean. There is no nodulation in the control uninoculated treatments which means that there was lack of indigenous french bean *Rhizobium* in soil at Sutiakhali, Mymensingh. The result indicated that the *rhizobium* inoculants FBR-1 could be used for the production of biofertilizer for the cultivation of french bean.

HORTICULTURE DIVISION

Research Highlights

Vegetables

- One mutant line (BL-4M7D150P3-3) of bottle gourd has been selected having higher number of fruits (17-18 fruit/plant), lower disease and insect susceptibility, bold leaves as well as good cooking quality.
- Two high yielding (88.24-90.33t/h) mutants of eggplant, moderately tolerant to brinjal shoot and fruit borer and Phomopsis blight have been selected. Six mutant lines have been selected for further selection in subsequent generations.
- The $V_2D_{75}P_3$ mutant of carrot has been selected having higher seed yield (1153.05 kg ha^{-1}) and root yield (21.58 t/ha).
- Twelve M_3 populationof aroids have been selected for growing next season.
- An advanced line of cherry tomato (CTL-1) was found to be promising with high yield potentiality (63.5 t ha^{-1}), taste and nutritional quality (Vitamin-C 38mg/100g fruit weight). Four tomato genotypes were collected from home & abroad which were irradiated with 200, 300, 400 and 500 Gy of gamma ray. Seeds of the survived M_2 generation of tomato seeds will harvest and preserve as breeding material for next season.
- Seeds of exotic cultivar of cucumber, M_2 generation were grown. The survived plants that produced seeds were harvested separately for growing M_3 population. Twelve M_3 population have been selected based on staminate flower and no. of fruit per plant and larger fruit size, shape and weight.
- Considering yield contributing traits of country bean mutants CB/350/M4/P2(1), CB/350/M4/P3(4) & CB/350/M4/P1(3) have been selected for future varietal evaluation**.** Fifteen germplasm were collected from different regions of Bangladesh and characterized. All these germplasm preserved as breeding materials for future research.
- Fifteen M_2 plants of bitter gourd have been selected for further selection in subsequent generation.
- From pollen irradiated M_2 seeds from one fruit of each plant (cucumber and sweet gourd) harvested to grow M_3 plants.
- Fourteen germplasm of sweet potato were collected from different regions of Bangladesh and characterized. All these germplasm preserved as breeding materials for future research.

Spices

- Three M_6 mutants (ACM-023, ACM-030 and ACM-026) of onion performed better on bulb yield and other yield contributing traits. Ten M_4 onion mutants have been selected for future trail. In addition, various number of mutants/lines at different generations were identified which will be evaluated in the next growing season.
- Three M_1V_6 mutants of garlic (B1M5D1.5P2, B2M5D1.5P5 and B2M5D1.5P5) having high yield potentiality 3.97- 4.53 kg/plot ($6m^2$) with moderate storage quality have been selected for further trial. Thirty M_1V_2 mutants were selected for growing further generation.
- Three M_1V_5 mutants of zinger (TRM1V5D2P5, SMM1V5D2P13 and RBM1V5D2P3) having high yield potential; lower susceptibility to rhizome rot and waterlogged tolerant (20 days) have been selected. These lines need to be further evaluated at different ginger growing areas. Three M_1V_2 mutants were selected for growing in next season.
- Two exotic chili genotypes (RCL-1, YCL-1) and two advanced mutants (CL-018 and CL-020) were found promising through observation yield trial in respect of yield and pungency.
- Four mutants of turmeric, CLM-21-2-12, CLM-21-2-02, CLM-21-2-10 and CLM-21-5-02 were selected with high yield potentiality and tolerant leaf blotch disease for further selection in next season. To Create genetic variability, Rhizome of Turmeric local cultivar kukurmoni was irradiated with 10, 15, 20, 25,30, 35 & 40 Gy of Gamma rays.
- One M_6 mutants of black cumin having high yield $BC_2M_6D_{150}$ (526.13 g) and short duration (121 days) have been selected for further yield trial in next season.
- Based on yield potentiality and number of fruits $plant^{-1}$(7-12), five M_4 generation mutants of sweet pepper have been selected for further selection in subsequent generations.

Fruits

- A high yielding advanced sapota mutants $MAD_{20}P_9$ has been registered as BINA sapota1 in 2022-23 which showed late potentiality. Fruits are oval in shape, scented and tasty. Single fruit weight is 250-450 g. Edible portion of the fruits are 75-90%. In biochemical parameters, Total Soluble Solid (TSS) is 24-28%; titratable acidity is 0.31%; vitamin C content is 14.6 mg/100 g fresh fruit weight; total sugar is 7.28% where reducing sugar is 5.02%. Yield of BINA sapota1 is 25-40 t/h.
- Considering fruit characteristics i.e., fruit number, TSS and yield potentiality of sweet orange mutants MMD_{40} was found promising.
- $CAD_{20}P_1$ mutant of lime showed the tallest plant (185cm) and shortest plant height (166cm) was found in $CAD_{40}P_{1.}$ The maximum number of fruits (145) per plant, weight of individual fruit (144g), accumulated higher TSS (7.9 %), minimum number of seeds $fruit^{-1}$ (3), length of fruit (5.17cm), breadth of fruit (4.62 cm) and yield (18.47 Kg/plant) were recorded in $CAD_{40}P_{1.}$
- Considering fruit characteristics i.e., number of seeds, fruit and yield potentiality of PG-2 (India-2) genotypes of pomegranate was found promising.
- The mutant SCD15P8 of jamun was found promising based on fruit characteristics i.e., fruit number, TSS, individual fruit weight, considerable yield potentiality.
- To select suitable fruits and flowers for rooftop gardening for year round supply of fresh produce and effective utilization of space. A total of 150 exotic and local germplasm (fruit, flowers and medicinal plants) were planted on the rooftop.

Flowers

- Two gladiolus mutants $M_1V_3D_{30}P_4$ and $M_1V_3D_{10}R$ (pink mutant and red mutant) and the control (pink and red) were planted separately in rows. Pink mutant produced maximum flower and longer vase life than control (mother). M_1V_5 corms from the survived plants were bulked as per dose and floret color and kept in storage for growing of M_1V_5 generation in the next growing season. Another experiment was carried out of gladiolus to develop gladiolus with various floret colours, long spikes with higher number of florets, and longer vase life. The M_1V_1 gladiolus mutants (red, white, yellow and violet) were planted separately (colour and dose wise) in rows. Finally, the M_1V_2 corms from the survived plants were bulked as per dose and floret color and kept in refrigerator for M_2V_2 generation in the next growing season
- The rose mutant $M_1V_1D_{20}PM$ rose mutant produced maximum number of flowers 18 flowers/plant) than mothers (11 flowers/plant). Again rose mutant produced more attractive and different colour large flowers than untreated mother plant.
- To develop flower variety of chrysanthemum, gerbera and salvia, germplasm were collected from home and abroad. The shoot tip of chrysanthemum and sucker of gerbera were irradiated @ 0, 10, 20, 30 and 40 Gy and the seeds of salvia were irradiated @ 0, 100, 200, 3000 and 400 Gy. The survived plants were grown separately and data were recorded for selection of germplasm.

Postharvest technology

- Gamma irradiation dose of 400 Gy might be improved the shelf life (10-12 days at ambient temperature) without adverse effects on qualitative characteristics on Mango fruits cv. Amrapali. Compared to other postharvest treatments.
- The litchi variety China 3 was subjected to 1500 Gy gamma rays irradiation subsequently wrapped in LDPE bags and stored in ambient room temperature (25- 28^0C) and humidity (69-70%) delayed the ripening process which maintained minimum percent of weight loss, disease incidence, disease severity and increased the shelf life of litchi.
- Gamma irradiation dose @1.0 kGy in Litchi cv. Bombai fruits might be improved the shelf life (3-5 days at ambient temperature) without detoriating qualitative characteristics.
- Imposed gamma irradiation dose @1.0 kGy in Jujube cv. Bollsundori might be improved the shelf life (3-4 days at ambient temperature) with delayed reddening and without detoriatingqualitative characteristics.

- The bitter gourd subjected to sanitized with 3% $CaCl_2$ and then 1000 Gy gamma rays irradiation subsequently wrapped in PP bags and stored in ambient room temperature (22-25 ^{0}C) and humidity (65-70%) delayed the physiological process which maintained minimum percent of weight loss, disease incidence, disease severity and increased the shelf life of export quality bitter gourd.
- The betel leaf subjected to 500 Gy gamma rays irradiation subsequently wrapped in LDPE bags and stored in ambient room temperature (21-25^{0}C) and humidity (60-70%) delayed the physiological process which maintained minimum percent of weight loss, disease incidence, and disease severity and increased the shelf life and maintained quality of betel leaf.

Tissue culture technique

- Among the plant growth regulators for callus initiation, 8.5 mg/L NAA performed better, 2 mg/LBAP showed good performance for shoot regeneration from callus and 2.5 mg/L IBA was found most responsive for root induction.
- Different somaclones showed fluctuating data in response to different parameter at field condition. To identify the desired somaclones the experiment will be conducted again.

Varietal improvement of fruits

On farm trail of different sapota mutants during 2022-23

On- farm trial of different sapota mutants was conducted at Mymensingh under Horticulture Division, during the season of 2022-2023. Three mutants viz. $MZD_{20}P_{9,}$ $MZD_{40}P_{6,}$ $MZD_{60}P_1$ with two mothers BAUSapota-4 and BARI Sapota-2 showed better performance in terms of individual fruit weight, yield per plant, edible portion, %TSS, sweetness and taste. The mutant $MZD_{60}P_1$ was found promising in terms of fruit shape, size, color, fruit quality attributes and late bearing habit. This mutant $MZD_{60}P_1$ was recommended for commercial multiplication, growing at farmer's field and conservation in the field gene bank for further evaluation. So the mutant $MZD_{60}P_1$ has been registered from the National Seed Board of Bangladesh as BINA sapota1.

Collection and evaluation of fruits germplasm

A total of 69 indigenous and 39 exotic fruits germplasm has been collected from the different parts of the country as well as outside the country and planted in the field. The germplasm were collected from farmers' home garden and nursery. The status of the sample was landraces. The samples were collected as scion from individual plant or population. Passport data like crop name, collector's number, local or cultivar name, sample status and source, date of collection, name of village, union, upazila and district were recorded. Collected germplasm were evaluated on the basis of morphological characters and yield.

Evaluation of mango germplasm at BINA HQs,Mymensingh

About 59 germplasm (Miyazaki, King chaka pat, Brunai King, Karate colombo, Nam Doc Mai, Kewsani, Taiwan red, Taiwan green, Rad, MARDI, Black stone, Honeydew etc) of mango have been planted and maintaining in the Germplasm Centre at BINA HQs, Mymensingh. A number of individuals were chosen on the basis of morphological and quantitative attributes. Two genotypes of mango, namely MI -009 and MI -076 were identified after screening. Between them, the earliest flowering and harvesting time observed in MI - 076 and the latest in MI -009. Maximum number of fruits (15fruits)/plant was produced by MI-009 and minimum number of fruits (12 fruits)/plant was produced from MI -076. The highest individual fruit weight (689.23gm) was produced by MI-076 and minimum individual fruit weight (505.66 gm) was produced from MI -009. Maximum total soluble solids (TSS) (22.12 %) was observed in MI -009 and minimum (20.57 %) TSS was observed in MI - 076. The highest yield per plant (7.78 kg) was produced in MI - 076 and the lowest yield per plant (6.47 kg) was produced in MI -009. Very good organoleptic taste was found in MI -076.

Evaluation of custard apple germplasm at BINA HQs, Mymensingh

Two custard apple germplasm were studied in the laboratory of Horticulture Division, BINA, during 2022-2023 to assess the suitable custard apple germplasm based on size, TTS, color and quality. The result indicated that wide range of diversity existed in fruit weight, TSS content, yield/plant and fruit

color etc. The weight of a matured fruit varied from 146.67 gm to 441.21 gm. The highest fruit weight (441.21 gm) was observed in AS -005 and the lowest fruit weight was noted in AS -003 (146.67 g). TSS varied from 21.3 to 25.4. The germplasm AS -005 showed better performances on the basis of no. of fruit per plant, TSS (25.4%) and yield (25.23 kg/plant).

Evaluation of exotic jackfruit germplasm

Two exotic jackfruit germplasm namely AH -001 and AH -002 were studied at the BINA HQs Farm, Mymensingh. Plant height, base girth, plant spreading and male inflorescences were recorded. Maximum plant height was recorded in AH -02 (4.3 m) and minimum plant height was recorded in AH -001 (3.2 m). All the germplasm were observed to produce male inflorescences and one of the germplasm was found to produce male inflorescences from the month of July 2020 which was the sign of off-season and year round behaviour. Male inflorescences were observed from the first year of planting, but female inflorescences were not found. The two exotic jackfruit germplasm (AH -02) and (AH -001) produced red and light pink coloured pulp, respectively. Textures of pulp of both germplasm were firm. Experiment will be conducted in the next year for further evaluation.

Evaluation of exotic longan germplasm

Two exotic longan germplasm namely EL -003 and EL -005 were studied at the BINA HQs Farm, Mymensingh. Fruit weight, fruit length, fruit diameter, aril weight, rind weight, seed weight, TSS (%) and edible portion were recorded. Wide range of variability was observed among the genotypes under study in respect of different physical characteristics of fruits. Fruit weight of different genotype varied from 6.65g to 8.86g. The highest fruit weight and TSS (21.21%) were recorded in the genotypes EL-003 (8.86g). The lowest fruit weight and TSS (16.5%) were obtained from the genotypes EL-005 (6.65g). The highest rind weight was recorded in EL-0 05 (1.02g) whereas, the lowest in EL- 003 (0.65 g).The weight of aril was the highest in EL-0 06 (4.33g), while the lowest in EL-005 (4.17 g). The highest percentage of edible portion was recorded in the germplasm EL- 003 (74.02 %) while the lowest in EL-005 (65.91 %).

Growing of M_1V_1 population of sweet orange

The experiment was conducted with 3 mutants derived from sweet orange M_1V_1 ($WNMD_{60}P_1$, $MMD_{40}P_1$ and BARI $D_{40}P_2$ and three check varieties ($WNMD_0$ P_1, MMD_0 P_1 and BARI D_0P_1) at the BINA HQ farm, 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 pumelo root stock. The experiment was laid out in row planting method with raw to raw 3m and plant to plant 3m spacing. Recommended production packages were followed to ensure normal plant growth and development. The $MMD_{40}P_1$ mutant showed the tallest plant (280 cm) along with maximum number of fruits (164 fruits) per plant, accumulated higher TSS (14.99 %) and minimum number of seeds fruit^{-1} (6) whereas the shortest plant height (154 cm), the minimum number of fruits (77 fruits) plant^{-1} and maximum number of seeds fruit^{-1} (10) were recorded in $WNMD_0$ P_1. The maximum fruit length (6.77 cm), fruit breadth (6.89cm) and individual fruit weight (198 gm) as well as yield / plant (27.33 kg/plant) were found in $MMD_{40}P_1$ muta. Considering fruit characteristics i.e., fruit number, considerable yield potentiality of $MMD_{40}P_1$ mutant was found promising.

Growing of M_1V_1 population of lime

The experiment was conducted with 3 M_1V_1 populations of lime and a check variety (CAD_0P_1) at the BINA Horticulture farm, Mymensingh to create genetic variability. Scions of lime were irradiated with 20 Gy, 40 Gy, 60 Gy and 80 Gy of gamma ray. Irradiated scions were graft on lemon root stock. The experiment was laid out in row planting method with raw to raw 3m and plant to plant 3m spacing. Recommended production packages were followed to ensure normal plant growth and development. Result from the experiment, there were differences among the mutants studied regarding plant height, number of fruits/plant, fruit length, fruit breadth, individual fruit weight and yield per plant. It was found that the $CAD_{20}P_1$ mutant showed the tallest plant (185cm) and the shortest plant height (166cm) was found in $CAD_{40}P_1$. The maximum number of fruits (145 fruits) per plant, weight of individual fruit (144gm), accumulated higher TSS (7.9 %), minimum number of seeds fruit^{-1} (3), length of fruit (5.17cm), breadth of fruit (4.62 cm) and yield (18.47 kg/plant) were

recorded in $CAD_{40}P_1$. Whereas the minimum no. of fruits (79 fruits), length of fruit (4.15 cm), breadth of fruit (4.14 cm) and weight of individual fruit (121 gm), maximum number of seeds fruit^{-1} (11) and minimum yield (8.44 kg/plant) were found in CAD_0P_1.

Screening of Pomegranate germplasm based on growth, yield and quality attributes

The experiment was conducted with seven pomegranate genotypes at BINA headquarters farm, Mymensingh to select germplasm of desirable value with high yield. Seven Pomegranate germplasms PG-1(India-1), PG-2 (India-2), PG-3 (India-3), PG-4 (Indian Anar-1), PG-5 (Indian Anar-2), PG-6 (Indian Bedana-1), PG-7 (Indian Bedana-2) were collected from India. The experiment was laid out in randomized complete block design (RCDB) with three replications with raw to raw 3m and plant to plant 3m spacing. Recommended production packages were followed to ensure normal plant growth and development. From the results, it was found that the tallest plant height (233 cm) was recorded in PG-2 (India-2) whereas the shortest plant height was recorded in PG-6 (Indian Bedana-1)(166 cm).The germplasm PG-2 (India-2) showed the maximum number of fruits (77 fruits plant^{-1}), length (5.6cm) and breadth (5.4cm) of fruit whereas the minimum number of fruits (33fruits plant^{-1}),shorter length and breadth (4.3cm and 4.4cm) of fruit were recorded in PG-4 (Indian Bedana-1). PG-2 (India-2) germplasm had the highest TSS (16.57 %) and maximum weight of fruit plant^{-1} (205 gm) where as the lowest TSS (15.12 %) and minimum weight of fruit plant^{-1} (122 g) was recorded in PG-5 (Indian Bedana-1). Considering fruit characteristics i.e., fruit number, weight of individual fruit, %TSS and yield potentiality of PG-2 (India-2) was found promising.

Growing of M_1 V_1 population of Sapota

The experiment was conducted with four M_1V_1 populations (MAD20P5, MAD20P9, MAD40P2 and MAD40P6 1) of sapota and one check variety (MAD0P1) at the BINA HQ, Mymensingh to create genetic variability. Scions of sapota were irradiated with 20Gy, 40Gy and 60Gy of gamma ray. Irradiated scions were grafted on khirni root stock. The experiment was laid out in row planting method with raw to raw 3m and plant to plant 3m spacing. Recommended production packages were followed to ensure normal plant growth and development. The mutant $MAD_{20}P_9$ showed the tallest plant height (260 cm) along with the highest number of fruits (33fruits/plant) per plant, accumulated higher TSS (23.0 %), onger fruit (6.8 cm), large breadth (6.3 cm) and individual fruit weight (335 g) thereby higher fruit yield / plant (9.21 kg/plant). The shortest plant height (222 cm) along with minimum number of fruits (25fruits) per plant, accumulated higher TSS (18.0 %), shorter fruit (4.4 cm), fruit breadth (4.3 cm) and smaller size fruit (95 g) thereby lower yield / plant (2.22 kg/plant) 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 sapota and one check variety (SCD0P1) at the BINA HQ, Mymensingh to create genetic variability. Scions of jamun were irradiated with 5Gy, 10Gy and 15Gy of gamma ray. Irradiated scions were grafted on jamun root stock. The experiment was laid out in row planting method with raw to raw 3m and plant to plant 3m spacing. Recommended production packages were followed to ensure normal plant growth and development. It was found that the SCD15P8 population showed the tallest plant height (302 cm) along with higher TSS (13.5 %), longer fruit (2.6 cm), fruit breadth (2.3 cm) and higher individual fruit weight (14.28 gm) and resulted higher fruit weight / plant (4.22 kg/plant). The shortest plant height (245 cm) along with accumulated higher TSS (10.0 %), length of fruit (2.1 cm), breadth of fruit (1.9cm) and weight of individual fruit (9.28 g) as well as yield / plant (1.98 kg/plant) were recorded in SCD0P1. Considering fruit characteristics i.e., fruit number, length and breadth of fruit, %TSS and yield potentiality, SCD15P8 mutant was found promising.

Improvement of Vegetables

Regional yield trial of promising mutant of Bottle gourd

The experiment was conducted at BINA Regional Research Center, Gazipur; BINA substation Cumilla and Ishwardi during Rabi season 2022-2023 to evaluate the performance of promising mutant

lines (BL-4$M_7D_{300}P_{4-2}$, BL-4$M_7D_{150}P_{3-3}$) of bottle gourd. The seeds of selected mutants were sown on the pit on November 10th, 2022. The experiment was laid out in a Randomized Complete Block design with three replications. The unit plot size was 10.0 × 2.0m maintaining 2.0 × 2.5m spacing between two adjacent block and 0.5m drain between two adjacent plots. Recomended fertilizers and cultural practices were followed. Results showed that Gazipur, the mutant line BL-4$M_7D_{150}P_{3-3}$ produced the highest fruits plant^{-1} (18), individual fruit weight (3.45 kg) and the yield (83.85 tha^{-1}) the colour of fruit is dark green with whitish spot. On the other hand, minimum number of fruits plant^{-1} (10.85), smaller fruit size (2.87kg) and the yield (52.82 tha^{-1}) were produced by BARI Lau-4 followed by BL-4$M_7D_{300}P_{4-2}$. At Ishwardi, the mutant line BL-4$M_7D_{150}P_{3-3}$ also produced maximum number fruits plant^{-1} (17.85), large fruit size (5.12kg) and higher fruit yield (80.33 t ha^{-1}) the minimum fruits plant^{-1} (10.23), fruit weight (3.18kg) and the yield (48.12 t ha^{-1}) was recorded by BARI Lau-4. Considering yield potentiality, fruit color, acceptable fruit shape (bottle) and taste two advanced mutant lines viz., BL-$_4M_7D_{150}P_{3-3}$ (proposed BINAlau-1) and BL-$_4M_7D_{300}P_{4-2}$were found promising which may be selected for further regional yield trials.

Regional yield trial of eggplant mutant lines at farmer's field

Three advanced mutant lines of eggplant were evaluated at BINA Regional Research Center, Gazipur and BINA substation Cumilla during Rabi season 2022-2023 to evaluate the performance of promising mutant lines (IND$M_7D_{75}P_{29}$,IND$M_7D_{75}P_{43}$,IND$M_7D_{75}P_{45}$) of eggplant. The mutant line Ind$M_7D_{75}P_{45}$ showed the highest fruit yield (7.03 kg plant^{-1} and 90.88t ha^{-1}7) which was statistically similar to Ind$M_7D_{75}P_{29}$ (6.28 kg plant^{-1}). The remaining mutants showed the fruit yield ranged from 6.2 to 3.91 kg plant^{-1}. The control plant BARIBegun-6 produced the lowest yield (47.68 tha^{-1}). In case of fruit length and fruit diameter the mutant line Ind$M_7D_{75}P_{29}$ produced the larger fruits and control (BARI Begun-6) produced the smaller fruits. Considering yield potentiality, tolerant to BFSB, acceptable fruit shape, color, taste etc. Ind$M_7D_{75}P_{45}$ mutant line was found promising which may be selected for the regional yield trials.

Advanced yield trial of promising cherry tomato line

An advanced cherry tomato line (CTL-1) was evaluated at BINA HQs farm and other three locations with two check varieties Binatomato-10 and BARI Tomato-11 (Cherry type) to see the yield performances. The experiment was laid out in a Randomized Complete Block (RCB) design with three replications. Recommended doses of fertilizers were applied. Recommended intercultural operations were done as and when necessary. . Results showed that mean over four locations, the genotype CTL-1 showed the longest plant height (205cm) and highest individual fruit weight (10.2g) compared to Binatomato-10 (162cm and 9.5g) and BARI Toamto-11 (145 cm and 8.8g). On the other hand, number of fruits (362), fruit yield (72.4 t ha^{-1}), TSS (9.5) and shelf life was highest (34 days) in Binatomato-10 compared to CTL-1 (318, 61.3, 5.7 and 29 days respectively). But in case of vitamin C content CTL-1 (28.5 mg/100g fr. weight) gave the highest result compared to Binatomato-10 (17.2 mg/100g fr. weight) and BARI Tomato-11 (19.2mg). At BINA sub-station farm Rangpur, the genotype CTL-1 showed the longest plant height (195cm) compared to Binatomato-10 (158cm). On the other hand at Rangpur, number of fruit (340), fruit yield (68.4 t/ha), TSS (9.8%) and shelf life was highest (34 days) respectively in Binatomato-10 compared to CTL-1. But in case of vitamin C content CTL-1 (27.2) gave the highest result compared to Binatomato-10 (16.9) and at Gouripur, Mymensingh, the genotype CTL-1 showed the longest plant height (198cm) compared to Binatomato-10 (157cm) and. On the other hand, number of fruit (332), fruit yield (65.5), TSS (9.2) and shelf life was the highest (35 days) in Binatomato-10 compared to CTL-1. Binatomato-10 produced the higher number of fruits plnat^{-1}, total fruit yield, TSS (%) and shelf life in all the locations compared to CTL-1 and BARI Tomato-11 but CTL-1 showed the higher yield performances compared to one check variety BARI Tomato-11. Among the locations, yield performances were better at BINA HQs farm. Though overall yield performance is better of Binatomato-10 but CTL-1 genotype perform better compared to BARI Tomato-11 and CTL-1 has longer harvesting duration as well as suitable to produce in kharif season. Due to the scarcity of suitable variety of cherry tomato both at winter and summer season, advanced genotype CTL-1 would be promising. A panel test was done with expert

panelist to evaluate fresh table fruits of CTL-1. Panelist suggested that, CTL-1 would be promising cherry tomato variety and also should be given further trial at farmer's field.

Evaluation of M_6 mutants of carrot (Seed to seed method)

The experiment was conducted with 4 M_6 mutants and two check varieties (*Brasilias agroflora* and *Prima agroflora*). It was laid out in Randomized Complete Block Design with three replications at BINA HQ, Mymensingh. The size of a unit plot was 2.0 m × 1.0 m accommodating thirty six plants per plot with a spacing of 25 cm × 10cm. Plot to plot distance was provided 50 cm while the block to block distance 1.0 m. All the parameters on plant growth, yield components and quality seed of carrot were significantly influenced by the mutants. The mutants $V_2D_{75}P_3$ produced the tallest plant (175.96 cm), higher number of primary umbel plant^{-1} (13.67), number of secondary umbel plant^{-1} (16.12), higher seed yield plant^{-1} (10.05 g) and seed yield per plot (168.30 g) than parents. The non irradiated plants took the minimum time to 50% flowering, days required from flower to fruit set whereas irradiated plants took the longer period in both of *Brasilia agroflora* and *Prima agroflora* varieties. The highest seed yield (1153.05 kg ha^{-1}) and root yield (21.58 t/ha) were recorded from $V_2D_{75}P_3$ populations while the lowest seed yield (772.55 kg ha^{-1}) and root yield (20.58 t/ha) were recorded from $V_1D_oP_1$ populations.

Growing of M_2 generation of Aroid

Four aroid genotypes were collected from Bagura, Rangpur, Mymensingh and Sherpur districts which were irradiated with 2,4,6,8 and 10 Gy of gamma ray. The modified stem of aroids was sown on 16th March 2023 at BINA HQs farm, Mymensingh to observe their performances. The experiment was laid out in row planting method with raw to raw 60 cm and plant to plant 45 cm spacing. Recommended production packages were followed to ensure normal plant growth and development. Gamma irradiation with different doses on corm of aroid, showed difference in plant height for all four genotypes. Increasing gamma irradiation doses significantly decreased plant height. The highest plants (Chuadanga92.8 cm, Bogura103.8 cm, Sherpur98.7 cm and Rangpur101.5 cm) were recorded in control. The shortest plant found from 8Gy and in highest dose (10 Gy) there were no plants survived. Twelve M_2 population of aroid were harvested to grow M_3 plants.

Growing of M_2 generation of Bitter gourd

Among the traditional vegetables bitter gourd occupied important position in export trade. However, inspite of its importance, adoptability and export potential, less research priority given to this crop especially on genetic improvement. To create genetic variability for higher yield with lower number of seeds, two local cultiver Gos corolla and Payerafuli were irradiated with 250, 300 and 350Gy of gamma rays. All M_2 seeds were sown 26 April 2023 at BINA HQs farm, Mymensingh to create genetic variability for desirable characters. The experiment was followed by non replicated design and sown separately (variety and dose wise). Recommended production packages were followed to ensure normal plant growth and development. ,Considering overall yield performance primarily a total of 15 mutants have been selected for further selection in subsequent generation.

Growing of M_2 generation of cucumber and sweet gourd through pollen irradiation techniques

Pollination with irradiated pollen was the effective way for the induction of haploid embryo in cucurbits. The experiments was conducted at BINA HQs farm, Mymensingh to create variability through pollen irradiation. M_2 seeds of cucumber and sweet gourd were sown 18 March, 2023 and 20 June, 2023 respectively. The experiment was followed by non-replicated design and sown separately (variety and dose wise). Recommended production packages were followed to ensure normal plant growth and development. Standard cultural and intercultural practices were followed as and when necessitated. M_2 seeds from one fruits of each plant (cucumber and sweet gourd) were harvested to grow M_3 plants.

Collection and screening of local sweet potato (*Ipomoea batatas*) germplasm

Fourteen germplasm were grown at BINA HQs farm, Mymensingh during 2022-23. After harvest, all these germplasm were collected and preserved as breeding materials for future research programme. Tuber length of collected genotypes ranged from 13.3cm to 18.8cm where the highest value recorded

in IB-1 and IB-5 genotype. Breadth of tuber ranged from 2.4cm to 9.5cm and the highest was recorded from IB-1genotype. Again fresh weight of tuber range from 34.7 to 675.6 gm and the highest value was found in IB-1 genotype. Dry weight. of tuber range form 37.5-19.5% and the water content of tuber range form 63-83%. TSS ranged from 8 to 13 where the highest value obtained by IB-6 genotype.

Collection and screening of local country bean germplasm

Country bean locally known as "Sheem" (*Lablab purpureus*) is an important vegetable-cum-pulse, food-secure and nutritious crop. Fifteen germplasm were grown at BINA HQs farm, Mymensingh during 2022-23 to select desirable germplasm for earliness, yield potentiality, tolerant to insects and diseases. After harvest, seeds of all these germplasm were collected and preserved as breeding materials for future research programme. Leaf length of collected genotypes ranged from 3.95 to 11.47 where the highest value recorded in Gybandha (Table 19). Seeds pod^{-1} ranged from 3.3 to 5.5 and the highest was recorded from putilal and Khirsapat, again 100 seed weight ranged from 30.8 to 110 g and the highest value found in Nowakhali. Finally single pod weight ranged from 4.2 to 10.4 where the highest value was obtained by Khirsapat.

Growing of M_4 generation of country bean

Fifteen country bean mutants with parents were grown in plant progeny-rows at BINA HQs Farm, Mymensingh on 25 September 2022. The experiment was conducted in a non-replicated design with 3m line to line and 3m plant to plant within a line. Recommended production packages was followed i.e., application of fertilizers, irrigation, weeding, thinning etc. were followed to ensure normal plant growth and development. On an average, number of flower clusters/plant ranged from 10 to 47. $CB/350/M_4/P_{3(6)}$ having the lowest number of flower clusters $plant^{-1}$ (10) and $CB/350/M_4/P_{1(3)}$ having the highest number of flower clusters $plant^{-1}$ (47). No. of $podsplan^{-1}$ is one of the major yield contributing characters of country bean. Among the mutants, $CB/350/M_4/P_{2(1)}$ bearing highest number of pods $plant^{-1}$(153) and $CB/350/M_4/P_{3(6)}$ bearing lowest number of pods $plant^{-1}$ (80). Considering yield contributing traits mutants $CB/350/M_4/P_{2(1)}$, $CB/350/M_4/P_{3(4)}$ and $CB/350/M_4/P_{1(3)}$ have been selected for future varietal evaluation.

Growing of M_3 generation of Egg plant

Eggplant (*Solanum melongena*) is an important and popular vegetable of Bangladesh. The Indian subcontinent is the gene center of eggplant The field experiment was conducted at BINA HQ farm, Mymensingh to develop attractive fruit size, fruit shape, fruit weight, fruit colour, fruit texture, insect and disease infestation resistant mutants, dry seeds of an Dub brinjal. The genotype were irradiated with 100,150, 200 & 250 Gy doses of gamma rays. A large number of M_3 populations were grown in plant-progeny-rows for selecting desirable mutants. Finally, a total of 6 mutant lines (BDB-01, BDB-02, BDB-03, BDB-04, BDB-05 & BDB-06) have been selected for further selection in subsequent generations.

Growing of M_2 generation of Tomato

Tomato is one of the most important vegetable of Bangladesh. Four tomato genotypes were collected from home & abroad which were irradiated with 200, 300, 400 and 500 Gy of gamma ray. The seeds were sown in the trays on 2th October 2022 at BINA HQs farm, Mymensingh to identify the line(s) based on yield potential, size, shape and nutritional quality. The seedlings were transplanted in the bed on 3 November 2022. All M_2 generation of tomato seeds were harvested and preserved as breeding material for next season.

Growing of M_2 generation of okra

Okra (has been reported to severely suffer from YVMV at growing period throughout the country. So, we collected two popular okra varieties BARIderosh-1 and BARIderosh-2 and were irradiated with 300, 450 and 600Gy of gamma rays. The field experiment was conducted at BINA HQs, Mymensingh grown on 21 February 2022 in plant progeny rows to select desirable mutants having higher fruits yield, seed yield, early maturing potentiality and yellow mosaic virus tolerance. Now we just select 9 lines (M3 seed) on the basis of number of branches/plant, number of fruits/plant, number

of seeds/ fruit, fruit diameter (mm), fruit length (cm), fruit weight (g). M_3 seeds from each plant were collected to grow M_4 population.

Growing of M_3 generation of egg plant

With a view to develop large to medium fruit size, fruit shape, fruit weight, fruit color, fruit texture, insect and disease tolerant mutants, dry seeds of a Dub brinjal genotype were irradiated with 100,150, 200 and 250 Gy doses of gamma rays to create genetic variability in winter season. A large number of M_3 populations from M_2 generation were grown in plant-progeny-rows for selecting desirable mutants. Seeds were sown on 2nd October, 2022 in seedbed. The germinated seedlings were transplanted in the main field on 5th November, 2022 at BINA HQ farm, Mymensingh in separate plots dose wise along with a control. Finally, a total of 6 mutant lines have been selected for further selection in subsequent generations.

Growing of M_3 generation of cucumber

Cucumber is grown for its tender fruits, which are consumed either raw as salad, cooked as vegetable or as pickling in its immature stage. Developing promising variety having high yield and improve nutritional quality is required for sustainable production and marketing. So, to create new variety of cucumber, the present experiment has been taken. A field experiment was conducted in May to September 2023 at BINA HQs farm following row planting to develop cucumber variety for desirable size, shape and color with improved nutritional quality and high yield potential. It was observed that cucumber seeds treated 300 Gy produced the highest number of pistillate flower and number of fruist per plant and larger fruit size, shape and weight.

Improvement of spices

Advanced yield trial of M_6 mutants of onion (Set-II, seed to bulb)

The experiment was conducted at BINA HQs farm and BINA substation, Rangpur during November 2022 to April 2023 with a view to study the yield performances of selected winter onion mutants and to select promising mutants for further trial. Four M_6 mutants of onion (ACM-022, ACM-023, ACM-026 and ACM-030) with BARI Piaz-1 as a check variety were sown in the seed bed on 26 November 2022 for raising seedlings. The 40 days old seedlings were planted on 06 January, 2022. The unit plot size was 3.0 m x 2 m having plant spacing of 15 cm x 10 cm. The experiment was laid out in randomized complete block design with three replications. Recommended production packages were followed to ensure normal plant growth. At both the locations, plant height was ranged from 45.2 cm to 56.2 cm. The lowest neck diameter (0.94 cm) was found from BARI Piaz-1 and the highest (1.16 cm) was recorded in ACM-023. The maximum bulb length (4.05 cm) was observed in ACM-023 and the minimum (3.35 cm) was recorded from BARI Piaz-1. ACM-023 had the highest bulb diameter and single bulb weight (3.82 cm & 4.98 g, respectively). The lowest bulb diameter and weight (3.02cm & 38.5 g, respectively) was recorded in BARI Piaz-1. The highest bulb yield (17.44 t/ha) was found from ACM-023 and the lowest (12.19 t/ha) was recorded from BARI Piaz-1. The highest dry matter (14.36%) was recorded from BARI Piaz-1 and the lowest (13.16%) was found from ACM-022. The highest TSS (16.44) was recorded from BARI Piaz-1 followed by ACM-023 (16.0) while the lowest (14.7) was found from ACM-030. From the above findings, it may be concluded that onion mutants ACM-023, ACM-030 and ACM-026 performed better, considering bulb yield and other yield contributing traits. These mutants will be promising and further trial will be conducted.

Growing of M_4 generation of onion

Forty two onion mutants with one parent(Lal Teer king) and three parents(BARI Peaj-1, BARI Peaj-4 & BARI Peaj-6 were transplanted in plant progeny-rows at BINA HQs Farm, Mymensingh on 20 December 2022. The experiment was conducted in a non-replicated design with 15cm line to line and 10 cm plant to plant distance. Recommended production packages were followed to ensure normal plant growth and development. . The individual bulb weight ranged from 8 g to 35 g. Taherpuri having the lowest individual bulb weight (8g) on the other hand, the mutant$LK/80/M_3/P_{10}$ having the highest individual bulb weight(35g). Bulb diameter ranged from 2.2 to 4.2 cm. $LK/80/M_3/P_{10}$ and

LK/100/M_3/P_{15} having the highest bulb diameter 4.2cm and 3.8, cm respectively.. The Brix (%) content ranged from 7.1% to 15.1%. LK/80/M_3/P_3 having the highest brix (15.1%) and LK/50/M_3/P_{13} having lowest brix 7.1% brix. Considering the overall performance and brix (%) content ten mutants have been selected for future trial.

Growing of M_1 generation of onion (bulb to seed) derived from gamma irradiation and EMS

In our country the number of germplasms is less and variability is scanty. But germplasm pool is the key of any breeding program. Again, variability within the pool is also important. So, the present study was undertaken to develop a diverse source population of onion with a view to increase the yield and keeping quality. For creation of genetic variation, seeds of BARI Piaz-1 and BARI Piaz-4 were irradiated with three different doses of gamma irradiation (50, 75 and 100 Gy) and four different concentrations of EMS (0.1, 0.2 and 0.3%) and grown bulb from seedlings at BINA HQs farm in previous season rabi 2021-22. For bulb to seed production, stored bulb was sown in 16th November, 2022 at BINA HQs farm to get M_2 seeds. This experiment was followed by non-replicated design and sown separately (variety and dose-wise). Recommended production packages were followed to ensure normal plant growth and development. After maturation of seeds, M_2 seeds were harvested and processed appropriately as well as stored for next season to grow bulb from the seeds.

Hybridization of onion genotypes with natural insects under netting (Bulb to seed)

Due to low keeping quality and highest rotting percentage, onion farmers cannot store traditional varieties for long time. Seed production is another constraint due to low keeping quality with highest rotting percentage of onion and also it takes two seasons to complete its cycle. Breeding of onion is also a complex system as it biennial to produce seed. Here if we create through natural crossing and annualize the population so it would be much easy for the onion breeders to develop new mutant/lines at very shorter period. So, it is urgently needed to select superior onion variety (s) for higher yield potential as well as good keeping quality and annual in nature. Considering these facts, the present study was undertaken to development of onion variants with annual type plant through random crossing (BARI Piaz-1, BARI Piaz-4, Binapiaz-1 and Binapiaz-2) under netting. To create genetic variability for developing onion mutants, bulbs of above-mentioned genotypes were planted on 28th November 2022 at BINA HQs farm, Mymensingh. This experiment was followed by non-replicated design. Recommended production packages were followed to ensure normal plant growth and development. After umbel formation total experimental area were covered with mosquito net with keeping the beneficial insects inside the net for random crossing. Finally, after seed setting and maturation of seeds, all the seeds were harvested and preserved to grow seed to bulb in next season.

Growing of M_1V_2 generation of Garlic

M_1V_2 mutants garlic with parents were transplanted in plant progeny-rows at BINA HQs farm, Mymensingh on 15 November 2022. The experiment was conducted in a non-replicated design with 15cm line to line and 10 cm plant to plant within a line. Recommended production packages were followed to ensure normal plant growth and development. Data on plant height, number of leaves/plant, neck diameter, weight of individual bulb, no. of clove/bulb & clove length were taken. Considering the overall performance thrity mutants were selected for growing further generation.

Preliminary yield trial with promising chili lines/mutants

Five promising chili lines/mutants (RCL-1, YCL-1, CL-018, CL-020 and CL-022) were evaluated with two check varieties viz. BARI Morich-3 and Binamorich-2 at BINA HQs farm, Kashiar char farm and BINA substation Rangpur to see their yield performances. Seeds were sown in the seedbed for seedling on 16th October and 35 days aged seedlings were transplanted in 4th and 5th December 2022 at HQs farm and Rangpur field. Experiments of all the locations were followed by RCB design with three replications. Recommended production packages were followed to ensure normal plant growth and development. Amongst genotypes, CL-018 produced taller plant (73.3 cm) and the shortest plant height was recorded in BCL-1 (48.4). Yield range was observed from 371.1 g plant^{-1} to 663.2 g plant^{-1}. The highest yield per plant (663.2 g plant^{-1}) was found from Binamorich-2 followed

by the genotype RCL-1 (539.9g plant^{-1}) while the lowest yield per plant (371.1 g plant^{-1}) was recorded in BCL-1. Highest numbers of fruits (96.2) was found from BARI Morich-1 which was followed by the mutants CL-020 (86.0) and lowest number of fruits was found from YCL-1 (43.2). The highest total fresh yield (18.51 t ha^{-1}) was observed in Binamorich-2 which was followed by the genotype RCL-1(17.10 t ha^{-1}) while the lowest yield was found from BCL-1 (11.12 t ha^{-1}). Though, YCL-1 produced lower number of fruits per plant as well as comparatively lower than Binamorich-2 but it gave the higher yield compared to others and its shape, color (yellow when ripe), pungency, scent and overall acceptability was good. From the trial, RCL-1, YCL-1, CL-020 and CL-018 were selected on the basis yield attributes and overall acceptability which will be further evaluated in next season.

Growing of M_1 generation of chili for waterlogging tolerance

To create genetic variability of Chili suitable for waterlogged tolerance, seeds of popular cultivar of Magura region "Magura morich" and a cultivar from Rangpur region "Zeerashail" was irradiated with 100, 150 and 200 Gy of gamma rays. Seeds were sown on 14 May 2022 at nursery shed, BINA HQs. This experiment was followed by non-replicated design and seedling were transplanted separately dose wise. Finally, seeds of the survived plants produced seeds were harvested separately for growing M_2 generation.

Growing of M_2 generation of Chilli

To create genetic variability, seeds of two exotic cultivar of Chili were irradiated with 100, 150, 200, 250, 300, 350, 400, 450 & 500Gy of gamma rays. The seeds were sown in the trays on 2nd November 2022 at BINA HQs farm, Mymensingh. The parent was also sown in this experiment. The seedlings were transplanted (variety and dose wise) in the bed on 8th November 2022 separately. All M_2 generation of chilli seeds were harvested and preserved as breeding material for next season.

Growing of M_2 generation of chilli

Chilli, an important spice crop of Bangladesh is widely grown both in winterand summer seasons. Chilli is usedin green and dried forms. Consumer's preference for size, colour and pungency differ from one place to another. Therefore, The field experiment was conducted at BINA HQs, Mymensingh to create genetic variability. Seeds of two exotic irradiated (200, 250, 300, 350 & 400Gy of gamma rays) cultivar of chili were grown in 2022-2023. The parent was also sown in this experiment. All M_2 generation of chilli seeds were harvested and preserve as breeding material for next season.

Observational yield trial of M_1V_5 Zinger mutants

The experiment was conducted to observe the performances of the M_1V_5 mutants derived from four zinger accessions viz. Rangpur local (Taragonj), Thanchy local, Dinajpur local (Aamgonj, Khanshama), Bandorban local (Ruma). Four mutants including parents were planted during 4th week of April 2022. The experiment was laid out in plant-progeny-row using spacing 40 cm × 20 cm. Recommended production packages were followed to ensure normal plant growth and development. In case of four mutants of zinger, the M_1V_5 mutants produced higher yield at which were irradiated at 2Gy than their parents. These mutants were also tolerant to waterlogged for 18 days in continuous rainfall and subsequent waterlogged condition. But the mutants were fully survived after the removal of waterlogged condition and there was no rhizome rot occurred. These mutants need to be further evaluated through preliminary yield trial at different locations for rhizome yield and other yield attributing characteristics as well as rhizome rot tolerance level in the next year.

Growing of M_1V_2 mutants of Zinger

In previous year, to create genetic variability of zinger through induced mutation techniques, a local germplasm (ZG-011) collected from Khagrachari hill tracts were imposed with different concentrations of EMS (0.5%, 0.75% & 1.0%). This experiment was conducted BINA HQs farm during April 2022 to February 2023 to grow M_1V_2 generation of zinger. Rhizomes were sown on 4th week of April, 2022, maintaining 60 cm x 30 cm spacing in the unit plot size of 3.0 m x 1.6 m. The

size of the seed rhizome was 45-50g. Recommended production packages were followed to ensure normal plant growth and development. Three weeding were done at 50, 85 and 110 DAP. The crop was harvested on 12 March 2023. Data on different characters were collected and analyzed in statistix 10 program. Plant height, number of tillers per hill, number of leaves/hill, weight of rhizome, disease scoring and dry matter (%) were varied significantly due to different concentration of EMS. Finally, M_1V_2 rhizomes were harvested from the selected clump and kept separately to grow M_1V_3 population in next season.

Morphological screening of zinger genotypes collected from home and abroad

The production trend of zinger is low due to its inherent poor yields which can be attributed to lack of improved varieties. It is obvious that ginger production in Bangladesh is based on a very narrow gene pool and improvement of ginger is greatly challenged. The experiment was conducted at BINA HQs farm during April, 2022 to March, 2023 to characterize some plant and rhizome characters as well as to find out some promising lines in respect of yield, different yield contributing characters, dry matter (%) and disease incidence. Fourteen ginger germplasm were collected from different parts of the country and abroad were considered in the trial. Each entry was planted on 6 April 2022 in two rows plot of 2.5 m x 1.0 m without following any design. The inter row and intra row spacing were 50 cm and 25 cm respectively. The crop was harvested on 23 February, 2023. The rhizomes were evaluated by characterization in this year following guidelines for the conduct of test for distinctiveness, uniformity and stability on zinger. Data were recorded on plant growth habit, plant height (cm), number of leaves, tillers, tiller height (cm), rhizome shape and habit, finger thickness (cm) and length and clump weight (g). The germplasm ZG-011, ZG-013, ZG-015, ZG-018 and ZG-024 were showed satisfactory performances regarding yield and yield contributing characters. So, a secondary yield trial will be conducted in next season with said materials.

Growing of M_1V_3 generation of Turmeric

Rich morphological and genetic diversity is observed among the cultivated types of turmeric probably due to vegetative mutations accumulated over a period of time. Thereby this study was intended to select turmeric mutants on the basis of high yield potentiality and tolerance to leaf blotch disease with M_1V_2 mutants and parent. This experiment was conducted at Kashiar char farm, Mymensingh during 2022-2023. Five mutant lines were used with a parent in this study to select the suitable mutants on the basis of yield potentiality and tolerance to leaf blotch disease. The seed rhizome was sown in seed bed on 24th April, 2022. The unit plot size was 3.4 m x 2m having plant spacing of 60 cm x 25 cm. Recommended production packages were followed to ensure normal plant growth and development. The tallest plant (126.8 cm) was found in the CLM-21-2-12 mutant followed by CLM-21-2-10 (121.0 cm). The shortest plant was recorded from CLM-21-5-02 (108.7 cm). The highest fresh rhizome weight per hill (728.5 g) was observed in CLM-21-2-12 followed by CLM-21-2-02 (696.5 g) and the lowest was recorded in CLM-21-5-02 (528.5 g). Considering yield and other attributing traits of five mutants and their parent, four mutants CLM-21-2-12, CLM-21-2-02, CLM-21-2-10 and CLM-21-5-02 were selected for further selection in next season.

Growing of M_1V_1 generation of Turmeric

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

Advance yield trial of black cumin in winter season

The experiment was conducted at BINA HQs farm, Mymensingh and BINA sub-station with M_6 mutants to evaluate the performance of black cumin mutants on the growth, yield attributes and short

duration. The seeds were grown on 15th November 2022. The experiments were laid out in Randomized Complete Block Design (RCBD) with three replications. Unit plot size was 2.0 m × 3.0 m and spacing was 10 cm ×15 cm for all the locations. The parent germplasm also included in the experiment as control. The tallest plant) was found in $BC_1M_6D_{150}$ (75.5 cm) mutant while the shortest plant (66.12cm) was recorded in parent (66.12cm). The highest number of branches, pods plant^{-1} and thousand seeds weight were obtained in $BC_2M_5D_{150}$ and the second highest (53.72) from $BC_2M_5D_{150}$ and highest 1000 seed weight (2.46g) were found in $BC_1M_6D_{150}$ followed by $BC_2M_5D_{150}$(2.42g). The highest seed yield plot^{-1} (509.67g) was recorded in $BC_1M_6D_{150}$ followed by $BC_2M_5D_{150}$ (490.60 g) and the lowest (452.00 g) from $BC_3M_5D_{150}$. Almost similar results were also observed at Rangpur. Finally, based on yield attribuesthree mutants ($BC_1M_5D_{150,}$ $BC_2M_5D_{150}$ and $BC_3M_5D_{150}$) were selected for further yield trial in next season.

Growing of M_1 generation of Black cumin

There is immense need of high yielding black cumin varieties, which is not possible without generating variability in black cumin and also in other seeds species. Mutagenic effectiveness is a measure of the mutations induced per unit dose of a mutagen (time×concentration/dose), while mutagenic efficiency gives an idea of genetic damage (mutation) in relation to the total biological damage caused in M_1 generation. To create variability for short duration and tolerant to leaf blight disease, BARI Kalozeera-1 was irradiated with different gamma irradiation doses (100 Gy, 150 Gy, 200 Gy, 250 Gy, 300 Gy, 350 Gy and 400 Gy). The experiment was set up at BINA HQs farm, Mymensingh and laid out in line sowing method with standard spacing of line to line (40 cm). Data on various characters such as plant height, days to 1st flowering, days to 1st fruiting, no. of seed plant^{-1} were recorded from randomly selected plant. All the M_1 seeds were harvested and stored for next season.

Growing of M_1 generation of Cumin

Cumin can be cultivated in all types of soils but well drained sandy loam and medium soils are suitable for the crop. Most of the demand has fulfilled through import.. Research on cumin in Bangladesh is very scanty or almost not done on cumin production. Recently, Spices Research Centre, Shibganj, Bogura, BARI has developed one variety adaptable to our agro-climate but still it's trial and error for yield and yield components. Last 3-4 years, Horticulture division try to adapt collected cumin germplasm in our climate but success is limited. Some germplasm was promising but they are not getting viable in subsequent generation. To create variability for short duration and tolerant to leaf blight disease, BARI Zeera-1 was irradiated with different gamma irradiation doses (100 Gy, 150 Gy and 200 Gy). The experiment was set up at BINA HQs farm, Mymensingh and laid out in line sowing method with standard spacing of line to line (40 cm). Data on various characters such as plant height, days to 1st flowering, days to 1st fruiting, no. of pod plant^{-1} were recorded from randomly selected plant. All the M_1 seeds were harvested and stored for next season.

Growing of M_1 generation of Coriander

To create genetic variability, seeds of coriander variety shariatpur local was irradiated with 50, 100, 150, 200, 250, 300, 350 & 400 Gy of gamma gays. Seeds were sown on 22 November 2022 at BINA HQs farm, Mymensingh. This experiment was followed non-replicated design and sown separately (variety and dose wise). At maturity stage, the survived plants that produced seeds were harvested separately for growing M_2 population.

Growing of M_2 generation of coriander

Coriander (dhoney) a strong-smelling annual herb. Coriander is a wonderful tastemaker to all the food or dishes. they are rich source of dietary fibers, vitamin c, vitamin k and other proteins. Therefore, we collect two local cultivar were grown on 11 november 2022 in plant progeny rows at Horticulture research field, BINA, Mymensingh. to create desirable mutants with high yield (leaves), year round cultivation and delay flowering. A large number of M_2 generation from irradiated (50, 100, 150 and 200 Gy of gamma rays) .All M_2 generation of coriander seeds were harvested and preserve as breeding material for next season.

Growing of M_1 generation of Fenugreek

To create genetic variability, seeds of fenugreek variety shariatpur local was irradiated with 100, 150, 200, 250, 300 & 400 Gy of gamma gays. Seeds were sown on 22 November 2022 at BINA HQs farm, Mymensingh. This experiment was followed non-replicated design and sown separately (variety and dose wise). At maturity stage, the survived plants that produced seeds were harvested separately for growing M_2 population.

Screening of M_4 generation of Sweet pepper

In Bangladesh, sweet pepper varieties are being cultivated almost these are F_1, which are being imported from exotic source spending foreign currency. Seed costs of those hybrid varieties are very high. However, it is necessary to develop high yielding having good quality OP varieties of sweet pepper. With view to develop high yielding and nutritionally improved sweet pepper mutants, previously dry seeds of an exotic genotype (CAG-09) were irradiated with 100,150, 200 & 250 Gy doses of gamma rays to create genetic variability. For continuing the growing M_3 generation, a large number of fifteen M_3 populations from M_3 seeds were grown for selecting desirable mutants. Seeds were sown on 10th November, 2022 in seedbed. The germinated seedlings were transplanted in the main field on 28th November, 2022 at BINA HQ farm, Mymensingh along with parent. The experiment was followed non replicated design. Line to line spacing was 60 cm and plant to plant was 40 cm. Recommended production packages i.e., fertilizer application, irrigation, pesticides, weeding etc were followed to ensure normal plant growth and development. Some of the mutants have shown the potentiality to tolerate high temperature. They gave fruit yield up to five months from the transplanting. Considering number of fruits plant^{-1} and comparatively high temperature tolerance capacity a total of five mutants (CAM-12/75/6, CAM-12/75/8, CAM-12/75/10, CAM-12/100/1 and CAM-12/100/22) have been selected for further selection in subsequent generations.

Improvement of flowers

Growing M_1V_4 generation of the selected gladiolus germplasm

To create new variation of gladiolus, the present experiment had been running for the last few years. A field experiment was conducted in November 2022 to April 2023 at BINA HQs farm, Mymensingh to develop gladiolus with various floret colours, long spikes with higher number of florets and longer vase life. The $M_1V_3D_{30}P$ and $M_1V_3D_{10}R$ gladiolus mutants (pink shade mutant, red mutant) and the control (pink and red) were planted in separately in rows. The $M_1V_3D_{30}P$ mutant gladiolus produced maximum pink mutant flower (15.3) than the untreated bulbs (12.0). In case of red colour flowers, $M_1V_3D_{10}R$ mutant gladiolus produced more flower (17.3) than the untreated bulbs (13.7.0. Longest shelf life (13.0 days) was found $M_1V_3D_{30}P$ mutant and shortest shelf life (10.0 days) was found untreated red flowers. On the other hand, $M_1V_3D_{30}P$ and $M_1V_3D_{10}R$ mutant produced attractive flowers colour. The $M_1V_3D_{30}P$ and $M_1V_3D_{30}P$ mutant gladiolus were required flowering time 67.2 and 83.3 days after planting on the other hand control flower required time 74.0 and 83.0 daysMutants were taller (136.7 cm) than control plant 129.6 cm). Inflorescence was longer in the mutant than control.. Rachis length was shorter in $M_1V_3D_{30}P$ than control. However flower diameter, corm size and weight was greater in two mutants than control. Finally, the M_1V_5 corms from the survived plants were bulked as per dose and floret color and kept in storage for growing of M_1V_5 generation in the next growing season. The findings would greatly contribute in developed new gladiolus variety in Bangladesh under natural condition.

Growing M_1V_1 generation of the collected gladiolus germplasm

A field experiment was conducted in November 2022 to April 2023 at BINA HQs farm to develop gladiolus with various floret colours, long spikes with higher number of florets, and longer vase life. The M_1V_1 gladiolus mutants (red, white, yellow and violet) were planted separately (colour and dose wise) in rows. The gladiolus bulbs treated with 10 and 30 Gy produced maximum red (16.5 and 12.0) and white (14.0) color flowers than the untreated bulbs (10.0 and 10.7), respectively. In case of corm production, 30 Gy treated bulbs of pink and white-colored flowers produced the highest number of corms (red: 3 corms/plant; white 3 corms/plant) than untreated bulbs (1 and 2 corms/plant). Again 10

and 30 Gy treated red and violet bulbs produced more attractive flower colour. Finally, the M_1V_2 corms from the survived plants were bulked as per dose and floret color and kept in refrigerator for M_2V_2 generation in the next growing season. The findings would greatly contribute in developed new gladiolus variety in Bangladesh under natural condition.

Radio sensitivity test and growing of M_1V_1 seedlings of chrysanthemum, gerbera and M_1 seeds salvia

A field experiment was conducted in November 2022 to April 2023 at BINA HQs farm to develop Chrysanthemum, gerbera and salvia with various floret colours, long spikes with higher number of florets and longer vase life. The shoot tip of chrysanthemum and sucker of gerbera were treated @ 20, 30, 40, 50 and 60 Gy and seeds of Salvia were treated @ 100, 200, 300 and 400 Gy of gamma rays using ^{60}Co gamma irradiator with control. Parameter investigated germination and survivability percentage. In case of chrysanthemum and gerbera, maximum survivability (70% and 60%) were found 20 Gy irradiated cuttings and seedlings. On the other hand 100 Gy irradiated salvia seeds showed maximum highest no of germination (80%). At harvest, the survived plants that produced sucker were growing for observation and the survived plants that produced seeds were harvested separately for growing M_2 population.

Postharvest Technology development of Horticultural crops

Shelf-life extension of litchi (cv. China-3) using gamma irradiation

Irradiation technology has been in use to prolong shelf life and reduces postharvest losses of agricultural produce in many parts of the world as a safe and commercial option for its high efficacy and safety. To evaluate the effectiveness of gamma irradiation and sanitizer on extending the shelf life of litchi (cv. China-3) under the ambient storage condition of Bangladesh, the research was carried out at the Postharvest Laboratory of Horticulture Division, BINA during the period from May 2023 to June 2023 following completely randomized design (CRD) with three replications. Different doses of gamma irradiation (0, 500, 1000 and 1500 Gy) and different concentration of sanitizer (1%, 2% and 3% of H_2O_2 and CaCl2) were applied, and the treated litchis were wrapped in LDPE (Low Density Poly Ethylene; 25 μM) bags along with a control treatment (unwrapped, untreated) to evaluate shelf life and quality of China 3 litchi at ambient condition. Different parameters viz. size, colour, texture, TSS, weight loss, disease incidence (DI), disease severity (DS), pH and vitamin C content were measured during the period of storage. Results revealed that irradiated litchi wrapped in LDPE bags showed minimal weight loss, DI and DS as compared to those of the untreated unwrapped control litchi. Minimum weight loss (2.9%) was found 1500 Gy treated litchi wrapped in LDPE bags and maximum weight loss (39.7%) was found untreated unwrapped control litchi at the 9 days after treating respectively. At the 9 days after treating, the minimum DI (13.3%) and DS (10.0%) were found 1500 Gy treated litchi wrapped in LDPE bags and maximum DI (87.5%) and DS (95.0) were found litchi treated in 3% CaCl2 and dipped in 5 minutes respectively (Table 44). In case of TSS, there was no significantly difference among the treatments, and TSS decreased with time.Vitamin C was decreased days after storage litchi. Longest shelf life (8.5 days) was found 1500 Gy treated litchi wrapped in LDPE bags and shortest shelf life (2 days) was found untreated unwrapped litchi respectively. So the China-3 litchi subjected to 1500 Gy gamma rays irradiation subsequently wrapped in LDPE bags and stored in ambient room temperature (25- 28^{0}C) and humidity (69-70%) delayed the ripening process which maintained minimum percent of weight loss, disease incidence, disease severity and increased the shelf life of litchi. The findings would greatly contribute in reducing postharvest loss of litchi and maintain their quality during marketing at ambient condition.

Enhancing postharvest storage life of export quality bitter gourd using gamma irradiation

Irradiation technology has been in use to prolong shelf life and reduces postharvest losses of agricultural produce in many parts of the world as a safe and commercial option for its high efficacy and safety. To evaluate the effect of gamma irradiation and sanitizer on extending the shelf life of export quality bitter gourd under the ambient storage condition of Bangladesh, the research was carried out at the Postharvest Laboratory of Horticulture Division, BINA during the period from November- 2022 to December 2022 following completely randomized design (CRD) with three

replications. The bitter gourds were collected from commercial grower at Shibpur Upazilla at Narshingdi district. Different doses of gamma irradiation (0, 1000, and 2000 Gy) and 3% concentration of CaCl2 were applied, and the treated bitter gourd were wrapped in PP (Polypropylene; 20μM) bags along with a control treatment (unwrapped, untreated) to evaluate shelf life and quality of bitter gourd at ambient condition. Results revealed that the combination of irradiated and sanitizer and wrapped in PP bags of bitter gourd showed minimal weight loss, DI, DS as compared to those of the untreated unwrapped control bitter gourd. Minimum weight loss (3.5%) , disease incidence (11.1%) and disease severity (6.7%) were found bitter gourd dipped 3% $CaCl_2$ solutions for 5 minutes after that irradiated @1000 Gy and wrapped in PP bags and maximum weight loss (55.0%), DI (77.8%) and DS (76.7) were found untreated unwrapped control bitter gourd at the 8 days after treating. DI and DS (≤10%) and the longest shelf life (10.0 days) was found bitter gourd dipped 3% $CaCl_2$ solutions for 5 minutes after that irradiated @1000 Gy and wrapped in PP bags and the shortest shelf life (4 days) was found untreated unwrapped bitter gourd respectively. The bitter gourd subjected to sanitized with 3% $CaCl_2$ and then 1000 Gy gamma rays irradiation subsequently wrapped in PP bags and stored in ambient room temperature (22-25 ^{0} C) and humidity (65-70%) delayed the physiological process which maintained minimum percent of weight loss, disease incidence, disease severity and increased the shelf life of export quality bitter gourd. The findings would greatly contribute in reducing postharvest loss of bitter gourd and maintain their quality during marketing at ambient condition.

Enhancing postharvest storage life of export quality betel leaf using gamma irradiation

Betel leaf is one of the important cash crops that gaining popularity in recent time in Bangladesh. It is locally known as 'Pan' in Bangladesh and one of the vital cash crops of this country, where millions of people chew the item regularly. Irradiation technology and modified atmosphere packaging has been in use to prolong shelf life and reduces postharvest losses of agricultural produce in many parts of the world as a safe and commercial option for its high efficacy and safety. To evaluate the effect of gamma irradiation and sanitizer on extending the shelf life of export quality betel leaf under the ambient storage condition of Bangladesh, the research was carried out at the Postharvest Laboratory of Horticulture Division, BINA during the period from January 2023 following completely randomized design (CRD) with three replications. The betel leaves were collected from commercial grower at Alamdanga Upazilla at Chuadanga district. Different doses of gamma irradiation (0, 500, 1000, and 15000 Gy) were applied, and the treated betel leaves were wrapped in LDPE (Low Density Poly Ethylene; 25μM) and PP (Poly Propylene) bags along with a control treatment (unwrapped, untreated) to evaluate shelf life and quality of betel leaf at ambient condition. Different parameters viz. size, colour, texture, weight loss, disease incidence (DI), disease severity (DS), moisture content and dry matter content during the period of storage. Results revealed that the irradiated and wrapped in LDPE bags of betel leaf showed minimal weight loss, DI, DS, maintain colour and texture and quality as compared to those of the untreated unwrapped control betel leaf. Minimum weight loss (9.4%) was found 500 Gy treated betel leaf wrapped in LDPE bags and maximum weight loss (88.5%) was found untreated unwrapped control betel leaf at the 9 days after treating respectively Shelf life was calculated on basis of colour, shrinkage, DI and DS (≤10%) and longest shelf life (10.0 days) was found 500 Gy treated betel leaf wrapped in LDPE bags and shortest shelf life (2.5 days) was found untreated unwrapped betel respectively. The betel leaf subjected to 500 Gy gamma rays irradiation subsequently wrapped in LDPE bags and stored in ambient room temperature (21-25^{0}C) and humidity (60-70%) delayed the physiological process which maintained minimum percent of weight loss, disease incidence, disease severity and increased the shelf life and maintained quality of betel leaf. The findings would greatly contribute in reducing postharvest loss of bitter gourd and maintain their quality during marketing at ambient condition.

Effect of different postharvest treatments on physico-chemical changes and shelf life of Mango (cv. Amrapali)

An experiment was carried out at postharvest laboratory of Horticulture division to study the effect of different postharvest treatment including an optimum dose of gamma irradiation on mango fruits ripening phenomena with emphasis of shelf life extension compared to non-irradiated control fruits at ambient condition (Temp. 28-32^{0}C and RH 80-90%). Different postharvest treatment viz. gamma

irradiation (400 Gy); dipping for 5 minutes in 2% calcium chloride solution; spraying fungicide (Group name: Dipheniconal, Trade name: Score, @0.5ml/L) and hot water dip (55^0C temperature for 5 minutes) were imposed on freshly harvested Mango fruits var. Amrapali. The fruits at the tinge yellow color with uniform size, shape, and free of any visible defects, disease symptoms and insect infestations were harvested from mango orchard and transported to the Postharvest Laboratory of Horticulture division, BINA, with careful handling to avoid damage and injury. Fruits were randomly selected and washed in running tap water for removing any surface contamination followed by distilled water. The washed fruits were placed on the table to allow air dry at room temperature (30 ± 2^0C). Fresh mango fruits were treated with abovementioned postharvest treatment and were stored at ambient temperatures i.e 30 ± 2^0C in corrugated fibre board cartoon cushioning with Styrofoam net for evaluation of effect of gamma irradiation @400 Gy and other treatments on changes of physico-chemical properties and shelf life at different gradient storage period. Data on various parameters were collected at every 5 days after irradiation. Results revealed that, gamma irradiation doses 400 Gy can improve the shelf life (10-12 days more compare to unirradiated control fruits at ambient condition) without adverse effects on qualitative characteristics (weight loss (%), firmness, pH, titratable acidity, TSS, vitamin-c content, reducing and non-reducing sugar, disease incidence, disease severity and shelf life). The fruits of mango subjected to 400 Gy gamma rays irradiation subsequently stored at ambient temperature delayed the ripening process which maintained lower percentage of physiological loss in weight and ripening per cent, higher percentage of marketable fruits, and increase the shelf life for longer period. It could be concluded that irradiated mango fruits with 400 Gy dose could be employed for increasing the shelf life of mango, although further experiments are needed to study more complex metabolic changes during storage in the fruit to explore extra dimensions.

Effect of gamma irradiation on changes of biochemical properties, anti-oxidant contents and shelf life of jujube

Reduction of postharvest loss is one of the key components for ensuring food security. An experiment was carried out to see the effect of gamma irradiation on changes of nutritional quality and anti-oxidant potentiality of jujube fruits (cv. ballsundori). Different doses of gamma irradiation (0.5, 0.75 and 1.0 kGy) were applied to the freshly harvested jujube fruit and there were three replicates for each treatment and control. The changes of nutritional properties, antioxidant content and shelf life of those fruits were evaluated at different days after interval. Irradiation played active role in the enhancement of total phenolics and flavonoids contents. The concentration of these antioxidants remained higher in irradiated samples in comparison to non-irradiated control samples throughout the storage period. However, the ascorbic acid content decreased gradually with the increase of radiation dose and storage period. The overall acceptability of the fruit samples was determined by the taste-taking panelist. The irradiated (1.0 kGy) fruits were acceptable up to 8 days whereas control, 0.5 and 0.75 kGy irradiated fruits lost their acceptability during storage. The study revealed that 1.0 kGy irradiation can extend the shelf life of jujube fruits without significant loss of overall antioxidant content and sensory attributes. Jujube fruits were procured directly from an orchard and transported to the laboratory immediately after collection. The samples used in this study were uniform in size, apparently free from any visible insect infestation, mechanical injury or deterioration. Collected fruit samples were put into sterilized perforated low-density polyethylene zipper bags. The packed samples were labeled properly with three selected doses of gamma irradiation (0.5 kGy, 0.75 kGy and 1.0 kGy) and a non-irradiated packed sample was kept as control. There were 3 replicates for each treatment and control (non-irradiated). Biochemical (Total soluble solids, Titratable Acidity, pH, sugar), antioxidant content (ascorbic acid, total phenolic compound, total flavonoid content) and sensory attributes of all samples were assessed before gamma irradiation, immediately after irradiation (0 day of storage) and also after 4 and 8 days of storage. For sensory evaluation, samples were evaluated by a taste testing panelist of five judges who observed the sensory attributes (color, flavor and texture) from randomly assigned irradiated and non-irradiated samples. They marked the samples on a 9-point Hedonic scale (Krum, 1955) where 0-2 represents extremely dislike, 3-5 dislike, 6-8 acceptable or good and 9 excellent for color, flavor and texture. An overall acceptability was calculated taking average of the three attributes. Fruit exposed to the highest γ-ray (1.0 kGy) entailed the highest TSS level during storage time. Results revealed that the applications of irradiation

significantly ($p \leq 0.05$) retained more TSS content during storage over control. The increase in TSS content during the early stage of ripening might be attributed to the enzymatic conversion of pectin and starch into simple sugar, while a fall in TSS content after peaks might be due to consumption of sugars in the respiration process. The titratable acidity (TA) value decreased through storage. Untreated fruit (control) had a lower TA (%) all-time, compared to the irradiated fruit. Among irradiation treatments, fruit exposed to 1.0 kGy had the highest TA content than other doses. This may be linked to better disinfecting impact of irradiation on decreasing the development of microbe and pest contamination, which decreased decay and avoid the changes in the desirable flavor of the fruit. For pH value, the irradiation doses applied had no significant effect after 8 days; however, storage time is a major responsible for differences observed. Sensory evaluation of jujube fruits revealed that treated samples had more acceptability in terms of color, flavor, and texture up to 8 days of storage at ambient temperature compared to control . Both irradiated and non-irradiated samples were good enough up to 4 days of observation. After 4 days, nonirradiated samples gradually lost its color, flavor and texture which ultimately lead to complete loss of acceptability within 8 days. This also corroborates with our findings that microbial counts increased significantly compared to that of initial counts in the non-irradiated jujube fruit samples. The overall acceptability of sample treated with 1.0 kGy radiation was found significant ($p<0.05$) in terms of all sensory attributes up to 8days compared to the control and the other irradiated samples. These results indicate that irradiation at 1.0 kGy can improve the shelf life of jujube fruits without adverse effects on sensory attributes.

Enhancement of postharvest life of through gamma irradiation at ambient condition (R & D project work, MoST)

In the present experiment, litchi fruits were subjected to different doses of gamma irradiation as well as biochemical and organoleptic evaluation were done to determine the effect of gamma radiation on these parameters and to judge the overall performances of radiated fruits for storage period. The experiment was carried out in completely randomized design with five replications at postharvest laboratory of Horticulture division to evaluate the effects of different doses of gamma irradiation on different physico-chemical properties and shelf life of freshly harvested litchi fruits (cv. Bombai). Here, three doses of gamma irradiation (900, 1000 and 1100 Gy) were imposed through cobalt-60 source and stored in LDPE bag at ambient storage condition i.e. 28 ± 1^0C temperatures and 80 ± 5 % relative humidity. At that time physiological weight loss, % decay loss, TSS, titrable acidity, sugar (reducing, non-reducing sugar) percentage, ascorbic acid, and shelf life were measured at every three days interval during storage. In fresh Litchi fruits (var. Bombai) gamma irradiation dose 1.0 kGy resulted increase the shelf with retaining good external color (upto 5 days more compare to un-irradiated fruits at ambient condition) and other physico-chemical characteristics

Rooftop gardening

Collection and screening of exotic fruits for roof top gardening through drip irrigation system

The rooftop garden is a garden on the roof of a building. It is an eco-friendly plan that offers the opportunity to get close to nature and harvest fruits and vegetables with our own hands. It is a must doing initiative which would be the best use for the top space of a rapidly growing city. The rapid growth of Bangladesh`s capital has destroyed crucial ecosystems, caused rising temperatures, and quickly lost its green. There is only one way to bring back its green, good air and repair its lung is "rooftop gardening. A rooftop garden was started in June 2020 at the rooftop, Horticulture Division in BINA HQs, Mymensingh to select suitable fruits for rooftop gardening for year round supply of fresh produce and effective utilization of space, time and manpower. The collected fruits germplasms are mango (Kathimon, Nam-dok-mai, King of Chakapat, Amrapalli, BARI Am-4, Gouromati) 08, orange (Darjeeling orange, Chinese orange, Exotic Orange)- 15 nos, Thai Pomelo- 02, ber(Ball Sundari, Apple Kul, Kashmiri Kul) -04, Guava (Madhuri, Thai, Exotic)-06, Thai wax Jamboo-01, plum (Exotic Plum, BARI Alubukhara)-03 nos, apple (Horimon and exotic)-02, Red jack fruit-01 no, Thai Sapota-01, hog palm -01, Passion fruit-01, Fig (Teen)- 20 etc. The suitable collected germplasm will be screened for varietal development using irradiation technique.

Collection and screening of exotic flowers suitable for growing in Bangladesh

The rooftop garden is a garden on the roof of a building. It is an eco-friendly plan that offers the opportunity to get close to nature and harvest fruits and vegetables with our own hands. It is a must doing initiative which would be the best use for the top space of a rapidly growing city. The rapid growth of Bangladesh`s capital has destroyed crucial ecosystems, caused rising temperatures, and quickly lost its green. There is only one way to bring back its green, good air and repair its lung is "rooftop gardeningA rooftop garden was started in June 2020 at the rooftop, Horticulture Division in BINA HQs, Mymensingh to identify suitable flower varieties of exotic sources with attractive flower colours, flower yield and longer vase life. The collected fruits germplasms are Rose exotic (Red, yellow, white, bicolour) -10, adenium exotic (Red, white, pink, pink shade, multicolour, single petal, double petal)-20, China rose exotic (Red, white, pink, pink shade, multicolour, single petal, double petal-08, Gerbera exotic (Red, yellow, white, bicolour, pink)-20, Orchid (Exotic, ground orchid)-10, Other flowers and ornamentals-15. The suitable collected germplasm will be screened for varietal development using irradiation technique.

Micropropagation and regeneration protocol development of horticultural crops

***In Vitro* regeneration of gladiolus from the callus through the culture of corm slice**

A study was conducted to determine the best concentration of growth regulator for rapid multiplication of gladiolus from the culture of cormel slice. Callus initiated in the cultures after two to four weeks from 1-2 mm thick longitudinal slices of the cormels. The maximum mean callus induction of 75% was observed on MS medium supplemented with NAA at 8.5 mg L^{-1} rather than 7.5 mgL^{-1}, 9.5 mgL^{-1} and no hormone. The 30 days after the calli initiation the best responded calli were taken into regeneration medium, while the highest percentage of shoot regeneration (60%), the highest number of shoots $explant^{-1}$ (25), length of shoot $explant^{-1}$ (13.23 cm) and the lowest days for shoot initiation (15 days) were obtained in MS medium containing 2.0 mg L^{-1} BAP in comparison of 1.0 mg L^{-1} , 1.5 mg L^{-1} and without BAP. After that, the best responded shoot was further explored for rooting. The better response for rooting was observed from the shoots on half strength MS medium having IBA 2.5 mg L^{-1}. 70% root induction, maximum number of root $shoot^{-1}$ (10) and the highest length of root (5.5 cm) were observed on half strength MS medium supplemented with IBA 2.5 mg L^{-1} showing the better performance from shoots cultured in MS media supplemented with 1.5 mgL^{-1}, 2.0 mgL^{-1} and the absence of IBA. From the study, it can be concluded that among the plant growth regulators 8.5 mgL^{-1} NAA performed better for callus induction, 2 mgL^{-1} BAP showed good performance for shoot regeneration from callus and the most responsive root induction was found in 2.5 mgL^{-1} IBA where further study is needed to confirm the results.

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

Seedlings of eight somaclones derived from two tomato varieties were grown at BINA HQs during the season of 2022-23 to mark out somaclonal tomato variant with high yield potential at field condition. Among the somaclones derived from Binatomato-11 the highest plant height was recorded in IVRP11.6 and in case of Binatomato-13 it was in IVRP 13.3, stood at 92.63 and 90 cm, respectively. In case of branch $plant^{-1}$ most of the somaclones showed decrease than their parents. Surprisingly, great increases in number of inflorescence $plant^{-1}$ were observed in IVRP 11.3 than its parent and IVRP 13.2 also showed supremacy (27.5) than all other somaclones and parents. However, there was little predominance in the number of flower $inflorescence^{-1}$ in some somaclones. A huge decrease in single fruit weight was recorded in case of Binatomato-11 derived *in vitro* plants and lowest fruit weight was in IVRP-11.2 followed by IVRP11.4. Single fruit weight of Binatomato-13 derived plants ranging from 60.25 to 66.67gm while 70 g was found in parent. In case of yield $plant^{-1}$, there was no remarkable change rather than IVRP 11.2, whereas highest yield was recorded in IVRP 11.3, stood at 4.45 kg $plant^{-1}$.

Plant Genetic Resources

Collection and growing of germplasm of different horticultural crops

During 2022-23 a total number of 53 germplam of different crops were collected from different places of the country as well as from abroad and a detailed passport data sheet were filled up by the collectors at the time of germplasm collection. Germplasm collection team were visited those areas and and recorded the passport information of the germplasm. Germplasm were collected from farmers field/farm store/farmers house and markets especially from floating seed/saplings traders. Propagating materials of different collected germplasm were cleaned, processed and stored in short term storage for seed multiplication and characterization. Some of the collected germplasm which need to be conserved immediately at field gene bank were planted and characterization is on-going. Collector's name, number and date were recorded during collection. Name of the crop species along with English, Bangla, local and cultivar name were recorded. Name of donor with ethnic group, village, union, upazila/thana, district, latitude and longitude were noted. Type of soil, topography, sample status, sample source, habitat, frequency, type of materials, cultural practices, season, sole or mixed with, sample type, sampling method, insect and disease and plant characteristics were noted.

AGRONOMY DIVISION

RESEARCH HIGHLIGHTS

Mutant line MEF-10 produced the highest grain yield (7.22 t ha^{-1}) when transplanted at 30 December but Binadhan-14 produced maximum grain for the transplanting date January 30 in Mymensingh.
BINA dhan25 produced the highest grain yield (7.35 tha^{-1}) when 40 days old seedlings were transplanted.
Mutant RM-Kas-80-C-1 produced the highest grain yield (5.3 t ha^{-1}) over RM-16-N-10-1 (5.2 t ha^{-1}) when transplanted at 30 July in Mymensingh during *Aman* season.

Binadhan-24 produced the highest grain yield (9.01 t ha^{-1}) among three popular BINA released Boro rice varieties followed by Binadhan-10 (6.81t ha^{-1}) in Sunamganj for assessment of yield gap relations and yield prediction of Boro rice varieties

Binadhan -24 produced the highest grain yield (7.77 t ha^{-1}) among six Boro rice varieties followed by Binadhan-10 (7.35 t ha^{-1}) in Sunamganj for escaping early flash floods in haor area.

Binadhan-17 produced statistically higher grain yield (5.73 t ha^{-1}) followed by Binadhan-16 (5.36 t ha^{-1}) in Cumilla.

Binadhan-17 produced the statistically higher grain yield (5.99 t ha^{-1}) followed by Binadhan-22 (5.75 t ha^{-1}) at farmers' field Cumilla.

The result of the experiment showed that that the Binadhan-24 produced the statistically higher grain yield (8.2 t ha^{-1}) followed by BINA dhan25 in Magura.

BINA dhan25 produced the statistically higher grain yield (7.62 t ha^{-1}) in Barisal.

BINA dhan25 produced the statistically higher grain yield (7.0 t ha^{-1}) in Nalitabari, Sherpur.

Binadhan-10, BINA dhan25 produced the statistically higher grain yield (7.0 t ha^{-1}) farmer's field in Nalitabari, Sherpur in synchronize farming Aman-Mustard-Boro cropping pattern.

Binadhan-24 produced the statistically higher grain yield (8.3 t ha^{-1}) among the rice varieties followed by Binadhan-10 (7.3 t ha^{-1}) in farmers' field Chapainawabganj.

BINA dhan25 produced the statistically higher grain yield (6.8 t ha^{-1}) among the rice varieties followed by Binadhan-24 (6.4 t ha^{-1}) at farmer's field in Noakhali.

Sea weed extracts as spraying to the active tillering stage exhibited that the dose of extract from1.25 t ha^{-1} produced the statistically higher grain yield 8.1 t ha^{-1}. Basal dose of sea weed 1.0 t ha^{-1} produced statistically higher grain yield (8.8 t ha^{-1}) in Mymensingh.

Application of salicylic acid dose 2.5 mM SA spray two time at active tillering stage and PI stage produced statistically higher grain yield (6.6 tha^{-1}) followed by 1.5 mM SA (6.4 t ha^{-1}) at Sarankhola in Bagerhat.
Rice mutants/varieties mutant line MEF 27 showed statistically higher grain yield 6.6 t ha^{-1} when transplanted at 30 December.
Yield gap in Boro season was in Binadhan-10 (1.43 t ha^{-1}) followed by Binadhan-24 (1.13 t ha^{-1}) BINA dhan25 yield gap 0.51 t ha^{-1}. In Aman season Binadhan-23 (0.52 t ha^{-1}). In Aus season, the highest yield gap was seen in Binadhan-19 (0.53 t ha^{-1}).
Binadhan-23 yield 4.64 t ha^{-1} when seed sowing at 8 August, and transplanted at 5 September in tidal flood prone region.
Application of Chlorophenoxy acidic acid 3g/L thirty days after sowing of mustard produced statistically higher seed yield 1.8 tha^{-1}.

Sowing of mustard at 30 November showed statistically higher grain yield (1.42 tha^{-1}). After November 30 the gradually decrease of mustard Bina sorisha-9 yield. But this variety remaining good late sowing potentialities in saline prone zone of Bangladesh.
Sowing of mustard at 30 November statistically higher seed yield was produced by Binasarisha-9 (1.76 t ha^{-1}) followed by Binasarisha-11.
Binamoog-8 produced the highest grain yield (1132 kg ha^{-1}) if it was sown in 15 February the germination percent was highest (78%) for Binamoog-8.
The highest yield gap of pulse crops was seen in Binamoog-8 (0.26 t ha^{-1}) followed by Binakhesari-1 (0.08 t ha^{-1}). In oil seed crops, highest yield gap was seen in Binasarisha-9 (0.29 t ha^{-1}) followed by Binasarisha-4 (0.13 t ha^{-1}).
Herbicide Repivox 60 OD had the lowest weed density (10.7 m^{-2}) along with their fresh weight and dry weight followed by penoxulam and the weed control efficiency of Repivox 60 OD was 82.6% as it provided the highest grain yield 5.5 t ha^{-1} in Aman season.

Herbicide Repivox 60 OD had the lowest weed density (10.2 m^{-2}) along with their fresh weight and dry weight followed by penoxulam and the weed control efficiency of Repivox 60 OD was 79.6% as it provided the highest grain yield 6.97 t ha^{-1} in Boro season.

Herbicide Super cleaner 18WP @ 500 g/ha had the lowest weed density (14.0 m^{-2}) along with their fresh weight and dry weight followed by penoxulam and the weed control efficiency of Super cleaner 18WP @ 500 g/ha was 83.6% as it provided the highest grain yield 5.77 t ha^{-1} in Aman season.

Herbicide Super cleaner 18WP @ 500 g/ha had the lowest weed density (10.3 m^{-2}) along with their fresh weight and dry weight followed by penoxulam and the weed control efficiency of Super cleaner 18WP @500 g/ha was 83.0% as it provided the highest grain yield 6.4t ha^{-1} in Boro season.

The penoxulum treated plot provide the highest grain yield (6.53 tha^{-1}) followed by Triafemon (6.23 t ha^{-1}). The weed control efficiency was found higher in Penoxulum (81.9%) followed by Triafemon (75.6%).

Pre and post emergence herbicide had the lowest weed dry wt. (90.4 g) and the highest weed control efficiency (69.1%) as it provided the highest grain yield 5.53 t ha^{-1} in Aus season.

Post emergence herbicide + Hand weeding had the lowest weed dry wt. (36.8 g) and the highest weed control efficiency (82.7%) as it provided the highest grain yield 5.53 t ha^{-1} in Aus season.

Solo mungbean yield 1.19 t ha^{-1}, solo sesame yields 1.22 t ha^{-1}, sesame, mungbean (4:6) row yield Sesame-1.3t ha^{-1}, Mungbean 0.83t ha^{-1}, sesame, mungbean, (2:4) yield Sesame-1.47t ha^{-1}, Mungbean-0.58t ha^{-1}, sesame, mungbean (3:3) rows yield Sesame1.02t ha^{-1}, Mungbean 0.83t ha^{-1}.

Binasarisha-9 yield 1.42 t ha^{-1} at Rakudia and Binasoybean-5 seed yield 2.05 t ha^{-1} Binatil-2 produced 1.6 t ha^{-1}.

Aman (Binadhan-23)-Mustard (Binasarisha-9)-Mungbean (Binamoog-8) patterns BCR 2.47 at Potuakhali Sadar.

Binadhan-10 in late Boro season had the highest grain yield (6.67 t ha^{-1}) whereas Binadhan-17 produced 6.32 t ha^{-1} grain yield in Aman season and it was followed by Binasarisha-9 that produced 1.48 t ha^{-1} seed yield in Rabi season.

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

The experiment was conducted at BINA, HQ farm Mymensingh during the Boro season 2022-23 to determine the optimum transplanting date (30 December, 15 January, 30 January and 15 February) for Boro rice mutants/varieties namely MEF 10, MEF 27, RM-16(N)-8-1, RM-16(N)-8-1, Binadhan-14 and BRRI dhan58. The objective of the study was to find out optimum transplanting date for maximizing yield of Boro rice mutants/varieties. Forty days old seedlings were transplanted in a randomized complete block design (RCBD) with three replications. The unit plot size was 4 m×3 m. Data on yield and yield components were recorded at harvest and analyzed statistically following the design used for the experiment and the means were compared with LSD. The results of the experiment showed that the grain yield was statistically higher in 30 December among the transplanting dates, the grain yield had significant difference among the transplanting dates, tillering capacity and number of filled grain was higher at 30 December for the mutant line MEF 10. Among the different mutants/varieties, MEF 10 showed the statistically higher grain yield (6.83 t ha^{-1}) followed by Binadhan-14 (5.53 t ha^{-1}). Interaction between transplanting date and mutants/varieties mutant line MEF 10 showed the highest grain yield 7.22 t ha^{-1} when transplanted at 30 December followed by Binadhan-14 when transplanted at January 30 (6.9 t ha^{-1}).

Agronomic management on different seedling ages for transplanting of Boro rice variety Binadhan-24 and BINA dhan25

The experiment was conducted at BINA HQs Mymensingh during the Boro season 2022-23. There were two factors namely seedling ages (30 days, 35 days and 40 days) and two rice varieties (Binadhan-24 and Binadhan-25). The objective of the study was to find out optimum seedling age for maximizing yield of *Boro* rice varieties. The experiment was conducted through split-plot design with three replications. The unit plot size was 4 m×3 m. Data on yield and yield components were recorded at harvest and analyzed statistically following the experimental design and the means were compared with LSD. The results showed that 40 days old seedlings produced the highest grain yield (6.8 t ha^{-1}) among the three seedling ages. Among the two varieties, the BINA dhan25 produced the statistically higher grain yield (7.25 t ha^{-1}). BINA dhan25 produced the highest grain yield (7.37 t ha^{-1}) when 40 days old seedlings were transplanted.

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

The experiment was conducted at BINA, HQ farm Mymensingh during the Aman season 2022-23 to determine the optimum transplanting date between July 30 and August 15 for *Aman* rice mutants/variety namely BSB-24 (V_1), MEF-10 (V_2), MEF-27 (V_3), MPQR-12 (V_4), MPQR-62 (V_5), RM-Kas-80-C-1(V_6), RM-16-N-8-1(V_7), RM-16-N-10-1(V_8) and BRRI dhan49 (V_9). The objective of the study was to find out optimum transplanting date for maximizing yield of Aman rice mutants/varieties. Twenty-five days old seedlings were transplanted in a randomized complete block design (RCBD) with three replications. The unit plot size was 4 m×3 m. Data on yield and yield components were recorded at harvest and analyzed statistically following RCBD two factor design used in the experiment and the means were compared with LSD. The results of the experiment showed that the grain and straw yield was the highest in July 30 between two transplanting dates, among mutants RM-Kas-80-C-1 obtained highest grain and straw yield. And the highest grain yield (5.3 t ha^{-1}) was obtained by RM-Kas-80-C-1 transplanted at July 30 followed by RM-16-N-10-1 (5.2 t ha^{-1}) transplanted at July 30.

Assessment of yield gap relations and yield prediction of BINA newly released Boro rice varieties in different AEZs

The experiment was conducted at BINA sub-station Sunamganj farm during the Boro season 2022-23 to find out the limiting factors of Boro rice. The three popular BINA released Boro rice varieties namely Binadhan-10, Binadhan-24, BINA dhan25 in transplanted in above mentioned location. The

experiment was conducted through randomized complete block design (RCBD) with three replications. The unit plot size was 3m× 4m. Data on yield and yield components were recorded at harvest and analyzed statistically following the design used for the experiment and the means were compared with LSD. The results showed the highest grain yield (9.01 t ha^{-1}) and lowest grain yield is (5.62 t ha^{-1}). Among three rice varieties the Binadhan-24 produced statistically higher grain yield because the number of effective tiller and thousands of grain yield was higher.

Effect of early sowing and transplanting of some promising Boro rice varieties for escaping early flash floods in *haor* area

The experiment was conducted at BINA sub-station Sunamganj farm during the Boro season 2022-23 to find out the limiting factors of Boro rice. The six popular Boro rice varieties namely Binadhan-10, Binadhan-17, Binadhan-24, BINA dhan25, BRRI dhan89, BRRI dhan92 in transplanted in above mentioned location. The experiment was conducted through randomized complete block design (RCBD) with three replications. The unit plot size was 3m× 4m. Data on yield and yield components were recorded at harvest and analyzed statistically following the design used for the experiment and the means were compared with LSD. The result of the experiment showed the highest grain yield (7.77 t ha^{-1}) and lowest grain yield is (5.46 t ha^{-1}). Among six rice varieties the Binadhan-24 produced statistically higher grain yield because the number of effective tiller and thousands of grain yield was higher.

Assessment of field gap relation of BINA released Aman rice varieties in Cumilla

The experiment was conducted at BINA substation farm Cumilla under the supervision of BINA substation Cumilla during Boro season 2022-23 to find out the yield limiting factors of Aman rice. There were six popular BINA released Boro rice varieties namely Binadhan-11, Binadhan-16, Binadhan-17, Binadhan-20, Binadhan-22, BRRIdhan-75. The experiment was conducted through randomized complete block design (RCBD) with three replications. The unit plot size was 4m×3m. Data on yield and yield components were recorded at harvest and analyzed statistically following the design used for the experiment and the means were compared with LSD. The result of the experiment showed that that the Binadhan-17 produced the statistically higher grain yield (5.73 t ha^{-1}) followed by Binadhan-16 (5.36 t ha^{-1}).

Assessment of field gap relation of BINA released Aman rice varieties at farmer's field Cumilla

The experiment was conducted at farmer's field Cumilla under the supervision of BINA substation Cumilla during Boro season 2022-23 to find out the yield limiting factors of Aman rice. There were six popular BINA released Boro rice varieties namely BINAdhan-11, BINAdhan-16, BINAdhan-17, BINAdhan-20, BINAdhan-22, BRRIdhan-75. The experiment was conducted through randomized complete block design (RCBD) with three replications. The unit plot size was 4m×3m. Data on yield and yield components were recorded at harvest and analyzed statistically following the design used for the experiment and the means were compared with LSD. The results showed that that the Binadhan-17 produced the statistically higher grain yield (5.99 t ha^{-1}) followed by Binadhan-22 (5.75 t ha^{-1}).

Assessment of field gap relation of BINA released Boro rice varieties in Magur

The experiment was conducted at the farmer's field Magura under the supervision of BINA substation Magura during Boro season 2022-23 to find out the yield limiting factors of Boro rice. There were four popular BINA released Boro rice varieties namely Binadhan-10, Binadhan-14, Binadhan-24 and BINA dhan25. The experiment was conducted through randomized complete block design (RCBD) with three replications. The unit plot size was 4m×3m. Data on yield and yield components were recorded at harvest and analyzed statistically following the design used for the experiment and the means were compared with LSD. The result of the experiment showed that that the Binadhan-24 produced the statistically higher grain yield (8.2 t ha^{-1}) followed by BINA dhan25 (7.6 t ha^{-1}).

Assessment of field gap relation of BINA newly released Boro rice varieties in Barishal

The experiment was conducted at the farmer's field Babugonj, Barishal and Nalcity, Jhalokati under the supervision of BINA substation Nalitabari during Boro season 2022-23 to find out the yield limiting factors of Boro rice. There were four popular BINA released Boro rice varieties namely Binadhan-24 and BINA dhan25. The experiment was conducted through randomized complete block design (RCBD) with three replications. The unit plot size was 4m×3m. Data on yield and yield components were recorded at harvest and analyzed statistically following the design used for the experiment and the means were compared with LSD. The result of the experiment showed that the BINA dhan25 produced the statistically higher grain yield (7.62 t ha^{-1}).

Assessing the yield gap of Boro rice varieties in different cropping systems in Nalitabari

The experiment was conducted at the farmers' field Nalitabari under the supervision of BINA substation Nalitabari during Boro season 2022-23 to find out the yield limiting factors of Boro rice. There were four popular BINA released Boro rice varieties namely Binadhan-10, Binadhan-14, Binadhan-24 and BINA dhan25. The experiment was conducted through randomized complete block design (RCBD) with three replications. The unit plot size was 4m×3m. Data on yield and yield components were recorded at harvest and analyzed statistically following the design used for the experiment and the means were compared with LSD. The results showed that the BINA dhan25 produced the statistically higher grain yield (7.0 t ha^{-1}) among the rice varieties followed by Binadhan-10 (6.9 t ha^{-1}).

Development of cropping pattern with BINA released varieties uses for synchronized farming in Nalitabari

The experiment was conducted at the farmers' field Nalitabari under the supervision of BINA substation Nalitabari during Boro season 2022-23 to find out the yield limiting factors of Boro rice. There were four popular BINA released Boro rice varieties namely Binadhan-10, Binadhan-14, Binadhan-24 and BINA dhan25. The experiment was conducted through randomized complete block design (RCBD) with three replications. The unit plot size was 4m×3m. Data on yield and yield components were recorded at harvest and analyzed statistically following the design used for the experiment and the means were compared with LSD. The results showed that the Binadhan-10, BINA dhan25 produced the statistically higher grain yield (7.0 t ha^{-1}) among the rice varieties.

Assessing the yield gap of Boro rice varieties in different cropping systems in Chapainawabganj

The experiment was conducted at the farmers' field Gomostapur, Chapainawabganj under the supervision of BINA substation Chapainawabganj during Boro season 2022-23 to find out the yield limiting factors of Boro rice. There were four popular BINA released Boro rice varieties namely Binadhan-5, Binadhan-10, Binadhan-14, Binadhan-24 and BINA dhan25. The experiment was conducted through randomized complete block design (RCBD) with three replications. The unit plot size was 4m×3m. Data on yield and yield components were recorded at harvest and analyzed statistically following the design used for the experiment and the means were compared with LSD. The results showed that the Binadhan-24 produced the statistically higher grain yield (8.3 t ha^{-1}) among the rice varieties followed by Binadhan-10 (7.3 t ha^{-1}).

Assessing the yield gap of Boro rice varieties in different cropping systems in Noakhali

The experiment was conducted at the farmers field Subarnochar, Noakhali under the supervision of BINA substation Noakhali during Boro season 2022-23 to find out the yield limiting factors of Boro rice. There were four popular BINA released Boro rice varieties namely Binadhan-10, Binadhan-14, Binadhan-24 and BINA dhan25. The experiment was conducted through randomized complete block design (RCBD) with three replications. The unit plot size was 4m×3m. Data on yield and yield components were recorded at harvest and analyzed statistically following the design used for the experiment and the means were compared with LSD. The results showed that the BINAdhan25

produced the statistically higher grain yield (6.8 t ha^{-1}) among the rice varieties followed by Binadhan-24 (6.4 t ha^{-1}).

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

The experiment was conducted at BINA HQ farm during the Boro season 2022-23 to find out suitable doses of sea weed (*Caulerpa racemosa*) on yield of Boro rice. There were two factors namely sea weed as a basal dose (control, 0.5 t/ha, 0.625 t/ha, 0.75 t/ha, 0.875 t/ha, 1.00 t/ha, 1.25 t/ha) and sea weed extracts with spraying at active tillering stage from the amount of seaweed (control, 0.5 t/ha, 0.625 t/ha, 0.75 t/ha, 0.875 t/ha, 1.00 t/ha, 1.25 t/ha) to find out the yield attribution of Binadhan-17. The proposed amount of sea weeds were collected from the Bay of Bengal. After collecting the sea weed it was dried and meshed properly. For the spraying at tillering stage, it was diluted with water then spraying to the near of the hill at the active tillering stage. The experiment was formulated through randomized complete block design (RCBD) with three replications. The unit plot size was 2 m×1 m. Data on yield and yield components were recorded at harvest and analyzed statistically following the design used for the experiment. The means were compared with LSD. The results showed that the sea weed as a basal dose 1.0 t ha^{-1} produced statistically higher grain yield (8.8 t ha^{-1}) but it was very near to the doses of 0.5 t ha^{-1}, 0.625 t ha^{-1}, 1.25 t ha^{-1} (7.2 t ha^{-1}). On the other hand, that the sea weed extracts as spraying to the active tillering stage exhibited that the dose of 1.25 t ha^{-1} produced the statistically higher grain yield (8.1 t ha^{-1}) followed by the doses of 0.75 t ha^{-1}, 0.825 t ha^{-1}, 1.25 t ha^{-1}.

Determination the effect of Salicylic Acid on yield and yield contributing characters of rice in saline prone region

The experiment was conducted at Farmers field Sarankhola, Bagerhat during Boro season 2022-23. The objective of the study was to find out the effect of salicylic acid on growth, yield and yield contributing characters of rapeseed. T_0=control, T_1=0.5mM SA, T_2=1mM SA, T_3=1.5 mM SA, T_4=2 mM SA, T_5=2.5 mM SA, T_6=3 mM SA, T_7=3.5 mM SA were used with the popular BINA released Boro rice variety Binadhan-10. Salicylic Acid were sprayed over the rice field at the vegetative growth stage at 30 days and 60 after transplanting. The experiment was conducted through randomized complete block design (RCBD) with three replications. The unit plot size was 5m×4m. Data on yield and yield components were recorded at harvest and analyzed statistically following the experimental design and means were compared with LSD. The results showed that salicylic acid 2.5 mM SA spray two time at active tillering stage and PI stage produced statistically higher seed yield (6.6 tha^{-1}) followed by 1.5 mM SA (6.4 t ha^{-1}).

Determination of optimum transplanting date for maximizing yield of Boro rice mutants/varieties

The experiment was conducted at BINA substation Rangpur during the Boro season 2022-23 to determine the optimum transplanting date for the promising BINA released Boro rice mutants/variety namely MEF 10, MEF 27, RM-16(N)-8-1, RM-16(N)-10-1, Binadhan-14 and BRRI dhan58 and the planting date were (December 30 and January 15, January 30, February 15). The objective of the study was to find out optimum transplanting date for maximizing yield of Boro rice mutants/varieties. Forty days old seedlings were transplanted in a randomized complete block design (RCBD) with three replications. The unit plot size was 4 m×3 m. Data on yield and yield components were recorded at harvest and analyzed statistically following the design used for the experiment and the means were compared with LSD. The results of the experiment showed that the higher grain yield was found 6.0 t ha^{-1} at 30 December among the transplanting date. The grain yield had significant difference among the transplanting dates, tillering capacity and number of filled grain were higher at 30 December for the mutant line RM-16(N)-10-1 (V_4) showed statistically higher grain yield (6.0 t ha^{-1}) followed by MEF 27 (5.9 tha^{-1}). Interaction between transplanting date and mutants/varieties mutant line MEF 27 showed the highest grain yield 6.6 t ha^{-1} when transplanted at 30 December followed by RM-16(N)-10-1 when transplanted at January 30 (6.36 t ha^{-1}).

Assessing the yield gap of Boro/Aman/Aus rice different cropping systems under scenario of climate change & resource scarcity in Satkhira

The experiment was conducted at the farmer's field of Satkhira during the year around 2022-23 to find out the yield gap of BINA released rice varieties. Here three varieties of Boro season (Binadhan-10, Binadhan-24, BINA dhan25), three varieties of Aman season (Binadhan-17, Binadhan-22, Binadhan-23) and two varieties of Aus season (Binadhan-19, Binadhan-21) were cultivated in the above mentioned location. Data on yield and yield components were recorded at harvest. The result of the experiment showed that the highest yield gap in Boro season was seen in Binadhan-10 (1.43 t ha^{-1}) followed by Binadhan-24 (1.13 t ha^{-1}) whereas the highest actual yield was produced by BINA dhan25 (6.69 t ha^{-1}) also having the lowest yield gap (0.51 t ha^{-1}). In Aman season, highest yield gap was seen in Binadhan-23 (0.52 t ha^{-1}) followed by Binadhan-17 (0.51 t ha^{-1}) which also produced the highest actual yield (6.29 t ha^{-1}). In Aus season, the highest yield gap was seen in Binadhan-19 (0.53 t ha^{-1}) followed by Binadhan-21 (0.42 t ha^{-1}).

Determination of optimum calendar for T. Aman seed sewing and transplanting dates for tidal floods regions basis of web and tide

The experiment was conducted at Boro season 2022-23 to find out optimum calendar for T. Aman seed sewing and transplanting dates for tidal floods regions basis of web and tide under supervision of Barishal substation. To meet the purpose of the study Binadhan-23 was used as test crops. The experiment was conducted through Split plot design with three replications. The unit plot size was 4m×3m. Data on yield and yield components were recorded at harvest and analyzed statistically following the experimental design and the means were compared with LSD. The result of the experiment exhibited that Binadhan-23 yield 4.64 t ha^{-1} when seed sowing at 8 August, and transplanted at 5 September.

Determination the effect of plant growth regulators on growth, yield and yield contributing characters of rapeseed

The experiment was conducted at Farmers field Fulbaria, Mymensingh during the Rabi season 2021-22. The objective of the study was to find out the effect of plant growth regulators on growth, yield and yield contributing characters of rapeseed. There the four common plant growth regulators namely Flora (Nitrobenzene 3g/L), Power (Gibberellic acid 20%, 1g/20L), Bioferty (Auxin +Amino acid 3g/L), Bumper (Chlorophenoxy acidic acid 3g/L) were used with the popular BINA released rapeseed variety Binasharisa-9 and Binasorisha-11. The plant growth regulators were sprayed over the rapeseed field at the vegetative growth stage at 30 days after sowing. The experiment was conducted through randomized complete block design (RCBD) with three replications. The unit plot size was 5m×4m. Data on yield and yield components were recorded at harvest and analyzed statistically following the experimental design and means were compared with LSD. The result of the experiment showed that Bumper folon (Chlorophenoxy acidic acid 3g/L) produced statistically higher seed yield (1.8 tha^{-1}) among the plant growth regulators followed by Bioferty (Auxin +Amino acid 3g/L) and Flora (Nitrobenzene 3g/L) (1.7 t ha^{-1}). The plant height (92.4 cm) and 1000 seed weight (4.1 g) also highest.

Evaluation of late sowing potentials of mustard varieties on yield and yield contributing characters in Barishal

The experiment was conducted at BINA substation farm Barishal during Rabi season of 2022-23. The objective was to evaluate the yield potentials of released mustard varieties in late sowing. Seeds of Binasharish-9 was sown on November 30 (D_1), December 10 (D_2) and December 20 (D_3), 2022 in three different dates. The experiment was carried out with split plot design with three replications. The unit plot size was 4m×3m. Data on yield and yield components were recorded at harvest and analyzed statistically following the design used for the experiment and the means were compared with LSD. The results are discussed below. Among three sowing dates, November 30 showed the highest grain yield (1.42 tha^{-1}). After November 30 the gradually decrease of mustard Binasorisha-9 yield. But this variety remaining good late sowing potentialities in saline prone zone of Bangladesh.

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

The experiment was conducted at the farmer's field of Satkhira during rabi season in the year 2022-23 to find out the effect of late sowing potentials of Binasarisha-9. Here Binasarisha-9, Binasarisha-11 was used as two treatments. Seeds of the both varieties were sown on 30 November, 2022. Data on yield and yield components were recorded at harvest. The result of the experiment showed that sowing of mustard at 30 November statistically higher seed yield was produced by Binasarisha-9 (1.76 t ha^{-1}) followed by Binasarisha-11 (1.20 t ha^{-1}). Other yield contributing characters like siliqua $plant^{-1}$, seeds $siliqua^{-1}$ and 1000-seeds weight (3.02 g) was highest in Binasarisha-9.

Determination of germination response of Mungbean under changing weather parameters in Barishal

The experiment was conducted at BINA substation Barishal during the Rabi season 2022-22 to find out optimum sowing time for maximum germination and yield. There were three sowing dates: February-15, February-28 and March-15 were used to evaluate the germination and yield performance of Binamoog-7 and Binamoog-8. The experiment was laid out split-plot design with three replications. The unit plot size was 3m×2m. Data on yield and yield components were recorded at first and second picking and finally count the final yield by addition of two times yield. The data were analyzed statistically following the experimental design and the means were compared with LSD. Binamoog-8 produced the statistically higher seed yield (894 kg ha^{-1}) than the Binamoog-7 (751 kg ha^{-1}) but the higher germination response was found in Binamoog-8 (75%). Sowing date 15 February had the highest seed yield (1022 kg ha^{-1}) and germination percent (75.44 %) among the three sowing dates. The interaction of sowing dates and varieties showed that Binamoog-8 produced the highest grain yield (1132 kg ha^{-1}) if it was sown in 15 February the germination percent was highest (78%) for Binamoog-8 when sown in 15 February.

Estimation of yield gap limiting factors for pulse and oil seed crops in Satkhira

The experiment was conducted at the farmer's field of Satkhira during year 2022-23 to find out the yield gap limiting factors of BINA released pulse and oil seed crops. Here Binamoog-8, Binakhesari-1 was used as pulse crops and Binasarisha-4, Binasarisha-9 was used as oil seed crops. Data on yield and yield components were recorded at harvest. The result of the experiment showed that the highest yield gap of pulse crops was seen in Binamoog-8 (0.26 t ha^{-1}) followed by Binakhesari-1 (0.08 t ha^{-1}). In oil seed crops, highest yield gap was seen in Binasarisha-9 (0.29 t ha^{-1}) followed by Binasarisha-4 (0.13 t ha^{-1}).

Field trial of Repivox 60 OD (a.i. Cyhalofop-butyl 5.1% + Penoxulam 1.02%) herbicide

The experiment was conducted at Bangladesh Institute of Nuclear agriculture (BINA), HQs farm during the *Aman* season 2022-23. The objective of the study to the effect of Repivox 60 OD on growth parameters of rice in *Aman* season. There were three different treatments as control, Repivox 60 OD (cyhalofop-butyl 5.1% + penoxulum 1.02%), penoxulam used as positive control and Binadhan-17 was used as test crop. The experiment was conducted through randomized complete block design (RCBD) with three replications. The unit plot size was 4m×8m. Data on yield and yield components were recorded at harvest and analyzed statistically following the RCBD single factor design used in the experiment and the means were compared with LSD. The result of the experiment showed that Repivox 60 OD had the lowest weed density (10.7 m^{-2}) along with their fresh weight and dry weight followed by penoxulam. And weed control efficiency of Repivox 60 OD was 82.6% followed by penoxulam (75.7 %). The highest grain yield 5.5 t ha^{-1} obtained when Repivox 60 OD was applied followed by 5.1 t ha^{-1} in penoxulam application. Similarly the highest straw yield (6.5 t ha^{-1}) was obtained in Repivox 60 OD.

Field trial of Repivox 60 OD (a.i. Cyhalofop-butyl 5.1% + Penoxulam 1.02%) herbicide

The experiment was conducted at Bangladesh Institute of Nuclear agriculture (BINA), HQs farm during the *Boro* season 2022-23. The objective of the study to the effect of Repivox 60 OD on growth

parameters of rice in *Boro* season. There were three different treatments as control, Repivox 60 OD (Cyhalofop-butyl 5.1% + penoxulum 1.02%), penoxulam used as positive control and Binadhan-24 was used as test crop. The experiment was conducted through randomized complete block design (RCBD) with three replications. The unit plot size was 4m×8m. Data on yield and yield components were recorded at harvest and analyzed statistically following the RCBD single factor design used in the experiment and the means were compared with LSD. The result of the experiment showed that Repivox 60 OD had the lowest weed density (10.2 m^{-2}) along with their fresh weight and dry weight followed by penoxulam. And weed control efficiency of Repivox 60 OD was 79.6% followed by penoxulam (73.2 %). The highest grain yield 6.97 t ha^{-1} obtained when Repivox 60 OD was applied followed by 6.60 t ha^{-1} in penoxulam application. Similarly the highest straw yield (7.63 t ha^{-1}) was obtained in Repivox 60 OD.

Field trial of super cleaner 18 WP (Bensulfuron methyl 4% w/w + Acetachlor 14% w/w) herbicide

The experiment was conducted at Bangladesh Institute of Nuclear agriculture (BINA), HQs farm during the Aman season 2022-23. The objective of the study to the effect of super cleaner 18WP on growth parameters of rice in Aman season. There were three different treatments as control, Super cleaner 18WP @ 450 g/ha, Super cleaner 18WP @ 500 g/ha, Super cleaner 18WP @ 550 g/ha, Super cleaner 18WP @ 600 g/ha, Double kill 18 WP as positive control and Binadhan-17 was used as test crop. The experiment was conducted through randomized complete block design (RCBD) with three replications. The unit plot size was 3m × 4m. Data on yield and yield components were recorded at harvest and analyzed statistically following the RCBD single factor design used in the experiment and the means were compared with LSD. The result of the experiment showed that Super cleaner 18WP @ 500 g/ha had the lowest weed density (14.0 m^{-2}) along with their fresh weight and dry weight. And the weed control efficiency of Super cleaner 18WP @ 500 g/ha was 83.6% followed by Super cleaner 18WP @ 550 g/ha (79.75%). The highest grain yield 5.77 t ha^{-1} obtained when Super cleaner 18WP @ 500 g/ha was applied followed by 5.32 t ha^{-1} in Super cleaner 18WP @ 550 g/ha application. Similarly the highest straw yield (6.68 t ha^{-1}) was obtained in Super cleaner 18WP @ 500 g/ha.

Field trial of super cleaner 18 WP (Bensulfuron methyl 4% w/w + Acetachlor 14% w/w) herbicide

The experiment was conducted at Bangladesh Institute of Nuclear agriculture (BINA), HQs farm during the Boro season 2022-23. The objective of the study to the effect of super cleaner 18 WP on growth parameters of rice in Boro season. There were three different treatments as control, Super cleaner 18WP @ 450 g/ha, Super cleaner 18WP @ 500 g/ha, Super cleaner 18WP @ 550 g/ha, Super cleaner 18WP @ 600 g/ha, Double kill 18 WP as positive control and Binadhan-24 was used as test crop. The experiment was conducted through randomized complete block design (RCBD) with three replications. The unit plot size was 3m×4m. Data on yield and yield components were recorded at harvest and analyzed statistically following the RCBD single factor design used in the experiment and the means were compared with LSD. The result of the experiment showed that Super cleaner 18WP @ 500 g/ha had the lowest weed density (10.3 m^{-2}) along with their fresh weight and dry weight. And the weed control efficiency of Super cleaner 18WP @ 500 g/ha was 83.0% followed by Super cleaner 18WP @ 550 g/ha (79.5%). The highest grain yield 6.4 t ha^{-1} obtained when Super cleaner 18WP @ 500 g/ha was applied followed by 6.2 t ha^{-1} in Super cleaner 18WP @ 550 g/ha application. Similarly the highest straw yield (7.3 t ha^{-1}) was obtained in Super cleaner 18WP @ 500 g/ha.

Determination of efficiency of different herbicide on Boro rice

The experiment was conducted at Bangladesh Institute of Nuclear agriculture (BINA), HQ's farm during the Boro season 2022-23. The objective of the study to select the efficient herbicide for Boro rice and analysis of their residues in soil and plants. There were eight popular herbicides namely 2 methyl 4 choloro-phenoxy acetic acid, Pretilachlor, Penoxulum, Cyhalop-butyl, Bensulfuron methyl + Acetachlor, Pyrazosulfuron ethyl, Amchlor and Triafemon with the test crop BINA dhan25. The experiment was conducted through randomized complete block design (RCBD) with three

replications. The unit plot size was 4m×3m. Data on yield and yield components were recorded at harvest and analyzed statistically following the design used for the experiment and the means were compared with LSD. The result of the experiment showed that Amchlor had the highest weed density (43.4) m^{-2} along with their fresh and dry weight after the control plot. Maximum number of weed species were found in Cyhalop-butyl (5) and Bensulfuron methyl + Acetachlor (5) after control plot. The penoxulum treated plot provide the highest grain yield (6.53 tha^{-1}) followed by Triafemon (6.23 t ha^{-1}). The weed control efficiency was found higher in Penoxulum (81.9%) followed by Triafemon (75.6%).

Improvement of weed management in Aus rice cultivation on the hill slope of Khagrachari

The experiment was conducted at farmer's field of Khagrachari during the Aus season 2022-23. The objective of the study to select suitable weed management techniques in Aus season. There were seven different treatments as Control, Pre-emergence herbicide, Pre-emergence herbicide + Hand weeding, Post emergence herbicide, Post emergence herbicide + Hand weeding, Hand weeding (2 times), Pre emergence herbicide + Post emergence herbicide and Binadhan-21 was used as test crop. The experiment was conducted through randomized complete block design (RCBD) with three replications. The unit plot size was 5m×4m. Data on yield and yield components were recorded at harvest and analyzed statistically following the RCBD single factor design used in the experiment and the means were compared with LSD. The result of the experiment showed that Post emergence herbicide + Hand weeding had the lowest weed dry weight (36.8 g) and highest weed control efficiency 82.7% followed by Pre-emergence herbicide + Hand weeding (81.1%). The highest grain yield 5.53 t ha^{-1} obtained when Post emergence herbicide + Hand weeding was applied followed by 5.49 t ha^{-1} in Pre-emergence herbicide + Hand weeding application. Hence highest straw yield (7.25 t ha^{-1}) was obtained in Pre-emergence herbicide + Hand weeding application.

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

The experiment was conducted at farmers' field Khagrachari during the Rabi season 2022-23 to find out optimum intercropping combinations between sesame and mungbean yield in hill tracts. There were five treatments (Solo mungbean, solo sesame, sesame, mungbean (4:6) row, sesame, mungbean, (2:4), sesame, mungbean (3:3) rows. The experiment was laid out RCB design with three replications. The unit plot size was 4m×4m. Data on yield and yield components were recorded at 30, 60, 90 days after sowing and final yield was recorded. The data were analyzed statistically following the experimental design and the means were compared with LSD. The result of solo mungbean yield 1.19 t ha^{-1}, solo sesame yields 1.22 t ha^{-1}, sesame, mungbean (4:6) row yield Sesame-1.3, Mungbean 0.83, sesame, mungbean, (2:4) yield Sesame-1.47, Mungbean-0.58, sesame, mungbean (3:3) rows yield Sesame1.02, Mungbean 0.83.

Estimation of yield gap limiting factors of oil seed crops under different cropping system in Barishal

The experiment was conducted at Rakudia, Vobanipur during the Rabi and Kharif season 2022-23 to find out the yield limiting factors of mustard, soybean and lentil. To meet the purpose of the study Binasarisha-9, Binasoybean-5, Binatil-2. The experiment was conducted through randomized complete block design with three replications. The unit plot size was 4m×3m. Data on yield and yield components were recorded at harvest and analyzed statistically following the experimental design and the means were compared with LSD. The result of the experiment exhibited that the Binasarisha-9 yield 1.42 t ha^{-1} at Rakudia and Binasoybean-5 seed yield 2.05 t ha^{-1} Binatil-2 produced 1.6 t ha^{-1}.

Development of cropping pattern with BINA released varieties uses for Synchronized farming in Barishal regions

The experiment was conducted 2022-23 to find out inclusion of BINA released rice mustard and mungbean varieties under supervision of Barishal substation. To meet the purpose of the study Aman (Binadhan-23)-Mustard (Binasarisha-9)-Mungbean (Binamoog-8) patterns were validated. The

experiment was conducted through RCB design with three replications. The unit plot size was 4m×3m. Data on yield and yield components were recorded at harvest and analyzed statistically following the experimental design and the means were compared with LSD. Aman (Binadhan-23)-Mustard (Binasarisha-9)-Mungbean (Binamoog-8) patterns BCR 2.47 at Potuakhali Sadar.

Development of cropping pattern with BINA released varieties uses for synchronized farming in Satkhira

The experiment was conducted at the farmer's field of Haroddah, Satkhira Sadar during the year around 2022-23 to develop the suitable cropping pattern using BINA released varieties. Here three popular BINA released varieties named Binadhan-10, Binadhan-17 and Binasarisha-9 were cultivated in the above mentioned location. The whole experimental plot size was 33 decimal. Data on yield and yield components were recorded at harvest. The result of the experiment showed that Binadhan-10 in late Boro season produced highest grain yield (6.67 t ha^{-1}) whereas Binadhan-17 produced 6.32 t ha^{-1} grain yield in Aman season and it was followed by Binasarisha-9 that produced 1.48 t ha^{-1} seed yield in Rabi season. From this experiment we can conclude that Aman-Mustard-Boro can be suitable cropping pattern to replace existing Aman- Fallow –Boro in Satkhira region.

Validation of drought tolerant potentials of BINA released soybean varieties in saline prone regions

The experiment was conducted at the farmers' field Hizla, Barishal under the supervision of BINA substation Barishal during Boro season 2022-23 to find out drought tolerant potentials of soybean varieties. There were four popular BINA released soybean varieties namely Binasoybean-3, Binasoybean-5 and Binasoybean-6. The experiment was conducted through randomized complete block design (RCBD) with three replications. The unit plot size was 4m×3m. Data on yield and yield components were recorded at harvest and analyzed statistically following the design used for the experiment and the means were compared with LSD. Here Binasoybean-5 produced statistically higher seed yield 2.97 t ha^{-1} under drought condition.

CROP PHYSIOLOGY DIVISION

RESEARCH HIGHLIGHTS 2022-23

Four Aman rice varieties (Binadhan-16, Binadhan-17, Binadhan-22 and binadhan-23) were evaluated under elevated temperature (36 ^{0}C) at booting and heading stages. No variety was found tolerant to elevated temperature.

Ten Boro rice genotypes viz., Biol L/14, BD-55, CPD-1, CPD-2, CPD-3, CPD-4, CPD-5, CPD-6, CPD-7 and CPD-8 were evaluated under four temperature levels viz., 25 °C (control), 20°C, 15°C and 10°C. No genotype was found tolerant to low temperature. However, BD-55 was found moderately tolerant to low temperature at seedling stage.

Eight soybean genotypes *viz*. SBM-07, SBM-17, SBM-25, AVRDC-262, AVRDC-266, Lokon, Binasoybean-2 and Binasoybean-6 were evaluated at two salinity levels (6 and 9 dSm^{-1}) at reproductive stage and only two genotypes viz., SBM-25 and Lokon could survive at 9 dSm^{-1}.

Nine chili genotypes *viz*. RCL-1, BCL-1, YCL-1, Binamorich-1, Binamorich-2, FC-025, Bindu morich, B-M-1-2 and Magura morich were evaluated under water logging for 72 hours at seedling stage and no genotype was found tolerant to water logging.

Eight sesame genotypes *viz*. Rajshahi khoyeri, GP-8, CPD-3, BD-6-993, Binatil-2, CPD brownish black, ES-08 and Ishwardi brown were evaluated under water logging for 72 hours at reproductive stage and no genotype was found tolerant to water logging. But Rajshahi khoyeri can tolerate up to 48 hour water logging condition.

Seven rice genotypes *viz*. BRRI dhan-28, Atomita, FR13A, BM-1, BM-2, BM-7, and BM-8 were evaluated under water stress (60%) for seven days at heading stage. Under water stress condition, all eight genotypes showed decreasing trend in physiological parameters, yield attribute and grain yield. However, the genotype BM-2 can tolerate water stress with 39.5% grain yield reduction.

Four mungbean varieties were undertaken to assess relationship in synchrony/asynchrony in pod maturity with canopy structure. Results indicated that those varieties which produced maximal opened flowers within 10 days, and ceased flowering within 14 days after first flowering, had synchrony in pod maturity. Branches are the major cause of asynchronous pod maturity in mungbean.

Aus rice mutant *cv*. NS-21 was evaluated to assess the effect of different levels of tillers on grain sterility and synchrony in maturity. The tillering levels were: control, 5, 7, 9, 11, 13 and 15 tillers $hill^{-1}$. Control plants had 20 tillers $hill^{-1}$. For getting synchronous grain maturity with higher grain yield, 9 tillers $hill^{-1}$ is the best suited of the mutant NS-21.

In order to investigate the protein percentage, five lentil and five mungbean advanced mutants were taken. The protein content range of lentil was 23.8 to 25.4. The protein content range of mungbean was 23.6 to 25.1.

Research report details

Screening of four *Aman* rice varieties under elevated temperature at reproductive stages

Global climate change is making high temperature a critical factor for plant growth and productivity. It is now considered to be one of the major abiotic stresses for restricting rice production. The experiment was conducted at the pot yard and plant growth chamber of the Bangladesh Institute of Nuclear Agriculture (BINA), Mymensingh, Bangladesh during Aman season of 2022. Each pot contained 10 kg soil. Recommended fertilizers were used. One seedling was transplanted in a pot. The tested four rice varieties were: Binadhan-16, Binadhan-17, Binadhan-22 and Binadhan-23. The experiment was set in a two factorial RCBD with three replications. The first factor was rice genotypes and the second factor was temperature: ambient, 36^0C at booting and at flowering stages of the rice varieties. Then all the plants were allowed to continue maturity. The physiological parameters were recorded after 5 days of temperature imposed. Data on yield and yield attributes were recorded at maturity. The collected data were analyzed statistically.

Results indicated that leaf chlorophyll content, nitrate reductase (NR) activity in leaves was lower under elevated temperature compared to control at both growth stages. But the elevated temperature was more detrimental when temperature was imposed at heading stage. The interaction effect between temperature and variety on chlorophyll content and NR activity in leaves indicated that all four rice varieties showed declining in trend with age. It means there was no significant variation amongst varieties for imposing high temperature on chlorophyll content and NR activity in leaves. However, the decreasing trend was the lowest in Binadhan-23. Plant height, yield attributes and grain yield had significant negative effect under high temperature. But negative effect was more at booting stage followed by grain filling stage. The lowest number of grains $hill^{-1}$ was found with high temperature at booting stage followed by flowering and grain filling stage. On the other hand, the highest number of unfilled grains $hill^{-1}$ was observed under high temperature at flowering stage followed by booting and grain filling stage. Thousand-grain weight was significantly reduced but straw weight increased with high temperature at all the growth stages. Grain weight $hill^{-1}$ was significantly decreased with high temperature at flowering stage followed by booting and grain filling stage. Grain weight $hill^{-1}$ was significantly reduced by high temperature in all the studied varieties. However, Binadhan-23 had less reduction under high temperature. The interaction effect between temperature and variety on yield attributes and grain yield was significant. The lowest grain yield and number of grains $panicle^{-1}$ of all varieties was recorded when high temperature was imposed at heading stage followed by high temperature imposed at booting stage. This result indicates that high temperature at booting and heading stages is most detrimental on rice grain yield. No variety was found tolerant to high temperature.

Effect of different levels of low temperature on germination and growth at seedling stage of ten *Boro* rice genotypes.

Cold stress is an emerging threat for rice production in the northern region of 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 present study aimed at identifying cold tolerance *Boro* rice at seedling stage. A pot experiment was conducted with 10 *Boro* rice genotypes viz., Biol L/14, BD-55, CPD-1, CPD-2, CPD-3, CPD-4, CPD-5, CPD-6, CPD-7 and CPD-8 at growth chamber, Bangladesh Institute of nuclear Agriculture during December 2022- January 2023 to assess the effect of different low temperature levels on germination, root and shoot length and to find out suitable temperature level for proper germination and growth. Four temperature treatments viz., 25 °C (control), 20°C, 15°C and 10°C was imposed for seven days in plant growth chamber. The experiment was laid out in a completely randomized design with three replications. Hundred seeds of each genotype for each temperature treatment were soaked in tissue paper in petridis. Then those genotypes were exposed to each temperature treatment in plant growth

chamber. Data on germination, root length and shoot length were recorded. Data were analyzed statistically and means were compared by DMRT. Result indicated that germination percentage, root and shoot length decreased with decreasing temperature. The highest germination percentage, root and shoot length was recorded at 25 ^{0}C and the lowest was recorded at 10 ^{0}C. The interaction effect between genotype and temperature on germination percentage, root and shoot length was non-significant. It means all 10 studied rice genotypes response similarity to temperature. However, 4 rice genotypes viz., BD-55, CPD-1, CPD-2 and CPD-6 showed its less reduction of germination percentage, root and shoot length under 10 ^{0}C with being the lowest in BD-55 whereas 3 rice genotypes viz., CPD-3, CPD-4 and CPD-5 showed its higher reduction of germination percentage, root and shoot length under 10 ^{0}C with being the highest in CPD-5. In conclusion, no rice genotype was found tolerant to cold temperature at seedling stage.

Screening of soybean genotypes for salinity tolerance based on morpho-physiological criteria

Soil salinity is the most dominant factor limiting crop production in the saline areas of Bangladesh. During dry season, salt tolerant soybean genotypes can bring substantial change in the agricultural practices in that problem soils. With considering above points the research work was undertaken to assess the effect of salinity stress on growth and yield of soybean mutants/varieties and to identify salinity stress tolerant soybean mutants. Eight soybean genotypes *viz*. SBM-07, SBM-17, SBM-25, AVRDC-262, AVRDC-266, Lokon, Binasoybean-2 and Binasoybean-6 were evaluated at pot yard of Bangladesh Institute of Nuclear Agriculture during January- May, 2023. Pots were filled with 10 kg soils. The experiment was set in a two factorial RCBD with four replications. The first factor was soybean genotypes and the second factor was two levels of salinity 6 and 9 dSm^{-1} and control (non-saline). Salt solution was prepared artificially by dissolving calculated amount of commercially available NaCl with tap water with the help of electrical conductivity (EC) to make 6 and 9 dSm^{-1} NaCl solution. Tap water was used as control (dSm^{-1}). The salt solution was applied with an increment of 1 dSm^{-1} for 6 dSm^{-1} and 1.5 dSm^{-1} for 9 dSm^{-1} in every alternate day till respective concentration 6 and 9 dSm^{-1} were attained. For the measurement of salt tolerance, Salinity Susceptibility Index (SSI) of each genotype for each of the character under consideration was calculated according to the Fisher and Mauer (1978) formula. Scoring of salinity susceptibility is done by modified IRRI standard protocol for scoring of salinity (IRRI, 1997). Data on chlorophyll was recorded at flowering and fruiting stage, and yield and yield attributes were recorded at maturity. The collected data were analyzed statistically.

The highest shoot length, shoot dry weight plant^{-1} and root dry weight plant^{-1} were observed in Lokon. Binasoybean-2 showed the highest seed yield due to the highest no. of pods plant^{-1} followed by SBM-25 under different salinity level. Yield and yield attributes and chlorophyll content of soybean genotype were less affected in 6 dSm^{-1} than in 9 dSm^{-1}. Under high salinity level (9 dSm^{-1}), only SBM-25 and Lokon were survived. At 6 dSm^{-1} only AVRDC-266 was not survived. It was also noticed that at 6 dSm^{-1}, SBM-17 and AVRDC-262 were survived but no economic yield was observed due to no pod formation. At 6 dSm^{-1}, the highest grain yield plant^{-1} was observed in Binasoybean-2 followed SBM-25. Binasoybean-2 showed the highest seed yield due to bearing the higher number of pods plant^{-1}. According to salinity susceptibility score (SSI) at 6 dSm^{-1}, among the 8 genotypes, 7 genotypes showed their performance moderately tolerant to highly tolerant. Only Lokon and SBM-25 showed tolerant performance at 9 dSm^{-1}. Based on these results, it may be concluded that at 9 dSm^{-1} only SBM-25 and Lokon survived and SBM-25 has the better potential in terms of yield and yield attributes and chlorophyll content. So, Lokon and SBM-25 can be used as breeding material to develop higher salinity tolerant soybean variety.

Screening of chili genotypes for water logging tolerance at seedling stage based on morpho-physiological criteria

Water logging is a common constrain of chili plant survival in rainy season. An experiment was conducted with nine chili genotypes *viz*. RCL-1, BCL-1, YCL-1, Binamorich-1, Binamorich-2, FC-025, Bindu morich, B-M-1-2 and Magura morich at pot yard of Bangladesh Institute of Nuclear Agriculture during March- June, 2023. Pots were filled with 10 kg soils. All soils pots were fertilized

with Urea: 220 kgha^{-1}, TSP: 400 kgha^{-1}, MOP: 200 kgha^{-1}, Gypsum: 100 kgha^{-1} and Zinc sulphate: 10 kgha^{-1}. Three seeds were sown in a single pot. All necessary intercultural operations were done as and when necessary for normal plant growth and development. The experiment was set in a two factorial RCBD with three replications. The first factor was chili genotypes and the second factor was two water logging conditions: Control (no water logging) and water logging (for 72 hrs). Water logging period (water height was 1–3cm above the soil surface) was applied at 38 days after transplanting for three days, and subsequent withdrawal of water logging, i.e., 39–45 DAE was designated as the recovery period. Result indicated that no genotype was found tolerant to water logging for 72 hours i.e. all studied genotypes died after 72 hours water logging.

Screening of water logging tolerant genotypes of sesame based on morpho-physiological criteria

Water logging is a common constrain of sesame plant survival in rainy season. A pot experiment was conducted with eight sesame genotypes viz., Rajshahi khoyeri, GP-8, CPD-3, BD-6-993, Binatil-2, CPD brownish black, ES-08 and Ishwardi brown at BINA pot yard, Mymensingh during March to June 2023. The main objectives of the study was to find out the water logging tolerant genotypes on the basis of morpho- physiological, yield and yield components of sesame genotypes. Two water logging treatments viz., control and 48 hours water logging period were imposed at flowering stage of the sesame genotypes. Each pot contained about 8 kg soil collected from BINA farm. Urea, TSP MoP and gypsum were applied 125, 150, 50 and 110kg ha^{-1}, respectively. Half of urea and all other fertilizers were mixed with pot soils and remaining urea was applied at 30 days after sowing. After seedling establishment (30 DAS) one seedling was allowed to grow in each pot. The experiment was laid out in completely randomized design with three replications. Morphological, biomass and yield component data were recorded at harvest. The collected data were analyzed statistically.

Under water logging condition, all morpho-physiological parameters and yield attributes drastically reduced than control plant. Interaction effect between genotypes and water logging indicated that four genotypes out of eight *viz*., GP-8, CPD3, BD-6-993, CPD brownish black did not survive under water logging condition and another four genotypes *viz.*, Rajshahi khoyeri, Binatil-2, ES-08 and Ishwardi brown had survive with drastic seed yield reduction. It indicates that all tested genotypes were susceptible to water logging but Binatil-2 and Rajshahi khoyeri can tolerate up to 48 hour water logging condition.

Drought stress affects reactive oxygen species, osmotic adjustment substances and antioxidant enzymes at the reproductive stage in rice

Water stress is a limiting factor in agriculture production. In plants, a better understanding of the morphological and physiological basis of changes in water stress resistance could be used to select or create new varieties of crops to obtain a better performance under water stress conditions. A pot experiment was carried out to assess the effects of drought stress on reactive oxygen species (ROS), osmotic adjustment substances, antioxidant enzymes and physiological parameters at the reproductive stage in rice. Control (100% FC) and drought stress (60% FC) were imposed at the heading stage and continued for seven days. The tested genotypes were: BRRI dhan-28, Atomita, FR13A, BM-1, BM-2, BM-7, and BM-8. The experiment was laid out in a complete randomized design with three replications. Thirty-day-old seedlings were transplanted in plastic pots containing 10 kg of soil on February 22, 2023. Recommended doses of fertilizers were applied, and cultural practices were followed whenever required. Biochemical parameters were recorded after 3 days of treatment. Data on yield attributes and grain yield were recorded at harvest. The collected data were analyzed statistically.

The lowest total chlorophyll content was recorded in the genotype BM-1 at 60% drought stress. The lowest percentage of MSI (5.43) was recorded from the control treatment in Atomita genotypes, and the highest percentage of MSI (24.28%) was recorded in BM-1 genotypes from 60% drought stress. The membrane damage was higher in susceptible genotypes than in tolerant genotypes. The ROS products H_2O_2 and malondialhihyde (MDA) production were higher in all the studied genotypes under

60% drought stress compared to the control condition. MDA production is higher in susceptible genotypes than in tolerant genotypes under drought stress conditions. It means when the plants are in drought-stressed conditions, lipid peroxidation occurs due to ROS production. The antioxidant enzyme POD activity was higher in the tolerant genotypes than the susceptible ones. The highest POD activity was recorded in the BM-2 genotypes, followed by the FR13A genotypes under a 60% drought stress condition, while the lowest POD activity was recorded in the BRRI dhan28. The scavenging system in the drought-tolerant variety, Atomina and FR13A, exhibited higher POD activities than in the drought-sensitive variety, BRRIdhan-28. The drought tolerance of rice varieties could induce the antioxidative enzyme system more efficiently to scavenge the MDA, and H_2O_2 accumulation under drought stress.

Drought stress imposed at heading stage decreased significantly on plant height, yield attributes and grain yield in rice genotypes. The interaction effect between genotypes and water stress on plant height, total and effective tillers, panicle length and grain weight was significant whereas number of filled and unfilled grains panicle^{-1}, straw weight hill^{-1} and harvest index was insignificant. It means under water stress condition, all eight genotypes showed decreasing trend in number of filled and unfilled grains panicle^{-1}, straw weight hill^{-1} and harvest index was similar. Under water stress condition, the highest grain yield decreasing trend was observed in FR13A and the lowest was recorded in BM-2.

Pod maturity synchrony in relation to canopy structure in mungbean

Asynchrony in pod maturity is a major problem in mungbean cultivation. Experiments were conducted to assess relationship in synchrony/asynchrony in pod maturity with canopy structure in four mungbean varieties (BARI mung-6, Binamoog-7, Binamoog-8 and Binamoog-12) at BINA farm, Mymensingh. The experiment was laid out in a Randomized Complete Block Design with three replications. Recommended fertilizers and proper cultural practices were followed as and when necessary. Flowers counts were recorded from each plant of each replication just from the date of first flowering and there after every day up to flowering ceased. At harvest, seed yield and yield attributes were recorded.

Daily flowering converted to 3-day interval had shown differential peak period. The flowering duration range from 12 to 30 days after flowering started. The shortest flowering duration was recorded in `BARI mung-6 followed by Binamoog-8 (11 & 14 DAF, days after flowering started, respectively) and the longest was recorded in Binamoog-7 (30 DAF) followed by BINAmung12 (18 DAF). The variety Binamoog-7 produced highest number of flowers (70 plant^{-1}). In contrast, BARI mung-6 produced the lowest number of flowers (19.2 plant^{-1}) followed by Binamoog-8 ((20.9 plant^{-1}) with same statistical rank. The highest seed yield was recorded in Binamoog-7 due to higher pod production. Binamoog-8 showed second highest seed yield with lower number of pods plant^{-1} might be due to good dry matter portioning to economic yield and larger seed size.

The varieties which produced most of the flowers within 10 days after commencement of flowering and ceased flowering within 15 DAF showed synchrony in pod ripening. The two varieties, BARImung-6 and Binamoog-8 produced maximum flowers (range 95-100% of the total) within 10 days and ceased flowering within 12-15 DAF showed synchronous pod maturity but produced lower yield due to production of fewer opened flowers per plant. In contrast, Binamoog-7 showed asynchrony in pod maturity due to longer flowering duration (30 days). This variety also showed high yield potential due to production of increased number of opened flowers per plant.

Results revealed that those varieties which produced maximal opened flowers within 10 days, and ceased flowering within 15 days after first flowering, had synchrony in pod maturity. Results further indicated that shorter plant with less or no branch (range 0-1 per plant), lower leaf (range 580-662 cm^2 per plant) and canopy area (471-637 cm^2 per plant) with erect plant showed synchrony in pod maturity. In contrast, taller plant having more number of branches (3 per plant), large leaf (1770 cm^2 per plant) and canopy area (1029cm^2 per plant) with dom or spread type plant showed asynchrony in pod maturity. In contrast, higher branch bearing (3-4 per plant) plants were dom or spread type. This

aspect may be used in future plant breeding programme for getting variety of mungbean having synchronous pod maturity with high yield potential.

Effect of different levels of tillers on grain sterility and synchrony in maturity of *Aus* rice.

The experiment was conducted at BINA pot yard during *Aus* season of 2023 to assess the effect of different levels of tillers on grain sterility and synchrony in maturity Aus rice mutant *cv*. NS-21. The tillering levels were: control, 5, 7, 9, 11, 13 and 15 tillers hill^{-1}. Control plants had 20 tillers hill^{-1}. Recommended fertilizers and cultural practices were followed. The treatments were imposed after tiller initiation and maintained up to harvest. At harvest, each hill uprooted and separated to main tiller, primary, secondary and tertiary tillers, and yield related parameters of each tiller (consider as plant) was recorded. The collected data were analyzed statistically.

Results showed that grain yield, harvest index and heading duration were statistically significant due to different levels of tillers. Results indicated that harvest index decreased with increasing tiller number while reverse trend was observed in case of grain yield and heading duration. The maturity was synchronous until 9 tillers hill^{-1} and further increase in tiller number showed asynchronous in grain maturity. The unfilled grain number increased with increasing tiller number hill^{-1}. The unfilled grain number increased with increasing tiller number hill^{-1}. The highest number of filled grains hill^{-1} was recorded in control plant though it's had asynchronous grain maturity with poor dry matter portioning to economic yield. Amongst the synchronous maturity, 9 tillers hill^{-1} showed higher grain yield and also had good dry matter partitioning to economic yield. Therefore, it may concluded that for getting synchronous grain maturity with higher grain yield, 9 tillers hill^{-1} is the best suited of the mutant NS-49.

Physico-chemical properties of some lentil and moogbean genotypes

Lentil and mungbean has taken a very important role in the human diet. In order to investigate the protein percentage, five lentil and five mungbean genotypes were taken. This study was conducted in BINA head quarters, Mymensingh by using Modified Kjeldahl method (plant) following digestion, distillation and titration activities. 0.5 gm plant samples were taken and mix with di- acid mixture (sulfuric acid and per chloric acid, 2:1) and followed in digestion chamber for sample digestion. After that distillation procedure were maintained by using sodium hydroxide and boric acid and then follow for titration by using titrant solution 0.01N sulfuric acid. Finally % of protein was calculated by using the equation.

% protein= estimated % N x 6.25

The protein content range of lentil was 23.8 to 25.4. The highest protein content was recorded in LMM-4 and the lowest was recorded in BINA mosur-12. The protein content range of mungbean was 23.6 to 25.1. The highest protein content was recorded in MI-12 and the lowest was recorded in Binamoog-11.

ENTOMOLOGY DIVISION

Research Highlights

To confirm sterility dose of cucurbit fruit flies, there was no satisfactory adult emergence from irradiated pupae compared to the control during experimentation. So further study is need to be conducted to find out the error and irradiation dose for sterility of *B. cucurbitae.*

Chemical insecticide Chlorantraniliprole **(**Coragen) had significant effect in reducing jassid, white fly, aphid and pod borer infestation of soybean as well as increased yield. Number of trapped spodoptera moth was higher at early weeks after sowing in kharif-2 season while abundance of moth gradually increased and the highest abundance were recorded at 14 weeks after sowing in rabi season.

Chlorantraniliprole **(**Coragen) alone significantly reduced fall armyworm infestation of 83.7% and 97.64% over untreated control at 10 days after 1st and 2nd application, respectively while alternate spray of SfNPV and Chlorantraniliprole (Coragen) played significant role in reducing FAW infestation by 86.77 percent at 10 days after 2nd spray.

Alternate and twice spraying of Spinosad 44.03% W/W (Tracer 45SC) @ 1ml/L water and Abamectin (Vertimec18EC) @ 1.25ml/L water starting from the first appearance of thrips or mite infestation at 10 days interval was most effective against thrips and mite complex of chili. The highest yield (19.59 t/ha) was obtained from Spinosad+Abamectin treated plant which was statistically similar to that of Imidacloprid+Abamectin treatment.

Radiation was applied on adult stage of rice weevil (*Callosobruchus chinensis*) @ 0, 20, 30, 40 and 50 Gy. Lethal Dose 50 (LD_{50}) was found in 40 Gy at third week of irradiation.

Twenty adult pulse beetles (*Callosobruchus chinensis*) were irradiated @ 50 Gy, 100 Gy, 150Gy, 200 Gy while 20 adults were used as untreated control. After 7 days of irradiation all of the 20 adult beetles were found dead at 200 Gy with 100% mortality which was statistically similar to that of 150 Gy irradiation.

Differences were observed among the seven tested variety/mutants of rice regarding stem borer infestation. There was no dead heart symptom among the tested variety/mutants but few white head by stem borer infestation ranged from 0.041 to 0.280 percent were found in RM-16-N-10-1 and TN1 respectively.

The lowest number of jassid/plant and infested leaf by cutworm was observed in advanced line BCB-4 and BCB 3-4-3 respectively. Lowest number of thrips/plant was observed in advanced mutant line BCB 3-1-2. For leaf roller infestation the lowest number of rolled leaf/plant were found in advanced mutant line BCB 3-4-3.

Mean infestation of jassid was higher in MBM-656-51-2 than BARI Mung-6. The tested mutant MBM-656-51-2 showed statistically same or better performance against all other major insect pests than the check variety BARI Mung-6.

The highest aphid infestation/plant was recorded in advanced lentil mutant LM-4 and lowest in advanced mutant LM-99-8 accordingly the highest percent plant infestation was observed in advanced mutant LM-4 and lowest percent plant infestation was in advanced mutant LM-99-8 at Ishurdi substation.

Among tested three advanced rice lines, BPH-P-065 was found to be moderately susceptible and rest two advanced lines were susceptible to brown plant hopper under artificial infested condition.

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

Two experiments were conducted during August-October 2022 and March-May 2023 to confirm the previous year results on investigation of the effect of gamma radiation doses on adult emergence, mortality and sterility of cucurbit fruit fly, *B. cucurbitae*. Experiments were carried out in the growth room of Entomology Division, BINA under controlled environment of 25^{o}C. In the first experiment, the pupae of cucurbit fruit fly were irradiated @ 0, 20, 30, 40 and 50 Gy of gamma rays as like previous year. In previous years study, larvae emerged at 0 and 20 Gy in F_1 generation while no larva emerged at 30, 40 and 50 Gy which revealed that 30 Gy of radiation to pupae found to induce sterility of cucurbit fruit fly and sufficient amount of adult was come out from pupae irradiated below 30 Gy. In the first experiment, there was no satisfactory adult emergence (only 10-25%) from irradiated as compared to the control (75-95%). In the 2nd experiment, four doses of irradiation (25, 30, 35, 40 Gy) was applied and pupae produces only (5-20%) compared to unirradiated pupae (80-90%) which was fully contradictory to the findings of previous year study. So further study needs to be conducted to find out the error and irradiation dose for sterility of *B. cucurbitae*.

Evaluation of different IPM treatments against major insect pests of soybean

Two experiments were conducted to evaluate the effectiveness of four bio rational and one synthetic insecticide along with pheromone trap against leaf roller, jassid, white fly and pod borer of soybean. Experiments were laid out at BINA farm, Mymensingh during kharif-2, 2022 and rabi season of 2022-23 following randomized complete block design with three replications. The test variety was Binasoybean-5 and unit plot size was 3m × 3m. Seed were sown on July 19, 2022 in kharif-2 and December 14, 2022 in rabi. Biorational insecticides were Ebamectin (Biomax M) Matrin (Biotrin), Azadirachtin (Fytomax), SNPV (Spodoptera Nuclear Polyhedrosis Virus) and synthetic insecticide was Chlorantraniliprole (Coragen). Insecticides were sprayed at 45 and 55 days after sowing at recommended dose by producer. Untreated plot was used as control. Data on leaf roller were taken on total infested plants in two rows while jassid and white fly were counted by 5 random caging method at 10 days after treatment application. Data on pod borer infestation was taken from 10 randomly selected plants at harvest. Two pheromone (spodolure) traps were set in the experimental plot and number of trapped spodoptera moths were counted daily starting from 8 weeks after sowing. Plots following disperse replication were used as untreated control. Data on per cent leaf roller infested plants, number of jassid, white fly per cage and per cent pod infested by pod borer were transformed and then analyzed using Statistix 10 software. Percentage of infestation reduction over control was calculated by the following formula:

$$\text{Reduction over control (\%)} = \frac{\text{Control-Treatment}}{\text{Control}} \times 100$$

Chlorantraniliprole **(**Coragen) had significant effect in reducing 66.90% of jassid infestation over untreated control in kharif-2. Matrin (Biotrin) and Ebamectin (Biomax M) also had significant role of 33.09 and 32.37 percent reduction of jassid infestation over control, respectively. Only Chlorantraniliprole (Coragen) played significant role of 50.70 percent white fly population reduction as compared to untreated control in kharif-2 season. Aphid and pod borer infestation were also highly reduced by Chlorantraniliprole (Coragen) followed by SNPV and Ebamectin (Biomax M). The highest yield increase of 33.82% was recorded in Chlorantraniliprole (Coragen) treated plot which was followed by Ebamectin (Biomax M) and Matrin (Biotrin). Number of trapped spodoptera moth was higher at early weeks after sowing in kharif-2 season and gradually decreased at 10 weeks after sowing. Abundance of spodoptera slightly increased in 11th week after sowing and number of trapped spodoptera recorded below 20 up to 16 weeks (October, 2022) when soybean became matured.

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

An experiment was conducted to evaluate the effectiveness of three bio-rational and one synthetic insecticide against fall army worm (FAW), *Spodoptera frugiperda* of maize. The experiment was laid out at BINA farm, Mymensingh during khaif-1 season of 2022-23 following randomized complete block design with three replications. The unit plot size was 4m × 5m. Seed were sown on April 22, 2023. Biorational insecticides were Cyantraniliprole (Fortenza), SfNPV (*Spodoptera frugiperda* Nuclear Polyhedrosis Virus), SNPV (Spodoptera Nuclear Polyhedrosis Virus) and synthetic insecticide was Chlorantraniliprole **(**Coragen). Seeds were treated with Cyantraniliprole (Fortenza) before sowing. Insecticides were sprayed at 25, 35 and 45 days after sowing at recommended dose by producer. Untreated plot was used as control. Data on spodoptera infestation were taken on total infested plants in the plot at 10 days after treatment application. Data on per cent FAW infested plants were transformed and then analyzed using Statistix 10 software. Percentage of infestation reduction over control was calculated by the following formula:

$$\text{Reduction over control (\%)} = \frac{\text{Control-Treatment}}{\text{Control}} \times 100$$

Chlorantraniliprole **(**Coragen) had significant effect in reducing 83.7% and 97.64% of FAW infestation over untreated control at 10 days after 1st and 2nd application of treatment, respectively. Although SfNPV did not have any significant role after 1st spray in reducing FAW infestation but alternate 2nd spray of Chlorantraniliprole (Coragen) significantly reduced 86.77 percent of FAW infestation. The experiment will be repeated in next year to confirm the result.

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

A field experiment was conducted to find out suitable management approach against mite (*Polyphagotarsonemus latus*) and thrips (*Scirtothrips dorsalis*) complex of chili during rabi season of 2022-23 at BINA farm, Mymensingh. The experiment was laid out in a randomized complete block design (RCBD) with 3 replications. There were five treatments namely, Matrin (Biotrin 0.5%) @ 1.4ml/L, K-mite 0.5% @ 1ml/L, Alternate spraying of Imidacloprid 20SL (Admire 20SL) @ 1ml/L and Abamectin (Vertimec18EC) @ 1.25ml/L, Spinosad 44.03% W/W (Tracer 45SC) @ 0.4ml/L, Alternate spraying of Spinosad 44.03% W/W (Tracer 45SC) @ 0.4ml/L and Abamectin (Vertimec18EC) @ 1.25ml/L twice starting from the first appearance of thrips or mite infestation at 10 days interval. The unit plot size was 3m × 2m and plant spacing was 45cm × 35cm. The seedlings were transplanted on December 12, 2022. Data on number of thrips were recorded from 12cm upper twig per plant from randomly selected 5 plants per plot. A piece of white paper was placed below twig and three equal pressures put on the twig with finger then fallen number of thrips was recorded at 3, 5 and 7 days after treatment application. Mite infestation data were recorded on number of infested leaves from 5 randomly selected plants at 7 and 14 days after 2nd dose of treatment application. Percent reduction over control of thrips and mite infestation was calculated by the following formula:

$$\text{Reduction over control (\%)} = \frac{\text{Control-Treatment}}{\text{Control}} \times 100$$

From the results, it was evident that after treatment application Spinosad+Abamectin followed by Imidacloprid+Abamectin perform better in reduction of mite and thrips infestation in chili. The untreated control exhibited significantly highest mite and thrips infestation. On the third day after treatment application, number of thrips was lowest

(2.27thrips/12cm twig) in Spinosad+Abamectin treated plots with population reduction of 64.53%. After 5th and 7th day of treatment application, number of thrips was lowest of 2.33 and 1.67 thrips/12cm twig in Spinosad treated plots with population reduction of 66.71% and 76.58%, respectively. At 14th day of treatment application, mean number of mite infested leaves/plant was lowest (16.00) in Spinosad+Abamectin treated plots with population reduction of 78.69% which was statistically similar to that of K-mite, Imidacloprid + Abamectin and Spinosad treated plots. The highest yield (19.59 t/ha) was obtained from Spinosad+Abamectin treated plot which was statistically similar to that of Imidacloprid+Abamectin (18.80 t/ha). So, it may be concluded that alternate spraying of Spinosad (Tracer 45SC) @ 0.4ml/L and Abamectin (Vertimec18EC) @1.25ml/L water twice starting from the first appearance of thrips or mite infestation at 10 days interval was the most effective against mite and thrips complex of chili in respect of reducing pest infestation with higher fruit yield.

Determination of radiation dose to control rice weevil in storage

An experiment was carried out to determine the lethal radiation dose (LD_{50}) to control rice weevil, *Sitophilus oryzae* during 2022-23 at Entomology laboratory, BINA, Mymensingh. The experiment was designed in CRD with three replications. For each treatment, 30 adult rice weevils in 50g of rice were exposed to different dosage of gamma radiation viz., 0, 20, 30, 40 and 50 Gy. After first week of irradiation, the lowest survival (89.89%) and the highest mortality (10.11%) was observed in 50 Gy which was significantly different than that of other treatments while no mortality was found in control treatment. After second week, the lowest survival (69.00%) and the highest mortality (31%) were observed in 50 Gy. After third week of irradiation, survival percent decreased and accordingly mortality percent increased with the increase of radiation dose. Considering all the treatments, it was evident that with the increase of radiation dose, survival percentage decreased accordingly mortality percentage increased.

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

An experiment was conducted to find out lethal dose of radiation to pulse beetle (*Callosobruchus chinensis*) during 2022-23 at Entomology laboratory, BINA, Mymensingh. The experiment was laid out in a complete randomized block design with three replications. There were four doses of radiation treatments namely, 50 Gy, 100 Gy, 150Gy, 200 Gy and untreated control. A total of 300 adult pulse beetles were separated from stock culture and they were distributed into three replications of four doses and untreated control. Each replicated treatment contains 20 adult beetles which were irradiated and placed in mungbean for further evaluation. Dead pulse beetles were counted after 24 hours, 72 hours and 7 days after irradiation. From the result, it was evident that after 24 hours of 200 Gy irradiation, 43.33% mortality of pulse beetle was found which was statistically similar to that of 150 Gy (40%). The untreated control exhibited significantly the lowest mortality (8.33%). After 72 hours of irradiation, highest mortality 98.33% was found at 200 Gy followed by 150 Gy treatment which resulted in 88.33% mortality of pulse beetle. After 7 days of irradiation, 100% mortality was found at 200 Gy of irradiation which was statistically similar to that of 150 Gy (98.33%) irradiation. The untreated control exhibited the lowest mortality (23.33%). We need to find out the exact lethal dose of irradiation for pulse beetle which will kill them instantly or as soon as possible after irradiation. None of the tested doses were found to be effective to do that. So, further investigation is needed to find out the lethal dose of radiation.

Evaluation of advanced rice mutant/lines against major insect pests in the field

An experiment was conducted to find out the reaction/performance of advanced rice mutant/lines against major insect pests in field condition. The experiment was laid out in a randomized complete block design with three replications during Boro season of 2022-23 at BINA farm, Mymensingh. Seven advanced mutant lines of rice, RM-16-N-8-1, RM-16-N-10-1, BLB-P-042, BPH-P-065, MEF-27, BN-P-102, BN-P-120 were tested along with one susceptible check, TN1 against major insect pest under field condition. No protective measure was taken to control the insect pests. Percent dead heart data was recorded at 45 days after transplanting and white head data at 10 days before harvesting. No dead heart symptoms were found during the tillering stage and very few percent of white head symptoms which ranges from 0.019 to -0.163 were observed among the tested mutants/lines of rice with respect to stem borer infestation. The infestation of stem borer was found to be below the economic threshold level.

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

An experiment was conducted to evaluate the performance of advanced groundnut mutant lines against major insect pests in field condition in a randomized complete block design with three replications at BINA farm, Mymensingh. Seven advanced mutant/lines of groundnut, BCB 3-1-2, BCB 3-4-1, BCB 4-2-2, BCB 3-4-3, BCB-4, BCB-3, BCB 3-4-5 were tested along with one check, Binachinabadam-4 against jassid, thrips, cutworm and leaf roller. No protective measures were taken to control the insect pests. The lowest number of jassid/plant (1.47) was observed in advanced mutant/line BCB-4 which was statistically similar to BCB 3-4-1, BCB 4-2-2 and BCB 3-4-5. The lowest number of thrips/plant (2.27) was recorded in advanced mutant/line BCB 3-1-2 which was statistically similar to BCB 3-4-1, BCB 4-2-2, BCB-3 and BCB 3-4-5. The lowest number of infested leaf by cutworm (12.93) was observed in advanced mutant/line BCB 3-4-3 which was statistically similar to BCB 4-2-2 and BCB-4. For leaf roller infestation, the lowest number (0.40) was found in advanced mutant/line BCB 3-4-3.

Evaluation of advanced mungbean mutant against major insect pests

One advanced mutant (MBM-656-51-2) and one check variety (BARI Mung-6) of mungbean were assessed for their performance against jassid, whitefly, hairy caterpillar, leaf roller, cutworm and pod borer at BINA substation, Ishurdi in kharif-I season of 2023 under natural infested condition. The experiment was laid out in a randomized complete block design (RCBD) with three replications. The unit plot size was 4m x 5m. The incidence of jassid, whitefly, hairy caterpillar, leaf roller, cutworm and pod borer were recorded from vegetative stage to harvesting.

From the result, it was evident that mean number of jassid per cage was higher (4.27) in MBM-656-51-2 than that of BARI Mung-6 (3.13). There was no significant difference in whitefly and percent leaf infestation by hairy caterpillar. The mutant MBM-656-51-2 significantly differed and performed better than check variety, BARI Mung-6 in respect of percent leaf infested by leaf roller (4.96) and cutworm (14.07). No significant difference was observed in percentage of pod infested by pod borer in MBM-656-51-2 and BARI Mung-6 but infestation was comparatively higher in BARI mung-6 (9.96%) than MBM-656-51-2(8.47).

Evaluation of lentil mutants against aphid

An experiment was conducted to find out the performance of advanced lentil mutant lines against aphid in field condition in a randomized complete block design with three replications in Rabi season, 2022-23 at BINA farm, Mymensingh and BINA substation, Ishurdi. Two advanced mutant of lentil, LM-99-8 and LM-4 were tested along with one check variety, Binamasur-8. No protective measure was taken to control the insect pest. There were no aphid infestation at BINA farm, Mymensingh and very few infestation of aphid was observed at Ishurdi. The highest percentage of plant infested by aphid (6.42) was observed in LM-4 and the lowest of that one (2.99) was in LM-99-8.

Evaluation of advanced rice lines against brown plant hopper under artificial infested condition

An experiment was conducted to find out the reactions of advanced rice lines against brown plant hopper (*Nilaparvata lugens*) under artificial infested condition. Three advanced lines of rice, viz. BPH-P-034, BPH-P-043 and BPH-P-065 were evaluated along with one susceptible check, TN1 against brown plant hopper under artificial infested condition during Aman season at the net house of Entomology division, BINA HQ, Mymensingh. Each test variety or line was seeded in 20-cm-long rows in a seed box (60 × 45 × 10 cm) rows were 5 cm apart. At the sixth day after seeding, plants were thinned to 25 to 30 seedlings per row. The seed boxes were placed on a galvanized iron tray on a table inside a screened room in the net house. The seedlings were infested at the 2-3 leaf stage (about 7 days after seeding) by uniformly scattering a large number of 2^{nd} and 3^{rd} instar BPH nymphs on them. The seed boxes were covered with fine-meshed nylon net after infestation. An average of 5-7 nymphs per seedling constituted an optimum population to differentiate the resistant level of tested lines. The damage rating was done when about 90% of the plants of the susceptible check were killed. The varieties were rated using the standard evaluation system for rice as described by IRRI. Among the three tested advanced lines of rice, one advanced line, BPH-P-065 was found to be moderately susceptible and rest two advanced lines were susceptible to brown plant hopper under artificial infested condition.

PLANT PATHOLOGY DIVISION

Research Highlights (2022-23)

Eight advanced lines and mutants showed moderately resistant reaction to bacterial leaf blight and fourteen mutant/lines showed moderately susceptible reaction to sheath blight under inoculated field condition in Aman season.

Twelve advanced lines were found to be moderately resistant to bacterial leaf blight and sixteen lines were showed moderately susceptible reaction to sheath blight under inoculated field condition in Boro season. All the tested line showed moderately resistant reaction to leaf blast disease in natural condition.

Three mustard lines (RT-35, RT-38 and RT-39) along with a check variety, Tori-7 were evaluated to alternria blight. The lowest disease incidence was recorded in the line RT-39 (25.7%) and the check variety Tori-7 had the highest (51.9%) incidence. All three lines showed moderately susceptible reaction to alternaria blight.

Three mutants of groundnut showed moderately resistant reaction to foot and root rot and cercospora leaf spot diseases.

Two mutants of soybean (SBM-02 and SBM-07) showed tolerant reaction to collar rot disease and three mutants (SBM-02, SBM-05 and SBM-07) showed resistant reaction to yellow mosaic disease.

Three advanced mutants of lentil (LM- 20-4, LM-99-8 and LM-118-9) were found to be tolerant to root rot and all three mutants were found moderately resistant to stemphylium blight in Ishwardi. In Magura, all the mutants were found moderately susceptible to susceptible against root rot and stemphylium blight. In Chapainowabganj, all the mutants were found moderately susceptible to susceptible against root rot while all mutants are moderately resistant against stemphylium blight disease.

Three advanced mutants (BM-63, BM-105 and BM-108) of blackgram showed moderately resistant reaction against cercospora leaf spot, powdery mildew and yellow mosaic at Mymensingh.

To control the black mold disease of onion (*Aspergillus niger*) bulbs were subjected to gamma radiation with four doses: 800Gy, 900Gy, 1000Gy and 1100Gy and were kept at ambient conditions for four months. Disease incidence decreased with increased dose of radiation and increased with the passage of time in all treatments as well as the control.

Twelve different waste products (rice straw, rice bran, chickpea bran, lentil straw, lentil bran, blackgram straw, peanut shell, saw dust, wheat bran, wheat straw, mungbean straw, cow dung) were evaluated for mass production *Trichoderma* isolate (TR-10). The highest number of colony of *Trichoderma* was found in the chickpea bran (398 cfu $\times 10^7$/g) and the least number of colony (68 cfu $\times 10^7$/g) was formed in saw dust.

The antagonistic activity of twenty isolates of *Trichoderma* against a soil borne pathogen *Sclerotium rolfsii* was evaluated through dual culture assay. The growth inhibition (%) of *S. rolfsii* ranged from 47.6-73.8%. The maximum inhibition against *S. rolfsii* was recorded by TR2 isolate (73.8%) and the minimum inhibition was recorded by the isolate TR7 (47.6%).

In fungicide evaluation against sheath blight of rice, in Mymensingh Iglare 24 SC was found to be superior in three different stage of plant growth in terms of low disease incidence (65.27b%, 77.95%, 81.83%), and low disease severity (4.86, 7.00 and 8.93). In Nalitabari, Nativo 75 WG performed the best in reducing percent disease incidence (70.94%, 84.85%,85.97%) compared to control.

In the experiment of fungicides treatment of rice seeds on bakanae disease, no disease was found in Safezim and Tufan treated plot in Mymensingh and Naliatbari.

Four chemical and one bio-agent were used for the management of root rot of lentil in the experiments at BINA sub-station farm of Ishwardi, Magura and Chapainawabganj, In Ishwardi and Magura the lowest disease incidence (21.66% and 20.00%) and the highest yield (1.706 and 1.758 t/ha.) was found by applying Filia 525 SE. In Chapainawabganj, the lowest disease incidence (16.56%) was found by applying Amister Top 325 SC.

In the experiment of isolation and molecular characterization of *Ustilaginoidea virens* isolates causing false smut of rice, a standard protocol for isolating *Ustilaginoidea virens* is in progress.

For molecular identification of *Fusarium* spp. associated with bakanae disease of rice in Bangladesh, 15 isolates were collected and preserved for next year experiment.

All thirteen (13) different varieties/advanced lines showed a highly susceptible response with a D.I. rating of 5. Three varieties, namely BINA Sarisha7, BINA Sarisha8, and BARI Sarisha18, exhibited high yields despite their susceptibility to Alternaria leaf spot disease.

Molecular screening of major rice blast resistance genes was determined with molecular markers, in which eleven genotypes carried the *pish* gene, twenty genotypes carried the *pi9* genes respectively out of seventy genotypes which includes Thirty indigenous varieties & Forty advanced lines.

The presence of *Xa4* gene in forty-seven genotypes, while *xa5* in forty genotypes & One genotype carried the *xa13* gene among seventy genotypes. Among these, eighteen genotypes had two (*Xa4 + xa5*) & 1 genotypes had three (*Xa4 + xa5 + Xa13*) BB resistance genes, respectively.

From the morpho-molecular study, the mutant lines CIMMYT Line-2 (150Gy), BARI Gom-26 (150 Gy), BARI Gom 33 (300 Gy), BARI Gom-26 (300 Gy) were highly proficient for reducing the disease incidence and disease severity of wheat blast disease and also had higher grain yield.

Evaluation of mutants/advanced lines of rice for sheath blight and bacterial leaf blight during aman season

An experiment was conducted to evaluate the level of field resistance/tolerance of advanced mutants/lines of rice against sheath blight and bacterial leaf blight in aman season of 2022 under inoculated field condition. Five mutants and 11 advanced lines of rice along with 4 varieties were used. The experiment was conducted in a randomized block design with three replications at BINA farm, Mymensingh. Twenty-five days old seedlings were transplanted in the field on 29 July 2022. Ten hills in each plot were inoculated at the booting stage with

X. oryae pv. *oryzae* by clipping method. Similarly, ten hills in each plot were inoculated at the booting stage with seven days old culture of *R. solani*. Plants were assessed for bacterial leaf blight and sheath blight severity after two and three weeks of inoculation, respectively following the developed scale (0-9) at IRRI (2013). Eight advanced lines and mutants of rice showed moderately resistant reaction to bacterial leaf blight and fourteen mutant/lines showed moderately susceptible reaction to sheath blight under inoculated field condition in Aman season.

Evaluation of some promising mutants and advanced lines of rice for bacterial leaf blight and sheath blight during boro season

Sixteen advanced lines along with four varieties were screened for resistance/tolerance to sheath blight and bacterial leaf blight during boro season of 2022-23 under inoculated field condition. The experiment was conducted in a randomized complete block design with three replications at BINA farm, Mymensingh. Thirty five days old seedlings were transplanted on 28 January 2023. The fertilizers were applied as per recommended doses. Ten hills in each plot were inoculated at the booting stage with *X. oryae* pv. *oryzae* by clipping method. Similarly, ten hills in each plot were inoculated at the booting stage with seven days old culture of *R. solani*. Plants were assessed for bacterial leaf blight and sheath blight severity after two and three weeks of inoculation, respectively following the scale (0-9) developed at IRRI (2013). Twelve advanced lines of rice were found to be moderately resistant to bacterial leaf blight and sixteen lines showed moderately susceptible reaction to sheath blight under inoculated field condition in boro season.

Evaluation of mustard-rapeseed lines against alternaria blight disease

A field evaluation of three mustard lines (RT-35, RT-38 and RT-39) and a check variety (Tori-7) against alternaria blight disease was conducted during November 2022 to February 2023 under natural field condition at BINA farm, Mymensingh. Experiment was laid out in a randomized complete block design with individual plot size of 6.0 m^2 with three replications. Seeds were sown on 13 November 2022. The severity scale 0-5 was followed for assessing the disease reaction at early pod maturity stage. The lowest disease incidence was recorded in the line RT-39 (25.7%) and the check variety Tori-7 had the highest one (51.9%). All four lines of mustard showed moderately susceptible reaction and the check variety was susceptible to alternaria blight.

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

Seven advanced lines of groundnut along with one variety were evaluated for their resistance to foot and root rot and cercospora leaf spot diseases under field conditions at Mymensingh in 2023. The experiment was conducted in a randomized complete block design with three replications. The unit plot size was 2 m x 2 m. Spacing between rows and plants were 40 cm and 15 cm, respectively. Seeds were sown on 23 January 2023. The disease severity was assessed following the scale 0-4 and 0-5 for foot and root rot and cercospora leaf spot, respectively. Three lines (BCB-3, BCB-4 and BCB-4-2-2) showed moderately resistant reaction and rest 4 lines (BCB-3-4-1, BCB-3-4-3, BCB-3-4-5 and BCB-3-1-2) showed moderately susceptible reaction to cercospora leaf spot.

Evaluation of soybean mutants against collar rot and yellow mosaic disease

An experiment was conducted at BINA farm, Mymensingh to screen the mutants of soybean against collar rot and Soybean Mosaic Virus (SMV) during rabi season of 2022-23 under field inoculated condition. Three mutants (SBM-02, SBM-05 and SBM-07) and two check varieties (Binasoybeean-5 and Binasoybeean-6) were used in this experiment by following RCBD design with three replications. The unit plot size was 2.0 m × 1.50 m. Seeds were sown on 15 December maintaining row to row distance 75 cm and line to line distance 30 cm. The fertilizer was applied at recommended doses. Twenty seedlings of thirty days old were inoculated with 10 days old culture of *Sclerotium rolfsii* in each plot. With appearance of visible symptoms, observation on disease severity of collar rot was made at pod ripening stage following (0-9) scale and the severity of yellow mosaic was recorded on a 0-8 scale. Two mutants of soybean (SBM-02 and SBM-07) showed tolerant reaction to collar rot disease and three mutants (SBM-02, SBM-05 and SBM-07) showed resistant reaction to yellow mosaic disease.

Evaluation of lentil mutants against root rot and stemphylium blight disease

Three trials using three advanced mutants and two check varieties of lentil were conducted to screen lentil mutants against root rot and stemphylium blight at Ishwardi, Magura and Chapainowabganj during the winter season of 2022-23 under inoculated condition. The experiment was conducted in randomized complete block design with three replications. The seeds were sown in rows on last week of November 2022 in three locations. Distance between rows and seeds were 30 cm and 5 cm, respectively. The root rot and stemphylium blight disease incidence and severity was recorded using standard disease rating scale 0-9. Two mutants (LM- 20-4 and LM-118-9) were found tolerant in Ishwardi, but LM-20-4 showed moderately susceptible reaction and LM-118-9 showed susceptible reaction in rest two locations. In case of stemphylium blight, three advanced mutants were showed moderately resistant reaction in Ishwardi and Chapainawabganj.

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

An experiment was conducted to evaluate black gram mutants against cercospora leaf spot, powdery mildew and yellow mosaic virus diseases. Screening was done under natural field conditions at BINA farm, Mymensingh in kharif-2 season of 2022. The experimental material included three advanced mutants (BM-4, BM-42 and BM-63) and two check varieties (Binamash-2 and BARI Mash-3) of black gram which were screened in a randomized complete block design with three replications. The seeds were sown on 11 October 2022 and the unit plot size was 2.0 m x 1.2 m. The recommended doses of fertilizer were applied and normal cultural practices were followed. The incidence and severities of CLS, powdery mildew and YMV were recorded from flowering to maturity. Three advanced mutants (BM-63, BM-105 and BM-108) of blackgram showed moderately resistant reaction against cercospora leaf spot, powdery mildew and yellow mosaic.

Management of storage disease of onion bulb with gamma radiation

An experiment was carried out in the laboratory of Plant Pathology Division, BINA to control the black mold disease of onion with radiation. Onion bulbs (variety Taherpuri) were irradiated at BINA using ^{60}Co gamma source with four different doses: 800Gy, 900Gy, 1000Gy and 1100Gy. The non-irradiated onion bulbs were kept as control (0Gy). The experiment was conducted with CRD having four replications. The irradiated and non-irradiated bulbs were kept at ambient conditions for four months. Data on disease incidence

of black mold (%) were recorded for four times at one month interval during the whole storage period. After 4 months of storage, the disease incidence increased upto 56.5% in the control, in 800Gy it was 15.2%, in 900Gy it was 14.1%, in 1000Gy it was 12.6% and in 1100Gy it was 8.4%. At the end of the storage the disease incidence increased upto 56.5% from 16.2% in the control, in 800Gy it was upto 15.2% from 4.8%, in 900Gy it was upto 14.1% from 4.4%, in 1000Gy it was upto 12.6% from 3.9% and in 1100Gy it was upto 8.4% from 3.5%. Therefore, disease incidence decreased with increased dose of radiation and increased with the passage of time in all treatments as well as the control.

Evaluation of different waste products for mass production of *Trichoderma*

Present study was undertaken to select effective substrate (s) for mass multiplication of *Trichoderma*. Twelve different waste products (rice straw, rice bran, chickpea bran, lentil straw, lentil bran, blackgram straw, peanut shell, saw dust, wheat bran, wheat straw, mungbean straw, cow dung) were evaluated in the laboratory of Plant Pathology Division, BINA following completely randomized design with four replications. The substrates were filled in the conical flasks (250ml) and sterile water was added in order to keep 60% moisture approximately and sterilized in an autoclave at 121.6°C (15 psi). Discs (5mm) of *Trichoderma* from 7 days old culture were inoculated in aseptic condition @ 5-6 discs/flask. The inoculated flasks were incubated for at 26^0C. After a month of inoculation, the entire content of the flasks was mixed thoroughly using a sterile glass rod. Then 1g substrate was taken and was serially diluted to get the final dilution of 10^7. One ml from this solution was spread over a petridish containing PDA medium. The inoculated petriplates were incubated at 26±1ºC for 7 days. The number of colony of *Trichoderma* spp. was expressed as cfu/g substrate. The highest number of colony was found in the chickpea bran (398 cfu $\times 10^7$/g) followed by wheat straw (280 cfu $\times 10^7$/g), rice bran (270 cfu $\times 10^7$/g) and peanut shell (255 cfu $\times 10^7$/g). The least number colony (68 cfu $\times 10^7$/g) was formed in saw dust followed by rice straw (109 cfu $\times 10^7$/g).

Characterization of *Trichoderma* isolates and their evaluation against major soil borne pathogens

This research aimed to isolate and identify native strains of *Trichoderma* spp. with potential activity against major soil borne pathogens. Twenty isolates of *Trichoderma* spp. were collected from rhizosphere soil of crop fields by soil dilution techniques. The isolates of *Trichoderma* spp. were characterized morphologically. The antagonistic activity of the isolates against the pathogen, *Sclerotium rolfsii* was evaluated through dual culture assay. Seven biochemical tests like hydrolysis of aesculin, starch, casein, tween 80, polypectate, gelatin test and reduction of tetrazolium test were conducted on PDA. The growth inhibition of *S. rolfsii* (%) ranged from 47.6-73.8%. The maximum inhibition against *S. rolfsii* was recorded by the isolate TR2 (73.8%), followed by TR8 (73.7%) and TR18 (73.5%). The minimum inhibition was recorded by the isolate TR7 (47.6%) followed by TR10 (63.2%), TR16 (63.6%) and TR12 (63.7%). Among 20 isolates, 15 isolates confirmed positive result and the rest 8 isolates had negative result in Hydrolysis of Starch. In hydrolysis of Casein, all 20 isolates confirmed positive result. In hydrolysis of Tween 80, all 20 isolates showed negative result. In hydrolysis of Gelatin, 16 isolates confirmed positive result and the rest 7 isolates had negative result. In reduction of Tetrazolium, all 20 isolates had negative result. In hydrolysis of Polypectate, 20 isolates confirmed positive result.

Evaluation of new fungicides against sheath blight of rice

The present study was undertaken to evaluate the new molecule of fungicides against *R. solani*. This experiment was conducted in Aman season of 2022 at BINA HQ, Mymensingh and Nalitabari under inoculated field condition. The disease susceptible Aman rice variety BR11 was used as the test material. Each plot was inoculated at the booting stage with seven days old culture of *Rhizoctonia solani*. The fungicides like Iglare 24 SC, Amister top 325SC, Seltima Nativo 75 WG and Contaf 5 EC were applied two times at 15 days interval after first appearance of diseases with the doses of 1.5 ml/L, 1ml/L, 2g/L, 0.4g/L and 1ml/L of H_2O, respectively. In Mymensingh, Iglare 24 SC was found to be superior in three different stage of plant growth in terms of low disease incidence (65.27b%, 77.95%, 81.83%), and low disease severity (4.86, 7.00 and 8.93). At Nalitabari, Nativo 75 WG performed the best in reducing disease incidence (70.94%, 84.85%, 85.97%) as compared to the control.

Evaluation of new fungicides for the control of bakanae of rice

To control bakanae disease five fungicides from different fungicidal groups were evaluated for their efficacy against seed-borne *Fusarium* spp. as seed treatment at BINA farm, Mymensingh and Nalitabari during Aman season of 2022. A rice variety BRRI dhan 32 which is susceptible to bakanae disease was used for the study. Fungicides were evaluated at the recommended dose. Twenty-two days old seedlings of each plot were inoculated by dipping their roots in freshly prepared inoculum suspension of *Fusarium sp.* (10^5 spores mL^{-1}) for overnight. Overall performance of the fungicides were found to be better in suppressing seed-borne pathogen *Fusarium sp.* and also were increased seed germination rate. Among the fungicides, no disease was found in Safezim and Tufan treated plot in Mymensingh and Nalitabari.

Management of Stemphylium blight disease of lentil

An experiment was carried out by using four chemical fungicides along with one bio-agent at BINA sub-station Ishwardi, Magura and Chapainawabganj following RCBD with three replications during Rabi 2022-23 to manage stemphylium blight. Four chemical treatment and one bio-agent viz. Amister top, Seltima, Nativo 75 WG, Filia 525 SE and *Trichoderma asperellum* (Suspension 2×10^6/ml) along with control plot were tested in the field. In Ishwardi, the mean incidence of stemphylium blight in treated plot ranged from 21.66-63.33% where Filia 525 SE performed the best for lower percent of disease incidence (21.66%), minimum leaf infection/plant (10.33%) and the highest yield (1.706 t/ha). The highest disease incidence was found in control (76.67%). In Magura, the mean incidence of stemphylium blight in treated plot ranged from 20-35%, and Filia 525 SE performed the best for lower percent of disease incidence (20%), minimum leaf infection/plant (12.37%) and the highest yield (1.758 t/ha). In Chapainawabganj, the mean incidence of stemphylium blight in treated plot ranged from 16.56-31.86% and Amister top 325SC performed the best for lower percent of disease incidence (16.56%) and minimum leaf infection/plant (9.3%).

Isolation and molecular characterization of *Ustilaginoidea virens* causing false smut of rice

An experiment was conducted to isolate and characterize *Ustilaginoidea virens* causing false smut disease of rice under Plant Pathology Division laboratory, BINA. Rice grain samples showing typical false smut symptoms were collected from different location of Kurigram, Rangpur and Mymensingh during Aman 2022. Infectious pathogen was isolated from the infected ball and tranferred on PSA medium. The PSA plates were incubated at 28 ± 2 °C for 15 days. After 15 days of incubation, as the colonies grew, they were periodically transferred to fresh PSA media and kept for full plate growth. After one month very poor growth was

found. A standard protocol for isolating *U. virens* will be established in the next year and then subsequent characterization will be done.

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

An experiment was carried out in the laboratory of Plant Pathology Division, BINA to assess the variability of *Fusarium* from bakanae disease infected rice in Bangladesh and evaluating their pathogenicity on susceptible rice cultivar. Infected rice plants having typical symptom of bakanae disease were collected from BINA sub-station, Chapainawabgonj, Cumilla, Barishal, BINA regional station Gazipur and BINA HQ, Mymensingh. Fifteen isolates of *Fusarium* spp. isolated from symptomatic diseased plants and these will be characterized for their morphology, pathogenicity and molecular variability using universal rice primers (URP) in next year.

Screening for alternaria blight disease of mustard-rape seed through conventional and gene based molecular marker

A study was conducted to identify the source of resistance gene against alternaria leaf spot disease from mustard plants. Thirteen different varieties/advanced lines were evaluated in 2022-23 at the experimental field of BINA HQ in Mymensingh. Specific fragment of ~600bp was amplified by PCR using primers *Acola-sens*: 5′-GCAGCA TCTGCTGTTGGG G-3′ and *Acola-reverse*: 5′-CAAGGTCAGCATCCATAAAGCC-3′ for *A. brassicicola* isolates. At 60 days after sowing (DAS), two varieties (Binasarisha-4 and Binasarisha-8) showed a moderately susceptible response with a Disease Incidence (DI) rating of 3, while seven varieties exhibited a susceptible response with a DI rating of 4. Four varieties were exhibited highly susceptible reaction with a DI rating of 5. At 70 DAS, eight genotypes showed a susceptible response with a DI rating of 4, while five lines were exhibited a 0highly susceptible reaction with a DI rating of 5. At the final assessment (80 DAS), all 13 genotypes showed a highly susceptible response with a DI rating of 5. Three varieties, namely Binasarisha-7, Binasarisha-8, and BARI Sarisha-18, exhibited high yields despite their susceptibility to alternaria leaf spot disease.

Detection of blast resistant gene(s) in BINA germplasm and advance lines of rice by usings gene based molecular markers

Experiments were conducted to identify blast-resistant fragrant genes in some indigenous, advanced lines and cultivated rice varieties for the development of a durable blast-resistant rice varieties based on phenotypic screening and molecular analysis. A total of seventy genotypes which included thirty indigenous varieties, forty advanced lines were selected to detect the presence of major blast resistance genes, i.e *Pish* and *Pi9* which are the effective blast-resistant genes against blast isolates in Bangladesh. Advanced rice lines showed better performance as compared to cultivated lines. Two primers (*pish, pi9*) were tested and found that eleven genotypes carried *pish* gene, twenty genotypes carried the *pi9* genes and other genotypes carried no blast-resistant genes.

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

The present study was undertaken to identify bacterial leaf blight resistant genes in some indigenous, advanced lines and cultivated rice varieties based on pathogenicity tests and molecular screening. A total of seventy genotypes which included thirty indigenous varieties and forty advanced lines were selected to detect the presence of major bacterial blight resistant genes, i.e., *Xa4, xa5, xa13, Xa21* and *Xa23*, using molecular markers. Among them,

forty-seven genotypes carried the *Xa4* gene, forty genotypes carried the *xa5* gene and one genotype carried the *xa13* gene, eighteen genotypes had two *(Xa4 + xa5)* and 1 genotype had three (*Xa4 + xa5 + xa13*) BB resistant genes.

Morpho-molecular screening of gamma irradiated wheat mutants for blast resistance

Seeds of two varieties (BARI Gom-26, BARI Gom-33) and one CIMMYT line (CIMMYT Line-2) were irradiated with four different doses of gamma rays (150, 200, 250 and 300Gy). The irradiated seeds were sown at BINA HQ Research Farm, Mymensingh. Among the treatments, 150 Gy and 300 Gy reduced the disease significantly. Molecular detection of 2NS/2AS translocation in mutant lines were also done using specific primers. The size of the band (259 bp) confirmed the 2NS/2AS translocation in mutant lines. From this morpho-molecular study, CIMMYT Line-2 (150Gy), BARI Gom-26 (150 Gy), BARI Gom-33 (300 Gy), BARI Gom-26 (300Gy) having 2NS/2AS translocation were observed as high yielding lines suppressing wheat blast significantly.

AGRICULTURAL ENGINEERING DIVISION

Highlight of the Research Results

- Under field condition, rice line BSB-24 is capable to produce yield 5.89 t ha^{-1} and 4.55 t ha^{-1} under supplemental irrigation and rainfed condition, respectively.
- Seed yield and straw yield of mustard decreased with the increase of sowingtime soil moisture.
- Longterm watertable dynamics showed that the patterns of monthly watertable at Mymensingh were decreased over time, which meant that the withdrawal rate was higher than the recharge.
- Maximum yield (2.68 tha^{-1}) of sunflower mutant was obtained in irrigating at vegetative, pre-flowering, and heading stages.
- Soil moisture stress during the growing period of lentil significantly affected the seed yield. The cultivar LM-1 was affected minimum due to moisture stress among the mutants.
- Foliar spray and replacement of fertilizer that contain chloride (KCl) had a positive effect on grain yield of Boro rice (Binadhan-10) under saline condition and able to produce 6.4 t ha^{-1} yield.
- For watermelon, in farmer's practice 10 nos. of irrigations was required (27 cm) whereas improved management like providing 'T. Aman rice residue layer below 20 cm root zone area' required less irrigations (8 nos, 18 cm) at Batiaghata, Khulna.
- Under field condition, sacrificing 10% yield, MEF-27 is capable to save about 34% irrigation water under irrigation at 7 days AWD (throughout the growing season).
- Application of three irrigations at 30, 75, and 110 days after sowing along with twinline and 30% excess of recommended fertilizer application produced the maximum grain yield of hybrid maize cultivars.
- The highest production (12.5 tha^{-1}) and BCR (3.5) of garlic were found with three irrigations along with organic matter @ 2 kg/m^2 in zero tillage practice.
- Under sandy loam soil, stagewise everyfurrow irrigation having twinrow line of plants produced the highest yield of potato compared to other management practices.
- The seed yields of mustard cultivars decreased with the increasing duration of water-logging.
- The accuracy of the irrigation sensor was found good (94 – 99% accuracy) under field condition.
- A smart insect controller has been developed. Further study is needed to evaluate the performance of the device.
- A biochar machine has been developed. Further study is needed to evaluate its performance, energy efficiency and economics.
- There was distinct increasing trend of monthly temperature at different decadal time scales (average of the decade) compared to that of base-year. For the monthly rainfall, there is evidence of distinct variation/fluctuating pattern over the months under both SSP4.5 and SSP8.5 emission scenarios.

Drought screening and irrigation management for field crops

Evaluation of some rice genotypes under different soil moisture stresses (in the field) during aman season

The field experiment was conducted at BINA HQs, Mymensingh to study the response of the cultivars to different levels of soil moisture stress.The scheduled treatments were: T_1 =

Control (Farmer's practice,i.e.rain-fed and irrigation), T_2= Supplemental irrigation at 15 days after disappearance of ponded water, T_3= Supplemental irrigation at 25 days after disappearance of ponded water, and T_4 = Onlyrainfed after establishment. Treatments were imposed after establishment (3 weeks from transplanting).The cultivars were: V_1 =BSB-24, V_2 = MPQR-62,V_3=MPQR-12, V_4 = BRRI dhan75 (check-1), V_5 = Binadhan-17 (check-2)and V_6 =BRRI dhan49 (check-3). The design was RCBD with split-plot technique. The seedling was 26 days old and transplanted on 27 July 2022. During the cropping period, 792 mm rainfall occurred. The statistical analysis was performed using statistical software of IRRI, "STAR".The irrigation treatments showed significant difference in grain yield, 1000 grain weight and seed panicle^{-1}.With the increase of water deficit (T_1 to T_5), the yield decreased. The cultivars showed significant differences in all parameters. The highest yield (5.21 t ha^{-1}) was obtained from cultivar V_5 (BSB-24). The cultivarsBSB-24, MPQR-62, and MPQR-12 were able to produce 3.92 t ha^{-1} under rain-fed condition at Mymensingh, but supplemental irrigation (3-4 Nos.) increased yield up to 5.19 t ha^{-1}. Among the cultivars, the line BSB-26 was the best as it was able to produce yield (4.55 t ha^{-1}) under rainfed condition and with supplemental irrigation (5.89 t ha^{-1}).

Optimization of soil moisture for direct seeded mustard under zero tillage

The field study was conducted at BINA HQ, Mymensingh to determine optimum soil moisture condition under zero tillage condition for higher yield of mustard (Binasarisha-9). The imposed treatments were: T_1 = Control (Farmer's practice, full tillage at farmer's moisture level), T_2 = Sowing at full saturation and 10-20% visible water stagnation/ponding, T_3 =Sowing at 80% saturation, T_4 =Sowing at full saturation and T_5 = Sowing at optimum moisture condition (37% VMC). Recommended fertilizer was applied before sowing except urea. First 50% urea was applied at 12 DAS and the rest was applied before flowering stage. Irrigation was applied when PASM (Plant Available Soil Moisture) goes below 50% of field capacity. Soil moisture was monitored by using TDR-300 (digital moisture meter).The soil was silty-loam and field capacity was about 36-38%. In full saturation condition, soil moisture was observed as 50-54%. During sowing of mustard seeds, existing moisture of soil were 36-38%. The germination rate was about 86-89% in all the treatments but final yieldable plants were reduced to about 53% in treatment (T_2) compare to treatment (T_1). In treatment T_2, the early vegetative growth was comparatively low.The maximum seed and straw yield, (1.89 t ha^{-1}) was obtained in the treatment (T_1) and minimum seed yield (1.25 t ha^{-1}) was obtained in the treatment (T_2). From overall observation it was noticed that seed yield and straw yield showed decreasing trend due to increase of sowing time soil moisture. To confirm the result, the experiment will be repeated in the next year.

Studies on groundwater dynamics for sustainable water management

Monitoring groundwater table fluctuation at BINA H_{qs}

The experiment was conducted to know the temporal and spatial pattern and trend of watertable. The water-table (WT) data were collected with the help of BINA developed watertable indicator at respected BINA sub-stations and BINA H_{qs}. Water table data recording protocol were: (i) weekly for dry period (March- April) and (ii) 15 days interval for the rest of the year. The patterns and trends of water-table data were examined by graphical method.Monthly watertable (WT) fluctuation pattern at BINA Head-quarters at Mymensingh in the yearly cycle (July-June) of 2011-12, 2012-13, 2016-17, 2020-21 and 2021-22. Normally, the suction limit is considered at 8 m from ground surface. It showed that the maximum depth to WT tend to below the suction limit of Shallow Tube Well (STW) started

from month of December-January at Mymensingh (BINA, H_{qs}) for cycle year 2016-17, 2020-21 and 2021-22. On the other hand, the maximum depth to WT tend to below the suction limit of STW started from month of February to March for cycle year 2011-12 and 2012-13. The patterns of monthly watertable yearly cycle (July – June) at Mymensingh indicated that, the depth of watertable was decreased over time, meaning that the withdrawal rate was higher than recharge.

Drought screening and irrigation management for field crops

Irrigation management for sunflower mutants

The field experiment was conducted at BINA H_{qs}, Mymensingh to find out the optimum irrigation requirement for sunflower mutants. The imposed treatments were: T_1 = Irrigation at vegetative, pre-flowering, heading and seed filling stages (4 irrigations); T_2 = Irrigation at vegetative, pre-flowering, and heading stages (3 irrigations); T_3 = Irrigation at 50% depletion of available soil moisture (ASM); and T_4 = Pre- or post-sowing irrigation, and then irrigation at 70% depletion of available soil moisture (ASM). The design was RCBD (Split-plot) with three replications and sunflower mutant lines were: L_1 = LP 300 and L_2 = DP 250. Soil moisture was monitored by using TDR-300 (digital moisture meter). The irrigation treatments showed significant difference. Maximum yield (2.68 t h^{-1}) was obtained in the treatment T_2 followed by the treatment T_1 (2.57 t h^{-1}) and minimum yield was obtained in the treatment T_4 (2.18 t h^{-1}). The mutants showed insignificant differences except flower diameter. The maximum seed yield (2.44 t h^{-1}) was found in mutant L_1 (LP-300). The maximum yield (2.70 t h^{-1}) was found in combination treatment T_2L_2 and the lowest yield (2.16 t h^{-1}) was obtained in treatment combination T_4L_2. To produce 1 kg of sunflower seeds, 347 litters, 326 litter and 214 litter water is required under the treatments T_2, T_3 and T_4, respectively, while normal irrigation (T_1) required 478 litters. Stage-wise irrigation of sunflower cultivation is important and maximum yield obtained irrigation at vegetative, pre-flowering, and heading stages for mutant line LP 300 (L_1) and DP 250 (L_2).

Evaluation of some lentil lines under different soil moisture stress in pot condition

The experiment was carried out at BINA H_{Qs}, Mymensingh to find out the effect of different soil moisture stress on lentil. The imposed drainage treatments were: T_1 = Sowing at field capacity and irrigation will be applied when root zone moisture will drop at 50% of PASM; T_2= Sowing at 80% FC and no irrigation over the growing season; T_3=Sowing at 60% FC and no irrigation over the growing season; T_4 =Sowing at field capacity and no irrigation over the growing season. When volumetric moisture content reached at 16%, irrigation was applied so that plant available moisture reached at 80%, 60% and 40% of field capacity for treatment T_2, T_3 and T_4, respectively. Time to time treatment wise soil moisture was monitored by using TDR-300 (Digital Moisture Meter). The test cultivars were: V_1 = LM-1, V_2 = LM-2, V_3 = LM-3, V_4= LM-4 and V_5 =Binamasur-8 (Check) and V_6 =Binamasur-10 (Check). The experimental design was RCBD (split-plot), with 3 replications. 38 cm diameter bucket (38 cm diameter at top) was used as pot with 45 cm effective depth of soil. The statistical analysis was performed using statistical software of IRRI, "STAR".The treatments demonstrated significant effect in all treatments except root length and 1000 grain weight. In control treatment T_1, per plant yield was maximum (0.799 g) and per plant yield was decreased due to increase stress. Same pattern was observed of parameters per plant straw yield, plant height, pod per plant and seed per plant. There was no effect due to moisture stress on branch per plant and root length. The cultivars showed significant difference in per plant seed yield, straw yield, root length and seed per plant and plant height. Maximum yield per plant (0.615 g) was obtained in the cultivar, V_1 (LM-1). The interaction between treatment and variety

showed insignificant effect except per plant seed and straw yield. From interaction effects, cultivar V_1 (LM-1)was obtained maximum seed yield per plant under normal and stress condition than that of others cultivars as well as check varieties (Binamasur-8 and Binamasur-10). Soil moisture stress during the growing period of lentil showed a significant effect and cultivar, LM-1 demonstrated minimum effect due to increasing moisture stress on seed yield than others cultivars along with two checks (Binamasur-8 and Binamasur-10).

Solute transport study in Boro rice cultivation and simulation modeling using one-dimensional model HYDRUS-1D in lysimeter condition

The experiment was conducted at raised-bed Lysimeter, BINA H_{qs}, Mymensingh. to study the movement of solutes under different irrigation practices and suggest optimum fertilizer application under different irrigation practices. Simulation model HYDRUS-1D was used to generate scenario under different situations. The test crop was Boro Rice, Binadhan-24. Initial and harvesttime soil solutes, input amounts and solutes from drainage were used for model inputs. The scheduled irrigation treatments were: Normal irrigation (Continuous ponding) (T_1), Irrigation at 3 days AWD (throughout the growing season) (T_2), and Irrigation at 5 days AWD (throughout the growing season) (T_3). The design was RCBD, with three replications. Initial soil samples were collected from each boxes of lysimeter (45 cm interval) for knowing initial nutrients status of soil. Fertilizer was applied with recommended dose (Urea-240 kgha^{-1}, TSP-115 kg ha^{-1}, MoP-70 kg ha^{-1}, Zypsum-47.5 kg ha^{-1} and $ZnSO_4$– 3.5 kg ha^{-1}). Drainage collection during crop period and during the monsoon was done for measuring solutes (NO^+_3, NH^+_4, PO^-_4, Cl^-, S, Ca^{++}, etc.) of collected drainage water. Last year we installed the software, ran it with arbitrary data, and field experimentation has been completed. All related data were taken. The irrigation treatments showed significant difference except pant height and tiller per plant. All yield attributing characters of Binadhan-24 showed decreasing pattern with the increase of water stress except tiller per plant. Maximum yield (6.94 t ha^{-1}) was obtained in the treatment T_1 [Normal irrigation (Continuous ponding)] followed by T_2 (6.01 t ha^{-1}) and minimum yield was obtained in T_3 (5.11 t ha^{-1}). To produce 1 kg of rice, 910 litters and 841 litters water was required under the treatments T_2 and T_3, respectively, while normal irrigation (T_1) required 1021 litters. Field experimentation has been completed and model calibration along with execution is going on.

Development of appropriate irrigation management strategy for increasing yield in saline area

Effects of irrigation management and amendments in Boro rice in saline area

From the findings of last two year's experiments, the best one among six treatments was intended to simplify, and the treatment was splitted down. The experiment was carried out at farmer's field Batiaghata, Khulna. The35 day seedlings were transplanted on 14 January 2023 at Batiaghata, Khulna. The test variety was Binadhan-10. Recommended dose of fertilizers for Binadhan-10 was Urea, TSP, MoP, Gypsum, and Zinc @217, 110, 70, 45, and 4.5 kg ha^{-1}. The experimental design was RCBD, with 3 replications. The imposed treatments were (splitted of earlier best treatment):T_1 = Continuous saturation + high density (15 cm × 15 cm) + 50% recommended fertilizer except MoP + K_2SO_4 equivalent to 50% K+ OM (Tricompost @100 kg acre^{-1}) + Foliar application of N-P-K-S-Zn (4 times: 25, 35, 45, 60 DAT) [Control], T_2= Continuous saturation + high density (15 cm × 15 cm) + 100% recommended fertilizer + OM (Tricompost @100 kg acre^{-1}), T_3 = Continuous saturation + high density (15 cm × 15 cm) + 75% recommended fertilizer + OM (Tricompost @100 kg acre^{-1}) + Foliar application of N-P-K-S-Zn (4 times: 25, 35, 45, 60 DAT) and T_4 = Continuous saturation + high density

(15 cm × 15 cm) + 50% recommended fertilizer + OM (Tricompost @100 kg acre^{-1}) + Foliar application of N-P-K-S-Zn (4 times: 25, 35, 45, 60 DAT). The statistical analysis was performed using statistical software of IRRI, "STAR". BCR analysis was performed considering full production cost.From previous two years (2020-21 and 2021-22) findings, best treatment was T_5[Continuous ponding (3-5 cm) + 50% recommended fertilizer except MoP + K_2SO_4 equivalent to 50% K+ OM + no ridge, high density (15 cm x 10 cm) + Change of standing water 20 days interval + Foliar application of N-P-K-S-Zn (4 times : 25, 35, 45, 60 DAT)].The treatments showed significant difference in all the parameter except tiller per plant and grain yield. The highest yield (6.40 t ha^{-1}) was obtained in treatment T_1followed by T_3. Minimum yield (5.80 t ha^{-1}) was obtained in T_2 where no foliar spray was applied. Effect of foliar spray and omission of fertilizer that contains chlorine had positive effect in case of Boro rice (Binadhan-10) cultivation under saline condition.

Effect of irrigation regimes and other management practices on watermelon

Watermelon is one of the important profitable and short duration crops in saline area of Bangladesh. After harvesting T. Aman rice (Nov-Dec), farmers of that area (Batiaghata, Khulna) are not so interested to cultivate Boro rice due to water scarcity at flowering to booting stage. Besides, salinity problem is another cause not to cultivate Boro rice. So they are motivated to cultivate watermelon during January to May. During mid-March to mid-April, they faced salinity problem due to shortage of fresh irrigation water with arid condition. To overcome this problem, following experiment was taken. The experiment was conducted to determine optimum irrigation management strategy for higher yield and water productivity of watermelon at Batiaghata, Khulna. The imposed treatments were: T_1 = Existing farmer's practice (Irrigation: Initially 3-4 days interval and after establishment 7-8 days interval); T_2 = Existing with improved arrangement (providing a parabolic 1-2″ clay layer below 20 cm root zone area) with residue covering of previous crop (T. Aman); T_3 = Existing with improved arrangement (providing Aman crop residue layer below 20 cm root zone area) with residue covering of previous crop (T. Aman).The design was RCBD with three replications and used watermelon cultivar was Sweet Dragon (Hybride). Two to three fruits per plant were observed with average weight (3 to 4 kg). In farmer's practice (T_1), it was required 10 nos. of irrigations (27 cm) whereas treatment (T_3) required 9 nos. of irrigations (18 cm). During sowing time, soil EC was around 2 dS/m and gradually increased but not more than 4 dS/m. There was no significant difference of soil EC for different treatments. In farmer's practice (T_1), it was required 10 nos. of irrigations (27 cm) whereas treatment (T_3) required 9 nos. of irrigations (18 cm). There was no significant difference of soil EC for different treatments and net treatments unable show good result against conventional practice.

Drought screening and irrigation management for field crops

Evaluation of Boro rice lines under different soil moisture stress (in Lysimeter condition)

The experiment was conducted in Lysimeter at BINA, H_{qs}, Mymensinghto investigate the response of the Boro line to different level of soil moisture stress. The scheduled treatments were: T_1 = Normal irrigation [3 days AWD (Alternate Wetting Drying) means, water was applied after 3 days of disappearance of standing water]; T_2= Irrigation at 7 days AWD (throughout the growing season) and T_3= Irrigation at 85% depletion of available soil moisture (throughout the growing season). Treatments were imposed after establishment of crop (3 weeks from transplanting). Tested line was MEF-27 and check variety was BRRI dhan28. Three series of containers (3 replicates) were used. The experimental design was

split plot in RCB. Thirty four days old seedlings were transplanted on 09 January 2023 and harvested on 27 April 2023. The statistical analysis was performed using statistical software of IRRI, "STAR".The cultivar showed significant difference, except grain yield, tiller plant^{-1} and seed panicle^{-1}. The maximum grain yield (5.89 t ha^{-1}) was found with MEF-27 (V_1). Maximum plant height (90 cm) and panicle length (24.44 cm) were observed with BRRI dhan28 (V_2). The irrigation treatments showed significant difference except tiller plant^{-1} and filled grain panicle^{-1}. The maximum yield (6.35 t ha^{-1}) was found in the treatment T_1 (3 Days AWD) and under stress conditions, T_2 and T_3 obtained 5.55 t ha^{-1} and 5.01 t ha^{-1}, respectively. Maximum 1000 grain weight (22.74), panicle length (23.12 cm) and filled grain panicle^{-1} (121 nos.) were observed in the treatment T_1 (3 Days AWD).In case of interaction effects, the maximum yield (6.41 t ha^{-1}) was found in the treatment combination T_1V_1 and the lowest yield (4.87t ha^{-1}) was obtained in treatment combination T_3V_2 (Table not shown). Under stress condition [Irrigation at 85% depletion of available soil moisture (throughout the growing season)], MEF-27 and BRRI Dhan28 obtained 5.21 t ha^{-1} (maximum) and 4.87 t ha^{-1} (minimum), respectively.780 litters and 825 litters water were required to produce 1 kg rice under the treatments T_2 and T_3, respectively, while normal irrigation (T_1) required 971 litters. Sacrificing 13% and 21% yield, MEF-27 is capable to save about 30% and 33% irrigation water (under T_2 and T_3, respectively). Sacrificing 13% yield, MEF-27 is capable to save about 30% irrigation water under irrigation at 7 days AWD (throughout the growing season) if treatment is applied after 3 weeks of transplanting.

Evaluation of Boro rice lines under different soil moisture stress in field condition

The field experiment was conducted at BINA, $H_{Qs,}$ Mymensinghto investigate the response of the Boro line to different level of soil moisture stress. The scheduled treatments were: T_1 = Normal irrigation [3 days AWD (Alternate Wetting Drying) means, water applied in Lysimeter after 3 days of disappearance (standing water of field)]; T_2= Irrigation at 7 days AWD (throughout the growing season) and T_3= Irrigation at 85% depletion of available soil moisture (throughout the growing season). Treatments were imposed after establishment of crop (3 weeks from transplanting). Tested line was MEF-27 and check variety was BRRI dhan28. Three series of containers (3 replicates) were used. The experimental design was split plot in RCB. Thirty three days old seedlings were transplanted on 08 January 2023 and harvested on 26 April 2023. The statistical analysis was performed using statistical software of IRRI, "STAR".The cultivar showed significant difference, except grain yield, tiller plant^{-1} and seed panicle^{-1}. The maximum grain yield (5.78 t ha^{-1}) was found with MEF-27 (V_1). Maximum plant height (92 cm) and panicle length (24.61 cm) were observed with BRRI dhan28 (V_2). The irrigation treatments showed significant difference except tiller plant^{-1} and filled grain panicle^{-1}. The maximum yield (6.19 t ha^{-1}) was found in the treatment T_1 (3 Days AWD) and under stress conditions, T_2 and T_3 obtained 5.57 t ha^{-1} and 5.21 t ha^{-1}, respectively. Maximum 1000 grain weight (22.57), panicle length (23.33 cm) and filled grain panicle^{-1} (118 nos.) were observed in treatment T_1 (3 Days AWD).In case of interaction effects, the maximum yield (6.22 t ha^{-1}) was found in the treatmentcombination T_1V_1 and the lowest yield (5.12 tha^{-1}) was obtained in the treatment combination T_3V_3 (Table was not shown). Under stress condition [Irrigation at 85% depletion of available soil moisture (throughout the growing season)], MEF-27 and BRRI dhan28 obtained 5.28 t ha^{-1} (maximum) and 5.15 t ha^{-1} (minimum), respectively.The cultivars V_1 andV_2produced reasonable yield under stress condition (T_3) compared to normal irrigation condition. 777 litters and 793 litter water were required to produce 1 kg rice under T_2 and T_3, respectively, while normal irrigation (T_1) required 1056 litters. Sacrificing 10% and 16% yield, MEF-27 is capable to save about 34% and 37% irrigation water (under T_2 and T_3, respectively). Sacrificing 10% yield, MEF-27 is capable to save about 34% irrigation water under irrigation

at 7 days AWD (throughout the growing season) if treatment is applied after 3 weeks of transplanting.

Development of appropriate irrigation management strategy for increasing crop yield in char land

Irrigation management for hybrid maize for higher yield and water productivity

The experiment was conducted in three locations, namely Ishwardi, Jamalpur, and Nalitabari, during Rabi season to find out the best irrigation management practice for higher yield and profitability of hybrid maize. The irrigation treatments were:Farmer's irrigation practice (T_1);Irrigation at 30-55-80-120 days after sowing (4 irrigations) (T_2); Irrigation at 30- 75 -110 days after sowing (3 irrigations) plus additional management (with twin-line, N-S orientation, 30% excess fertilizer of recommended dose) (T_3); Irrigation at 70% depletion of available soil moisture (ASM) (T_4); Irrigation at 30- 75 -110 days after sowing (3 irrigations) plus additional management (with twin-line, N-S orientation)(T_5).The Cultivars were BARIhybrid maize17(V_1), and locally cultivated hybrid maize DURJOY5577 (V_2) and Five Star 8855 (V_3). Randomized complete block design (RCBD) with split-plot was used for the experiment by assigning the irrigation in the main plots and cultivars in the sub-plots. The treatments were replicated three times. ***At Sherpur,*** the highest yield (13.13 t ha^{-1}) was obtained with the application of 3 irrigations(Irrigation at 30- 75 -110 days after sowing plus additional management with twin-line, N-S orientation) and 30% excess fertilizer of recommended dose. The cultivars DURJOY 5577(V_2) and Five Star 8855(V_3) showed statistically similar result.From interaction effects, the cultivar V_3 under treatment T_3 produced the highest yield.***At Ishwardi,*** the highest yield (12.73 t ha^{-1}) was obtained in the treatment T_3. Among the varieties, the highest yield was obtained in Five Star 8855(V_3). From interaction effects; the cultivar V_3 under treatment T_3 produced the highest yield.***At Jamalpur,*** the treatments demonstrated significant effect on grain yield. The highest yield (13.09t ha^{-1}) was obtained in the treatment T_3, irrigation was applied at 30, 75, and 110 days after sowing plus additional management (with twin-line, N-S orientation, 30% excess fertilizer of recommended dose). The cultivars showed significant effect on cob length and yield. The highest grain yield was obtained in Five Star 8855(V_3). Interaction effects of treatments and cultivars on grain yield demonstrated that cultivar V_3 under treatment T_3 produced the highest yield.The BCR of crop yield is presented on the basis of treatments applied in the experiment.From the last two years study, it was found that application of three irrigations at 30, 75, and 110 days after sowing along with twin-line, N-S plant orientation and 30% excess fertilizer produced the maximum grain yield of maize.

Irrigation management for garlic cultivars for higher yield and water productivity under zero tillage condition

The experiment was conducted at the farmer's field of Haybatpur and Chalan Bill (Gurudaspur) of Natoreto develop appropriate irrigation management practice for higher yield of garlic. The experiment consisted of four treatments: farmer's irrigation practice (T_1); Four irrigation frequency (1^{st}:Irrigation @ 20-25 days after sowing + 2^{nd} to 4^{th} Irrigation @23-26 days interval) (T_2); Three irrigation frequency (1^{st}: at 20-25 days after sowing + 2^{nd}: at 45-46 DAS + 3^{rd}: at 60 DAS) + Organic matter at basal dose @ 2kg $decimal^{-1}$ (T_3); Three irrigation frequency (1^{st}: at 20-25 days after sowing + 2^{nd}: at 45-46 DAS + 3^{rd}: at 60 DAS) (T_4). The genotypes were used Binarosun-1 (V_1) and Italy hybrid (V_2). Randomized complete block design (RCBD) with split plot arrangement was used for the experiment by assigning the irrigation in the main plots and cultivars in the sub-plots. The statistical analysis was performed using statistical software "Statistix10" (version 10.0). The highest yield (12.54 t

ha^{-1}) was obtained with the application of three times irrigation(1^{st}: at 20-25 days after sowing + 2^{nd}: at 45-46 DAS + 3^{rd}: at 60 DAS) + Organic matter at basal dose @ 2kg $decimal^{-1}$ (T_3). Local cultivar namely 'Italy hybrid' showed the highest yield.In case of interaction effects, treatment $T_3$and variety V_2 produced the highest yield. The cultivars V_2 produced higher yield compared to V_1 under all treatments. BCR of garlic production found positive for all cases. The highest BCR was found in treatment T_3 in both the locations.Garlic production was found profitable in the Natore area and the highest yield and BCR was found with the application of three times irrigation and organic matter at basal dose with zero tillage practice.

Effectiveness of irrigation regimes on the yield and water productivity of potato in cropping pattern in the charland of Rangpur region

The experiment was conducted at the farmer's field of Tista, Lalmonirhat during rabi season of 2021-2022to identify the water saving irrigation schedule for potato and following the cropping pattern 'Potato-Groundnut-T. Aman' at the Charland of Rangpur region. There were five different irrigation treatments as: Farmers' irrigation practice including farmer's line spacing (T_1); Alternate furrow irrigation at different stages (e.g. 1+1+1+1) with Farmer's line spacing (T_2); Every furrow irrigation but deficit mode (1+1+1+0), with Farmer's line spacing (T_3); Stagewise (1+1+1+1) everyfurrow irrigation with twinrow [e.g. First line 22.5 cm from border, then line spacing 20cm - 45cm- 20cm -20 cm – 45 cm -20cm-20cm-45 cm, and so on) plus 30% excess of recommended fertilizer (T_4); Every furrow irrigation but deficit mode (1+1+1+0) with Twinrow plus 30% excess fertilizer (T_5). BARI Alu 25 was used as test crop. Randomized complete block design (RCBD) with split plot arrangement was used for the experiment. The size of each plot was 4 m ×3m. The experimental land was fertilized with BARI recommended dose (Urea@1.42t ha^{-1}, TSP@0.89t ha^{-1}, MoP@1.21 t ha^{-1}, Gypsum@0.49t ha^{-1}, Zinc Sulphate @0.040t ha^{-1}, Magnesium Sulphate@0.65t ha^{-1}, Compost@ 41t ha^{-1}). The tubers were planted on 1^{st} November 2022.Irrigation was given through poly pipe. Irrigation was given through polypipe. The pump discharge rate was determined and time of irrigation application was recorded with 'stop watch'. The crop was harvested on 27 December 2022. The highest average yield was obtained with the application of Stage-wise (1+1+1+1) everyfurrow irrigation with twinrow (treatmentT_4). This may be due to higher plant density and optimum irrigation. The TreatmentT_4 showed the highest yield with water productivity of 3000.9 kg $ha^{-1}cm^{-1}$ and saved 13.01 % irrigation. Under sandy loam soil, stagewise everyfurrow irrigation having twinrow line of plants produced the highest yield of potato compared to others management practices tested.

Drought screening and irrigation management for field crops

Response of Binasharisha-9 to waterlogging at different growth stages

The experiment was conducted at BINA HQ, BINA substation Barishal and farmer's field at Satkhira in Rabi season of 2022-2023to identify the effect of waterlogging at different growth stages of Binasharisha-9. There were five different irrigation treatments as: Farmers' irrigation practice with no water-logging) (T_1); Water-logging at seed sowing stage (2 days after sowing) for 2 days (T_2); Water-logging at early growth stage (15 DAS) for 2 days (T_3); Water-logging at early growth stage (15 DAS) for 4 days (T_4); Water-logging at early growth stage (15 DAS) for 6 days (T_5); Water-logging at early growth stage (15 DAS) for 2 days and vegetative growth stage (30 DAS) for 2 days (T_6). Binasarisha-9 (V_1) andBARI Sarisha-13 (V_2) were used as test crop. Randomized complete block design (RCBD)was used for the experiment. The treatments were replicated three times. The size of each sub-plot was 3m ×3m. The experimental plots were fertilized with BARI recommended dose (Urea

@300kg/ha, TSPP @180kg/ha, MoP@100 kg/ha, Gypsum @180 kg/ha, Boric Acid @0.10kg/ha, Zinc Oxide @0.5 kg/ha, Compost@8 t/ha). The experiment was conducted between November-February 2022-23. Water-logging was created as per treatments applying water through poly pipe. The statistical analysis was performed using statistical software "Statistix10" (version 10.0). The treatments showed significant effect on yield at Barishal andSatkhira, but not at BINA Hqs. The cultivar Binasarisha-9 (V_1) performs better Barishal and shows similar result in BINA Hq and Satkhira with cultivar BARI Sarisha-13 (V_2). The yield of the cultivars was very low with higher duration of water logging condition. Although the Binasarisha-9 sustained in the 4 days and 6 days water logging condition.

Development of irrigation system for BINAdeveloped varieties for hill areas of Bangladesh

Development of efficient irrigation practice for citrus crops for hilly area of Bangladesh

The experiment was carried out at farmer's field in hill track of Jadurampara, Khagracharito ensure efficient use of Jhiri-water and maximize water productivity for citrus crops and develop efficient irrigation practice for lemon production in hill slopes. The imposed treatments were: T_1= Control/ Farmers practice (water carrying by labor) /no irrigation; T_2 = Drip Irrigation using power sprayer. The tested cultivar was local cultivar Kagji. Drip irrigation system was settled in the slope of hill for applying irrigation on 30 lemon trees whereas no irrigation wasapplied in another 10 tree (as control). Irrigation was applied for 5 times in the dry months (December-March). Single dripper was used for each tree. Water source for irrigation was Jhiri of hill which is located on the underneath of the hill. A water pump including 6 Hp engine (which is locally used for spraying chemicals at orchards) was used for uplifting the waters from the jhiri to the tank (1000ltr) which is placed on the top of the hill (around 120-150 ft). Dripper were placed on the base of each tree and connected with the water tank using water conveying pipes. The highest average yield was obtained in the treatment T_2 .The treatment T_1produced the lowest yield of lemon. On average, 300 lemons was harvested in each tree where drip irrigation was applied and around 180-200 lemon was produced in non-irrigated lemon trees (sold @ 5-7 tk/piece).

Automatic irrigation management system for field crops

Design and development of an automated irrigation system for rice

The study was carried out to measure the accuracy of the sensor to develop an automated irrigation systemfor rice. The system prototypes consists of an ESP32 microcontroller, four ultrasonic sensors, a 12V pump with a 5V relay module, Blynk cloud, and an IFTTT webhook that connects to Google Sheets. The ESP32 receives data from the ultrasonic sensors and controls the pump through the relay module based on the water height. The data is sent to the Blynk cloud for monitoring and control through a smartphone or PC. The IFTTT webhook connects the system to Google Sheets, allowing users to monitor the water level and track changes over time.The system was implemented by placing four ultrasonic sensors, a breadboard, a DC pump, a relay, and an ESP32 microcontroller in a lysimeter field at BINA, Mymensingh. The sensors were positioned to face downwards toward the bottom of the lysimeter field and were connected to the ESP32 microcontroller via the breadboard. The DC pump was used to circulate water within the lysimeter field, while the relay was used to turn the pump on and off based on the water level in the field. The ESP32 microcontroller was programmed to read data from the sensors and control the pump and relay. The system was tested by monitoring the water level in the lysimeter field over a period of time. The data collected from the sensors were analyzed to determine the performance of the system in

maintaining a desired water level.The results of the accuracy calculation showed that the ultrasonic sensors had an average accuracy of 96.4%. The system displays each sensor value on the OLED display, along with the average water height display and the pump on/off operation. This helps to monitor the water level and pump status in real time. Each sensor value is displayed separately, allowing to monitor the water level at each point in the field. The average water height display shows the overall water level in the field, which is calculated based on the readings from all the sensors. The pump on/off operation is also displayed, indicating whether the pump is currently running or not.The prototype module utilizes ultrasonic sensors to determine the water level in the rice field and a relay module with a water pump to automate the irrigation process. The Blynk app and IFTTT webhook provide remote monitoring and data logging capabilities, allowing users to track and analyze the system's performance over time. The accuracy of the sensor found good under field condition. Further study will be carried out in the upcoming year with testing the prototype device in the field.

Development of low-cost small scale farm machinery suitable for farmers

Development of Smart Insect Controller

Pest infestation causes damage to sow seeds, seedlings, fruits, seeds, flowers, buds, leaves, roots, and tubers of crops in the field. Ultrasonic devices emit sound of predetermined frequency, when targeted at pests; they make them uncomfortable within the area of coverage thereby repelling them away from the area without affecting the environment and non-target organisms. Application of lights cantrap pests with effective wave lengths and can prevent pests from entering a cultivation area by presenting light at various wavelengths and intensities.The study was carried out to develop a smart insect controller with a view to controlvarious insects. Arduino Nano, Node MCU, Solar Panel, Solar Charge Controller, Battery, Buck Converter, Relay, Boost Circuit, GSM,GPS, Speaker, Capacitor, Resistor.This Solar Power Generation system works on the principle of auto power generating from different sources. A solar panel is used for power generating elements and restores it in a battery. Solar takes sunlight and produces some energy and stores it battery. This solar cell is controlled by the Arduino Nano Micro-controller. The voltage trap net consists of a mesh or grid that is electrified with a low-voltage electrical charge. When an insect comes into contact with the net, the electrical charge immobilizes or eliminates the insect. The device emits ultrasonic sound waves at specific frequencies that are uncomfortable or irritating to insects. The ultrasonic sound waves act as a repellent, discouraging insects from approaching the device. Red, Green and Blue (RGB)lights are incorporated into the device, attracting insects that are attracted to light sources. The lights can be used to lure insects towards the device, where voltage traps net will electrified the pests. The device is equipped with sensors to detect movement or unauthorized access. Further study will be continued to evaluate the performance of the device.

Development of bio-char production machine.

Biochar is a type of charcoal produced from organic materials such as agricultural waste, wood chips, and crop residues through a process called pyrolysis. Traditionally, biochar production has relied on fossil fuel-based heat sources, such as wood or gasfired kilns, which can contribute to greenhouse gas emissions and environmental pollution. Biochar production machines with electricity as a heat source is an innovative device designed to efficiently convert biomass into biochar using electrical energy as a heat source. The study was conducted to design and develop a biochar production machine.Crop residues, straw, husks, stalks, or any other biomass materials can be used for biochar production. The biochar

machine will contain approximately 250 kg of hard wood or 160 kg soft wood at a time. Biomass needed to be chipped and dried properly before loading to the reactor for the pyrolysis .Heater Board (1000W),Glass wool, Temperature Controller were used to complete the reactor. Crop residues, straw, husks, stalks, or any other biomass materials can be used for producing biochar in the developed machine. The biochar machine will contain approximately 250 kg of hard wood or 160 kg soft wood at a time. Further research will be carried to explore the performance, energy efficiency and economic feasibility of the machine.

Climate changes and its impact on hydrological aspects and crop production at different AEZ / hydrological regions of Bangladesh

Future climate scenario and its impact on hydrologic components

The experiment objectives were: (1) To predict climate change using Global Climate Model, and (2) to estimate 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). 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).The hydrological parameters such as ET_0, PET, runoff, recharge, and drought indices (e.g. Aridity index, PI, SPI) were calculated using predicted climatic data.There is distinct increasing trend of monthly temperature at different decadal time scales (average of the decade) compare to that of base-year. In almost all cases (except 2040-50 decade, during June-August), the predicted temperatures are higher than the base-temperature. Under SSP4.5 emission scenario, in contrast to base year, there is two distinct peak of the temperature - one at about March-April and another at September (except 2090-2100 decade). On the contrary, under SSP8.5 emission scenario, the first peak appears during April-May and the second peak at September- October. For the monthly rainfall, there is evidence of distinct variation/fluctuating pattern over the months under both the emission scenarios.

ADAPTIVE RESEARCH AND EXTENSION DIVISION

RESEARCH SUMMARY

During 2022-23 a total of 4666 demonstration with block farming through BINA developed different crop varieties were conducted at the farmers' field in collaboration with the Department of Agricultural Extension (DAE).

In block farming with BINA developed early T. Aman rice varieties, Binadhan-11 produced average grain yield of 5.15 tha^{-1} with maturity period of 114 days. Binadhan-11 can tolerate 10-15 days submergence. Binadhan-12 produced average grain yields of 4.46 t ha^{-1} with average maturity period of 125 days. Binadhan-13, a fine grain rice produced average grain yield of 3.37 t ha^{-1} with average maturity period of 136 days. Binadhan-16 produced average grain yield of 5.15 t ha^{-1} with average maturity period of 103 days. The farmers of Cumilla, Khagrachari, Magura, Jashore, Rajshahi and Gopalganj districts were encouraged to cultivate Binadhan-16. Binadhan-17 produced average grain yields of 6.20 t ha^{-1} with average maturity period of 114 days. Binadhan-20 is Zn rich rice variety produced average grain yields of 4.95 t ha^{-1} with average maturity period of 127 days. Binadhan-22 produced average grain yields of 5.60 t ha^{-1} with average maturity period of 115 days. During maturity stage it was affected by BLB but had no significant effect on grain yield. Binadhan-23 is dual tolerant (saline and tidal submergence) variety produced average grain yields of 5.33 t ha^{-1} with average maturity period of 121 days. Only the farmers of Bhola districts found interested to cultivate Binadhan-23 in future.

Advanced lines adaptive trials with two Boro rice mutants (RM-16-8 and RM-16-10) revealed that the mutant RM-16-10 showed the highest grain yield of 7.04 t ha^{-1} with maturity period of 154 days that was 05 days delay than check variety BRRI dhan-58 (149 days). Some farmers preferred to cultivate the mutant RM-16-10 for its higher yield performance.

Advanced lines adaptive trials with five Boro rice mutants (BNDR-9, BNDR-18, BNDR-48, BNDR-26 and BNDR-55) revealed that the mutant BNDR-26 showed the highest grain yield of 8.23 t ha^{-1} with maturity period of 151 days that was 05 days earlier than check variety BRRI dhan-89 (156 days). Farmers preferred to cultivate the mutant BNDR-26 for its higher yield performance.

In farmers' observation trial with the variety Binadhan-17 in Boro season performed better (7.20 t ha^{-1}). Farmers are interested to cultivate the Binadhan-17 in Boro season for its better yield performance with fine grain size. In block farming with Boro rice varieties, Binadhan-10 (saline tolerant) produced average grain yields of 6.54 t ha^{-1} with maturity period of 134 days. Farmers' preferred to cultivate Binadhan-10 due to its good yield performances in the coming years. Binadhan-14 produced average grain yields of 5.82 t ha^{-1} with average maturity period of 116 days. Binadhan-24 produced average grain yields of 6.67 t ha^{-1} with average maturity period of 144 days. BINA dhan25 produced average grain yields of 7.25 t ha^{-1} with average maturity period of 140 days.

In block farming with Aus rice varieties, Binadhan-19 produced average grain yields of 4.13 t ha^{-1} with maturity period of 103 days. Farmers' were found interested to cultivate Binadhan-19 due to its earliness and fine grain size with acceptable yield performances in the coming years. Binadhan-21 produced average grain yields of 4.20 t ha^{-1} with average maturity period of 104 days.

Block farming with Binasarisha-4, Binasarisha-9, Binasarisha-11 produced average grain yields of 1.56, 1.64, 1.71 tha^{-1} with the maturity period of 89, 85, 87 days respectively. Binatil-2, Binatil-3, Binatil-4 produced average seed yield of 1.37, 1.10 and 1.40 t ha^{-1} with maturity duration 94, 92, 89 days, respectively. Farmers were found very much interested to cultivate Binatil-2 due to its better yield performance with comparative less susceptible to water lodging. Block farming with Binachinabadam-4, Binachinabadam-6 and Binachinabadam-8 produced average seed yield of 2.6, 2.52 and 2.10 t ha^{-1}, with maturity period 141, 140 and 136 days, respectively. Binasoybean-2, Binasoybean-3, Binasoybean-5 and Binasoybean-6 produced average seed yield of 1.5, 1.85, 1.72 and 1.77 t ha^{-1} with maturity period 114, 106, 102 and 98 days, respectively.

Binamasur-8 produced average yield of 1.92 t ha^{-1} with maturity period of 101 days. Binamoog-8 produced average seed yield of 1.42 t ha^{-1} with maturity period of 67 days. Binakhesari-1 produced average seed yield 1.76 t ha^{-1} with duration of 117 days.

Binahalud-1 produced average seed yield 24.4 t ha^{-1} with duration of 295 days. Under late winter cultivation, Binapiaz-1 (8.50 t ha^{-1}) with an average duration of 112 days.

In order to establish BINA technology villages, a total of 217 block farming was conducted around BINA headquarters. Based on the BINA released technology adoption and overall activities in different locations a cropping pattern like "Binadhan-11/17→ Binasarisha-9/11→ Binadhan-24/BINA dhan25" had demonstrated very suitable and profitable of Mymensingh Sadar and Tarakanda Upazilla, Mymensingh. However, establishment of BINA technology villages in other locations are now in progress.

In order to promotion of BINA generated crop varieties, a total of 70 farmers training were organized during this period, and 4180 male and female farmers were trained on cultivation of BINA developed improved crop varieties across the country. A total of 107 field days were also organized in different areas of the country to motivate farmers and popularize the BINA developed crop varieties/technologies to the end users. A total of 05 workshops were also organized to motivate DAE personnel for popularizing the BINA developed crop varieties/technologies to the end users.

Rice

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

During Aman season of 2022, block farming with Binadhan-7 was conducted at the farmer's fields in different locations in collaborations with DAE. The main objectives were to evaluate the performance of this variety at different flood prone and normal areas for widening its adoption by the farmers. Area of each plot was 0.33 acre. Spacing between line to line and plant to plant was 20 cm×15 cm. All fertilizers were applied by farmers as per recommendation. Transplanting dates ranged from July 20 to August 15, 2022 and age of seedlings were 20 to 28 days. Based on the available reports, Binadhan-7 performed well in two locations. The average grain yield was 4.70 t ha^{-1} with maturity period of 110 days. Farmers were found keen to cultivate Binadhan-7 in upcoming years.

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

During Aman season of 2022, block farming with Binadhan-11 was conducted at the farmer's fields in different locations in collaborations with DAE. The main objectives were to evaluate the performance of this variety at different flood prone and normal areas for widening its adoption by the farmers. Area of each plot was 0.33 acre. Spacing between line to line and plant to plant was 20 cm×15 cm. All fertilizers were applied by farmers as per recommendation. Transplanting dates ranged from July 20 to August 20, 2022 and age of seedlings were 20 to 25 days. Based on the available reports, Binadhan-11 is a submergence tolerant variety. The average grain yield was 5.15 t ha^{-1} with maturity period of 114 days. Farmers of most districts were very much interested to cultivate Binadhan-11 in upcoming years.

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

During Aman season of 2022, block farming with Binadhan-12 was conducted at the farmer's fields in different locations collaborations with DAE. The main objective was to evaluate the performance of this variety at different flood prone and normal areas for widening its adoption by the farmers. Area of each plot was 0.33 acre. Spacing between line to line and plant-to-plant was 20 cm×15 cm. All fertilizers were applied by farmers as per recommendation. Transplanting dates ranged from July 20 to August 15, 2022 and age of seedlings were 25 to 30 days. The results revealed that Binadhan-12 performed well in all locations except Cumilla district. Binadhan-12 is a submergence tolerant variety. The average grain yield of Binadhan-12 was 4.46 t ha^{-1} with mean maturity period of 125-130 days. Farmers were found keen to cultivate Binadhan-12 in upcoming years especially farmers of Khagrachari district highly accepted this variety.

Expt. 04: Block farming performance of fine grain aromatic Aman rice variety, Binadhan-13 at different locations

During Aman season of 2022, block farming with Binadhan-13 was conducted at the farmer's fields in different locations of Gopalganj and Cumilla districts in collaborations with DAE. The main objective was to evaluate the performance of this variety at different areas for widening its adoption by the farmers. Area of each plot was 0.33 acre. Spacing between line to line and plant to plant was 20 cm×15 cm. All fertilizers were applied by farmers as per recommendation. Transplanting dates ranged from 04 to 15 August, 2022 and age of

seedlings were 30 to 35 days. The results revealed that the average grain yield of Binadhan-13was 3.37 t ha^{-1} with maturity period of 136 days. Farmers of most districts were reluctant to cultivate Binadhan-13 due to less aroma than the other aromatic rice cultivars. Farmers of both districts found keen to cultivate Binadhan-13 in upcoming years.

Expt. 05: Block faring performance of Aman rice variety, Binadhan-16 at different locations

During Aman season of 2022, block farming with Binadhan-16 was conducted at the farmer's fields in different locations in collaborations with DAE. The main objective was to evaluate the performance of this variety at different areas for widening its adoption by the farmers. Area of each plot was 0.33 acre. Spacing between line to line and plant to plant was 20 cm×15 cm. All fertilizers were applied by farmers as per recommendation. Transplanting dates ranged from 16 July to 10 August, 2022 and age of seedlings were 20 to 25 days. The results revealed that Binadhan-16 performed well in all locations. The average grain yield of Binadhan-16 was 5.15 t ha^{-1} with maturity period of 103 days. Anyway, Binadhan-16 is a short duration variety and after harvest of Binadhan-16, farmers can easily cultivate early winter crops. Gopalganj, magura and Jamalpur districts performed better than other districts. Farmers of most districts were found keen to cultivate Binadhan-16 in upcoming years.

Expt. 06: Block faring performance of Aman rice variety, Binadhan-17 at different locations

During Aman season of 2022, block farming with Binadhan-17was conducted at the farmer's fields in different locations (Magura, Satkhira, Jamalpur, Jessore, Natore, Pabna, Cumilla, Kishoreganj, Noakhali, Feni, Barisal, Rangpur, Nilphamari, Rajshahi, Sherpur, Netrokona, Gazipur, Mymensingh, Cox's Bazar and Sunamganj) in collaborations with DAE. The main objective was to evaluate the performance of this variety at different areas for widening its adoption by the farmers. Area of each plot was 0.33 acre. Spacing between line to line and plant to plant was 20 cm×15 cm. All fertilizers were applied by farmers as per recommendation. Transplanting dates ranged from 16 July to 10 August, 2022 and age of seedlings were 20 to 25 days. The results revealed that Binadhan-17 performed well in most of the locations except Mymensingh and Barishal districts. The average grain yield of Binadhan-17 was 6.20 t ha^{-1} with maturity period of 114 days. Binadhan-17 was highly accepted by the farmers of North-west and south-west of Bangladesh. Anyway, Binadhan-17 is a short duration variety and after harvest of Binadhan-17, farmers can easily cultivate early winter crops. Magura, Satkhira, Jamalpur, Cox's Bazar and Sunamganj districts performed better than other districts. Farmers of most districts were found keen to cultivate Binadhan-17 in upcoming years.

Expt. 07: Block farming performance of Zn enrich Aman rice variety, Binadhan-20 in different locations

During Aman season of 2022, block farming with Binadhan-20 was conducted at the farmer's fields in different locations (Gopalganj, Satkhira, Jamalpur, Gazipur, Barishal and Cumilla) in collaborations with DAE. The main objective was to evaluate the performance of Binadhan-20 at areas for widening its adoption by the farmers. Area of each plot was 0.33 acre. Spacing between line to line and plant to plant was 20 cm×15 cm. All fertilizers were applied by farmers as per recommendation. Transplanting dates ranged from July 20 to August 15, 2022 and age of seedlings were 20 to 35 days. Based on the available reports, Binadhan-20 performed well in all locations. Binadhan-20 is Zn and Fe fortified variety and market price is high. Farmers are interested to cultivate Binadhan-20 in most areas.

Binadhan-20 preformed high yield potential in Gopalganj, Satkhira, Jamalpur, Barishal and Cumilla districts. The average grain yield of Binadhan-20 was 4.95 t ha^{-1} with maturity period of 127 days. Farmers of most districts were found keen to cultivate Binadhan-20 in upcoming years.

Expt. 08: Block farming performance of early maturing Aman rice variety, Binadhan-22 in different locations

During Aman season of 2022, block farming with Binadhan-22 was conducted at the farmer's fields in different locations in collaborations with DAE. The main objective was to evaluate the performance of this variety at different areas for widening its adoption by the farmers. Area of each plot was 0.33 acre. Spacing between line to line and plant to plant was 20 cm×15 cm. All fertilizers were applied by farmers as per recommendation. Transplanting dates ranged from 16 July to 10 August, 2022 and age of seedlings were 20 to 25 days. The results showed that Binadhan-22 performed well in North-West and South-West in Bangladesh. Whereas Binadhan-22 did not performed well in middle, east and north-east area of Bangladesh. The average grain yield of Binadhan-22 was 5.60 t ha^{-1} with maturity period of 115 days. Binadhan-22 was accepted by the farmers of North-West and South-West of Bangladesh. Anyway, Binadhan-22 is a short duration variety and after harvest of Binadhan-22, farmers can easily cultivate early winter crops.

Expt. 09: Block farming performance of dual tolerant Aman rice variety, Binadhan-23 in different locations

During Aman season of 2022, block farming with Binadhan-23 was conducted at the farmer's fields in southern area of Bangladesh. The main objectives were to evaluate the performance of this variety at different areas for widening its adoption by the farmers. Area of each plot was 0.33 acre. Spacing between line to line and plant-to-plant was 20 cm×15 cm. All fertilizers were applied by farmers as per recommendation. Transplanting dates ranged from 16 July to 10 August, 2022 and age of seedlings were 20 to 25 days. The results revealed that Binadhan-23 performed well in Satkhira over Barishal district. The average grain yield of Binadhan-23was 5.33 t ha^{-1} with maturity period of 121 days. However, Binadhan-23 is a short duration variety and after harvest of Binadhan-23, farmers can easily cultivate winter crops.

Boro rice

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

During Boro season of 2022-23, adaptive trials with two rice mutants RM-16(N)-8-1 and RM-16(N)-10-1were conducted at farmers' field at two districts of Pabna and Kustia districts. The objectives were to evaluate the performance of mutant lines at different locations and to provide the feedback information about the concerned lines. The experiment was setup in RCB design with three replications. The unit plot size was 5m × 6m at all locations. Seed were sown during middle to end of December 2022 and transplanting was completed within last week of January to 1st week of February, 2023. Recommended doses of nitrogen, phosphorus, potassium, sulphur and zinc were applied in the form of Urea, TSP, MoP, Gypsum and Zinc Sulphate. Proper cultural practices were followed as and when necessary for normal plant growth and development. Data on morphological and yield attributes were recorded at harvest from 10 randomly selected plants in each plot. Grain yield was recorded from whole plot and converted into t ha^{-1}. The recorded data were finally subjected to proper

statistical analysis and were presented. Results indicated that the mutant lines were shorter than the check variety, BRRI dhan58 (92.40 cm). The maturity period of the two mutant lines took 4-5 days more than the check variety, BRRI dhan58 (149 days) with being the longest in RM-16(N)-10-1(154 days). Grain yield was greater in Kustia district. The mutant RM-16(N)-10-1 showed the highest grain yield (7.04 t ha^{-1}) at two locations and showed 6.00% higher grain yield than the check variety, BRRI dhan58 (6.65 t ha^{-1}). On the other hand, the mutant RM-16(N)-8-1 showed apparently lower grain yield than the check variety, BRRI dhan58 at two locations. However, BRRI dhan58 showed lodging tendency. Considering farmers' observation, as the mutant RM-16(N)-10-1 had higher grain yield over the check, BRRI dhan58; farmers are interested to cultivate the mutant but the farmers were reluctant to cultivate the mutant RM-16(N)-8-1 in future due to longer duration and coarse grain size.

Expt. 11: Adaptive trial with five mutants BNDR-9, BNDR-18, BNDR-48, BNDR-26, and BNDR-55 of Boro rice at different locations

During Boro season of 2022-23, adaptive trials with five rice mutants BNDR-9, BNDR-18, BNDR-48, BNDR-26, and BNDR-55 were conducted at farmers' field at five districts of Pabna and Kustia districts. The objectives were to evaluate the performance of mutant lines at different locations and to provide the feedback information about the concerned lines. The experiment was setup in RCB design with three replications. The unit plot size was 5m × 6m at all locations. Seed were sown during middle to end of December 2022 and transplanting was completed within last week of January to 1st week of February, 2023. Recommended doses of nitrogen, phosphorus, potassium, sulphur and zinc were applied in the form of Urea, TSP, MoP, Gypsum and Zinc Sulphate. Proper cultural practices were followed as and when necessary for normal plant growth and development. Data on morphological and yield attributes were recorded at harvest from 10 randomly selected plants in each plot. Grain yield was recorded from whole plot and converted into t ha^{-1}. The recorded data were finally subjected to proper statistical analysis and were presented. Results indicated that the mutant lines were shorter than the check variety, BRRI dhan89 (104.67 cm). The maturity period of the five mutant lines took 3-4 days less than the check variety, BRRI dhan89 (156 days) with being the shortest in BNDR-9 (143 days). Grain yield was greater in Pabna district. The mutant BNDR-26 showed the highest grain yield (8.23 t ha^{-1}) at two locations and showed 7.02% higher grain yield than the check variety, BRRI dhan89 (7.69 t ha^{-1}). Considering farmers' observation, the mutant BNDR-26 had higher grain yield over the check, BRRI dhan89 and farmers were interested to cultivate the advance line.

Expt. 12: Farmers' observation trial with Binadhan-17 in Boro season

During Boro season of 2022-23, block farming with Binadhan-17 was conducted at the farmer's fields in different locations. The main objective was to evaluate the performance of this variety at Haor and Beel area and also normal areas in Boro season. Area of each plot was 0.33 acre. Spacing between line to line and plant to plant was 20 cm×20 cm. All fertilizers were applied by farmers as per recommendation. Transplanting dates ranged from 20 to 31 January 2023 and age of seedlings were 30 to 35 days. Based on the available reports, Binadhan-17 performed very well at Sunamganj. The average grain yield was 7.20 t ha^{-1} with maturity period of 147 days. Farmers choice Binadhan-17 to cultivate in Boro season due to no lodging tendency, less disease infestation, attractive grain size with high yield potential.

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

During Boro season of 2022-23, block farming with Binadhan-10 was conducted at the farmer's fields in different locations in collaborations with DAE. The main objective was to evaluate the performance of Binadhan-10 coastal areas and also normal areas in Boro for widening its adoption by the farmers. Area of each plot was 0.33 acre. Spacing between line to line and plant to plant was 20 cm×20 cm. All fertilizers were applied by farmers as per recommendation. Transplanting dates ranged from 20 to 31 January 2023 and age of seedlings were 30 to 35 days. The results revealed that Binadhan-10 performed better under non-saline soil than saline soil. However, under saline condition, Binadhan-10 also performed well regarding grain yield. Binadhan-10 performed the best in Gopalganj district. Under saline condition, the average grain yield was 6.54 t ha^{-1} with maturity period of 134 days. Farmers of Gopalganj, Khulna, Satkhira, Bagerhat and Chattagram districts were found keen to cultivate Binadhan-10.

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

During Boro season of 2022-23, block farming with Binadhan-14 was conducted at the farmer's fields in different locations in collaborations with DAE. The main objectives were to evaluate the performance of this variety in Boro season for widening its adoption by the farmers. The main objective was to evaluate the performance of this variety in Boro season. Area of each plot was 0.33 acre. Spacing between line to line and plant to plant was 20 cm×20 cm. All fertilizers were applied by farmers as per recommendation. Transplanting dates ranged from 15 to 28 February 2023 and age of seedlings were 20 to 25 days. The results revealed that Binadhan-14 performed better in western areas of Bangladesh. The average grain yield was 5.82 t ha^{-1} with maturity period of 116 days. Farmers of most districts were found keen to cultivate Binadhan-14.

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

During Boro season of 2022-23, block farming with Binadhan-24 was conducted at the farmer's fields in different locations in collaborations with DAE. The main objectives were to evaluate the performance of this variety in Boro season for widening its adoption by the farmers. The main objective was to evaluate the performance of this variety in Boro season. Area of each plot was 0.33 acre. Spacing between line to line and plant to plant was 20 cm×20 cm. All fertilizers were applied by farmers as per recommendation. Transplanting dates ranged from 20 to 31 January 2023 and age of seedlings were 35 to 40 days. The results revealed that Binadhan-24 performed better in south-west than middle and south-east areas of Bangladesh. The average grain yield was 6.67 t ha^{-1} with maturity period of 144 days. Farmers of most districts were found keen to cultivate Binadhan-24.

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

During Boro season of 2022-23, block farming with BINA dhan25 was conducted at the farmer's fields in different locations in collaborations with DAE. The main objectives were to evaluate the performance of this variety in Boro season for widening its adoption by the farmers. The main objective was to evaluate the performance of this variety in Boro season. Area of each plot was 0.33 acre. Spacing between line to line and plant to plant was 20

cm×20 cm. All fertilizers were applied by farmers as per recommendation. Transplanting dates ranged from 20 to 31 January 2023 and age of seedlings were 35 to 40 days. The results revealed that BINA dhan25 performed well in all locations. The average grain yield was 7.25 t ha^{-1} with maturity period of 140 days. Farmers of most districts were found keen to cultivate BINA dhan25.

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

During Aus season of 2023, block farming with Binadhan-19 was conducted at the farmer's fields in different locations in collaborations with DAE. The main objective was to evaluate the performance of this variety at different areas for widening its adoption by the farmers. Area of each plot was 0.33 acre. Spacing between line to line and plant to plant was 20 cm×15 cm. All fertilizers were applied by farmers as per recommendation. Transplanting dates ranged from 26 April to 16 May, 2023 and age of seedlings were 20 to 22 days. The results showed that Binadhan-19 performed well in most of the locations. The average grain yield of Binadhan-19 was 4.13 t ha^{-1} with maturity period of 103 days. Binadhan-19 was highly accepted by the farmers of North-West and South-West of Bangladesh. Anyway, Binadhan-19 is a short duration variety and after harvest of Boro rice, farmers can easily cultivate next crop Aman rice timely. Greater Rajshahi, Satkhira districts performed better than other districts. Farmers of most districts were found keen to cultivate Binadhan-19 in upcoming years.

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

During Aus season of 2023, block farming with Binadhan-21 was conducted at the farmer's fields in different locations in collaborations with DAE. The main objective was to evaluate the performance of this variety at different areas for widening its adoption by the farmers. Area of each plot was 0.33 acre. Spacing between line to line and plant to plant was 20 cm×15 cm. All fertilizers were applied by farmers as per recommendation. Transplanting dates ranged from 26 April to 16 May, 2023 and age of seedlings were 20 to 22 days. The results revealed that Binadhan-21 performed well in most of the locations except greater Dinajpur and Rangpur districts. The average grain yield of Binadhan-21 was 4.20 t ha^{-1} with maturity period of 104 days. Binadhan-21 is a short duration variety and after harvest of Boro rice, farmers can easily cultivate next crop, Aman rice. Greater Rajshahi district performed better than other districts. Farmers of most districts were found keen to cultivate Binadhan-21 in upcoming years.

Oilseed crops

Expt. 19: Adaptive trial with four rapeseed (RM-11, RL-13, RL-14, RL-17) mutants at different locations of Mymensingh, Jamalpur and Gopalganj distrits

During winter season of 2022-23, adaptive trials with four rapeseed mutants RM-11, RL-13, RL-14, RL-17 and one check variety, Tory-7 were conducted at farmers' field at three districts viz. Mymensingh, Jamalpur and Gopalganj. The objectives were to evaluate the performance of mutant lines at different locations and to provide the feedback information about the concerned lines. The experiment was setup in RCB design with three replications. The unit plot size was 5m×5m at all three locations. Seed were sown during middle to end of November 2022. Recommended doses of nitrogen, phosphorus, potassium, sulphur and boron were applied in the form of Urea, TSP, MoP, Gypsum and Borux. Proper cultural practices

were followed as and when necessary for normal plant growth and development. Data on morphological and yield attributes were recorded at harvest from 10 randomly selected plants in each plot. Grain yield was recorded from whole plot and converted into t ha^{-1}. The recorded data were finally subjected to proper statistical analysis and presented. Results indicated that the mutant lines were taller (96.7-111.7 cm) than the check variety, Tory-7 (94.7 cm) with being the tallest in RL-14 (111.7 cm). The maturity period of the four mutant lines took 5-6 days (88-89 days) more than the check variety, Tory-7 (83 days) with being the longer duration in RL-14 (89 days). Grain yield was greater in Mymensingh than Jamalpur and Gopalganj districts. The mutant RL-13 showed the highest seed yield (1.79 t ha^{-1}) at all three locations and also showed 15.6% higher seed yield than the check variety, Tory-7 (1.51 t ha^{-1}). The mutant RL-14 performed the second highest seed yield (1.63 t ha^{-1}) and showed 7.46% higher grain yield than the check variety. However, the mutant RL-14 showed greater straw yield than the others. Farmers of all locations were highly accepted the mutant RL-13 for its high yield potential though the mutant RL-13 were 5 days delay than the check variety.

Expt. 20: Block farming performance of rapeseed variety, Binasarisha-4 in different locations of Bangladesh

During winter season of 2022-23, block farming with Binasarisha-4 was conducted at the farmer's fields in different locations in collaborations with DAE. The main objective was to evaluate the performance of this variety in winter season for widening its adoption by the farmers. Area of each plot was 0.33-5 acre. All fertilizers were applied by farmers as per recommendation. Sowing dates ranged from 1st week to last week of November 2022. The results revealed that Binasarisha-4 performed well in most of the locations. Binasarisha-4 performed inferior in these districts due to lately sowing. But farmers are happy for giving some seed yield of Binasarisha-4, because the land is fallow after harvest of Aman. On the other hand, there is no seed yield of other rapeseed variety in lately sowing but Binasarisha-4 gave some seed yield under late sowing condition (last week of November to 1st week of December). Results further indicated that seed yield is positively related with days to maturity. For example, north-west and south-west part of Bangladesh took longer duration for maturity. The average grain yield was 1.56 t ha^{-1} with maturity period of 89 days. Farmers of most districts were found keen to cultivate Binasarisha-4.

Expt. 21: Block farming performance of rapeseed variety, Binasarisha-9 in different locations of Bangladesh

During winter season of 2022-23, block farming with Binasarisha-9 was conducted at the farmer's fields in different locations in collaborations with DAE. The main objective was to evaluate the performance of this variety in winter season for widening its adoption by the farmers. Area of each plot was 1-5 acre. All fertilizers were applied by farmers as per recommendation. Sowing dates ranged from 1st week to last week of November 2022. The results revealed that Binasarisha-9 performed well in most of the locations except Noakhali, Chattagram, Feni, Barishal and Netrokona districts. Binasarisha-9 performed inferior in these districts due to lately sowing. But farmers are happy for getting some seed yield of Binasarisha-9, because the land is fallow after harvest of Aman. Results further indicated that seed yield is positively related with days to maturity. The average grain yield was 1.64 t ha^{-1} with maturity period of 85 days. Farmers of most districts were found keen to cultivate Binasarisha-9.

Expt. 22: Block farming performance of rapeseed variety, Binasarisha-11 in different locations

During winter season of 2022-23, block farming with Binasarisha-11was conducted at the farmer's fields in different locations in collaborations with DAE. The main objective was to evaluate the performance of this variety in winter season for widening its adoption by the farmers. Area of each plot was 0.33-5 acre. All fertilizers were applied by farmers as per recommendation. Sowing dates ranged from 1st week to 31 last week of November 2022. The results revealed that Binasarisha-11 performed well in most of the locations. Binasarisha-11 performed inferior in these districts due to lately sowing. But farmers are happy for giving some seed yield of Binasarisha-11, because the land is fallow after harvest of Aman. On the other hand, there is no seed yield of other rapeseed variety in lately sowing but Binasarisha-11 gave some seed yield under late sowing condition (last week of November to 1st week of December). Results further indicated that seed yield is positively related with maturity duration. The average grain yield was 1.71 t ha^{-1} with maturity period of 87 days. Farmers of most districts were found keen to cultivate Binasarisha-11.

Expt. 23: Performance of rapeseed variety, Binasarisha-9 under zero tillage condition at different locations

During winter season of 2022-23, block farming with Binasarisha-9 was conducted under zero tillage condition at the farmer's fields in different locations. The main objective was to evaluate the performance of Binasarisha-9 under zero tillage for widening its adoption by the farmers. Area of each plot was 0.33-1.5 acre. All fertilizers were applied by farmers as per recommendation after 15 days sowing of seeds. Sowing dates ranged from 3-15 Nov. 2022. The results showed that Binasarisha-9 performed farmers' acceptable level at all three locations. Binasarisha-9 performed inferior at Mymensingh district because farmers did not take care properly. The average grain yield was 1.36 t ha^{-1} with maturity period of 86 days. Farmers were found keen to cultivate Binasarisha-9 under Zero tillage in future.

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

During Kharif-1season of 2023, block farming with Binatil-2 was conducted at the farmer's fields in different locations in collaborations with DAE. The main objective was to evaluate the performance of Binatil in Kharif-1 season for widening its adoption by the farmers. Area of each plot was 0.33 acre. All fertilizers were applied by farmers as per recommendation. Sowing dates ranged from 1st week to last week of March 2023. Based on the available reports, Binatil-2 performed well in Rangpur, Pabna, Natore, Naogaon, greater Kustia, Jhenaidah districts whereas Mymensingh and Sunamganj did not performed well. Though yield was not up to the mark in Satkhira and Sunamganj districts, but farmers were happy due to get additional crop after Aman cultivation. The average seed yield of Binatil-2 was 1.37 t ha^{-1} with maturity period of 94 days. Farmers of most districts were found keen to cultivate Binatil-2. The results also revealed that average seed yield of Binatil-3 was 1.10 t ha^{-1} with maturity period of 92 days at Chapainawabganj and Rajshahi districts. Binatil-4 was 1.40 t ha^{-1} with maturity period of 89 days at selected locations. At Pabna district yield was maximum, 1.50 t ha^{-1}.

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

During winter season of 2022-23, block farming with Binachinabadam-4, Binachinabadam-6 and Binachinabadam-8 were conducted at the farmer's fields in different locations in collaborations with DAE. The main objective was to evaluate the performance of Binachinabadam-4, Binachinabadam-6 and Binachinabadam-8 for widening its adoption by the farmers. Area of each plot was 0.33-1.0 acre. All fertilizers were applied by farmers as per recommendation. Sowing dates ranged from 1st week to 3rdweek of January 2023. The results revealed that Binachinabadam-4 performed well in Rangpur districts. The average pod yield of Binachinabadam-4 was 2.16 t ha^{-1} with maturity period of 141 days. Farmers of most districts were found keen to cultivate Binachinabadam-4 except Sunamganj. In case of Binachinabadam-6, performed best in Jamalpur district (2.90 tha^{-1}) followed by Mymensingh, Noakhali, Cumilla district. Binachinabadam-8 is becoming a popular variety in Rangpur district. In case of Binachinabadam-8, performed best in Gazipur district (2.40 t ha^{-1}). Binachinabadam-8 did not perform well in Brahmanbaria district. In Satkhira district, farmers are happy for cultivating salt tolerant Binachinabadam-8 in saline fallow land.

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

During winter season of 2022-23, block farming with Binasoyabean-2, Binasoybean-3, Binasoybean-5 and Binasoybean-6was conducted at the farmer's fields in different locations of Bangladesh in collaborations with DAE. The main objective was to evaluate the performance of Binasoyabean-2, Binasoybean-3, Binasoybean-5 and Binasoybean-6 for widening its adoption by the farmers. Area of each plot was 0.33acre. All fertilizers were applied by farmers as per recommendation. Sowing dates ranged from 1st week to 3rd week of November 2022. The results revealed that Binasoybean-2 performed well in Noakhali. Binasoybean-3 performed well in Noakhali, Laximpur and Chadpur districts. The average seed yield of Binasoybean-3 was 1.85 t ha^{-1} with maturity period of 106 days. Most farmers were found keen to cultivate Binasoybean-3. Binasoybean-5 performed better in Luximpur and Feni districts than Chadpur district. Most farmers were found interested to cultivate Binasoybean-5. In Chadpur district, farmers were keen to cultivate Binasoybean-6.

Pulse crops

Expt. 27: Block farming performance of mungbean variety, Binamoog-8 at different locations

During Kharif-1 season of 2023, block farming with Binamoog-8 was conducted at the farmer's field in different locations in collaborations with DAE. The main objective was to evaluate the performance of Binamoog-8 for widening its adoption by the farmers. Area of each plot was 0.33 acre. All fertilizers were applied by farmers as per recommendation. Sowing dates ranged from 1st week, February to last week of March, 2023. The results showed that Binamoog-8 performed better in Gopalganj districts than greater Barishal and Potuakhali districts. The average seed yield of Binamoog-8 was 1.42 t ha^{-1} with maturity period of 67 days. Most farmers were found keen to cultivate Binamoog-8 in future.

Expt. 28: Block farming performance of lentil variety, Binamasur-5, Binamasur-8 and Binamasur-10 in different locations

During winter season of 2022-23, block farming with Binamasur-8 was conducted at the farmer's field in different locations in collaborations with DAE. The main objective was to

evaluate the performance of Binamasur-8 for widening its adoption by the farmers. Area of each plot was 0.33 acre. All fertilizers were applied by farmers as per recommendation. Sowing dates ranged from 1st week to 3rd week of November 2022. The results revealed that Binamasur-8 performed well in Gopalganj, Faridpur and Shariatpur districts than Pabna district. The average seed yield of Binamasur-8 was1.92 t ha^{-1} with maturity period of 101 days. Most farmers were found keen to cultivate Binamasur-8 in future.

Expt. 29: Block farming performance of grasspea variety, Binakhasari-1 at different locations

During winter season of 2022-23, block farming with Binakhasari-1was conducted at the farmer's field at different locations in collaborations with DAE. The main objective was to evaluate the performance of Binakhasari-1 for widening its adoption by the farmers. Area of each plot was 0.33 acre. All fertilizers were applied by farmers as per recommendation. Sowing dates ranged from 1st week to last week of November, 2022. The results revealed that Binakhasari-1 performed better in Gopalganj district than Magura and Jashore districts. The average seed yield of Binakhasari-1 was1.76 t ha^{-1} with maturity period of 117 days. Most farmers were found keen to cultivate Binakhasari-1 in future.

Expt. 30: Block farming performance of chickpea variety, Binasola-4, Binasola-7, Binasola-8, BINA sola11 at different locations

During winter season of 2022-23, block farming with Binasola-4,7,8,11 were conducted at the farmer's fields at different locations in collaborations with DAE. The main objective was to evaluate the performance of Binasola for widening its adoption by the farmers. Area of each plot was 0.33 acre. All fertilizers were applied by farmers as per recommendation. Sowing dates ranged from 1st week to last week of November, 2022. The results revealed that the average seed yield of Binasola-4,7,8,11, were 1.22, 1.49, 1.78, 1.63 t ha^{-1}, respectively with maturity period of 126, 122, 122, 125 days in Rajshahi and Pabna districts.

Horticultural crops

Expt. 31: Block farming performance of turmeric variety, Binahalud-1 at Mymensingh region

During the Kharif-1season of 2022, block farming with Binahalud-1was conducted at the farmer's fields at Mymensingh. The main objective was to evaluate the performance of Binahalud-1for widening its adoption by the farmers. Area of each plot was 0.33 acre. All fertilizers were applied by farmers as per recommendation. Sowing dates ranged from last week of April to 2nd week of May, 2022. The results revealed that Binahalud-1 performed better in Mymensingh. The average rhizome yield of Binahalud-1was 24.4 t ha^{-1}. The maturity period of Binahalud-1 was 295 days. Farmers preferred Binahalud-1 for its good yield performance.

Expt. 32: Performance of summer onion variety, Binapiaz-1 at Rangpur district

During the late winter season of 2023, block farming with Binapiaz-1was conducted at Rangpur district. The main objective was to evaluate the performance of Binapiaz-1 for widening its adoption by the farmers. Area of each plot was 0.20 acre. All fertilizers were applied by farmers as per recommendation. Transplanting dates was last week of January 2023. The results revealed that average yield of Binapiaz-1 was .5 t ha^{-1} with a duration of 113 days.

Expt. 33: Establishment of BINA-Technology Pilot Area (BINA-Village)

In order to establish BINA-Technology Village, 214 block farming were conducted at farmers' fields in surrounding areas of BINA head quarter, Mymensingh. Results of overall promotional activities to BINA village establishment at different locations are presented below:

During Aman, Boro, Aus, and rabi season of 2022-23, block farming with T. aman (Binadhan-11, Binadhan-16, Binadhan-17, Binadhan-20 and Binadhan-13), Boro (Binadhan-10 and Binadhan-24), Aus (Binadhan-19 and Binadhan-21) rice varieties and oilseed variety Binasarisha-9 were conducted at Satiantola, Begunbari, Kallanpur, Sutiakhali, Boira and Chargobodia villages under Sadarupazila; Kashiarchar, Churali, Charghoramara and Shahebkachari villages under Gouripurupazila; Getuari village under Tarakandaupazila of Mymensingh district. The main objectives were to evaluate the performance of those varieties in three upazila of Mymensingh district for widening its adoption by the farmers. Area of each plot was 0.33 acre.

Mymensingh district is mostly suitable for rice cultivation and that of partly for mustard cultivation. Results in Table 35 depicted that rice varieties of Binadhan-11, Binadhan-16, Binadhan-17, Binadhan-20, Binadhan-13, Binadhan-24, BINA dhan25, Binadhan-19 and Binadhan-21 produced average grain yield of 4.80, 4.65, 5.30, 4.00, 3.00, 7.25, 7.60, 4.20 and 4.25 t ha^{-1} with average maturity period of 116, 103, 116, 125, 140, 145, 104 and 105 days, respectively. Binasarisha-9 produced average seed yield of 1.50 t ha^{-1} with average maturity period of 87 days and Binasarisha-11 produced 1.67 t ha^{-1} with maturity period 5 days. By the introduction of early T. aman, an extra Rabi crop could easily be cultivated between T. Aman and Boro rice like T. aman-Mustard-Boro cropping sequences instead of T. aman-Fallow-Boro cropping sequence. The introduced cropping pattern had demonstrated very suitable and highly profitable in Satiantola, Begunbari, Kallanpur, Sutiakhali of Mymensingh Sadar. Farmers highly accepted Aman-Mustard-Boro cropping pattern with BINA released varieties. These varieties following above cropping pattern are disseminating spontaneously among the farmers of surrounding areas.

Expt. 34: Organized Farmers' Training, Field days & Workshop during 2022-23

In order to technology promotion, a total 70 training courses of different crops were organized across the country by both ARED and 13 sub-stations during the period of 2022-23. A total of 4180 female and male farmers were trained on cultivation technique and seed preservation method of BINA developed promising varieties. In order to motivate the farmers to adopt BINA developed varieties/technologies, 107 field days/on-farm farmers' training on different crop varieties was organized across the country. In order to motivate the extension and seed producer personnel to adopt BINA developed varieties/technologies, five workshops were organized at Mymensingh, Cumilla and Khagrachari districts during 2022-23. The participants were DAE, BADC, AIS, SCA and NGO personnel. Total number of participants was 500.

AGRICULTURAL ECONOMICS DIVISION

Highlight of the Research Results

- In total, 160 farmers were interviewed for the profitability of Binadhan-22 study of which 40 farmers from each district. The average costs of Binadhan-22 cultivation were Tk. 73204 and Tk. 50125 ha^{-1} on full cost and cash cost basis, respectively. The highest production cost was for human labour (52.6%), followed by land use (11%), power tiller (8.7%) and irrigation (6.2%). The average yield of Binadhan-22 was 5133 kg ha^{-1}. The yield was highest in Rangpur (5259 kg ha^{-1}) followed by Bogura (5162 kg ha^{-1}), Mymensingh (5101 kg ha^{-1}) and Naogaon (5011 kg ha^{-1}). The average gross margin was found Tk. 51955 ha^{-1} on variable cost basis. Gross margin was highest in Rangpur (Tk. 55202 ha^{-1}) followed by Naogaon (Tk. 51607 ha^{-1}), Mymensingh (Tk. 50747 ha^{-1}) and Bogura (Tk. 50265 ha^{-1}), respectively. The average net return was Tk. 28876 ha^{-1}. The net return was highest in Rangpur (Tk. 32480 ha^{-1}) followed by Naogaon (Tk. 28554 ha^{-1}), Mymensingh (Tk. 27331 ha^{-1}) and Bogura (Tk. 27139 ha^{-1}), respectively. BCR was estimated at 1.39 and 2.04 on full cost and variable cost basis implying that the Binadhan-22 cultivation at farm level was profitable. The regression coefficients for power tiller and human labor for Binadhan-22 under all areas were positive and significant at 1% level. Coefficients for fertilizers and weeding were found to be positively significant at 5% level and coefficient of seed, irrigation and insecticides were positively significant at 10% level under all areas. The regression coefficients for farming experience and agricultural training under all areas had negative but significant relationship at 5% and 10% level, respectively. The regression coefficient of age was positive and significant at 10% level. Under all areas, the regression coefficient of education and farm size was positive but not significant. The average return to scale was 1.057 indicating increasing returns to scale. The first ranked constraint was unavailability of Binadhan-22 varieties seeds in all areas. Other constraints were lack of proper training (61%), lack of capital (38%) and lack of technical know-how (16%), respectively.

- A total of 180 sample taking 60 from each district and among the 60 samples 40 farmers and 20 traders/intermediaries were randomly selected from each of the districts for marketing system of Binachinabadam-8. The average costs of Binachinabadam-8 cultivation were Tk. 90470 ha^{-1} and Tk. 54938 ha^{-1} on full cost and cash cost basis, respectively. The highest production cost was for human labour (51.56%) followed by seed (17%), land use cost (9.54%), land preparation/power tiller (7.68%) and irrigation (5.66%). The cost of Binachinabadam-8 cultivation was found highest in Rangpur (Tk. 94215 ha^{-1}) followed by that in Kurigram (Tk. 89397 ha^{-1}) and Gaibandha (Tk. 87797 ha^{-1}), respectively. The average yield of Binachinabadam-8 was 1761 kg ha^{-1}. The yield was highest in Rangpur (1875 kg ha^{-1}) followed by Gaibandha (1715 kg ha^{-1}) and Kurigram (1694 kg ha^{-1}). The average net return per hectare was Tk. 68064. The net return was highest in Rangpur (Tk. 74535 ha^{-1}) followed by Gaibandha (Tk. 69983 ha^{-1}) and Kurigram (Tk. 59675 ha^{-1}), respectively. BCR was estimated at 1.75 and 2.89 on full cost and variable cost basis. Major marketing chain was found in the study areas: Chain-I: Farmer > Faria > Arathdar > Stockist> Paiker > Retailer > Consumer; Chain-II: Farmer > Faria > Stockist > Bepari > Retailer > Consume; Chain-III: Farmer >Bepari >Arathdar >Paiker >Retailer >Consumer. Chain-IV: Farmer > Paiker > Retailer > Consumer. The per quintal marketing cost of groundnut of different actors like Faria for Tk. 121, Bepari for Tk. 278, Arathdar for Tk. 87, Stockist for Tk. 925, Paiker for Tk. 141 and Retailer for Tk. 45 in all areas. Marketing cost of stockist was the highest among the intermediaries. Chain-I incurred the highest marketing cost (Tk.1697/100 kg) followed by Chain-II (Tk.1440/100 kg) and Chain-III (Tk.1286/100 kg). Lowest marketing cost was found in Chain-IV and it was Tk. 863/100 kg. The net margin of the actors like Faria for Tk. 184, Bepari for Tk. 297, Arathdar for Tk. 115, Stockist for Tk. 1787, Paiker for Tk. 222 and Retailer for Tk. 298 per 100 kg. Farmer's share in consumer prices of Binachinabadam-8 in different marketing chains was the highest in Chain-IV followed by Chain-III and Chain-II and

was lowest in Chain-I. The performance indicators revealed that the chain-IV (Farmer>Paiker>Retailer>Consumer) is more efficient than that of other chains. The first ranked production problem was lack of irrigation facilities (92%) in the all areas. Other problems were high value of seed (65%), incident of flood (40%), high price of fertilizer (36%), lack of capital (26%), lack of training (14%) and insect and pest (12%). Eighty six percent farmers were suffered unstable price during their business. Seventy six percent farmers had to paid high charge for transportation followed by lack of storage facilities (73%) and lack of cash capital (54%).

- The Yield gap study of Binadhan-19 was covered 180 farmers of three districts taking 60 farmers from each district. The average total yield gap was 0.73 t ha^{-1} (16.22%) and much scope for yield enhancement in the variety. The farmers among the study areas did not consider the recommended doses of inputs. The average costs of Binadhan-19 cultivation were Tk. 68858 ha^{-1} and Tk. 44467 ha^{-1} on total cost and variable cost basis, respectively. The average yield of Binadhan-19 was 3953 kg ha^{-1}. The average net return was Tk. 45273 ha^{-1}. BCR was estimated at 1.66 and 2.57 on full cost and variable cost basis. The regression coefficients for human labor, fertilizers and weeding for Binadhan-19 under all areas were positive and significant at 1% level. Coefficients for power tiller and farming experience were found to be positively significant at 5% level and coefficient of seed and insecticides were positively significant at 10% level under all areas. The regression coefficients for age under all areas had negative but significant relationship at 5% and education was negative and not significant. The regression coefficient of irrigation and farm size were positive but not significant. The return to scale was 1.047 in case of Binadhan-19 meaning increasing returns to scale. About 61% farmers opined inadequate supply of quality seeds at proper time as a top ranked constraint of Binadhan-19 cultivation. Other constraints were lack of technical know-how (44%), lack of capital (38%), natural calamities (37%), labor problem (26%), and adulteration & higher price of fertilizers & insecticides (24%). In order to decrease the yield gap of Binadhan-19 at farm level, there ensure timely adequate supply of quality seed. Frequent interaction was needed among farmers, extension personnel and scientists. Hand-on training on Binadhan-19 cultivation and crop management practices for the Binadhan-19 growing farmers. Ensuring labour facilities during harvesting time influence Binadhan-19 farmers to a greater extent to reduce yield gap.

- A total of 120 respondents taking 40 farmers and 20 traders were randomly selected from each of the aforesaid districts for the supply chain analysis study of Binasharisha-9. The average total variable cost of Binasarisha-9 cultivation was Tk. 36561 ha^{-1}. On an average, the total cost of production was Tk. 56130 ha^{-1}. Per hectare average yield of Binasarisha-9 was 1.53 ton. The highest and lowest gross returns of Binasarisha-9 cultivation were found Tk. 99029 ha^{-1} in Pabna district and Tk. 98471 ha^{-1} in Rangpur district. The average BCR on cash cost basis was found 2.70. But BCR on total cost basis was found 1.76. Average milling cost Tk. 9000.00 mt^{-1} of Binasarisha-9. Highest marketing cost was wholesaler (Arathdar/paiker) who were involved processing of dry mustard to consumable mustard (oil) which was Tk. 10320 mt^{-1}. Faria total cost was Tk. 995/mt, bepari cum local arathdar was Tk. 940 mt^{-1} and retailer cost was Tk. 1655 mt^{-1}. Faria net margin was Tk. 180 mt^{-1}, bepari cum local arathdar was Tk. 110 and arathdar cum paiker was Tk. 330 mt^{-1}. Retailer net margin was highest (Tk. 1365 mt^{-1}). Channel I: [Farmer> Faria> Bepari> Arathder (local)> Arathdar (city)> Retailer>Consumer]: Accounts for 48 % which was ranked as 1. Channel II [Farmer>Bepari(local)> Bepari (City)>Retailer>Consumer]: Accounts for 19% which was ranked as 2. Channel III [Farmer> Faria>Paiker>Miller>Retailer>Consumer]: Accounts for 16% which was ranked as 3. Channel IV [Farmer>Paiker>Retailer>Consumer]: Accounts for 10% which was ranked as 4. Channel V [Farmer>Retailer>Consumer]: Accounts for 7 % which was ranked as 5. The Government should ensure the adequate supply of adulteration

free or quality inputs (seed, fertilizer, pesticides, etc.). Drainage system should be developed to reduce loss during harvesting time. The farmers were supported by adequate credit facilities in time for using inputs timely with favorable terms & conditions. Frequent interaction was needed among farmers, extension personnel and Binasarisha-9 growers.

- From area coverage study, it was observed that the overall area coverage of BINA developed rice varieties were 8.69%. Among the three seasons; Aus, Aman and Boro the highest area coverage was found in Aman season that was 14.09% followed by Aus 5.93%, and Boro 2.90% respectively. Among the 14 agricultural regions the highest area coverage of rice was found 15.41% in Rajshahi region (Reg-7) and the lowest found 1.01% in Dhaka region (Reg-11). The overall area coverage of BINA developed pulse varieties were 8.88% and among the 14 regions the highest area coverage for pulses was found Barishal region 58.52% (Reg-6) and the lowest was found Rangamati region 0.001% (Reg-4), respectively. The overall area coverage of BINA developed oilseed varieties were 13.62% and among the 14 regions the highest area coverage for oilseed was found in Jashore region 16.38% (Reg-13) and the lowest was found in Bogura region 1.21% (Reg-10). Area coverage BINA developed horticultural varieties were 0.20% and among the 14 regions the highest area coverage for horticultural crop was found 483.00 ha (52.36%) in Rangamati agricultural region (region-2) and the lowest was found in Khulna region (region-9). 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.

Profitability of Binadhan-22 production in some selected areas of Bangladesh

Agriculture contributes about 11.38% to the gross domestic product (GDP) (BBS, 2022). Rice production covers 11.69 million ha, which is about 75% of total cropped area and stands third among the rice producing countries (MoA, 2019; Rahman *et al.*, 2021). The present study has a vital role in *Aman* rice production of Bangladesh. Therefore, the findings of this study would guide the policy makers in designing policies that can contribute to the measures needed to improve the nation's potential for food production efficiently. The study was conducted in four locations of Binadhan-22 growing areas, namely Mymensingh, Bogura, Naogaon and Rangpur district of Bangladesh during 2022. The objectives were (i) to determine the profitability of Binadhan-22 growers; (ii) to assess the factors affecting production of Binadhan-22 and (iii) to identify the major constraints faced by the Binadhan-22 producers. A total of 200 farmers were randomly selected as sample size in the study areas, 50 from each District. Data were collected from Binadhan-22 growers through interview schedule. Collected data were edited, summarized, tabulated and analyzed to fulfill the objectives. Descriptive statistics were used for analyzing the collected data. The Cobb-Douglas production function was used to estimate the parameters. Total cost consists of variable cost and fixed cost that covered 68.5% and 31.5% of total cost for Binadhan-22 production. The average costs of Binadhan-22 cultivation were Tk. 73204 and Tk. 50125 per hectare on full cost and cash cost basis, respectively. The average yield of Binadhan-22 was 5133 kg ha^{-1}. The average gross margin was found Tk. 51955 ha^{-1} on variable cost basis. The average net return per hectare was Tk. 28876. Benefit cost ratio was estimated at 1.39 and 2.04 on full cost and variable cost basis implying that the Binadhan-22 cultivation at farm level was profitable. The regression coefficients for power tiller and human labor for Binadhan-22 under all areas were positive and significant at 1% level. On the other hand, coefficients for fertilizers and weeding were found to be positively significant at 5% level and coefficient of seed, irrigation and insecticides were positively significant at 10% level under all areas. The regression coefficients for farming experience and agricultural training under all areas had negative but significant relationship at 5% and 10% level, respectively. The regression coefficient of age was positive and significant at 10% level. Under all areas, the regression coefficient of education and farm size was positive but not significant. The coefficients of under all areas was 1.057 means that 1 percent increase in all inputs simultaneously would result on average 1.057 percent increase in gross return of Binadhan-22 in the study areas. The first ranked constraint was unavailability of

Binadhan-22 varieties seeds in all areas. Other constraints were lack of proper training (61%), lack of capital (38%) and lack of technical know-how (16%). There is a need of proper guide to farmers about Binadhan-22 production management practices in the study areas.

Production and marketing system of Binachinabadam-8 in some selected char areas of Bangladesh

Bangladesh has vast char area but most of the char lands are not suitable for crop production. So the present study was undertaken to examine the suitability of crop production by assessing profitability, marketing system, production and marketing problems of rabi season Binachinabadam-8 in char lands of Rangpur, Gaibandha and Kurigram district during 2023. A stratified random sampling technique was used for the selection of district, upazila, block and market for the collection of data. A total of 180 sample taking 60 from each district and among the 60 samples 40 farmers and 20 traders were selected from each of the districts. Descriptive statistics, profitability model and marketing efficiency model was used in analyzing the collected data. The average costs of Binachinabadam-8 cultivation were Tk. 90470 and Tk. 54938 per hectare on full cost and cash cost basis, respectively. The average net return per hectare was Tk. 68064. Benefit cost ratio was estimated at 1.75 and 2.89 on full cost and variable cost basis. The following major marketing chain was found in the study areas: Chain-i: Farmer > Faria > Arathdar > Stockist> Paiker > Retailer > Consumer, Chain-ii: Farmer > Faria > Stockist > Bepari > Retailer > Consumer, Chain-iii: Farmer >Bepari >Arathdar >Paiker >Retailer >Consumer, and Chain-iv: Farmer > Paiker > Retailer > Consumer. Chain-wise marketing cost was observed that Chain-i incurred the highest marketing cost (Tk.1697/quintal) followed by Chain-ii (Tk.1440/quintal) and Chain-iii (Tk.1286/quintal). It was revealed from the study that the net margin of the actors like Faria for Tk. 184, Bepari for Tk. 297, Arathdar for Tk. 115, Stockist for Tk. 1787, Paiker for Tk. 222 and Retailer for Tk. 298 per quintal. The Chain-I of Binachinabadam-8 marketing has incurred highest marketing cost whereas the lowest in case of Chain-IV. The data revealed that the highest margin in Chain-I and the lowest in Chain-IV. The efficiency of different marketing chains was drawn as the basis of ranks of different performance indicators in different chains using composite index formula. The performance indicators revealed that the chain-IV is more efficient than that of other chains. Binachinabadam-8 is a profitable oilseed variety in the study areas. The farmers in the study areas faced some problems to Binachinabadam-8 production. The first ranked problem was lack of irrigation facilities (92%) in the all areas. The traders or intermediaries were faces different marketing problems during their business. Eighty six percent farmers were suffered unstable price during their business. Seventy six percent farmers had to paid high charge for transportation followed by lack of storage facilities (73%) and lack of cash capital (54%) were the trader's opinion to minimize the marketing problems of Binachinabadam-8. Therefore the study will be helpful to increase groundnut cultivation and improved the marketing system in char lands of Bangladesh.

Yield gap analysis of Binadhan-19 in some selected areas of Bangladesh

The study has a vital role in rice production of Bangladesh. This study not only identify yield gap but also analyses the profitability, factors affecting the production and to suggest some policy guidelines to minimize the yield gap about Binadhan-19 production. Therefore, the findings of this study would guide the policy makers in designing policies that can contribute to the measures needed to improve the nation's potential for food production efficiently. The specific objectives of the study were (i) to determine the yield gap of Binadhan-19 at the farm level; (ii) to identify the factors affecting the production of Binadhan-19; (iii) to estimate the costs and return of Binadhan-19 cultivation in the study areas and (iv) to suggest some policy guidelines to minimize the yield gap. This study was conducted in the three districts namely Pabna, Rangpur and Chapainawabganj in Bangladesh. A total of 180 Binadhan-19 cultivating farmers having 60 farmers from each districts were randomly selected with the help of Department of Agricultural Extension (DAE) personnel through interview. Field level primary data were collected by the researcher with the help of trained enumerators for the period of October-December, 2022. The total cost was composed of total variable costs (TVC) and total fixed costs (TFC). The gross return (GR) was computed as total output multiplied by the market price of

Binadhan-19. Profits or gross margin (GM) was defined as GR-TVC, whereas the net return (NR) was defined as GR-TC. BCR was computed as GR/TC. Total yield gap can be integrated into two parts i.e. Yield gap I and Yield gap II. Yield Gap I refer to the difference between research station's yield and potential farm yield obtained at demonstration plots, while Yield Gap II, reflecting the effects of biophysical and socio-economic constraints, was the difference between yield obtained at the nearest potential plot and actual yield obtained on farmers' fields. The estimated average yield gap-I was 0.31 t ha^{-1} (6.71%) and average yield gap-II was 0.42 t ha^{-1} (9.51%). The farmers among the study areas did not consider the recommended doses of inputs. In average 52.65% farmers used power tiller in three times, 43.48% farmers used power tiller more than three times, 75.98% farmers irrigated their land only one time because of Aus season, 52.19% farmers weeded their land 2 times and 86.33% farmers spray pesticide and insecticide to control disease and insect in the study area. The regression coefficients for human labor, fertilizers and weeding for Binadhan-19 under all areas were positive and significant at 1% level. Coefficients for power tiller and farming experience were found to be positively significant at 5% level and coefficient of seed and insecticides were positively significant at 10% level. About 61% farmers opined inadequate supply of quality seeds at proper time as a top ranked constraint of Binadhan-19 cultivation. Yield gaps caused by biological, socio-economic and institutional constraints can be effectively addressed through an integrated crop management (ICM) practices.

Profitability and supply chain analysis of Binasarisha-9 in some selected areas of Bangladesh

Mustard is very important oil crop in Bangladesh to ensure high return and the self-sufficiency in oilseed production. It is not satisfactory and cannot fulfill the country requirement. Keeping this in mind Bangladesh Institute of Nuclear Agriculture, BINA released Binasarisha-9 variety with high yielding potentiality. The study was conducted to find out the profitability of Binasarisha-9 in two major Binasarisha-9 growing areas, namely Pabna and Rangpur district of Bangladesh. The specific objectives were (i) to measure the costs and return of Binasarisha-9 production in the study areas; (ii) to find out the key players involved in the supply chain of Binasarisha-9; (iii) to determine the marketing efficiency of Binasarisha-9; and (iii) to suggest some policy guidelines for the cultivation of Binasarisha-9. The present study was conducted at two district namely Pabna and Rangpur during 2022. A total of 120 respondents taking 40 farmers and 20 traders were randomly selected. Profit model, descriptive statistics was used in analysing the collected data. The study revealed that the average total variable cost of Binasarisha-9 cultivation was Tk. 36561 per hectare. Per hectare average yield of Binasarisha-9 was 1.53 ton. The average net return was Tk. 42620 per hectare. BCR on variable cost basis was found 2.70. BCR. Marketing cost of different traders were identified in the study area. Average milling cost Tk. 9000.00/MT of Binasarisha-9. If one MT mustard seed milling in the oil mill then it get 410 kg mustard (oil) and 590 kg was byproduct (khoyl). Highest marketing cost was wholesaler (Arathdar/paiker) who was involved processing of dry mustard to consumable mustard (oil) which was Tk. 10320/MT. Faria total cost was Tk. 995/MT, bepari cum local arathdar was Tk. 940/MT and retailer cost was Tk. 1655/MT. Marketing margin of mustard oil and residue has also value and it sell Tk. 12.00/kg (Tk. 12000.00/MT). Paiker sell mainly milled mustard to retailer so it calculated 410 kg out of 1000 kg (1 MT) of mustard. Faria net margin was Tk. 180/MT, bepari cum local arathdar was Tk. 110 and arathdar cum paiker was Tk. 330/MT. Retailer net margin was highest (Tk. 1365/MT) from Binasarisha-9. The supply chain can be classified into four types: Channel I: Accounts for 48% which was ranked as 1; Channel II: Accounts for 19% which was Ranked as 2; Channel III: Accounts for 16% which was Ranked as 3, Channel IV: Accounts for 10% which was ranked as 4; Channel V: Accounts for 7% which was Ranked as 5. Farmers of Binasarisha-9 growing areas were facing some problem in cultivating this variety by which yield. In order to increase the yield of Binasarisha-9 at farm level, the Government should ensure the adequate supply of adulteration free or quality inputs (seed, fertilizer, pesticides, etc.). Therefore, Government should take appropriate steps on these aspects so that farmers become enthusiastic toward improved mustard cultivation.

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

The study was conducted in 64 district of Bangladesh to examine the area coverage of BINA developed rice, pulse and oilseed varieties during 2022-23 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 8.69%. Among the three seasons (Aus, Aman and Boro) the highest area coverage was found in Aman season that was 14.09% followed by Aus 5.93% and Boro 2.90%, respectively. It was found that among three seasons, area coverage was the highest for Aman that was 79.91% followed by Boro (13.47%) and Aus (6.62%), respectively. Among the 14 agricultural regions the highest area coverage was found 15.41% in Rajshahi region (Reg-7) and the lowest noted as 1.01% in Dhaka region (Reg-11). The overall area coverage of BINA developed pulse varieties were 8.88%. The highest area as well as coverage was found 23.98 % for Binakhesari-1 and lowest was seen 0.001% in case of Binasola-6. It was also observed that, among the 14 regions the highest area coverage for pulses was found for Barishal region 58.51% (Reg-6) and the lowest value was found for Rangamati region (Reg-4), respectively. It was found that, the overall area coverage of BINA developed oilseed varieties were 13.62%. The highest area coverage was found as 9.15% for Binachinabadam-4 and the lowest 0.01% was seen in case of Binasoybean-3. It was also found that among the 14 regions, the highest area coverage for oilseed was found in Jashore region 16.38% (Reg-13) and the lowest was found in Bogura region 1.21% (Reg-10). It was found that, the overall area coverage of BINA developed horticultural crop varieties were 0.20%. The highest area coverage was found 4.46% for Binalebu-1 and the lowest was found 0.06% for Binalebu-2. It was revealed that, among the 14 regions the highest area coverage for horticultural crop was found 176.00 ha (45.19%) in Rangamati agricultural region (region-4) and the lowest was found in Bogura region (region-10). The study identifies some constraints of increasing area coverage of BINA developed varieties such as-Non availability of seed which was top ranked problem. Area coverage BINA developed variety is increasing day by day. For continuation of variety expansion, the institute should ensure quality seed supply in proper time. Besides, more training, demonstration, collaboration with DAE & BADC as well as research and its budget should be increased which will support in food production as well as minimize the future hazard of climate change for ensuring food and nutritional security.

REGIONAL STATION AND SUB-STATIONS

BINA Regional Research Center, Gazipur

Exp-1: Regional yield trial of Bottle gourd mutant line at regional station and substation farm

Two advanced mutant lines of bottle gourd were evaluated at BINA Regional Research Center, Gazipur; BINA substation Cumilla and Ishwardi during rabi season 2022-2023 to determine the performance of promising mutant lines of bottle gourd. So, the present study was undertaken to select desirable mutants of bottle gourd for desirable size, shape, color with improved nutritional quality and high yield potential. The seeds of these selected mutants were sown on the pit on November 10th, 2022. The experiment was laid out in a Randomized Complete Block design with three replications. The unit plot size was 10.0 x 2.0m maintaining 2.0 x 2.5m spacing between two adjacent block and 0.5m drain between two adjacent plots. The land was fertilized with cow dung, N, P, K, S, B and Zn @ 10000, 80, 45, 88, 25, 1.8 and 4.5 kg/ha, respectively. Results showed that at BINA Regional Research Center, Gazipur, the mutant line BL-4$M_7D_{150}P_{3-3}$ produced maximum in individual fruits plant^{-1} (18), fruit weight (3.45 kg) and the yield (83.85 tha^{-1}) which is dark green with whitish spot. In the other hand minimum fruits plant^{-1} (10.85), fruit weight (2.87kg) and the yield (52.82 tha^{-1}) were produced by pasent BARI Lau-4 followed by BL-4$M_7D_{300}P_{4-2}$. At Ishwardi, the mutant line BL-4$M_7D_{150}P_{3-3}$ also produced maximum fruits plant^{-1} (17.85), fruit weight (5.12kg) and the yield (80.33 t ha^{-1}) which is dark green with whitish spot in colour and the minimum fruits plant^{-1} (10.23), fruit weight (3.18kg) and the yield (48.12 t ha^{-1}) was recorded by BARI Lau-4. At BINA substation Cumilla, the experiment was damaged due to unfavorable climatic condition.

Exp-2: Regional yield trial of eggplant mutant lines at farmer's field

Three advanced mutant lines of eggplant were evaluated at Gazipur and Narsindi during rabi season 2022-2023. BSFB is most destructive disease in Bangladesh and to select BSFB tolerant lines and to increase the yield of eggplant this experiment has been taken. The experiment was conducted with three M_7 mutants and BARI Begun-6. The seeds of these selected mutants were sown in seed bed on 23th October, 2022 and seedlings were transplanted 27th November, 2022 in the experimental field. The experiment was laid out in a Randomized Complete Block design with three replications. The experiment was laid out in row planting using suggested spacing 70cm × 60cm. Fertilizers were used at 138-40-100-18-1.7–3.6 kg/ha (NPKSBZn) and cowdung at10 t/ha. Irrigation, weeding, pruning of side shoots and other cultural operations were done when necessary following standard practices for brinjal production in Bangladesh (Mondal et al. 2011). Results showed that at Gazipur, the mutant line Ind$M_7D_{75}P_{45}$ showed the highest fruit yield (5.78 kg plant^{-1}) which was statistically similar to Ind$M_7D_{75}P_{29}$ (5.18 kg plant^{-1}) and the control showed the lowest fruit yield (4.20 kg plant^{-1}).The mutants Ind$M_7D_{75}P_{45}$ contributed the highest yield (88.24 t ha^{-1}) followed by Ind$M_7D_{75}P_{43}$ (85.87 t ha^{-1}) while control produced the lowest yield (44.12 tha^{-1}, BARI Begun-6). The mutant line Ind$M_7D_{75}P_{45}$ showed maximum plant height 138.20 cm and the control (BARI Begun-6) showed the minimum plant height 65.38 cm. The highest number of branches were found in mutant Ind$M_7D_{75}P_{45}$(7.05) and the lowest number of branches were found in control (4.16). The maximum number of fruits were found in mutant Ind$M_7D_{75}P_{43}$(20.25) and the lowest number of fruits were found in control (14.45). The range of fruit length was 16 cm to 9.24 cm, while fruit diameter ranged from 16.18 cm to 8.30 cm. In case of fruit length and fruit diameter the mutant line Ind$M_7D_{75}P_{29}$ produced the larger fruits and cheek variety (BARI Begun-6) produced the smaller fruits. Considering high yield, fruit size and tolerance to biotic stresses Ind$M_7D_{75}P_{45,}$ Ind$M_7D_{75}P_{29}$ andInd$M_7D_{75}P_{43}$ mutant lines were found promising. At Narsingdi, the mutant line Ind$M_7D_{75}P_{45}$ showed the highest fruit yield (5.73 kg plant^{-1}) which was statistically similar to Ind$M_7D_{75}P_{43}$ (5.21 kg plant^{-1}) and the cheek variety showed the lowest fruit yield (3.45 kg plant^{-1}). The mutants Ind$M_7D_{75}P_{45}$ contributed the highest yield (90.33 tha^{-1}) followed by Ind$M_7D_{75}P_{43}$ (85.24 tha^{-1}) while cheek variety produced the lowest yield (47.24 tha^{-1}, BARI Begun-6). The mutant line Ind$M_7D_{75}P_{45}$ showed maximum plant height 140.56 cm and the cheek variety (BARI Begun-6) showed the minimum plant height 70.50 cm. The highest number of

branches were found in mutant $IndM_7D_{75}P_{45}$ (7.24) and the lowest number of branches were found in cheek variety (4.80). The maximum number of fruits were found in mutant $IndM_7D_{75}P_{45}$ (25.50) and the lowest number of fruits were found in control (17.24). The range of fruit length was 16.0 cm to 7.15 cm, while fruit diameter ranged from 17.18 cm to 8.35 cm. In case of fruit length and fruit diameter the mutant line $IndM_7D_{75}P_{29}$ produced the larger fruits and cheek variety (BARI Begun-6) produced the smaller fruits. Considering high yield, fruit size and tolerance to biotic stresses $IndM_7D_{75}P_{45,}$ $IndM_7D_{75}P_{29}$ and $IndM_7D_{75}P_{43}$ mutant lines were found promising.

Up-scaling of BINA developed crop varieties in Gazipur region

A total of 212 demonstrations of BINA developed aman rice, mustard, sesame, boro rice, aus rice and groundnut varieties to observe the yield performance and spreading its adoption by the farmers in Gazipur, Dhaka, Tangail, Narsingdi and Manikgonj district were conducted at the farmer's fields during 2022-23 in Gazipur region through BRRC, Gazipur and DAE. The main objective of these demonstrations was to observe the yield performance and widening its adoption by the farmers in this region. The demonstration plot was 33 decimals with recommended spacing. Application of fertilizer and intercultural operations were done following the BINA recommendations. The demonstrations were Binadhan-11(3), Binadhan-16 (6), Binadhan-17 (18), Binadhan-20 (4), Binasarisha-4 (4), Binasarisha-9 (45), Binasarisha-11 (36), Binachinabadam-8 (5), Binatil-2 (35), Binatil-4 (15), Binadhan-24 (15), Binadhan-25 (21) and Binadhan-19 (5). Among the BINA developed aman rice varieties Binadhan-16 & Binadhan-17 produced higher yield in farmers field and becoming popular in Manikganj and Tangail as they get enough time to cultivate oil crops. In case of mustard varieties Binasarisha-11 and Binasarisha-9 produced higher yield in farmers field. Binatil-4, Binadhan-14, Binadhan-24, BINA Dhan25, Binadhan-19, Binadhan-21 and Binachinabadam-8 produced higher yield and becoming popular in Gazipur, Dhaka, Munshiganj, Narsindi, Manikganj and Tangail.

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

To popularize the conservation agriculture and reduce production cost and time; two modern varieties of mustard viz. Binasarisha-9 and BARI Sarisha-14 were evaluated following a RCB design with four dispersed locations under the Kalihati upazila of Tangail district during rabi season of 2022. Unit plot size was 1 bigha for each variety. The seeds were broadcasted after harvesting of aman rice @ 1 kg/bigha rate on 16th November 2022. All sorts of fertilizer were applied as per FRG'2018 using medium soil analysis interpretation level. Yield and yield attributes were taken after final harvesting of the crop plants. Findings disclosed that, the highest seed yield was obtained from Binasarisha-9 (1.4 tha^{-1}) and the lowest seed yield was obtained from BARI Sarisha-14 (1.1 t ha^{-1}). The shorter life cycle was seen with BARI Sarisha-14 (79.3 days) and Binasarisha-9 (85.5 days. The yield under optimum tillage was 12.5% higher than zero tillage condition and the expenditure was double compare to zero tillage. Now, farmers were very much interested towards the zero-tillage cultivation technique of mustard as it lets them time to prepare for next crops (boro rice). But they need some proven technology for the agronomic management of the crops i.e. time of weeding, thinning considerations, pesticide spray, fertilizer management etc. to gain the potential yield of the mustard cultivars. In addition, BINA Regional Research Center, Gazipur is trying to develop a new cropping pattern as fallow – mustard (Binasarisha-9 in zero tillage) – Boro (Binadhan-24/25) instead of (fallow–fallow–boro) pattern using BINA released technology.

Evaluation of improve cropping pattern in Gazipur and Tangail region

For the determination of profitable cropping patterns in farmers' fields at Gazipur region, different proposed cropping pattern were conducted along with existing cropping pattern during 2022-2023 at Gazipur and Tangail. Experiments were conducted in the different locations of Gazipur sadar, Kapasia, Mirzapur & Kalihati upazila in Gazipur and Tangail. Land size of the proposed patterns on which experiment was done was 1 bigha (33 decimal) for each pattern. For land preparation, planting

method, plating time, weeding, pest control, irrigation, fertilization, rouguing, harvesting, etc. farmers local practice was used.

Existing Cropping Pattern: Aman – Fallow - Boro rice
Improved Cropping pattern: Aman (Binadhan-17) – Mustard (Binasarisha-9) – Boro (Binadhan-24)
Time period: Year round 2022-23.

In an improved cropping pattern, the highest yield of Binadhan-17 is 6.2 ton/ha and the BCR is highest (1.72) (Benefit cost ratio is the proportion of net return (benefit) and total cost of production. Production Cost = (Total Cost of cultivation– Price of by-product)/Total Paddy Production (Tk./kg). Benefit cost ratio = Net return (benefit)/Total cost). The highest yield of Binasarisha-9 is 1.71 ton/ha and also contributes the highest BCR 1.8. The highest yield of Binadhan-24 is 7.1 ton/ha and also contributes the highest BCR 1.35. The highest yield of BRRI Dhan-28 is 5.4 ton/ha and also contribute the BCR 1.12. From the above studied cropping patterns Aman (Binadhan-17) – Mustard (Binasarisha-9) – Boro (Binadhan-24) rice (improved cropping pattern) was found more profitable compared to Aman (Ranjit) – Fallow – Boro (BRRI Dhan-28/29) rice (existing cropping pattern). Hence, further research is needed to justify this in greater area/region to get the more accuracy in case of above statement. Farmers expressed their reactions to execute such type of cropping patterns again for the consecutive years.

Breeder and TLS seed production

Breeder and truthfully labeled seed (TLS) were produced at the regional research center farm of Gazipur according to the requisition from different Division of BINA Headquarters. The Regional Research Center also produced few amounts of seeds on the basis of land availability after producing demanding seed by the divisions of head quarter. Seeds of BINA released crop varieties popular in Gazipur, Dhaka, Manikganj, Narsingdi, Munshiganj and Tangail region were produced at the Regional Research Center farms and also in the farmer's fields of different locations and part of those seeds were purchased during 2022-23. A total of 1419 kg seeds were produced where 128 kg were breeder seeds and 1289 kg were TLS at BINA regional research center, Gazipur during 2022-23.

Farmer's training (2022-23)

In order to technology transfer and rapid extension, 4 training programs were organized during the period of 2022-23 where, a total of 415 farmers and 12 SAAOs of DAE were trained on cultivation of BINA developed improved rice, oil seed, pulse, spices etc. crop varieties.

Field Days (2022-23)

For field motivation of the farmers and technology adoption, Farmers Field Day (FFD) on BINA developed varieties/technologies were carried out. A total of eight (8) field days on different crop varieties were organized in Gazipur region.

Germplasm collection

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

BINA Sub Station, Rangpur

Exp-1: Collection and characterization of minor cereal germplasm from different char land ecosystem

Small millets are known for their climate-resilient features, including their broader adaption to diverse ecological conditions, lesser water requirement, lower occurrence of insects-pests diseases and minimum vulnerability to environmental stresses. Germplasm collection and conservation as well as for crop improvement–genetic variability is an important thing. The study was executed to estimate the genetic diversity and to identify the accessions having the useful traits. Presence of genetic variability in crops is essential for its further improvement by providing options for the breeders to develop new varieties/ lines/ mutants. Eleven (11) Foxtail millet germplasm and thirteen (13) Proso millet germplasm were collected last year of 2022-23. These germplasm were collected from different (Gaibandha and Kurigram districts) charland, char homestead garden, river side, farmers farm store, cultivated habitat, roadside from char areas etc. In Foxtail millet, the result indicated that comparatively earlier maturity recorded (110 days) from Panchagarh source of germplasm followed by Birol, Dinajpur. Longest panicle length (12.3 cm) observed in Panchagarh and shortest panicle length (9.7 cm) from Birol, Dinajpur. In Proso millets, Shorter duration (104 days) to mature proso millet recorded from the source of Panchagarh. Highest number of effective tiller along with panicle length found from Panchagarh germplasm.

Exp-2: Maintenance of gremplasm for minor cereals

In order to develop broad genetic source pool of minor cereal twenty two germplasm were collected during 2022-23 and growing in kharif-1 in Rangpur substation farm. Plastic pods were used maintaining a sandy soil texture which was suitable for minor crop production. Total seeds of each entry were collected, sun dried, processed and preserved for further sub sequent generations.The seeds of 11 germplasm were collected based on agronomic performance. These will growing for next generations.

Exp-3: Growing of M_3 groundnut population

With a view to identify suitable high yielding and shorter durable mutants from the irradiated M_2 populations, the experiment was conducted in Rangpur sub-station during 2022-23. Two seasons (Rabi and Kharif-2) were considered to ahead of generation or breeding cycle. The experiment had seven (7) lines (SP-1-1, SP-1-3, SP-2-2, NP-2-3, NP-2-4, NP-3-1, NP-3-3) and conducted with RCB design with 3 replicates. Unit plot size was 3m x 4m. Data were recorded for plant height, pod number, pod yield/plant, 100-pod weight, 100-kernel weight, yield/plot and yield (t/ha). Shelling percentage was calculated using the following formula. It is reported that highest seed yield (2.01 t/ha) was in NP-3-1 whereas the lowest yield observed in (1.39 t/ha) in NP-2-3. The highest shelling percentage (79.64%) reported in SP-1-1 followed by SP-1-3 (73.31%). The weight of 100 pod recorded highest (117.4 g) in NP-2-3 where the lowest (101.9 g) in NP-1-3.

Exp-4: Effect of mulch material on weed control that affects the growth & yield of groundnut

Groundnut is one of the most important crops ranked fourth in oilseeds and 13th among food crop of the world. The raw groundnut seeds contain 7.40 % moisture, 24.70 % protein, 46.10 % fat and 17.41 % carbohydrate. They also contain other beneficial minerals like sodium,

phosphorous, potassium, zinc and iron. The intensity of weed is more in groundnut cultivation. Common weeds found in groundnut are *Digitaria sanguinalis*, *Cynodon dactylon* and *Cyperus rotundus*. Weeds are the most important biotic constraints to groundnut production in Bangladesh. Mulching can be the effective measure for weed control as it prevents sunlight from reaching the soil surface and maintains soil temperature to enhance the crop productivity. A field based study was conducted from September, 2022 to January, 2023 at BINA sub-station Rangpur to observe the effect of mulch material on the productivity of groundnut. The experiment was laid out in randomized complete block design with 4 treatments viz., rice husk (T_2), black polythene sheet (T_3), sawdust (T_4) and control (T_1) with RCBD three replications. The variety Binachinabadam-4 was used to conduct the study. Harvesting was done manually at the first week of January, 2023 when the nuts were fully matured i.e., when they turn brown. The weeds were collected and were categorized into two forms i.e., narrow leaf weed and broad leaf weed. Parameters such as days of flowering, days to maturity, pegging, weed infestation and plant height were noted earlier. After the harvest, pods per plant, actual plot yield and 100 seed weight were measured. The number of pods were found significantly (T_2) highest (2.07 t/ha) in plot mulched with rice husk (Presence of cellulose, lignin and silica in rice husk help in overall growth and development of plants which could be responsible for higher yield) and lowest (0.96 t/ha) in plot mulched with (T_3) black polythene sheet (because groundnut pegging cannot penetrate polythene sheets). Similar trend was also observed in pod/plant (27.2) for the treatment T_2 (Mulching with rice husk).

Exp-5: Increasing cropping intensity through profitable cropping pattern at Rangpur region

Sustainable crop production in Bangladesh through improvement of cropping pattern in rice based cropping system is regarded as increasingly important in national issues such as food security, poverty alleviation and create job opportunities. It is a great opportunity to increase our cropping intensity by developing four crops based cropping pattern. The main challenge of the new millennium is to increase per unit yield by at least 50% through manipulating the limited land resource. The present experiment was therefore, undertaken to study the economic feasibility of growing four crops in a year in a piece of land by incorporating aus rice, groundnut and potato in the existing three crops based pattern. The experiment was conducted at two locations (Farmers field at Char bissonath, kawnia, Rangpur and BINA sub-station farm, Rangpur) during 2022-23. There were two treatments viz., T_1= Exiting cropping pattern (Potato- Boro- groundnut), T_2= Developed cropping pattern (Potato- Groundnut- Aus-Groundnut). Potato variety Diamont, Groundnut variety Binachinabadam-8 and aus rice variety Binadhan-19 were used as the test crops. It is observed; generally proposed pattern has the greater gross return as compared to its existing pattern. Similarly, gross margin was highest in proposed pattern in comparison with previous pattern. The total gross margin in the proposed cropping pattern was Tk. 103610/- ha^{-1} whereas in existing pattern this was Tk. 82510/- ha^{-1} . The BCR of proposed pattern was 1.73 while 1.58 BCR of existing one. Total duration for existing pattern was 300 days but the improved pattern took 356 days to complete its whole cycle. Therefore, it may be concluded that an incremental economic progress (Tk-82510/- to Tk-103610/-) was noticed by the proposed cropping pattern in charland ecosystem at Rangpur by which the farmers will benefited.

Up-scaling of Binadhan-17 in Rangpur region

To demonstrate the performance of Binadhan-17 and widening their adoption by the farmers, during Aman/2022-23, a total of 64 demonstrations were conducted in greater Rangpur divisions. The check varieties ware BRRI dhan87 and BRRI dhan75. The trials were carried out in the farmers' level. Each demonstration plot covered with 33 decimals area of land. Seeds were sown in seed bed during mid-July to 1st week of August. All required amount of fertilizer were applied as per recommendation in demonstrate plot. To control insects-pests and diseases, pesticide/fungicide was sprayed as and when necessary. Binadhan-17 produced average seed yields of 6.0 tha^{-1} which was 5.89 percent higher than compared to check variety BRRI dhan87. Average maturity period of Binadhan-17 was 108 days. The check varieties BRRI dhan75 and BRRI dhan87 produced average gain yield of 5.65 tha^{-1} with average maturity period of 117.3 days**.** Therefore, it was found that Binadhan-17 had a shorter duration Aman variety which facilitates the multiple cropping and enhance the cropping intensity. Farmers were found interested to cultivate Binadhan-17 in Rangpur region and it was increased gradually day by day. Another observation was made by the respective farmer that Binadhan-17 consumes less urea and less water. The findings of all the demonstration plots indicated that there was an ample scope of Binadhan-17 to get popular among the farmers of respective areas.

Block demonstrations with BINA developed Aus variety Binadhan-19 and Binadhan-21in Rangpur region

In order to enhance the syncrononize cultivation of BINA released Aus variety, Binadhan-19 and Binadhan-21 were demonstrated to farmers' in Aus season 2022-23, during Aus growing season, 2022-23. A total of 8 block demonstrations were put into set up at greater Rangpur division. BINA released Aus rice varieties (Binadhan-19 and Binadhan-21) along with a check BRRI dhan48 and BRRI dhan98 were used in these trials. Data on duration and yield (t/ha) were recorded. Farmers' reaction was also noticed in order to consider dissemination of these varieties towards farmers level randomly. The demonstration plots were furnished with a land area of 33 decimals having recommended plant to plant and row to row distance based on crop variety. The report was on the basis of DAE information and crop cutting data from the demonstrative field plot. Binadhan-19 and Binadhan-21 produced average seed yield of 4.17 tha^{-1}, which was 7.78 percent lower as compared to check variety(s) BRRI dhan48/98. Average maturity period of Binadhan-19 was 100 days. BRRI dhan48/98 produced average gain yield of 5.02 tha^{-1} with average maturity period of 112 days. Therefore, it was noted that Binadhan-19/21 was a shorter duration than BRRI dhan48/98 having lower yield potentiality but Binadhan-19 and Binadhan-21 had a great market value due to fine grain size. Considering duration, farmers' motivation is essential to cultivate Binadhan-19 and Binadhan-21. It would be recommended to the farmers for greater dissemination of these varieties. Regarding duration to get maturity indicated that there was a large scope to fit upland ecosystem with BINA released Aus rice varieties.

Head to head adaptive trial (one bigha/trial)

In order to evaluate the performance of promising BINA released varieties, an adaptive trial was conducted using BINA varieties along with the popular varieties for rice and mustard at different locations in greater Rangpur and Dinajpur region during 2022-23. In Aman/2022-23 trail, Binadhan-17 took shorter duration (114,117 days) than Swarna (140 days) and BRRI dhan87 (125 days) having the yield 6.3, 6.2 t/ha for the test variety, Bnadhan-17. In Aus, BRRI dhan48 perform better as compared to Binadhan-19 considering the yield performance. Similarly, BINA dhan25 recorded higher yield than its respective check variety, BRRI dhan89 with premium quality grain size.

Demonstration results of different BINA varieties over the year (2022-23) at different locations in Rangpur and Dinajpur region.

A total of 412 demonstrations for the BINA variety like rice (Aus, Aman and Boro), mustard, groundnut (Rabi and kharip) and sesame were successfully carried out at different locations in greater Rangpur division during 2022-23. For conducting the demonstrations, seeds and with some other input costs were provided to the selected farmers by BINA, Rangpur**.** During 2022-23 in Aman growing seasons, among all tested Aman varieties in Rangpur, Binadhan-17 took 107 days to mature with an average yield of 6.2 t/ha. On the other hand, Binadhan-20 produced the grain yield of 4.67 t/ha with its maturity period of 125 days. Binadhan-11 and Binadhan-22 had the maturity period of 116 and 115 days by producing the yield of 4.12 and 5.28 t/ha respectively. On an average, BINA dhan25 produced the grain yield of 6.9 t/ha with its maturity period of 146 days. In Rabi season, Binachinabadam-8 took 120 days to get its maturity along with the average yield of 2.6 t/ha at different charland of Rangpur. In contrast, it requires only 110 days in kharif season having the yield of 1.8 t/ha. Other oil seed crops Binatil-2 and Binatil-4 produced the average seed yield of 1.16 t/ha taking the maturity period of 92 days . Binasarisa-9 took 96 days to mature having the average yield of 1.51 t/ha.

Determination of profitable cropping pattern in farmers' fields at Rangpur region

Different proposed cropping patterns were conducted along with existing cropping pattern during 2022-23 at Rangpur. These were funded by different project/program/revenue. Proposed promising four (4) crops cropping pattern were **Aman (Binadhan-7)–Potato–Maize (Fodder)–T. Aus (Binadhan-19/21)**. Another promising cropping pattern established in river side of Ranpur which was **Aman (Binadhan-11)–Mustard/Potato–Maize.** Very soon, these profitable cropping patterns will be released as the technology(s).

Seeds produced/purchased & distribution (Breeder/TLS) during 2022-23

A total of 2.3 tons of breeder seeds of different BINA varieties were produced in station with proper inspection by SCA officials during reporting period. Due to limited farm area, a little amount of the production of TLS was performed of different BINA varieties. A total of 23.3 tons TLS seed were stored of which maximum amount was purchased from progressive farmers. In case of farmer's field, partial input subsidies and free seeds or only free seeds were provided. During reporting period, a total of 23.3 tons of seeds of different crops varieties of BINA were produced and purchased and finally distributed to all stakeholders.

Training on the use of BINA developed technologies

During 2022-23, in order to disseminate BINA varieties, several trainings were conducted at BINA sub-station and at different UAO office. For performing these training programmes UAOs, SAAOs and farmers from different upazilas were trained up and it was covered the number of 60 SAAOs and 330 Farmers (Male and Female).

Field Days (2022-23)

During 2022-23 a total of 5 (five) field days were successfully completed for different popular varieties. To conduct these field days the crop variety were considered as Binadhan-17, Binasharisha-11, BINA dhan25 and Binachinabadam-8. The DAE and BADC personnel along with print and electronic media were present during the crop cutting and field days period.

Bina Sub-station, Ishurdi

Experiment 1: Integration of organic and inorganic fertilizer on T.Aman- Garlic rice cropping pattern.

A field experiment was conducted for integration of organic and inorganic fertilizer on Binadhan-17 and garlic at BINA Sub-Station, Ishurdi. The objective was to find out the suitable and profitable fertilizer dose for maximized crop production and improvement of soil health. There were six treatments viz. T_1=Native soil fertility (without fertilizer), T_2=100% Chemical Fertilizers (CF), T_3=70% CF+2t ha^{-1}Vermicompost (VC), T_4=70% CF + 2.5 t ha^{-1} Cow dung (CD), T_5=85% CF+2t ha^{-1} VC, T_6=85% CF + 2.5 t ha^{-1} CD. The experiments were laid out in a randomized complete block design with three replications in July, 2022. Irrigation and weeding were done as and when necessary. Yield and yield attributing characters were recorded. Integration of organic and inorganic fertilizer on T. Aman rice cropping pattern demonstrated that the highest number of total tiller, effective tiller was recorded in the treatment T_4 and number of filled grain, unfilled grain in the treatment T_6. The highest plot yield (6.0 t ha^{-1}) was obtained in the treatment T_2. In order to maintain soil fertility, organic fertilizer sources are crucial for crop productivity. According to the study, treatment T2 (100% chemical) generated the highest yield compared to the other treatments. T5 (85% CF + 2t ha^{-1} VC) produced the 2nd highest yield of the organically treated plots. Two ton vermicompost cannot compensate 30% chemical fertilizer or 2.5 t ha^{-1} cowdung. Whereas 15% chemical fertilizer can be compensated by vermicompost or cowdung. On the other hand integration of organic and inorganic fertilizer on garlic the highest no. of cell per bulb, wt. of 10 bulbs (g) was recorded in thetreatment T5. The highest plot yield (1.71 t ha^{-1}) was obtained in the treatment T6. In order to maintain the soil fertility, organic fertilizer sources are crucial for crop productivity. According to the study, treatment T6 (85% CF + 2.5 t ha^{-1} CD) produced the highest (3.16 t ha^{-1}) which received 2.5 t ha^{-1} cowdung that can compensate 15% chemical fertilizer.

Experiment 2: Study on the performance of 2 cropping patterns

Economically profitable cropping patterns were executed against the existing one. Improved cropping patterns (**Fallow- Mustard- Groundnut**) were studied for the purpose against the existing pattern (**Fallow-Fallow-Groundnut**). The experiment was conducted at two farmer's field Majdiya, Ishurdi, Pabna and Nandigram, Bogura during the year 2022-2023 to develop an economically profitable cropping pattern against the existing one. The unit area for each farmer's was 33 decimal. In char land Binasharisa-9, Binachinabadam-8 was cultivated under improved cropping pattern whereas only groundnut was cultivated under existing cropping pattern. The experimental plot was a char land of Padma river and few months were inundated by flood water. In another cropping pattern experiment oil crops included (**T.aman-Mustard-Boro rice**). In our short duration variety was used in this experiment. To increase the cropping intensity, evaluation of BINA released varieties regarding suitability; enhance farmers' per unit income from a limited land by ensuring maximum utilization of space and time. After the end of each crop's harvest, data were collected on yield and yield attributes, gross return, total variable cost, gross margin, rice equivalent yield and BCR (Benefit cost Ratio). Then summation of different parameters of the individual crop's result was done separately and average performance was calculated. In the cropping pattern study it was revealed that improved cropping pattern gave maximum BCR and net income. Between the studies, BCR and REY were found to be highest in improved pattern compared to the existing cropping pattern. Overall, farmers' were eager to

cultivate the improved pattern for higher yield and market value. Thus they appreciated the addition of short duration mustard and groundnut based pattern.

Experiment 3: Validation of Binadhan-24, BRRI dhan29 and BINA dhan25 in Boro season.

The experiment was conducted for the performance of BINA and BRRI released Boro rice varieties at BINA Sub-Station, Ishurdi. The objective was to find out the higher yield variety. The experiment was laid out in a randomized complete block design with three replications in January, 2023. Field validation of Binadhan-24, BRRI dhan29 and BINA dhan25 in boro season revealed that the highest grain yield (7.67 t/ha) was produced by BRRI dhan29 with delayed mature (159 days) but BINA dhan25 produced the best yield within the shortest time (143 days). Its market value is high for premium quality.

Experiment 4: Growing of M_3 generation of Lentil (*Lens culinaris*).

The experiment was conducted at BINA Sub-Station, Ishurdi. The objective was to develop short duration and drought tolerant mutant lines of lentil. Binamasur-5, BARI masur-6 and a local cultivar were irradiated with 150Gy, 200Gy and 300Gy doses. After field growing 25 (twenty five) mutant variants were selected based on early maturity and higher yield in the M_3 generation. The seeds were preserved for further screening in the M_4 generation.

BINA Sub-Station, Magura

Research Highlights

- A total of 45 experiments from BINA Head quarter and scientists of BINA Sub-Station, Magura were conducted and maintained at BINA Sub-Station farm and the farmers' field of Jashore region and Rajbari district of Faridpur region. Monitoring, data collection, data analyses and reporting were done by respective PI with the help of BINA Sub-Station, Magura.
- Based on earliness, plant height and grain size, 3 M_6 mutant lines (ZM-231, ZM-421, ZM-611) of rice have been selected from Indian Zirashail for further trials.
- M_1 population harvested from irradiated Shubhol lota (a local cultivar) for growing M_2 population.
- Yield performance of Binadhan-16, Binadhan-17 and BRRI dhan58 was recorded 6.70, 8.50 and7.75t/ha, respectively in Boro season 2022-23.
- Two (02) rice germplasm (Khato babu & Habu dhan) have been collected from Jashore region.
- Binasarisha-11 produced maximum yield of 1.51 t/ha with water-logging for 24 hours at 55-60 DAS.
- Binadhan-17 produced maximum yield of 9.55 t/ha in Boro season with irrigation at 7 days AWD (throughout the growing season).
- A total of **137** block demonstrations were conducted with BINA released crop varieties at different crop growing areas of Jashore region and Rajbari district of Faridpur region during Aman, Rabi, Boro& Kharif-I season of the reporting year 2022-23.
- In T. Aman season 2022, a total of **84** block demonstrations were conducted with Binadhan-16, Binadhan-17 and Binadhan-22 produced average yield of 5.22 t/ha, 6.27 t/ha and 5.69 t/ha, respectively.
- In Boro season 2022-23, a total of **10** block demonstrations were conducted with BINA dhan25 with average yield of 7.54 t/ha.
- In Rabi season 2022-23, a total of **23** block demonstrations were conducted with Binasarisha-9, Binamasur-8, Binamasur-9, Binamasur-10 & Binakheshari-1 having average yield of 1.69, 1.84 2.0, 1.83 and 1.50 t/ha, respectively.
- In Kharif-I season 2023, a total of **20** block demonstrations were conducted with Binatil-2 & Binatil-4with average yield of 1.54 and 1.49 t/ha, respectively.
- A total of **315** demonstrations were conducted with BINA released crop varieties at different crop growing areas of Jashore region and Rajbari district of Faridpur region during Aman, Rabi, Boro, Kharif-I & Aus season of the reporting year 2022-23.
- In T. Aman season, a total of **89** demonstrations were conducted with Binadhan-16, Binadhan-17 and Binadhan-22 were produced average yield of 4.95 t/ha, 6.17 t/ha and 5.61 t/ha respectively.
- In Boro season 2022-23, a total of **50** demonstrations were conducted with Binadhan-24 and BINA dhan25 with average yield of 7.45 t/ha and 7.50 t/ha respectively.
- In Rabi season 2022-23 a total of **127** demonstrations were conducted with Binasarisha-4, Binasarisha-9, Binasarisha-11, Binamasur-8, Binamasur-10, Binakheshari-1,

Binachinabadam-4 and Binachinabadam-8 produced average yield of 1.62, 1.62, 1.44, 1.87, 1.84, 1.66, 2.18 & 2.41 t/ha, respectively.

- In Kharif-I season 2023, a total of **27** demonstrations were conducted with Binatil-1, Binatil-2, Binatil-3 & Binatil-4 with average yield of 1.18, 1.54, 1.24 & 1.52 t/ha, respectively.
- In T.Aus season 2023, a total of **22** demonstrations were conducted with Binadhan-19 & Binadhan-21with average yield of 4.21 & 4.67 t/ha, respectively.
- A total of **22.165** tons seed of different popular BINA released varieties were produced in BINA Sub-Station, Magura farm as well as contract growers.
- A total of **300** farmers, seed dealers and SAAO were trained up during the reporting year 2022-23.
- A total of **09** field days were conducted with Binadhan-16, Binadhan-17, Binadhan-21, Binadhan-22, Binamash-2 and 3, Binasola-8, Binasola-11, Binatil-4 and Binamoog-7 during the reporting year 2022- 23.

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

Zirashail is an Indian HYV. Farmers of Jashore region cultivate this variety in all the three (03) rice growing season (Aus, Aman and Boro) because of its short duration and fine grain quality. To evaluate early maturing and higher yielding mutants of Zirashail this experiment was conducted. To evaluate the yield performance of the 08 selected mutant variants, M_5 seeds of irradiated Indian Zirashail were sown on 29th November 2022 and transplanted on 9th January 2023 at BINA Sub-Station farm, Magura along with the parent in Boro season, 2022-23. The experiment was followed by randomized complete block design with the spacing 20cm and 15cm. A unit plot size was 4.5m×3.0m. Recommended doses of Urea, TSP, MoP, Gypsum and Zinc Sulphate were applied and intercultural practices were followed as and when necessitated.

Three (03) mutant lines ZM-231 (7.28 t/ha), ZM-421 (6.96 t/ha), ZM-61 (6.75 t/ha) have been selected for further trials.

Experiment 02. Growing M1 generation of rice for earliness and higher yield

Subhol lota is an Indian HYV. Farmers of Jashore region are very much interested to cultivate this variety in Boro season. A satisfying area is covered with this variety. That is why to create variability for early maturing and higher yielding mutants of Subhol lota rice variety this experiment was conducted. To create genetic variability, seeds of a local cultivar Shubhol lota was irradiated with 100, 200, 250, 300 and 400 Gy of gamma rays. Seeds were sown on 24th December 2022 and transplanted on 10th January 2023 at BINA Sub-Station farm, Magura. The parent was also included in this experiment. The experiment was followed by non-replicated design and sown separately (dose and variety wise). Basal doses of fertilizers were applied and intercultural practices were followed as and when necessary. Survived irradiated rice plants of Shubhol lota which produced seeds were harvested separately in bulk for growing M_2 population. M_2 population will be grown in next season to select desirable mutants.

Experiment 03. Performance of Binadhan-16 and Binadhan-17 in Boro Season

BINA developed varieties are getting popular day by day. Binadhan-16 and Binadhan-17 are very popular in Aman season in Jashore region due to their short duration with higher yield

performance. Though these are aman varieties farmers of this region started cultivating these varieties in Boro season.

To assess/evaluate the performance of these varieties in Boro season this experiment was conducted. This experiment was carried out to assess/evaluate the performance of these varieties in Boro season. This experiment was conducted during Boro season 2022-23 at the research field of BINA Sub-station, Magura. Binadhan-16 and Binadhan-17 were selected for this experiment and as check variety BRRI dhan58 was taken. This experiment was laid out in randomized complete block design (RCBD) with 3 replications. Plot size was 3m×4m. Seeds were sown in 20th December 2023 and seedlings were transplanted in 25th January 2023. Recommended doses of fertilizers, pesticides and insecticides were applied. Intercultural operations were done when necessitated.

Results showed that average plant height was shorter in both the BINA varieties Binadhan-16 and Binadhan-17 which was 92 cm and 96 cm respectively. Average panicle length of BINA varieties was longer than BRRI dhan58. But data from the Table no. 5 revealed that among the three varieties BRRI dhan58 produced the highest seed yield (8.67 tha^{-1}) followed by Binadhan-17 (8.50 tha^{-1}) and Binadhan-16 (6.87 tha^{-1}). In terms of total duration, the shortest life cycle was recorded for Binadhan-16 (129 days). Considering the yield performance of the varieties Binadhan-16 and Binadhan-17, further trial will beneeded for releasing as a Boro rice variety.

Experiment 04. Collection and evaluation of germplasm of different crops

There are so many local and Indian cultivars present in Bangladesh. Farmers cultivate these varieties around the country. Each cultivar has its own characteristics with specific genes. So, this experiment was conducted to enrich the gene bank of BINA and to characterize the selected germplasm.

To assess yield potential and other morpho-physiological attributes, seeds of two (02) local cultivar (Khato babu & Habu dhan) were sown on different seasons throughout the year 2022-23 at BINA Sub- Station farm, Magura. The experiment was followed by non-replicated design and sown separately variety wise. Basal doses of fertilizers were applied and intercultural practices were followed as and when necessary. Two (02) local cultivar Khato babu & Habu dhan were collected and evaluated. At harvest, duration, plant height and seed yield were recorded.

Experiment 05. Effect of different durations of water-logging at different growth stages on seed yield of mustard

During the mustard growing season, sometimes rainfall occurs and mustard crop is damaged due to unexpected water logging. As the weather patterns are constantly changing, we are dying for the need of comparative water-logging tolerant varieties even in Rabi season. The aim of this experiment is to determine the level of water tolerance of conventional mustard varieties (Binasarisha-9, Binasarisha-11 and BARI Sarisha-14).

The experiment was conducted at BINA Sub-Station, Magura farm during Rabi 2022-23. The test varieties were V1=Binasarisha-9, V2=Binasarisha-11, and V3=BARI Sarisha-14. The experiment was laid out in a randomized complete block design (split plot) with three replications. Seeds were sown on 12 November 2022. Unit plot size was 21m^2 (7m×3m) with

25cm line to line spacing. Recommended production packages i.e., application of fertilizers, weeding, thinning, irrigation, and application of pesticides were followed to ensure normal plant growth and development. The imposed irrigation treatments were: i. No water-logging, ii. Water-logging for 24 hours at 55-60 DAS, iii. Water-logging for 48 hours at 55-60 DAS, iv. Water-logging for 72 hours at 55-60 DAS. Appropriate statistical analyses were performed for the comparison of the means of each character.

Water-logging for 24 hours at 55-60 DAS for Binasarisha-11 produced the highest seed yield (1.51t/ha) among the treatments. Water-logging for 24 hours at 55-60 DAS for Binasarisha-9 showed statistically almost same result on seed yield (1.46t/ha). No water-logging for BARI Sarisha-14 showed the highest result on seed yield (1.47t/ha) among other treatments implied on BARI Sarisha-14. With water-logging for 24 hours at 55-60 DAS for Binasarisha-11 produced the highest seed yield (1.51t/ha) among the treatments. This experiment will be repeated in the next year to confirm the results.

Experiment 06. Evaluation of Binadhan-17, Binadhan-24 and BINA dhan25 under different'soil moisture stress/drought tolerance level' in Boro season

In Bangladesh, cultivated rice varieties of Aman season get adequate natural rainfall. But due to some shortage of water in Boro season, we have to depend on ground water for paddy cultivation in Boro season. In this case, the aim of this experiment is to check the drought tolerance level of the popular varieties (Binadhan-17, Binadhan-24 and BINA dhan25) cultivated in Boro season.

The experiment was conducted at BINA Sub-Station, Magura farm during Boro 2022-23. The test varieties were V_1=Binadhan-17, V_2=Binadhan-24 and V_3=BINA dhan25. The experiment was laid out in a randomized complete block design (split plot) with three replications. Seeds were sown on 04 December2022. Unit plot size was 21m^2 (3m×7m). The seedlings (35 days old) were transplanted on 08 January 2023. Recommended production packages i.e., application of fertilizers, weeding, irrigation, and application of pesticides were followed to ensure normal plant growth and development. The imposed irrigation treatments were: T_1=Normal irrigation (3 days AWD); T_2=Irrigation at 7 days AWD (throughout the growing season); T_3= Irrigation at 15 days AWD (throughout the growing season). Appropriate statistical analyses were performed for the comparison of the means of each character.

The irrigation treatments showed insignificant differences due to field conditions. Irrigation at 7 days AWD for V_1 (Binadhan-17) produced the highest seed yield (9.55 t/ha) among the treatments. Irrigation at 15 days AWD for V_1 (Binadhan-17) showed statistically similar results comparing Irrigation at 7 days AWD for V_1 (Binadhan-17). Irrigation at 7 days AWD for V_2 (Binadhan-24) produced the lowest seed yield (7.50 t/ha). Though **Binadhan-17** is a popular T. aman variety, it can also be performed well in the Boro season with low water demand. This experiment will be repeated in the next year to confirm the results.

Experiment 07. Block farming with BINA varieties/technologies

There are so many local, high yielding and hybrid varieties available in the market as well as in farmers' field. Every variety differs from each other. Demonstrations are needed to be done to specify suitable variety for particular area based on agro-climatic condition. The following experiment was taken to demonstrate BINA developed varieties to encourage farmers for

extensive cultivation of BINA developed popular varieties. A total of 137 block demonstrations were conducted during the reporting year 2022-23 in Jashore and Faridpur (Rajbari district) region. BINA developed popular varieties were used as tested varieties and as check BRRI/BARI developed varieties were used in this experiment. Before sowing, the seeds were treated with chemicals to prevent seed borne diseases. Balanced doses of fertilizers were used as and when needed. Urea, DAP, MoP, Gypsum and Zinc and Boron fertilizers were used in appropriate doses. Intercultural operations were done as and when necessary.

It can be concluded that Binadhan-17, Binadhan-22, BRRI dhan75, BINA dhan25, Binasarisha-9, Binamasur-8, Binamasur-9 and Binamasur-10, Binakheshari-1, Binatil-2 and Binatil-4 should be cultivated in broad aspect for getting higher yield under the agro-climatic condition of Jashore region and Rajbari district of Faridpur region.

Experiment 08. Dissemination of BINA varieties/Technologies

There are so many local, high yielding and hybrid varieties available in the market as well as in farmer's field. Every variety differs from each other. Demonstrations are needed to be done to specify suitable variety for particular area based on agro-climatic condition. The following experiment was taken to demonstrate BINA developed varieties to encourage farmers for extensive cultivation of BINA developed popular varieties. In order to disseminate BINA developed popular varieties/technologies demonstrations of different varieties were conducted during the reporting year 2022-23. Each demonstration was conducted in 1 bigha land (33 decimal).

A total of 315 demonstration of different BINA developed popular varieties were conducted. Farmers' were found interested to cultivate BINA developed varieties due to short duration and higher yield than previously cultivated varieties.

Experiment 09. Development of suitable and profitable cropping patterns with BINA released varieties/technologies

To increase cropping intensity and crop yield as well as farmers' income through designing suitable cropping patterns by including HYV mustard/Sesame varieties between early Aman and Boro/Aus rice this experiment was taken. The experiment was started from Kharif (T. Aman) season of 2022 and ended in Aus season, 2023. BINA developed varieties were selected to cultivate in cropping sequences. This experiment was laid out in randomized complete block design (RCBD) with 3 dispersed replications at 3 different locations. Recommended fertilizer doses were applied in each crop. Intercultural operations were done as and when necessary.

All the proposed pattern performed better than the existing pattern. The details of crop sequence of different crops under proposed and existing cropping pattern are shown inthe table

Cropping pattern no.	Existing pattern	Proposed pattern	BCR	Locations
C.Pattern-1	T. Aman-Fallow-Boro No. of plots: 21	Binadhan-11/16/17-Binasarisha-4/9/11- BINA dhan25	2.04	Magura, Jhenaidah, Jashore, Chuadanga, Meherpur, Kushtia & Rajbari

C.Pattern-2	T. Aman-Mustard-Boro No. of plots: 03	Binadhan-17 -Binasarisha-4/9- Binatil-2/4- Binadhan-19/21	1.85	Sadar, Jhenaidah
C.Pattern-3	T. Aman-Mustard-Mungbean No. of plots: 03	Binadhan-17-Binasarisha-4/9 – Binamoog-8 – Binadhan-19	1.77	Kaliganj, Jhenaidah
C.Pattern-4	Banana (year round) No. of plots: 03	Sobri (banana)-Binachinabadam-4 - Binachinabadam-4 (mixed/inter cropping)	1.73	Sreepur, Magura
C.Pattern-5	Fallow-Mustard-Sesame No. of plots: 03	Binadhan-11- Binasarisha-4/9/11- Binatil-2/4	1.89	Mohammadpur,Magura

Experiment 10. Development of BINA-technology village in surrounding areas of BINA Sub-Station, Magura

Demonstrations are needed to assess BINA developed technologies in special situations or sites evaluating reactions of farmers and extension personnel. To establish BINA Technology pilot area in surrounding village(s) of BINA Sub-Station, Magura for extension of BINA developed varieties/ technologies for improving farmers socio-economic status by motivating adoption of BINA technologies by including BINA technologies in the existing cropping pattern(s) to extend promising mutant varieties/ technologies among the farmers through seed exchange programme this experiment was conducted. In order to establish BINA Technology village demonstrations and other extension/promotional works were done in surrounding area of BINA Sub-Station, Magura at the farmers' field.

Moghi union in Sadar, Magura district is very suitable area for growing rice, pulse, oilseeds and vegetables. Results indicated that in T. Aman season Binadhan-17 produced the highest grain yield (6.25 t/ha) with short duration. Farmers had been interested to cultivate BINA released oilseed varieties(Binasarisha-4, 9,11) & pulse variety (Binamasur-8, 10) in Rabi season for their short duration and higher yield. Mustard variety Binasarisha-9, Lentil variety Binamasur-8 showed immense potentials in terms of yield and short duration. In Boro season BINA dhan25 produced the highest yield of 7.60 t/ha. Establishment of BINA Technology village in Moghi union is in progress.

Experiment 11. Truthfully labeled seed production of BINA released crop varieties

BINA developed varieties are getting popular day by day. With the increasing popularity of the varieties, seed demand also increasing. To fulfill the demand of seeds and to supply seeds for demonstration of BINA-village programme, GOs, NGOs, farmers and other research purposes, this experiment was conducted. BINA developed popular crop varieties. During the reporting period a total of 22.165 ton Truthfully Labeled Seed (TLS) were produced by BINA Sub-station, Magura. TLS seeds of T. Aman rice and Groundnut varieties are distributed among the farmers of Magura, Jashore, Chuadanga, Jhenaidah, Rajbari, Meherpur and Kushtia districts and seeds of

Boro rice, mustard, lentil, chickpea and grasspea varieties are stored in the seed store of BINA Sub- station, Magura.

Experiment 12. Training on the use of BINA developed varieties/technologies

For minimizing the yield gap of BINA developed varieties the production technology should be properly introduced to farmers. To improve farmers' knowledge about BINA developed varieties/ technologies and to publicize BINA generated technologies to its end user farmers' training were conducted. In order to disseminate BINA developed varieties/technologies 5 (five) day long training were arranged at BINA Sub-station, Magura and Mohammadpur Upazila Agriculture Office. The participants (300) were farmers (both male and female) and Sub-Assistant Agriculture Officers.

Experiment 13. Field Day(s): 09

For the extension of BINA developed varieties at field level field days should be done. To improve farmers' knowledge about BINA developed varieties/ technologies and to encourage farmers to adopt BINA generated technologies these field days were conducted. In order to motivate the farmers to adopt the BINA developed varieties/technologies 09 field days of Binadhan-16, Binadhan-17, Binadhan-21, Binadhan-22, Binamash-2 & 3, Binasola-8, Binasola-11, Binatil-4 & Binamoog-7 were organized.

BINA Sub-station, Satkhira

Late potentiality evaluation of BINA released *Aman* rice varieties

T. Aman rice varieties are generally cultivated in the rainfed ecosystem, which covers about 48.97% of the total rice area and contributes to 38.14% of total rice production in Bangladesh. Due to climate change, sometimes heavy rainfall and sudden floods damage the seedbed or delay transplanting. However, this fluctuation from optimum planting time might be responsible for incomplete and irregular panicle exertion and increased spikelet sterility in rice. Therefore, it is necessary to figure out the degrees of delayed planting and evaluate the performance of BINA-released Aman varieties. This trial was carried out at the BINA sub-station farm, Satkhira during the Aman season in 2022 to investigate the degrees of delayed planting for grain yield production of BINA-developed Aman rice varieties in the Khulna region. The 21 days seedlings of eight rice varieties namely Binasail, Binadhan-7, Binadhan-11, Binadhan-16, Binadhan-17, Binadhan-20, Binadhan-22 and Binadhan-23 were transplanted on 30 July, 14 August, 30 August and 15 September, 2022. The experiment was designed in an RCBD two factors with three replications using unit plot size 2 m × 2 m following spacing between hills and rows 15 and 20 cm, respectively. Ten randomly selected plants from each plot were collected for data on different yield contributing characters of rice and then analyzed using the statistical computer package program R.

Different transplanting dates of rice seedlings had a significant effect on agronomical traits and grain yield production in rice. The highest grain yield was recorded in rice, where the seedlings were transplanted on 30 July, 2022 and then gradually decreased with the delayed transplanting of rice seedlings. Besides, variations in yield and yield-contributing traits largely depend on the rice cultivars. The highest yield was recorded in Binadhan-17 (6.30 tha^{-1}) followed by Binadhan-22 (6.05 tha^{-1}) and the lowest was found in Binadhan-16 (4.77 tha^{-1}). Considering the interaction effect between rice varieties and transplanting time; it was observed that all the studied characters showed significant differences among the treatments. Here, Binadhan-17 produced the highest grain yield with seedlings transplanted on 30 July 2022 whilst the lowest grain yield was recorded in Binadhan-16 with seedlings transplanted on 15 September 2022. Correlation analysis revealed that there was a strong and positive correlation between panicle length and the number of filled grains per panicle with grain yield. Besides, there was a strong negative correlation between flag leaf length and the number of filled grains per panicle with grain yield.

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

Transplant Aman rice varieties are generally cultivated in the rainfed ecosystem, which covers about 48.97% of the total rice area and contributes to 38.14% of total rice production in Bangladesh. In the Khulna region, Aman rice is cultivated in different ecosystems under diversified cropping patterns using varied crop varieties. However, seedling age is an important factor for rice production in the Aman season. BINA-released Aman varieties are of short duration and seedling age impacts their yield production. Therefore, it is necessary to observe the effect of different seedling ages on Aman rice cultivation for better grain yield production. This experiment was conducted at the BINA sub-station farm, Satkhira during the Aman season in 2022 to observe the effect of different seedling ages on grain yield of BINA-developed Aman rice varieties in the Khulna region. There were eight rice varieties, namely Binasail, Binadhan-7, Binadhan-11, Binadhan-16, Binadhan-17, Binadhan-20, Binadhan-22 and Binadhan-23

evaluated under natural growth conditions using seedlings aged 15, 25, 35, 45 and 55 days. The experiment was designed in an RCBD two factors with three replications using unit plot size 2 m × 2 m. The rice seedlings were transplanted following 15 and 20 cm spacing between hills and rows, respectively. The recommended fertilizer dose was used, and intercultural operations were done when necessary to ensure the proper growth and development of rice plants. Five randomly selected plants from each plot were harvested for collecting data on yield contributing characters and then analyzed using the statistical computer package program R.

All the tested varieties showed significant differences in different yield contributing characters. The highest grain yield was observed in Binadhan-7 followed by Binadhan-20, Binadhan-23 and Binadhan-17 and the lowest was recorded in Binadhan-16. Morphological traits have an important role in the rice yield improvements in different rice varieties. Considering the interaction (seeding age × variety) effect on different agronomical traits was found statistically significant. Binadhan-17 produced the highest grain yield in 25 days of seedling followed by Binadhan-23 in 15 days of seedling. Besides, the lowest grain yield was recorded in 55 days of seedling in all the tested varieties and the gradual increase was noticed with decreasing seedling age.

Development of salt tolerant small grain rice lines through induced mutation and advanced breeding technique

Soil salinity is one of the major constraints affecting rice production, especially in the coastal areas of Bangladesh. There are few salt-tolerant rice varieties cultivated in saline-prone areas and all of them are reported as bold grain rice. However, there is no report on fine-grain rice, even though grain size and shape play a major role in consumer preferences. Therefore, to create variability for developing fine-grain rice lines with improved salt tolerance and higher grain yield. The crossing between Binadhan-10 and Binadhan-17; Binadhan-10 and Hwachungbyeo was carried out at the BINA sub-station farm, Satkhira during boro season in 2022-23 to create genetic variability for salt tolerant fine grain rice development. The F_1 seeds were collected for planting next year.

Morpho-molecular characterization of rice landraces growing in Khulna region

Salinity is a complex issue that causes yield reductions in the coastal region for rice production. Being a staple food, its production is considered a key factor in food security in Bangladesh. Thus, there are a few salt-tolerant rice varieties cultivated in about 10 lac ha of saline-prone areas. Therefore, salt-tolerant rice landraces may be identified which are used as a genetic resource for rice breeding to ensure yield stability in the future. The experiment was conducted at the BINA sub-station, Satkhira throughout the Kharif-II season in 2022 to find out the suitable rice cultivar for saline tolerance as well as for higher grain yield production. A total of 99 rice cultivars were used in this study including Bangladeshi landrace (94) and High Yielding Variety (HYV) (5) were assessed to find the morphological superiority for salinity tolerance. The experiment was laid out in alpha-lattice design with two replications. Unit plot size was 2m × 1m. Fertilizer application and intercultural operations were done as recommended. Phenotypic data were collected from five randomly selected plants from each plot. The collected data were analyzed using the statistical computer program R.

Results showed that all the studied traits are significantly different and widely distributed in different parameters among the rice landraces. Considering the data on the PCA biplot, it is revealed that positive and negative correlation within the traits was found. Based on the

morphological observation all the tested cultivars are classified into three distinct major groups. The varieties that have similar genetic relations with local cultivars may be descendants from the crosses of those varieties or varieties having close genetic similarity to them. Molecular markers analysis will be done with the help of a plant breeding division for selecting suitable rice landraces for saline-prone areas.

Screening of different Mungbean cultivars in saline prone areas

Mungbean is one of the most important pulse crops in Bangladesh and provides high-quality protein for human consumption. Dry land areas are experiencing low crop yields due to severe water shortages and salinity Mungbean is gaining attention as a short-season crop that can cultivate in water shortage conditions and fix atmospheric nitrogen as well as add organic matter for soil improvement. The performance of mungbean varieties in saline areas has not been tested yet. However, it is important to identify suitable mungbean cultivars for developing new varieties for saline-prone areas. The experiment was conducted at the BINA sub-station farm, Satkhira during the Kharif-1 in 2023 to find out the suitable mungbean cultivars for developing new varieties for saline-prone areas in Bangladesh. Nineteen mungbean cultivars were assessed to identify the morphological superiority for grain yield production. Finally, the experiment was designed in an RCBD with three replications using a unit plot size of 2 m × 2 m. All intercultural operations were done as needed to ensure the normal growth and development of crops. Morphological data were collected from randomly selected three plants of each plot and then analyzed using the statistical package program R.

The phenotypic traits were compared at the maturity stage and significant variation was observed in all studied parameters among the different varieties. The tallest plant was recorded in BARI moog4 followed by Binamoog-7, BARI moog3and the shortest plant was found in Local Patuakhali cultivars. In addition, the highest number of branches per plant was identified in Binamoog-4 and the lowest number of branches was noted in BARI moog5. Plant leaves are an important source of higher photosynthetic capacities which ultimately contribute to grain yield. The highest number of leaves per plant was observed in BARI moog6 and the lowest number of leaves per plant was obtained from BARI moog5. Besides, the variety BARI moog6 also displayed the longest pod, and the shortest pod was recorded in BARI moog7. The highest number of pods per plant was exhibited by BARI moog8 followed by BARI moog2 and BARI moog7 produced the lowest number of pods per plant. In contrast, the maximum number of seeds per pod was counted in BARI moog2 followed by BU moog2 which was similar to BU moog4. However the minimum number of seeds per pod was obtained from BARI moog7.

Growing of M_2 mutant lines of summer mungbean

Mungbean is a major pulse crop in Asia due to its short duration, and adaptation to various cropping systems; it increases tenant farmers' income and improves soil fertility by fixing atmospheric nitrogen through nodulation in roots but the low yield and asynchronous pods formation is a big challenge for cultivation. Therefore, it is important to develop higher-yielding synchronized pod-bearing mungbean varieties.

The experiment was executed at the BINA sub-station farm, Satkhira during the Kharif-1 season in 2023 to find out the genetic variation for synchronous pod maturity with high yielding. The M_2 population of Binamoog-8 (300 Gy, 350 Gy, 400 Gy, 450 Gy and 500 Gy) was grown in line with target selection. In the M_2 populations, 143 plants were selected based on plant height,

growth duration, pods per plant and yield per plant. The parent was also included in this experiment. The M_3 seeds were collected and stored for future cultivation.

Varietal improvement of canola through advanced breeding techniques

Canola is the most productive variety which is also low in erucic acid (<2% in the oil) and glucosinolates that differentiate it from earlier rapeseed varieties. Canola oil was a source of oil for lighting purposes in ancient times. Canola is now the second most common oilseed crop in the world with greater than 12% of the world's oil supply. The protein quantity, quality, and overall nutrient content of canola are quite good. BARI developed the Canola variety namely BARI Sarisha-18 whose production is higher and also the duration is higher, so it is difficult to cope with cropping patterns in Bangladesh. However, therefore, it is important to develop higher yieldingcanola lines with having growth duration is less than 90 days to set the major cropping pattern (Aman-Mustard-Boro) across the country.

The experiment was conducted on the BINA sub-station farm, Satkhira during the Rabi season in 2022-2023 to develop early maturing, high-yielding with less erucic acid canola/rapeseed lines. A total of 16 F_1 seeds with parental varieties were sown in lines. Intercultural and fertilizer management were done as recommended. Finally, three lines were selected from the cross between BARI Sarisha18 and Binasarisha-9 compared to parental lines. The F_2 seeds were collected and stored in a refrigerator for future cultivation.

Up-scaling of BINA developed crop varieties in Khulna region

A total of 318 demonstrations were conducted at the farmer's fields during 2022-23 in different districts of Khulna region using BINA-developed crop varieties. The main objective of these demonstrations was to observe the yield performance and its adoption by the farmers. The demonstration was piloted in 33 decimals area following the recommended spacing and management practices. Data was collected from DAE personnel and farmer's cultivated different crops.

There were 92 demonstrations distributed through the Khulna region at the farmer's field using Aman rice varieties namely, Binadhan-11, Binadhan-16, Binadhan-17, Binadhan-20, Binadhan-22 and Binadhan-23. The data on crop duration revealed that Binadhan-16 was harvested in the shortest time 103 days and Binadhan-20 took 125 days for ripening among the cultivated varieties. Data suggested that Binadhan-17 and Binadhan-22 produced the highest grain yield and became a popular variety in the Khulna region.

About 183 demonstrations were conducted in the Rabi season using BINA-developed mustard, Boro rice, and grass pea varieties. The performance of Binadhan-10, Binadhan-14, Binadhan-24, Binadhan-25, Binasarisha-4, Binasarisha-9, Binasarisha-11 and Binakhesari-1 were promising for Khulna region.

In the Kharif-1 season, about 43 demonstrations were distributed in Satkhira, Khulna, and Bagerhat districts using Binamoog-8, Binachinabadam-8, Binatil-2, and Binatil-4. Crop duration and the average yield of different cultivated varieties showed that these varieties might be promising for this region. Recently, BINA sub-station Satkhira introduced some new crop varieties namely BINA dhan25, Binatil-4, and Binachinabadam-8 in the Khulna region, and received a good response from the farmers.

BINA Sub-station, Barishal

Determination of submergence tolerance ability and durability of Aman rice seedling and their effect on grain yield

A pot experiment was conducted at BINA Sub station Barishal during July to October, 2022 to find out submergence tolerance ability and durability of aman rice seedling and their effect on grain yield in Barishal region. This experiment was conducted in pot with 6 Aman varieties such as V_1=Binadhan-11, V_2=Binadhan-13, V_3= Binadhan=17, V_4= Binadhan-20, V_5= Binadhan-23 and V_6= BRRI dhan52 V_3= Binadhan-20. Binadhan-23 and one BRRI developed variety BRRI dhan52 maintain four treatment such as T_1= no stress (Control), T2= 5 days stress, T3= 10 days stress, T4= 15 days stress. The treatments were replicated thrice to avoid any effect of heterogeneity as per standard procedure. Seven kg soil and the recommended doses of fertilizers were applied in each pot as basal dose. 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 first irrigation as top dressing. 20 days seedlings were sown in a pot. After overcome transplanting shock, all experimental pot except control pot were filled with water for 5 days, 10 days and 15 days. After 5 days, 10 days and 15 days complete saturation, seedling survival percentage was counted. Yield contributing parameters were collected after physiological maturity. Binadhan-13, Binadhan-20 and Binadhan-23 showed maximum survival percentage and the lowest survival percentage was shown in Binadhan-17. Panicle length decreasing rate was very negligible but filled grain number decreasing rate prominent in Binadhan-17 that was 31.36% where 9%, 15.32%, 2%, 16.56% and 15.88% respectively in Binadhan-11, Binadhan-13, Binadhan-20, Binadhan-23 and BRRI dhan52. Grain size or 1000 grain weight also decreased at submerge condition at different duration. This decreasing rate was very low. Grain weight per plant was also decreased at submerge condition at different duration. At treatment T_4 (15 days stress) maximum grain weight decreasing rate was observed in Binadhan-17 that was 49.73% where minimum in Binadhan-23 (22.18%) followed by Binadhan-20 (26.86%). It can be concluded from the results that Binadhan-20 and Binadhan-23 variety showed best performance at 15 days submergence condition. Binadhan-17 have no ability to submergence condition.

Collection and morphomoloecular characterization of T. Aman rice landraces cultivated in Barishal region.

An experiment was conducted at the BINA sub-station, Rahmatpur, Barishal, during the period from June 2022 to Novembere 2022 to investigate the genetic divergence of local rice landraces and to select the source of gene for tidal submergence tolerant for Barishal region. The experiment was carried out in a Randomized Complete Block Design with 15 landraces and three replications. The landraces were used Lalvojon, Skkhorkhora, Vushihara, Chaulamani, Kauathuti, Holdemota, Motadhan, Dudhsona, Dudhkalam, Chinigura, Moulota, Bashfulchikon, BRRI Dhan76, and Sadamota. The plots were prepared as per design. During final land preparation cowdung was incorporated into soil at the rate of 5 t/ha. A blanket fertilizer dose of 100 kg N, 20 kg P, 50 kg K and 20 kg S was applied during final land preparation. One third urea and all other fertilizers were applied during final land preparation. The remaining amount of urea was applied as top dressing in two equal installments as vegetative (25 days after transplanting) and after tillering stage (45 DAT). At 37 days old rice seedling were transplanted in with two seedling per hill on puddled soil. After attaining 80% physiological maturity the rice were harvested. Chaulamani required maximum days to maturity (152 days) followed by BRRI dhan76 (139 days) and Motadhan (129 days). The longest panicle length (32 cm) was found Dudhsona and most similar were observed in BRRI dhan76 (30 cm) and BRRI dhan-77 (28 cm). Chinigura was recorded highest number of grain per panicle (124.20) followed by Sadamota (123) and BRRI dhan77 (121). Among the 15 cultivar studied Dudhsona (34.33 gm) and Motadhan (34.33) showed significantly highest

thousand seed weight followed by Kauathuti (30 gm) and BRRI dhan77 (27gm). Landraces Motadhan recorded the highest grain yield and second highest yield was produced from Chaulamani. So, we can use as well as Motadhan and another landraces Sadamota, Holdemota, Dudhsona as a genetic resources or parent material for further evaluation at different place of Barishal district.

Response of biofertilizer on growth and yield of BINA released soybean varieties

Soybean (*Glycine max*) is an important legume crop especially for its high protein content. A field experiment was conducted in the farm at BINA sub station Barishal to evaluate the efficiency of Rizobium Biofertilizer on V_1= Binasoybean-5, V_2= Binasoybean-6 and V_3=BARI soybean-6 variety considering yield and yield attributing characters. The experiment was laid out in a Randomized Complete Block Design (RCBD) with treatments T_1= control (All recommended fertilizers except Urea), T_2= Bio fertilizer @ 30 g/kg seed, T_3= All recommended fertilizers and T_4= Cow dung. Results of the experiment showed that maximum seed yield (1610 kg/ha) was obtained with the application of Bio fertilizer @ 30 g/kg seed followed by all recommended fertilizers except urea. The result suggested that Bio fertilizer @ 30 g/kg seed and all recommended fertilizers except urea could be useful for the sustainable soybean production. The experiment was conducted in 2023 during Rabi season at BINA station, Barishal (Longitude: 90.288482; Latitude: 22.789604, elevation 9 m) where Binasoybean-5, Binasoybean-6 and BARI soybean-6 were used as a soybean variety where Rizobium Biofertilizer were used @ 30 g/kg seed. The experiment was laid out in randomized completely block design (RCBD) with three replications and plot size was 7.5 m^2 each. Soybean seeds were sown on 2 February 2023 in rows of 30 cm apart. Land was fertilized with 86.95 kg of Urea, 66.66 kg of TSP and 100 kg of MoP , respectively. The entire amount of these fertilizers were applied during final land preparation. Rhizobium bio fertilizer was applied with seeds directly during sowing. Five soybean plants were collected from each individual plot outside the harvested area for recording plant height, number of pods $plant^{-1}$, number of seeds pod^{-1}, pod length, number of branches $plant^{-1}$, yield and other yield contributing characters. Yield and most of the yield attributing characters exhibited better performance for the combination of T_2V_2= Bio fertilizer @ 30 g/kg seed + Binasoybean-6 (table 1). The highest yield was found 1.61 ton ha^{-1} for T_2V_2 combination and the lowest yield was found 0.92 tons ha^{-1} for T_1V_2 treatment. It may be concluded that seed yield and yield attributing characters of soybean with the application of Rhizobium bio fertilizer @ 30 g/kg seed produced highest yield. For the sustainability of soil fertility and soybean crop productivity, judicious use of chemical fertilizers along with *Rhizobium* bio fertilizer is very beneficial.

Assessment of salinity tolerance in *Capsicum chinense* (Naga morich) genotypes

Salinity is a major abiotic constraint in crop cultivation. However, when tolerant genotypes are cultivated they improve their physiological mechanisms to cope up with salinity stress. An investigation was carried out to assess the impact of salt stress on growth and yield characters of chilli genotypes. A pot culture experiment was conducted during 2022-23 at at BINA sub station Barishal to evaluate the performance of three chilli genotypes at four salinity levels with control viz., S_0 = control, S_1 = 4, S_2 = 8, S_3 = 12 and S_4 = 16 dS/m. The study showed that the used genotypes could tolerate upto 4 ds level of salinity. All genotypes were died where salinity level was greater than 4 ds. Highest number of fruits were harvested from V_1=Binamorich-1 where salinity was less than 4 ds and the lowest number of fruits were harvested from V_3=Naga Morich (*Capsicum chinense)*. The experiment was conducted in 2022-23 during Rabi season at BINA station, Barishal where V_1= Binamorich-1, V_2= Binamorich-2, V_3=Naga Morich (*Capsicum chinense)* were used as a chilli genotypes. The experiment was laid out in randomized completely block design (RCBD) with three replications in pot culture experiment. Pot soil was fertilized with recommended doses of fertilizers with cowdung. Forty days old healthy seedlings were transplanted in the pot. Saline conditions were simulated by employing aqueous NaCl solutions for maintaining 4, 8, 12 and 16 dS/m salinity level. The treatment control was maintained for each chilli genotype where only normal water was applied. Data were collected from each individual plant and analysis was performed

using statistical software. Plant survivability, plant height, number of branch plant^{-1}, number of fruits plant^{-1} were recorded. Most of the yield contributing characters showed significant difference among different Salinity treatments. The result showed that the used variety could tolerate upto 4 dS/m level of salinity. All variety were died where salinity level was greater than 4 dS/m. Highest number of fruits were harvested from V_1=Binamorich-1 where salinity was less than 4 dS/m and the lowest number of fruits were harvested from V_3=Naga Morich (*Capsicum chinense)*. The results of the present study demonstrated that NaCl present in the soil affects the physiological processes of growth and yield of chilli. The increase in salinity level, decreased the growth, flowering, fruiting and yield and yield contributing characters like fruit length, number of fruits and fruit weight. This study will be helpful for farmer who are cultivating chilli in saline prone areas for minimizing loss.

Effect of mustard under zero tillage with different fertilizer doses at farmers field in coastal region of Bangladesh.

A field experiment was conducted throughout the rabi season of 2022-23 at Barishal and Patuakhali districts in relay cropping system under zero tillage system. The experiment was outlined randomized block design with 3 replications. The plot treatment consisted of 3 fertiliser doses viz. T_1=(U-250 kg/ha, TSP-105 kg/ha, MoP-100 kg/ha, Gyp-110 kg/ha, B-10/kg and Zn-5 kg/ha), T_2= (U-270 kg/ha, TSP-110 kg/ha, MoP-105 kg/ha, Gyp-115 kg/ha, B-12/kg and Zn-7 kg/ha), T_3= (U-300 kg/ha, TSP-115 kg/ha, MoP-115 kg/ha, Gyp-120 kg/ha, B-15/kg and Zn-9 kg/ha). Yield and most of the yield attributing characters exhibited better performance for the treatment T_3= (U-300 kg/ha, TSP-115 kg/ha, MoP-115 kg/ha, Gyp-120 kg/ha, B-15/kg and Zn-9 kg/ha)) in both locations. The experiment was conducted in 2022-23 during Rabi season at Babugonj upazila of Barishal and sadar upazila of Patuakhali districts in relay cropping system under zero tillage system. The experiment was outlined randomized block design with 3 replications. Binasarisha-9 was used a mustard variety. The experiment was laid out in randomized completely block design (RCBD) with three replications in farmers field. All recommended doses of fertilizer except urea were applied in the field before seed sowing. For seed yield, 1 m^2 area was harvested from the center of the plot. Most of the yield contributing characters showed significant difference among different treatments. Yield and most of the yield attributing characters exhibited better performance for the treatment T_3 (table 1 and 2) in both locations. The highest seed yield was found 1.27 ton ha^{-1} at Babugonj upazila of Barishal district and 1.36 ton ha^{-1} at Sadar upazila of Patuakhali district for the treatment T_3. The present study revealed that yield and most of the yield attributing characters exhibited better performance for the treatment T_3= (U-300 kg/ha, TSP-115 kg/ha, MoP-115 kg/ha, Gyp-120 kg/ha, B-15/kg and Zn-9 kg/ha) in both locations. Farmer can apply these doses of fertilizer for better yield of mustard under zero tillage condition before seed sowing.

Impact of mung bean picking at different growth stage on grain yield

A field experiment was conducted in experimental field at BINA Sub station Barishal during February to April 2023 to find out the impact of mung bean picking at different duration on grain yield. This experiment was conducted in RCBD design with three varieties such as V_1=Binamoog-8, V_2=Binamoog-9 and V_3= BARI Mung-6 maintain three picking time such as T_1= First picking, T_2= Second picking, T_3= Third picking. The treatments were replicated thrice to avoid any effect of heterogeneity as per standard procedure. The size of the unit plots were 3.0 m × 2.0 m. Recommended doses of nitrogen, phosphorus, potassium, sulphur and zinc were applied from Urea, TSP, MoP, Gypsum and Zinc sulphate. Cultural and intercultural practices were followed as and when necessitated. After pod setting every five days interval 5 plants were collected and total dry matter was calculated from these sample. All morphological and yield contributed parameters were recorded after harvest from 5 rendomly selected competitive plants. Maturity was assessed plot basis. 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. Mung bean varieties showed different growth rate due to varietal character. Total dry mass (TDM) increased with the age of the plant until maturity 57 DAS (Days after sowing) but the increment rapidly increased in BARI Mung-6 (Fig. 1). At 57 DAS Binamoog-9 showed maximum TDM followed by Binamoog-8. BARI Mung-6 showed minimum TDM. TDM started to decreased at 57 TDM in all varieties. Binamoog-8 had shorter duration (63 DAS) then the variety Binamoog-9 (68 DAS) and BARI Mung-6 (70 DAS). In case of Binamoog-8 and Binamoog-9 maximum pod number was observed in first picking plot that was 38.33 and 38.11 and minimum in 3rd picking that was 14.33 and 26.44 in Binamoog-8 and Binamoog-9 respectively. In case of BARI Mung-6 pod number was similar in 1st, 2nd and 3rd picking. Seed number in each pod also high in 1st picking and low in 3rd picking for all varieties. Pod length and seed size was slightly decreased from 1st picking to 3rd picking for all varieties. Maximum grain weight was observed in 1st picking that was 1.39, 1.26 and 0.97 kg for Binamoog-8, Binamoog-9 and BARI Mung-6, respectively. Among these three varieties Binamoog-8 produce maximum grain at 1st picking period. It can be concluded from this experiment that 1st picking is the best time for gaining maximum yield and this time Binamoog-8 produce maximum grain compare to Binamoog-9 and BARI Mung-6.

BINA released varietal extension

Establishment of BINA technology in Barishal region through block demonstration and quality seed dissemination

A total of 300 demonstrations were conducted at the farmer's fields during 2022-23 in Barishal region using BINA developed different crop varieties. The main objective of these demonstrations was to observe the yield performance and increase its adoption by the farmers in Barishal region. Each demonstration plot was 33 decimals with recommended spacing based on crop varieties. Application of fertilizer and intercultural operations were done following the BINA recommendation.

In kharif-1 season, 20 demonstrations were conducted at the farmer's field using Binadhan-19 and Binadhan-21. The data on crop duration reveled that Binadhan-19 and Binadhan-21 was harvested at 121 and 105 days where the average yield of Binadhan-19 and Binadhan-21 was recorded 3.52 and 3.54 t ha^{-1} , respectively.

About 80 demonstrations were distributed to the farmers of different districts through DAE in Barishal region in Aman 2022 season. The Aman rice varieties mainly Binadhan-11, Binadhan-17, Binadhan-20 and Binadhan-23 were harvested at 102, 120, 130 and 125 days and produced average yield 5.0, 5.0, 4.5 and 4.7 t ha^{-1} respectively. Among the cultivated Aman rice varieties Binadhan-20 and Binadhan-23 have been widely accepted in Barishal region.

In Boro and Rabi season, there were 110 demonstrations for Binadhan-10, Binadhan-24 and Binadhan-25; 30 demonstrations for Binasarisha-4, Binasarisha-9 and Binasarisha-11, 15 demonstration for Binasoybean-3 Binasoybean-5 and Binasoybean-6 and 10 Binachinabadam-4 and Binachinabadam-8 throughout the Barishal region. All the varieties cultivated in Rabi season are popular and well accepted to the farmers of Barishal region. Binadhan-10 produced the average yield 7.0 t ha^{-1} within 130 days, Binadhan-24 produced 6.0 t ha^{-1} within 135 days and most popular premium quality BINA dhan25 produced 8 t ha^{-1} within 130 days . In addition, Binasarisha-4, Binasarisha-9 and Binasarisha-11 produced the average yield 1.20, 1.42 and 2.0 t ha^{-1} and matured in 83 and 80 days of seeding, respectively.

In kharif-1 season, about 30 demonstrations were established in Barishal, Patuakhali, Jhalokathi and Borguna district using Binamoog-8. Average yield of Binamoog-8 was recorded 1.54 t ha^{-1} and harvested in 65 days after seeding.

From BINA sub station Barishal total 4600 kg Aman rice, 7500 kg Boro rice, 1500 kg mustard, 600 kg soybean, 800 kg groundnut, 2000 kg Binamoog-8, 100 kg sesame and 1500 kg Binadhan-19 seeds were distributed to the farmers through DAE. Total 800 lemon sapling (Binalabu-1) was distributed to nearest Horticultural center and DAE for distributing to the farmers.

For the dissemination of BINA developed technology in Barishal, 6 farmers training were conducted where 340 farmers (female and male) and 15 Sub-assistant Agriculture Officers (SAAO) were trained on the cultivation procedure of BINA developed Aman rice varieties, and seed storage techniques and production technology of BINA released oil crops varieties. Besides, nine farmers field days were organized on Binadhan-20, Binadhan-10, Binasarisha-4, Binasarisha-9 and Binamoog-8 to motivate the farmers in Barishal region for cultivation. In addition, BINA sub-station is trying develop a new cropping pattern Aman (Binadhan-11/Binadhan-17) - Binasarisha-9 - Aus (Binadhan-19) instead of (Aman-Mustard – fellow) pattern using BINA released technology for fulfilling the local demand.

BINA Sub-Station Cumilla

Research Highlights

- BINA dhan25 produce the highest yield when it was transplanted on 31 December but reduce yield significantly for late transplanting. BINA released *Aman* variety Binadhan-17 produce better yield at Boro season in Cumilla region.
- Binadhan-14 produced the maximum yield when 20 days seedling transplanted on first week of March and shattering is also remain acceptable
- Relay cropping with Binasarisha-4 was found as effective cultivation practice for saving time and improving cropping intensity by incorporating more crops
- Some promising germplasm (Chengri murali, Surjamukhi, Gofra) were identified and this germplasm would be used for varietal development.
- Three proposed cropping patterns namely i. Aman-Mustard-Boro-Aus ii. Aman-Mustard-Sesame-Aus, iii. Aman-Mustard-Boro was found profitable against existing pattern with BCR 1.64, 1.98 and 1.77 respectively.

Comparative study of some *Boro* rice cultivars for different transplanting time in Cumilla region

The experiment was conducted at BINA Substation Cumilla farm to find out the appropriate transplanting time for maximizing yield of some Boro rice cultivars at Cumilla region**.** In this experiment the boro rice cultivar V_1= Binadhan-14, V_2= Binadhan-16, V_3= Binadhan-17, V_4= Binadhan-24, V_5=BRRI dhan84 and V_6= BINA dhan25 were transplanted at two different time (T_1=31.12.2022 and T_2=16.1.2022). Thirty-days old seedlings were transplanted at 3m × 4m unit plot. The experimental design was split plot with 3 replications. Optimum doses of fertilizer were applied to the plots. Intercultural operation was done during the vegetative, flowering and at grain filling stage. Data on Plant height (cm), panicle length (cm), number of total tiller hill^{-1}, number of effective tiller hill^{-1}, filled grain panicle^{-1}, unfilled grains panicle^{-1} was recorded from randomly selected 5 plants from each. The unit plot was harvested on different dates according to the maturity of the varieties; the maturity period was counted when 90% of the panicle was matured in a plot. Seed yield per square meter was recorded from each plot and converted to ton per hectare. All the recorded data were statistically analyzed using STATISTIX 10 computer program. Considering the main effect of transplanting time, days to maturity (135 days) was observed lowest when transplanting at T_2 (16.1.2023) followed by T_1 (31.12.2022). The grain yield 7.89 tha^{-1} was observed significantly higher when transplanting at T_1. The cultivars Binadhan-17 (V_3), BINA dhan25 (V_6) and Binadhan-24 (V_4) took 153days, 143.50 and 142.16 days respectively to mature whereas Binadhan-16 (V_2), Binadhan-14 (V_1) and BRRI dhan84 (V_5) took significantly less days to mature 127.67days, 129days and 129.67 days respectively. In addition, all the varieties produced more or less similar numbers of effective tiller. Statistically higher filled grain per hill was produced by V_6 (154.67) followed by V_3 (140 tha^{-1}). Maximum grain yield 7.93 tha^{-1} produced by Binadhan-24 followed by V_3, V_6 and V_2 (7.8 tha^{-1}, 7.76 tha^{-1} and 7.6 tha^{-1}) and minimum was recorded in V_1 (6.18 tha^{-1}) V_5 (6.5 tha^{-1}), an interaction effect between transplanting date and varieties shows earliest maturity of V_2 (127.00 days), V_1 (129 days), and V5 (127.33 days) when transplanted at T_2. Variety V_3 took highest days (154.33 days) to mature when transplanted on T_1. The heights grain yield (9.03 tha^{-1}) produced by the variety V_6 when transplanted on T_1 followed by V_3 (8.50) and V_4 (8.40). Transplanting of BINA dhan25 on 31 December gave the highest yield but the delay transplanting caused significant yield loss. BINA released aman variety Binadhan-17 produced better yield in Boro season in Cumilla region.

Effect of seedling age & transplanting time on the yield and shattering of Binadhan-14 in Cumilla region

The study was conducted to find out the appropriate sowing time and seedling age of late boro Binadhan-14. The experiment was carried out at BINA Substation, Cumilla during 2022-23 followed by split plot design with three replications. Three different aged seedling (S_1=20days, S_2=25 days and S_3=30 days) were sown at three different times (01 March, 2023. 08 March, 2023 and 22 March, 2023). The unit plot size was 2m×2.5m. Recommended production packages i.e., application of fertilizers, irrigation and pesticides, weeding, roughing etc were followed to ensure normal plant growth and development. Data on 50% flowering (DF), Days to maturity (DM), plant height (PH), panicle length (cm), Total tiller/hill, Effective tiller/hill, Filled grain/hill, Un-Filled grain/hill, Yield (ton ha^{-1}) and Shattering (%) were taken from 5 randomly selected plants from each plot. The unit plot was harvested on different dates according to the maturity of the varieties; maturity period was counted when 80% grains $panicle^{-1}$ was matured in a plot. Grain yield of per square meter was converted into t ha^{-1}. All the recorded data were statistically analyzed using STATISTIX 10 computer program. According to analysis, T_1 resulted higher yield (5.60 t/ha) compare to other two transplanting dates which took 105.89 days to mature. Maximum days to maturity were recorded for T3 which produced minimum yield (3.77 t/ha). Maximum shattering (13.81%) was noted for T_2 followed by T_1 (6.08) and T_3 (4.34). In case of seedling age, S_3 produce maximum yield (5.60 t/ha) which is statistically similar with other two seedling age. But maximum days to maturity were recorded in S_1 followed by S_2 and S_3. The highest shattering was recorded in S_2 (9.20) whereas S_1 and S_3 resulted 7.77 and 7.26% respectively. Interaction effects between transplanting date and sowing time shows that, transplanting T_1 along with 20 days seedling age (S_1) produced the maximum yield (5.81t/ha) in 115.65days which is statistically similar with T_1S_3 that matured in lowest 96.67 days. Comparatively lower shattering was noted for this treatment combination (6.07 and 5.82% respectively). Lowest yield was observed in case of T_3S_3 which took only 105.67 days to mature followed by T_3S_2 which matures in 105.33 days and produced 3.86t/ha yield. Here, statistically similar shattering was noted for both this treatment combination (4.58 and 3.84 respectively). Maximum shattering was noted for T_2 in combination with all three seedling ages but yield was moderate.

Binadhan-14 produced maximum yield when 20 days seedling transplanted on first week of March and shattering remain acceptable.

Estimation of appropriate time saving cultivation practice for mustard

This study was executed to find out the appropriate time saving mustard cultivation practice in Cumilla. This experiment was carried out at BINA Substation, Cumilla during 2022–23, followed by RCBD with three replications. Three cultivation practice along with conventional approach (T_1= Relay Cropping with aman, T_2= Zero Tillage, T_3= Zero tillage with mulch, T_4= Conventional practice with mulch, and T_5= Conventional practice) and three improved mustard varieties (V_1=Binasarisha-4, V_2=Binasarisha-9 and V3=BARI sarisha14) were used in this experiment. The seeds were sown on 28 November, 2023 except T_1(Relay Cropping with aman). The unit plot size was 5m×2.5m. Recommended production packages, i.e., application of fertilizers, irrigation, pesticides, weeding, thinning, etc., were followed to ensure normal plant growth and development. Data on plant height, branches $plant^{-1}$, siliqua $plant^{-1}$, siliqua length, seeds $siliqua^{-1}$, thousand seed weight (g) was taken from 5 randomly selected plants from each plot. The unit plot was harvested on different dates according to the maturity of the varieties; the maturity period was counted when 90% of the siliqua matured in a plot. The seed yield per square meter was converted into tha^{-1}. All the recorded data was statistically analysed using the STATISTIX 10 computer program. Analysed result depicts that T_4 produced highest yield (2.64 tha^{-1}) followed by T_5 and T_1. Minimum yield was produced in T_3. Among the three varieties, V_1 (Binasarisha-4) produced the maximum yield followed by V_2 an V_3. Interaction results shows that, BARI Sarisha-14 produce highest yield (1.68t/ha)- in conventional practice with mulch but not significantly different from Binasarisha-4 (1.60t/ha) and Binasarisha-9 (1.61t/ha). Binasarisha-4 in relay cropping produced higher yield compared to other two varieties (T_1V_1). Relay cropping with Binasarisha-4 was found as effective cultivation

practice for saving time and improving cropping intensity by incorporating more crops. Conventional practice with mulching gave the best yield performance.

Morphological characterization of local rice landraces for *Aus season*

To characterization of local rice germplasm the experiment was carried out during the period from April to August 2022. In this study, 37 rice germplasm were used as plant materials. Observed variables of quantitative characters of included seven traits and five plants from each replication of each germplasm were randomly selected for recording data on plant height (cm), Days to 50% flowering, Days to 80% of maturity, Number of effective tillers, Panicle length (cm), 100 seed weight (g), Grain yield per plant. Range, mean, standard deviation (SD) and coefficient of variation (CV) of different quantitative characters of rice germplasm were calculated. The range of plant height 105cm -168 cm, the tallest plant was recorded in Tarbali (168.00 cm) whereas the shortest plant was recorded in Pedidhan (105.00 cm). Days to 50 % flowering ranged from 68 to 96 days with an average 80.14 days. Among the studied germplasms, Surjamukhi took the shortest time (68 days) while Anakkhapru binni (97 days) took the longest time. The maturity (80%) of the studied germplasm ranged 88- 114 days with a 100.38 days and CV% was lowest (3.47%) among the characters. Budhmari took the maximum time (114 days) to mature, while Gofra took only 88 days to mature. Number of effective tillers per hill ranged 6.00 to 27.66 with an average 9.6, CV% was 14.96 and SD was 5.40. Beurkani produced the maximum number of effective tillars (27.66), Anakkhapru binni had lowest number of effective tillers. Tarbali had the longest panicle length (37.8 cm) and Chitramurali (25.00cm) had the shortest panicle. Average panicle length was 28.93 with 12.10 % CV and SD was found 3.42. The highest grain yield per plant found 22.41gm in Chengri murali and lowest was 2.27 gm in Burimurali and average yield was 10.35 gm. The highest CV% (28.48%) was found in grain yield among the studied quantitative characters and SD was 5.63. In this study, 100-grain weight ranged from 1.62 gm to 3.77 g with an average value of 2.43 g. The variation observed for this trait was highly significant. Hundred grain weights have been used for characterizing rice varieties which was reported by several workers (Bose and Pradhan, 2005 and Joshi *et al.*, 2007). 100-grain weight has been used for characterizing rice varieties which was reported by several workers (Bose and Pradhan, 2005 and Joshi *et al.*, 2007). Significant variations were found among the seven quantitative characters such as plant height, days to 50 % flowering, days to 80 % maturity, panicle length. 1000 Seed weight, grain yield per m^2 had shown significant difference among the germplasm. The maximum coefficient of variations was in grain yield per plant. Some promising germplasm (Chengri murali, Surjamukhi, Gofra) were identified and these germplasm would be used for varietal development.

Growing of M_3 generation of turmeric

To create genetic variability of a popular local turmeric variety (Binniholud) was irradiated with 5,10 and 15Gy of gamma rays. Dose wise M_3 rhizomes were sown on 27 April, 2022 at BINA Substation, Cumilla. The experiment was followed by non-replicated design and sown separately (dose wise). Thirty rhizomes were selected on the basis of color, size and yield. These rhizomes will be evaluated for M_4 Population.

Development of profitable four crops-based cropping pattern including oil crop at upland of Cumilla district

This experiment was conducted at different farmers' fields in Muradnagar upazilla of Cumilla to develop profitable four-crop-based cropping patterns (CP), including oil crop, to enhance the farmer's income. The existing cropping pattern was Aman (BR 22)-Fallow-Boro (BRRI dhan28)-Fallow and the studied pattern was Aman (Binadhan-16)-mustard (Binasarisha-9)-Nabi Boro (Binadhan-14)-Aus (Binadhan-19). The pattern was implemented during the period of July 2022 to June 2023. The land size of the patterns was one bigha (33 decimal) and the type of land was high and medium high under the Agro-Ecological zone (AEZ 19). Yield data was recorded and benefit cost ratio (BCR) was calculated from individual

fields. The main product yield (Tk/ha.), value of by-product (Tk/ha.), gross return (Tk/ha.), total cost (Tk/ha.), net return (Tk/ha.) and BCR were calculated using the following formula:
(i) The Main product Yield ((Tk/ha) = Yield (tha^{-1}) ×1000×31.25(Tk kg^{-1})
(ii) Value of by-product (Tk/ha) = Straw price of crop (bigha) × 7.47
(iii) Gross return (Tk/ha) =The Main product Yield ((Tk/ha) + Value of by-product (Tk/ha)
(iv) Total cost (Tk/ha) = Fertilizer, Labour cost and others
(v) Net return (Tk/ha) = Gross return (Tk/ha.)-Total cost (Tk/ha)
(vi) BCR= Gross return (Tk/ha.)/Total cost (Tk/ha.)
In existing and proposed CP, total input cost was 2,61,450 and 4,18,320Tk/ha respectively. Considering total input cost of proposed CP was 60% higher compared to existing CP due to higher cropping intensity. In existing CP, the value of main product and by-product was 3, 36,250 and 14,940 Tk/ha (Aman+Boro). The gross return of existing CP was 3,51,190Tk/ha. On the other hand, in proposed CP the value of main product and by-product was 6, 43,125/- and 28,535.4/- Tk/ha respectively (Aman+Mustard+Boro+Aus). The gross return of proposed CP was 6, 71,660.4/- Tk/ha. The net return of existing and proposed CP 89,740/-, 2, 53,340.4/-Tk/ha. Considering the net return or income of farmer from proposed CP was 182.30% profitable compared to existing CP. The BCR of existing and proposed CP was 1.32 and 1.65 respectively.

From this study, it can be concluded that four crops-based Cropping pattern ultimately more economical to farmers. So, this proposed CP would be adopted by farmers for better profitability.

Development of profitable four crops-based cropping pattern including oil crop at medium high and high land of Cumilla region

In order to promote crop intensification by integrating oil crops while continuing to produce grain crops, this experiment was carried out at several farmers' fields in Burichang and Chouddogram of Cumilla. The examined cropping pattern was Aman (Binadhan-17)-Mustard (Binasarisha-4)-Sesame (Binatil-2)-Aus (Binadhan-19), whereas the local existent cropping pattern was Aman (BRRI dhan49)-Fallow-Boro (BRRI dhan28). The pattern was implemented during the period of July 2022 to June 2023.The land size of the patterns was one bigha (33 decimal) and the type of land was high and medium high under the Agro-Ecological zone (AEZ 19). The Main product Yield ((Tk/ha.), Value of by-product (Tk/ha.), Gross return (Tk/ha.), Total cost (Tk/ha.), Net return (Tk/ha.) and BCR were calculated using the formula (i) to (vi) from cropping pattern-1.

Total variable cost (production or cultivation related expenses) was 2,53,980/- and 3,26,439/-Tk/ha in the existing and proposed CP, respectively. Due to greater cropping intensity, the proposed CP's total input costs were 28.53% more than that of the current CP. The major product and by-product values in the current CP were 3, 76,562.5 and 14,940 Tk/ha (Aman+Boro). The current CP's gross return was 3,915,502.5/-Tk/ha. The major product and by-product values in the proposed CP, however, were 6, 22,187.5 and 24,216.9 Tk/ha, respectively (Aman+Mustard+Seasame+Aus). The proposed CP's gross return was 6.46.404.4/-Tk/ha. The net return of CPs 1, 37,522.5/- and 3,19,965.4/-Tk/ha, both existing and proposed, respectively. When compared to the existing pattern, the net return or revenue to farmers from the proposed CP was 132.67% higher. The proposed and existing CP had BCRs of 1.98 and 1.54 respectively. From the study, it can be concluded that proposed CP including two oil crops can save our economy and health effects.

Development of profitable three crops cropping pattern including oil crop at medium high and high land of Cumilla region

This experiment was conducted at various farmers' fields in the Sadar Dakshin upazilla of Cumilla in order to boost crop intensification by including oil crops while maintaining the production of grain crops and raising farmer revenue. *Aman* (BR 22)-Fallow-Boro (BRRI dhan 29) was the existing cropping

pattern, and the examined pattern was *Aman* (Binadhan-17)-Mustard (Binasarisha-9)-Boro (Binadhan-24). The experiment was carried out from July 2022 until June 2023. Experimental land size was one bigha (33 decimal), and the land type was medium high and high land, which covered the Agro-Ecological Zone (AEZ 19). For each crop, yield data was collected and the benefit cost ratio (BCR) was determined. The Main product Yield (Tk/ha.), Value of by-product (Tk/ha.), Gross return (Tk/ha.), Total cost (Tk/ha.), Net return (Tk/ha.) and BCR was calculated using the formula (i) to (vi) from cropping pattern-1.

Total variable costs (expenses associated to production or cultivation) in the existing and proposed CP were 2, 53,980 and 3, 26,439 Tk/ha, respectively. The projected CP's total input cost was 28.53% higher than the current CP's due to the increased cropping intensity. The main product and the by-product had a value of 3, 51,562.5 and 14,940 Tk/ha (*Aman+Boro*) in the current CP. The existing CP's gross return was 3, 66,502/-Tk/ha. In contrast, the proposed CP's primary product and by-product values were 5, 42,187.5 and 24,216.9 Tk/ha, respectively (Aman+Mustard+Boro). The proposed CP's gross return was 5,62,879.4/-Tk/ha. The net return of current and proposed CPs is 1, 12,522/- and 2,45,404.4/-Tk/ha, respectively. The net return or income of the farmer from the proposed CP was 118.09% more than the present CP. The existing and recommended CPs had BCRs of 1.44 and 1.77, respectively. From this study, it can be concluded that proposed cropping pattern should be adopted by farmers for better profitability.

Variety-wise demonstration trials conducted during 2022-23

During 2022-23, 230 demonstrations were implemented. Among them, 117 demonstrations were BINA released high yielding rice varieties (Binadhan-10, Binadhan-11, Binadhan-12, Binadhan-16, Binadhan-17, Binadhan-19, Binadhan-20, Binadhan-21, Binadhan-22, Binadhan-24 and BINA dhan-25) in Cumilla region. In Aus season, Binadhan-19 produced the highest yield (4.98 t ha^{-1}) which was also recommended by DAE personnel for its grain quality and high yielding characters. In Aman season, Binadhan-17 produced the highest yield (6.13 t ha^{-1}). In the boro season, BINA dhan25 produced the highest yield (7.15 t ha^{-1}) and the second highest yield was observed in Binadhan-24 (6.41 t ha^{-1}) (table 8). Most of the farmers are interested to cultivate mustard after Aman and preferred to Binadhan-16/17 for its short duration and satisfactory yield. Among the mustard varieties, Binasarisha-11 produced the highest average yield (1.7 t ha^{-1}) followed by Binasarisha-4 and Binasarisha-9. Binasarisha-4 and Binasarisha-9 are getting popular day by day for its late potentiality and maximum oil percentage. In Cumilla region, average yield of Binatil-2 was 1.38 t ha^{-1} which is being popular to the farmers and extension worker for its black grain color and comparative higher price in market. Binasoyabean-5 and Binasoybean-6 produced 1.75 and 1.77 tha^{-1} respectively. Binachinabadam-6 produced the highest 1.81 yield tha^{-1} whereas Binachinabadam-8 produced 1.74 tha^{-1}. Binalebu is being cultivated commercially in different areas of Cumilla region.

Training and workshop on the use of BINA developed technologies

In order to transfer BINA developed technology promotion, four training courses were organized during the period of 2022-23 at Cumilla sub-station. A total of 275 male and female farmers were trained on establishment of entrepreneurs and demonstration set, seed production procedure & preservation method of BINA developed promising varieties. Details of the training and workshop are presented in table 1.

Table 1: Training and workshop on BINA developed technologies conducted at BINA sub-station Cumilla

Sl. No	Name of the training/workshop	Place of training	Date	No. of Participant	Source of fund
1.	Farmer training on “Incorporation of unintroduced mustard in crop rotation, seed production and conservation techniques and creation of seed entrepreneurship while continuing to increase production of grain crops	BINA, Cumilla	12.11.2022	60	Revenue
2.	Farmer training on “Introduction of non-innovative high yielding boro rice varieties, modern cultivars, seed production and storage techniques and development of seed promoters”	BINA, Cumilla	6.12.2022	60	Revenue
3.	“Training of Small Entrepreneurs and Farmers in Implementation of Innovative Concepts for Creating Small Entrepreneurs in Vermicompost Production”	BINA, Cumilla	15.01.2023	30	Revenue
4.	"Collection, Conservation Techniques and Seed Entrepreneurship of Uninvented Mustard Seed and Cultivation of Sesame in Fallen Land"	BINA, Cumilla	03.02.2023	75	EPOC
5.	Farmer training on "Vermi-compost production techniques"	BINA, Cumilla	15.02.2023	65	Revenue
6.	Farmer training on "Cultivation techniques of BINA developed seedless, cented, year-round Binalebu-1& Binalebu-2"	BINA, Cumilla	16.03.2023	65	Revenue
7.	Farmer training on "Cultivation techniques & seed preservation method of BINA developed high yielding, short duration Aus rice variety Binadhan-19 & Binadhan-21"	BINA, Cumilla	16.05.2023	70	Revenue
	Total=			**275**	

Field Days

In order to motivate farmers and to adopt BINA developed varieties/technologies seven field days on different crops were organized by BINA substation Cumilla during 2022-23

Table 2: Field days on the use of BINA developed technologies conducted at BINA sub-station Cumilla

Sl. No	Variety	Location	Date	No. of Participant	Source of fund
1.	Binadhan-19	Muradnagar, Cumilla	29.08.2022	60	Revenue
2.	Binadhan-20	Adorshosadar, Cumilla	17.11.2022	50	Revenue
3.	BINA dhan25	Sadar Dakshin, Cumilla	27.04.2023	60	Revenue
4.	Binasarisha-9	Burichang, Cumilla	02.02.2023	50	Revenue
5.	Binasarisha-4	Choddogram Cumilla	20.02.2023	48	Revenue
6.	Binatil-2	Nabinagar, Brahmanbaria	21.05.2023	56	Revenue
		Adorsha Sadar, Cumilla	31.05.2023	60	
			Total	476	

BINA Sub-Station, Gopalganj

Experiment-1: Characterization of local rice variety

An experiment on characterization of local rice variety was carried out at BINA sub-station, Gopalganj during Aman season in 2022-2023 to compare the performance among eleven local rice varieties which were collected from Gopalganj region. The study was performed in a Randomized Complete Block Design (RCBD) with three replications. Seedlings of each genotype were transplanted in a unit plot size of 3 m × 2 m. Plot-to-plot distance of 0.5 m was maintained. The dose of chemical fertilizer (N-P-K-S) was applied @ 60-50-40-10 kg/ha. The data on plant height (cm), tiller/plant, effective tiller/plant, panicle length (cm), grain/panicle, 1000 seed weight (gm), grain yield (t/ha), straw yield (t/ha) were collected. Among all varieties highest plant height was observed in Jabra (160.13 cm) and had the lowest plant height Rangadigha (137 cm) compared to the other varieties and cultivars. Highest effectivr tiller/plant was observed in Rangadigha (16.30 cm) and had the lowest effectivr tiller/plant Debmoni (9.00 cm) compared to the other varieties and cultivars. Highest panicle length was observed in Jabra (24.62 cm) and had the lowest panicle length rangadigha (22.10 cm) compared to the other varieties and cultivars. Highest Filled grain/panicle was observed in laxmidigha (1527.00 cm) and had the lowest Filled grain/panicle Modhudigha (766.00 cm) compared to the other varieties and cultivars. Highest unfilled grain/panicle was observed in Bidigha (561.33 cm) and had the lowest unfilled grain/panicle Kachkalam (127.00 cm) compared to the other varieties and cultivars. Highest 1000 seed weight was observed in Jabra (44.74 g) and had the lowest 1000 seed weight Rangdigha (23.00 g) compared to the other varieties and cultivars. Highest Grain yield was observed in Sishumaty (5.56 t/ha) and had the lowest Grain yield kachkalam (1.99 t/ha) compared to the other varieties and cultivars. The experiment will be continued in next growing season for more physiological and more morphological characteristics.

Experiment-2: Effect of seedling age on growth and yield contributing characters of BINA released Aman rice varieties cultivated in Gopalganj region

An experiment was conducted to find out the appropriate time of transplanting and avoid the disease and insect infestation during the maturity period of Binadhan-16 and Binadhan-17 at the BINA Sub-station, Gopalganj during the Aman growing season 2022-23. The trial was laid out in RCBD with 3 replications. Unit plot 3m×2m having the spacing of 15cm×20cm as plant to plant and row to row respectively. The experiment was conducted at different seedling age (T_1= 15 days, T_2= 20 days, T_3= 25 days, T_4=30 days). Recommended doses of fertilizer and irrigation was done as per required. Data on Plant height, effective tillers, panicle length, filled grains, unfilled grains and seed yield were collected from five randomly selected plants from the field. Finally the grain yield was converted into tha^{-1}. Highest yield (6.65 tha^{-1}) was recorded in T_1 treatment for Binadhan-16 and highest yield (6.80 tha^{-1}) was recorded in T_2 treatment for Binadhan-17 and lowest yield was recorded in T_3 in both cases. Therefore, T_1 treatment is appropriate age of seedlings for transplanting of Binadhan-16 and T_2 treatment is appropriate age of seedlings for transplanting of Binadhan-17.

Experiment-3: Yield performance of Aus rice at different planting method at Gopalganj

A field experiment was conducted at BINA Sub-station Gopalganj farm to find out the effect of planting methods on the yield and yield attributes of Aus rice in Gopalganj region. The treatments comprised of two BINA released and one BRRI released high yielding varieties viz., Binadhan-19 (V_1), Binadhan-21(V_2), and BRRI dhan82 (V_3), in Factor B, 4 planting methods viz.: direct seeding of dry seed (DS), seedling transplanting (ST), sprouted seed seeding (SS), and seed dibbling (SD). For DS, Continuous line sowing of dry seed at 40 $kgha^{-1}$ was done manually and for SD, 3 seeds put in a prepared hole with a line to line distance of 20 cm in the assigned plots when soil moisture was at field capacity. Seeds were immersed into water in a bucket on the same date of direct seeding of dry seed for 24 hours. These were then taken out of water and kept tightly in gunny bags. The seeds started sprouting after 48 hours which were suitable for sowing. The sprouted seeds were sown in line (line to line distance 20 cm) in the assigned plots by manually and also sown in the nursery bed for raising seedling which was prepared previously. 25 day old seedlings were transplanted (single seedlings $hill^{-1}$) with a spacing of 20 cm × 15 cm. Light irrigation was applied 4 - 5 days after seeding to facilitate germination and plant establishment, depending upon soil moisture in dry seeded plots. Maximum plant height was observed in BRRI dhan48 at DS method (71.53 cm) that was statistically different from other treatment and other varieties. Maximum number of effective tiller per hill (10.27) was observed in Binadhan-21 at sprout seeding method. Results showed that highest panicle length (22.87 cm) was observed in BRRI dhan82 at DS method. Maximum number of filled grain $panicle^{-1}$ (100.73) was recorded in Binadhan-21 at SD method followed by DS method (80.13/ panicle) in BRRI dhan82. Maximum unfilled grain was observed in Binadhan-21 in ST method. On the other hand, minimum number of unfilled grain $panicle^{-1}$ (15.47) was observed in Binadhan-19 at DS method that was statistically different from other treatment and variety. The thousand grain weight was not significantly affected by various planting methods. However, the 1000 grain weight (22.87 g) attained by the crop established through sprout seeding method was the highest in Binadhan-21 at SD method. The maximum grain weight was observed Binadhan-21 (4.04 tha^{-1}) at SD method. The lowest grain weight was recorded in Binadhan-19 (2.38 tha^{-1}) at direct seeding method. High yield of Seed Dibbling method are attributed to good crop conditions, more availability of nutrients which resulted higher tiller number, number of grains $panicle^{-1}$, filled grain $panicle^{-1}$ and 1000-grain weight that finally contributed to produce higher grain yield. It can be concluded from the results that Binadhan-21 variety showed best performance at seed dibbling method. Therefore, the cultivation of Binadhan-21 with seed dibbling method is recommended for best yield in short growth duration. Further experiment should be performed in different field condition in future for more accurate recommendation.

Experiment-4: Development of a profitable Cropping Pattern in Gopalganj Region

An experiment was conducted to find out a profitable cropping pattern throughout the year in different growing seasons with different crops at BINA sub-station, Gopalganj farm. Existing three and proposed four crops cropping pattern where the existing cropping pattern was T.aman-Fallow- Boro and the proposed cropping pattern was T. aman (Binadhan-16)-Mustard (Binasarisha-9)-Mungbean (Binamamung-8)-T.aus (Binadhan-21). The experiment was laid out in RCBD design with three replications. Experimental plots size was 3m × 2m. Intercultural operations were done when needed. Phenotypic data was collected from five randomly selected plants from each plot. Yield of ten meter squares was converted to tha^{-1}. All crops performed

better in terms of yield and yield contributing characters. The yield of Binadhan-16 was 5.4 tha^{-1}, Binasarisha-9 was 1.75 tha^{-1}, Binamung-8 was 1.78 tha^{-1}, and Binadhan-21 was 4.15 tha^{-1}.

Experiment-5: Demonstration results of different BINA varieties over the year 2022-2023 at various locations in Faridpur-Gopalganj region

A total of 212 demonstrations for BINA released variety like rice (Aus, Aman and Boro), mustard, groundnut, lentils, sesame, mung bean, Grass pea (Rabi and kharip) were successfully carried out at different locations in greater Faridpur region during 2022-23. The main objective of the demonstrations was to observe the yield performance and extend the adoption by the farmers in Faridpur-Gopalganj region. The demonstration plot was 33 decimals with recommended spacing based on crop varieties. Application of fertilizer and intercultural operations were done following the BINA recommendation. The average duration and yield was observed for Binadhan-10 (132 days & 8.05 tha^{-1}), Binadhan-11 (113 days & 5.25 tha^{-1}), Binadhan-13 (139 days & 3.45 tha^{-1}), Binadhan-14 (115 days & 6.6 tha^{-1}), Binadhan-15 (119 days & 5.75 tha^{-1}), Binadhan-16 (102 days & 7.0 tha^{-1}), Binadhan-17 (112 days & 6.85 tha^{-1}), Binadhan-20 (127 days & 4.75 tha^{-1}), Binadhan-22 (113 days & 6.0 tha^{-1}), Binadhan-24 (144 days & 6.70 tha^{-1}), BINA dhan-25 (142 days & 7.3 tha^{-1}), Binamosur-5 (102 days & 2.05 tha^{-1}), Binamosur-7 (111 days & 1.8 tha^{-1}), Binamosur-8 (97 days & 2.3 tha^{-1}), Binamosur-9 (102 days & 2.15 tha^{-1}), Binamosur-10 (109 days & 1.9 tha^{-1}), Binasarisha-4 (87 days 7 1.7 tha^{-1}), Binasarisha-9 (83 days & 1.65 tha^{-1}), Binacinabadam-6 (146 days & 2.7 tha^{-1}), Binacinabadam-8 (145 days & 2.2 tha^{-1}), Binacinabadam-9 (146 days & 2.45 tha^{-1}), Binakhesari-1 (112 days & 2.0 tha^{-1}), Binamoog-8 (65 days & 1.9 tha^{-1}), Binatil-2 (94 days & 1.5 tha^{-1})

Quality seed production of potential BINA released crops

Seeds of demanding and promising crop varieties of BINA were produced in BINA Sub-station, Gopalganj farm and also in the farmer's field at different locations at BINA Sub-station, Gopalganj farm in 2022-2023. A total of 5.2 tons of TLS seeds of different BINA released varieties were produced in the station with proper inspection and finally distributed to all stakeholders.

Training on use of BINA developed technologies

During 2022-23, in order to disseminate BINA released varieties, several trainings were conducted at BINA sub-station Gopalganj and at different UAO office. For performing the training programs UAOs, SAAOs and farmers from different upazillas were trained up and it was covered the number of 50 SAAOs and 160 Farmers (Male & Female).

Field days

For field motivation of the farmers and technology adoption, Farmers Field Day on BINA developed varieties/technologies were carried out. A total of eight field days on different crop varieties (Binadhan-16, Binadhan-17, Binasarisha-9, Binatil-2, BINA dhan25, Binamung-8, and Binadhan-10) were organized in Faridpur-Gopalganj region.

BINA Technology Village

BINA technology village was established at Fukhra, kashiani, Gopalganj. BINA Substation, Gopalganj is continuously distributing promising mutant varieties among the farmers for developing existing cropping pattern.

BINA Sub Station, Nalitabari, Sherpur

Exp-1: The combined effect of organic and inorganic fertilizers on the growth and yield of T. Aman rice (Binadhan-17) and mustard (Binasharisha-9).

An experiment was carried out to determine the combined effect of organic and inorganic fertilizers on the growth and yield of T. Aman rice and mustard at the BINA sub-station farm, Nalitabari, Sherpur. The variety of rice was Binadhan-17 and mustard was Binasharisha-9. The experiment consists of five treatments including T_1 =100% CF (STB), T_2 = 85% CF+ 5 t ha^{-1} cowdung, T_3 = 85% CF+ 2 t ha^{-1} vermicompost, T_4 = 70% CF+ 5 t ha^{-1} cowdung, and T_5 = 70% CF+ 2 t ha^{-1} vermicompost. Twenty days old rice seedlings were carefully uprooted from the seedbed. The seedlings per hill were placed at a spacing of 20 cm × 20 cm on 20.7.2023 and harvested on 20.10.2023. Mustard seed was sown on 17.11.2023 and harvested on 07.2.2023.

Plant height, tillers $hill^{-1}$, panicle length, number of grains $panicle^{-1}$, and 1000-grain weight of Binadhan-17 responded significantly to the combined application of organic and fertilizers. The tallest plant of 104.9 cm was found in T_1 (100% CF) which was identical to T_2, T_3 and T_5 with the value of 103.5 cm, 103.3 cm and 102.6 cm respectively. The shortest plant of 100.2 cm was observed in T_4 treatment. The highest number of tillers $hill^{-1}$ of 14.7 was found in T_3 (85% CF+ 2 t ha^{-1} vermicompost) and the lowest value of 11.7 was observed in T_4 (70% CF+ 5 t ha^{-1} cowdung). The maximum panicle length (25.1 cm) was found in T_3 which was at par with T_1 (100% CF), T_2 (85% CF+ 5 t ha^{-1} cowdung) with the value of 23.8 cm, 24.3 cm and 23.30 cm, respectively. The minimum panicle length (21.1 cm) was found in T_4 treatment. The number of grains $panicle^{-1}$ varied from 145.1 to 156.7 with the highest value in T_3 treatment. The lowest number of grains $panicle^{-1}$ (145.1) was found in T_4 treatment. The 1000-grain weight of Binadhan-17 responded significantly to the combined effects of organic and inorganic fertilizers (Table-3). The 1000-grain weight varied from 21.8 to 22.6 gm with the highest value (22.6 gm) in T_3 treatment. The lowest number of 1000-grain weight (21.8 gm) was found in T_4 treatment. The highest grain yield (6.1 t ha^{-1}) was observed in T_3 (85% CF+ 2 t ha^{-1} vermicompost) and the lowest value (4.8 t ha^{-1}) was recorded in T_4 (70% CF+ 5 t ha^{-1} cowdung). Based on grain yield, the treatments may be ranked in order of $T_3>T_2>T_1>T_5>T_4$. The maximum straw yield of 7.02 t ha^{-1} was found in T_3 and the minimum value of 5.48 kg ha^{-1} was noted in T_4 treatment. The treatment may also be ranked like grain yield in the order of $T_3>T_2>T_1>T_5>T_4$ in terms of straw yield.

Mustard:

Plant height, number of branches, pod $plant^{-1}$, pod length, seed pod^{-1}, 1000-seed weight of Binasharisha-9 responded significantly to the effects of organic and different levels of CF. The tallest plant of 109.8 cm was found in T_2 (85% CF+ 5 t ha^{-1} cowdung), and the second highest was found in T_3 (85% CF+ 2 t ha^{-1} vermicompost) which was identical to T_4 and T_5 with the value of 104.6 cm, 101.8 cm and 101.9 cm respectively. The shortest plant of 100.7 cm was observed in T_1 treatment. The highest number of branch $plant^{-1}$ of 3.1 was found in T_3 (85% CF+ 2 t ha^{-1} vermicompost) and the lowest value of 2.5 was observed in T_4 (70% CF+ 5 t ha^{-1} cowdung) treatment which was identical with T_1, T_4 and T_5. The maximum pod length (8.9 cm) was found in T_3 which was at par with T_2 (85% CF+ 5 t ha^{-1} cowdung), with the value of 8.6 cm. The minimum pod length (8.1 cm) was found in T_5 treatment. The number of Pod $plant^{-1}$ varied from 129.5 to142.7 with the highest value (142.7) in T_3 treatment. The lowest number of Pod $plant^{-1}$ (129.5) was found in T_1 treatment. The 1000-seed weight of Binasharisha-9 responded significantly to the combined effects of organic and inorganic fertilizers (Table 4). The 1000-grain weight varied from

2.9 to 3.3 gm with the highest value (3.3 gm) in T_3 treatment. The lowest number of 1000-seed weight (2.9 gm) was found in T_5 treatment. The highest grain yield (1.42 t ha^{-1}) was observed in T_3 (85% CF+ 2 t ha^{-1} vermicompost) and the lowest value (1.24 t ha^{-1}) was recorded in T_4 (70% CF+ 5 t ha^{-1} cowdung). Based on grain yield the treatments may be ranked in order of $T_3>T_2>T_1>T_5>T_4$. yield of 3.34 t ha^{-1}.

Exp-2: Growing M_2 generation of two local variety Pajam and Chinishail

An experiment was carried out to identify fine grain rice mutant with short duration and higher yield from M_1 populations derived by irradiated seeds of two local variety of Pajam and Chinishail. Seeds were sown on 27 June and transplanted on 28 July 2022, following non replicating design at BINA substation Nalitabari farm, Sherpur. Seedlings were transplanted at 20 cm distance within rows of 20 cm distance. Data on Plant height, Number of effective tillers, Panicle length, filled and unfilled grains per panicle and grain yield $hill^{-1}$ were recorded after harvest.

The highest plant height (159 cm) was recorded in Pajam-300-1 and the lowest (128 cm) in Pajam-300-6. The highest number of effective tiller (30) was recorded in Pajam-400-2 and the lowest (10) in Pajam-150-1. The maximum number of filled grain (460) was obtained from Pajam-200-2 and lowest (100) in Pajam-150-6. The maximum 1000 seed weight (18.53 gm) was found in Pajam-300-2 and minimum (14.17 gm) in Pajam-300-6. The highest grain yield (72.47 gm) was recorded in Pajam-250-5 and the lowest (18.22 gm) in Pajam-150-6. Grain yield of nine mutants were significantly higher than the parental line. All these mutants have been selected for further evaluation in the M_3 generation in Aman season 2023-24.

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

During T.Aman season of 2022-23, 35 demonstrations with Binadhan-11, Binadhan-16, Binadhan-17 and Binadhan-20 were conducted at the farmer's fields in Sherpur and 30 demonstrations with Binadhan-11, Binadhan-16, Binadhan-17 and Binadhan-20 were conducted at the farmer's fields in Netrokona. The plot size was 33 decimals. The spacing between line to line and plant to plant was 20 cm×15 cm. All fertilizers were applied as per recommendation. Transplanting dates ranged from 15-28 July 2022 and age of seedlings was 18 to 22 days. The farmers managed all the production practices as per recommendation.

The total of 65 demonstrations with short duration T. aman rice Binadhan-11, Binadhan-16, Binadhan-17 and Binadhan-20 produced average grain yields of 4.83 t ha^{-1}, 5.02 t ha^{-1} and 5.75 t ha^{-1} and 5.03 t ha^{-1} respectively. Average maturity period of Binadhan-11 was 117 days, Binadhan-16 was 104 days, Binadhan-17 was 117 and Binadhan-20 was127 days. One of the mostly popular cultivars was used as a check, BRRI dhan75. BRRI dhan75 produced average gain yield of 5.01 with the maturity period of 119 days. The results showed that BINA released variety increased crop productions, income of farmer's and cropping intensity and farmers are interested to cultivate BINA released varieties like Binadhan-11, Binadhan-16, Binadhan-17 and Binadhan-20.

During Aus season of 2022-23, 50 demonstrations with Binadhan-19 and Binadhan-21 were conducted at the farmer's fields in Sherpur and Netrokona districts. The main objectives were to demonstrate the yield performance of the variety and widening its adoption by the farmers. Area of demonstration plots was 33 decimals. Spacing between line to line and plant to plant was 20 cm × 15 cm. All fertilizers were applied as per recommendation. Transplanting dates ranged

from 15 April to 10 May 2023, and age of seedlings was 18 to 23 days. A total of 50 demonstrations with Binadhan-19 and Binadhan-21 produced average grain yields of 4.01 t ha^{-1} and 3.97 t ha^{-1}, average maturity period of Binadahn-19 and Binadhan-21 was 101.7 and 102.2 days respectively. Check variety BRRI dhan75 produced average gain yield of 4 t ha^{-1} with average maturity period of 111.5 days. Farmers easily can grow four crops in their field. Therefore, the variety of BINA, Binadhan-19 and Binadhan-21 increased crop production as well as farmer's income. Farmers were found interested to cultivate Binadhan-19 and Binadhan-21 in Sherpur and Netrokona districts.

During the Rabi season of 2022-23, a total of 65 demonstrations were conducted with Binasarisha-9 and Binasarisha-11 in Sherpur and Netrokona districts. The main objectives were to demonstrate the performance of Binasarisha-9 and Binasarisha-11 as well as widening their adoption by the farmers. Area of demonstration plots was 100 decimal or one acre. Seeds were sown during November 2022 at the rate of 7.5 kg ha^{-1}. The check variety was BARI sarisha-14. Fertilizers were applied as per recommendation and 1-2 irrigation was applied in the demonstration plots. Pesticides were sprayed when necessary to control insects and pests. Data were recorded on crop duration and seed yield.

A total 65 demonstrations with short duration high yielding Binasarisha-9 and Binasarisha-11 which produced average yields 1.54 and 1.6 tha^{-1} respectively, whereas the check variety of BARI Sarisha-14 gave 1.45 tha^{-1}. Average maturity period of Binasarisha-9 and Binasarisha-11was 80.5 and 79 days respectively, with less maturity period in most of the time BARI sarisha-14 with average maturity period of 81.6 days. Therefore, farmers were interested to cultivate Binasarisha-9 and Binasarisha-11.

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

Rice based pattern are in Sherpur and netrokona district mostly Indigenous rice (75% 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-9)–Boro (Binadhan-24) during 2022-23 at Baghber Union, Naliatabari, Sherpur. The experiment continued for last 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 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 2022-23. Seed production activities, locations, crop varieties and areas during the reporting period. In case of farmer's fields, partial inputs subsidies and free seeds or only free seeds were provided.

Training on the use of BINA developed technologies: In order to transfer BINA developed technologies three training programmes were arranged at BINA Substation, Nalitabari, Sherpur. The participants were 150 farmers (both male and female) and Sub-assistant Agriculture Officer (SAAO).

Field Day

Four field days on different crop varieties were organized in Sherpur and Netrokona district.

BINASub-station, Khagrachari
Research Highlights

- A total number of **nine** experiments from BINA Head quarter and **five** experiments of BINA Sub-Station, Khagrachai were conducted and maintained at BINA Sub-Station farm and the farmers' field. Monitoring, data collection, data analyses and reporting were done by respective PI with the help of BINA Sub-Station, Khagrachari.
- Under the validation program, **farmer's observation trial (FOT)** was conducted in three locations of Khagrachari. For T. Aman Binadhan-12 performed better in respect of yield (4.6 tha^{-1}) and yield contributing characters than sylheti Pajam.
- In another **FOT** of T. Aus rice which was conducted also in three areas of Khagrachari, Binadhan-19 performed better than Binadhan-21 and a local variety named Gelon in respect of yield (4.53 tha^{-1}) and other yield contributing characters.
- An **observational trial** of mustard resulted better for Binasarisha-9 (2.09 tha^{-1}) than, Binasarisha-4 (1.79 tha^{-1}), BARI sarisha-14 (1.49 tha^{-1}) and Binasarisa-10 (1.09 tha^{-1}) in respect of yield but BARI sarisha-14 (88.7 days) was matured earlier than other varieties of Binasarisha-4, 9 and 10.
- In **zero tillage** experiment though BARI sharisha-14 matured earlier than Binasarisha-10, Binasarisha-10 performed better in both optimum and zero tillage condition considering yield and contributing characters. But yield difference is very ignorable for both methods.
- **Mechanical stress** experiment for T. Boro rice revealed no convenient evidence of differences between the treatments.
- **Eight cropping pattern** experiments showed better BCR in comparison with existing pattern in eight different locations of CHT (Chittagong hill tracts).
- A total number of **two** block demonstrations were conducted with BINA dhan25 in Khagrachari sadar and Manikchari upazila during Boro season of the reporting year 2022-23 in which BINA dhan25 performed better than BRRI dhan 50 with average yield of 7.55 tha^{-1} and also short in duration (146 days).
- A total of **149** demonstrations were conducted with BINA released high yielding crop varieties at different crop growing areas of Khagrachari, Rangamati and Bandarban during Aman, Rabi, Boro, Kharif-I & Aus season of the reporting year 2022-23.
- In T. Aman season, a total of **44** demonstrations were conducted with Binadhan-12, Binadhan-16, Binadhan-17, Binadhan-20 and Binadhan-22 produced average yield of 4.38 tha^{-1}, 4.71 tha^{-1}, 4.55 tha^{-1}, 4.02 tha^{-1} and 5.00 tha^{-1} respectively.
- In Boro season 2022-23, a total of **51** demonstrations were conducted with Binadhan-5, Binadhan-10, Binadhan-14, Binadhan-24 & BINA dhan25 with average yield of 6.16 tha^{-1}, 6.34 tha^{-1}, 5.5 tha^{-1}, 6.40 tha^{-1} and 7.63 tha^{-1} respectively.
- In Rabi season 2022-23 a total of **29** demonstrations were conducted with Binasarisha-4, Binasarisha-9, Binasarisha-10, Binasarisha-11 and Binachinabadam-8 produced average yield of 1.67, 1.45, 1.15, 1.44 & 2.27 tha^{-1}, respectively.
- In Kharif-I season 2023, a total of **10** demonstrations were conducted with Binatil-2 with average yield of 1.12 tha^{-1}.
- In T.Aus season 2022-23, a total of **15** demonstrations were conducted with Binadhan-19 & Binadhan-21 with average yield of 4.8 & 5.0 tha^{-1} respectively.

- A total of **30.10** tons seed of different popular BINA released varieties were produced in BINA Sub-Station, Khagrachari farm as well as contract growers.
- A total of **220** farmers, seed dealers and SAAO were trained up during the reporting year 2022-23.
- A total of **three** field days were conducted with BINA dhan25 & Binatil-2 during the reporting year 2022-23.
- A total of **30 DAE** personnel participated in a workshop arranged in BINA sub-station, Khagrachari during the reporting year 2022-23.

Name of the Program : Validation Trials of BINA Developed Crop Varieties
Experiment 1 : Farmers observation trials with T. Aman rice

BINA developed aman rice varieties are taking place of local varieties in respect of duration, production and quality. The experiment was conducted at Farmer's Field, Khagrachari during aman season 2022-23 with the objectives to demonstrate the performance of Binadhan-12 in farmer's field of different areas of CHT and to identify suitable areas for expensive promotional work and encourage the farmers for cultivation of Binadhan-12. The varieties for the selected treatments were Binadhan-12 and Sylheti Pajam. The experiment was laid out in a randomized complete block design (RCBD) with three replications. Seedlings were transplanted on 10 July 2022. Spacing was 25cm line to line. Recommended cultural operations viz. application of fertilizers, weeding, thinning, irrigation, application of pesticides was followed to ensure normal plant growth and development.

It was observed from results that Plant height of Sylheti Pajam was 125.60 cm which was higher than Binadhan-12 (111.47cm). Number of effective tiller in Binadhan-12 was higher than the check variety, Sylheti Pajam (12.60). Binadhan-12 produced the highest yield (4.6 tha^{-1}) compared to the check variety.

The study showed that plant height, grain yield and straw yield were significantly different between the two varieties though number of tillers $plant^{-1}$ and number of effective tillers $plant^{-1}$ showed no significant pairwise differences between two varieties. Binadhan-12 performed better than Sylheti Pajam. Due to the earliness, comparatively better yield and fine grain quality, farmers found that Binadhan-12 as a good variety to cultivate in the respective area.

Experiment 2 : Farmers observation trials with Aus rice

BINA developed rice varieties are taking place of local varieties in respect of duration, production and quality. The experiment was conducted at farmers field, Khagrachari during aus season 2022-23 with the objectives to demonstrate the performance, identify suitable areas for expensive promotional work and encourage the farmers for cultivation of Binadhan-19 and Binadhan-21**.** The varieties for the selected treatments were Binadhan-19, Binadhan-21 with the Check variety, Gelon. The experiment was laid out in a randomized complete block design with three replications. Seedlings were transplanted on 05 May, 2022. Line to line spacing was 25cm. Recommended cultural operations viz. application of fertilizers, weeding, thinning, irrigation, application of pesticides was followed to ensure normal plant growth and development.

The result of the experiment showed that Plant height of Gelon was higher (124.7 cm) than Binadhan-19 (92.2 cm) and Binadhan-21 (81.7cm). Number of effective tillers in Binadhan-19 was the highest (22.4) among other varieties. Binadhan-19 produced highest yield (4.53 tha^{-1}) compared to Binadhan-21 (4.2 tha^{-1}) and check variety Gelon (2.80 tha^{-1}). Highest straw yield

was found in Gelon (9.68 tha^{-1}), followed by Binadhan-19 (7.4 tha^{-1}) and Binadhan-21 (6.18 tha^{-1}).

The study showed us that plant height and straw yield was significantly different from one another between the selected three Aus rice varieties. For yield of grain Binadhan-19 and Binadhan-21 is significantly higher from Gelon. For number of tillers $plant^{-1}$ and number of effective tillers $plant^{-1}$ Binadhan-19 was significantly higher than Bindhan-21 and Gelon. Due to the earliness, less water requirement, comparatively better yield and good grain quality, farmers found Binadhan-19 as a good variety to cultivate in the respective area.

Experiment 3 : Observational trials of four mustard varieties

To observe the performance, identify the promising characters and encourage the farmers for cultivation, the experiment was conducted at BINA Sub-station Farm, Khagrachari during rabi season 2022-23. The varieties for the selected treatments were a) Binasarisha-4, b) Binasarisha-9 c) Binasarisha-10 and d) check variety, BARI sarisha14. The experiment was laid out in a randomized complete block design with three replications. Seeds were sown on 12 November, 2022. Recommended cultural operations viz. application of fertilizers, weeding, thinning, irrigation, application of pesticides was followed to ensure normal plant growth and development.

The result of the experiment showed that BARI sharisha14 matured earlier than the other varieties (88.7 days). Binasarisha-9 had the highest number of siliquae per plant (112), followed by Binasarisha-4 (101), BARI sarisha-14 (97) and Binasarisha-10 (91). Binasarisha-9 produced the highest yield (2.09 tha^{-1}) compared to Binasarisha-4 (1.79 tha^{-1}) and BARI sarisha-14 (1.49 tha^{-1}) and Binasarisha-10 produced the lowest yield (1.09 tha^{-1}).

Among the considered 4 varieties of mustard Binasarisha-9 performed better than the other 3 varieties. BARI sarisha-14 matured earlier than others and produced 1.49 tha^{-1}. So, for hills where climate is a big factor both Binasarisha-9 and BARI sarisha-14 can be recommended in Rabi season.

Name of the Program : Crop Management And On-Farm Research

Experiment 4 : Evaluating the yield performance of mustard varieties under zero tillage

Zero tillage is one of the most used RCTs (Gupta, 2007) employed for saving precious resources, which gives more economic production (Hobbs, et al., 2002), lower production cost and saving in water and energy (Reifschneider, 2007). To observe the yield potentiality of BINA released mustard varieties under zero tillage, the experiment was conducted at BINA Sub-station Farm, Khagrachari during rabi season 2022-23. The tested varieties were Binasarisha-10 and BARI sarisha-14. .The experiment was laid out in a randomized complete block design with three replications. Seeds were sown on 20 November, 2022. Recommended cultural operations viz. application of fertilizers, weeding, thinning, irrigation, application of pesticides was followed to ensure normal plant growth and development. The imposed treatments were- Factor A: T_0=Zero tillage**,** T_2=Optimum tillage and Factor B: V_1=Binasarisha-10 & V_2= BARI sarisha-14.

The result of the experiment showed that Binasarisha-10 with zero tillage produced the tallest plant (T_0V_1= 118.7 cm) among the other treatments. Number of branches per plant was the highest in Binasarisha-10 with optimum tillage (T_1V_1 = 17) followed by BARI sarisha-10 with

optimum tillage (T_1V_2 = 13.7) compared to other treatments. Binasarisha-10 with optimum tillage produced the highest number of siliquae per plant (T_1V_2= 129) among the other treatments. Binasarisha-10 with optimum tillage produced the highest yield (1.9 tha^{-1}) followed by BARI sarisha-14 with optimum tillage (1.8 tha^{-1}), Binasarisha-10 with zero tillage (T_0V_2= 1.7 tha^{-1}) and BARI sarisha-14 with zero tillage (T_0V_1= 1.6 tha^{-1}). BARI sarisha-14 matured earlier (75.3 days) than Binasarisha-10 (78.2) in zero tillage condition.

Though BARI sarisha-14 matured earlier than Binasarisha-10, Binasarisha-10 performed the best in both optimum and zero tillage condition considering yield and contributing characters. Further elongation is needed for more validation. Since there is inferior distinctions between two of the cultivation methods in respect of yield, considering the overall conditions of hilly areas zero tillage can be advised.

Experiment 5 : Effects of mechanical stress on plant at tillering capacity and yield of T. boro rice

Tillering gives the crop the necessary number of stalks required for a good production. In some parts of Bangladesh, there is a common knowledge among the farmers that if rice plants are imposed with mechanical stress during early tillering stage, the tillering ability of rice increases. In order to find out the effect of mechanical stress on tillering capacity and yield of rice, an experiment was conducted in Bangladesh Institute of Nuclear Agriculture (BINA), substation, Khagrachari during Boro season 2022-23. The objective of the experiment was to find out tillering capacity and yield performance of selective Boro rice under mechanical stress. The study included three varieties and two levels of mechanical stress imposed at 30 days after transplanting (DAT) and 40 DAT. The experiment was laid out in a randomized complete block design with 3 replications. Mechanical stress was imposed by trampling over the plants twice with a banana trunk. Seeds were sown on 11 January 2023. Line to line spacing was 25cm. Recommended cultural operations viz. application of fertilizers, weeding, thinning, irrigation and application of pesticides was followed to ensure normal plant growth and development.

The result of the experiment showed that the plant height was higher at T_2 treatment of each variety and the number of effective tillers was higher in V_1T_0, V_2T_0 and V_3T_1. That means mechanical stress has no effect on the tillering capacity at Binadhan-5 and Binadhan-10, but in Binadhan-24 the treatment showed a little variation. In case of yield potentiality, Binadhan-5 gave the highest yield in control plot, but Binadhan-10 and Binadhan-24 gave the highest yield in T_1 treatment i.e. mechanical stress at 30 DAT. The treatment, T_1 gave the best performance. There was no significant difference found among the treatments.

The results revealed that none of the growth and yield contributing parameters of rice was significantly affected by mechanical injury. Similar results were found for all varieties under the study. The interaction effect of variety and mechanical injury was not statistically significant. Therefore, it is evident that mechanical stress does not increase neither tillering nor yield of rice.

Name of the Program : Development of a profitable cropping pattern for Chattogram Hill Tracts

Experiment 6 : Development of improved cropping pattern in Chattogram Hill Tracts

To increase the cropping intensity (%), develop a profitable cropping pattern, increase the land use efficiency and conserve soil health with the BINA released different varieties in the farmer's field, the experiment was conducted in aman/ kharif-II season, rabi/ boro season and aus/ kharif-I season during the year 2022-23 in Khagrachari, Rangamati and Bandarban districts.
Area of experiment al plots was 33 decimals. Recommended cultural operations viz. application of fertilizers, weeding, thinning, irrigation, application of pesticides was followed to ensure normal plant growth and development.

The details of crop sequence of different crops under proposed and existing cropping pattern are shown in the table below :

Sl. No.	Location	Existing pattern	Proposed pattern	Total duration (Days)	Rice Equivalent Yield (t/ha)	BCR
1	Sadar, Khagrachari	Aman-Mustard-Fallow	Binadhan- 12 Binasarisha- 9 Binadhan-21	316 days	11.03	1.56
2	Dighinala, Khagrachari	Aman-Mustard-Fallow	Binadhan- 12 Binasarisha- 9 Binadhan-19	311 days	10.79	1.56
3	Panchari, Khagrachari	Aman-Fallow-Aus	Binadhan- 12 Binasarisha- 9 Binadhan-19	310days	10.16	1.49
4	Manikchari, Khagrachari	Aman-Mustard-Fallow	Binadhan- 12 Binasarisha- 9 Binadhan-19	315 days	10.59	1.65
5	Naniarchar, Rangamati	Fallow-Boro-T.Aman	Binasarisha- 9 Binadhan-10 Binadhan- 12	325 days	11.96	1.59
6	Matiranga, Khagrachari	Aman-Fallow-Boro	Binadhan- 17 Binasarisha- 9 Binadhan-10	313 days	12.83	1.61
7	Rowangchari, Bandarban	Aman-Groundnut-Fallow	Binadhan- 12 Binachinabadam-8- Binadhan-19	350 days	10.9	1.69
8	Sadar, Bandarban	Aman-Fallow-Fallow	Binadhan- 12 Binasarisha- 9 Binadhan-21	318 days	10.16	1.52

Name of the Program : **Technology Transfer**

Experiment 7 : **Block farming of BINA developed varieties**

To demonstrate the performance of BINA released different varieties to the farmer's field and increase production and income of the farmers, the experiment was conducted of boro season in the year of 2022-23. A total of two demonstrations were conducted with BINA dhan25 in Manikchari and Sadar of Khagrachari. The check was a local variety: BRRI dhan50. The main objectives were to demonstrate the performance of BINA dhan25 and widening their adaptability

by the farmers. Area of demonstration plots was 10 bigha. Seeds were sown during December 2022. Seedlings were transplanted after 30 days to sowing and harvested in 146 days. Fertilizers viz. Urea (20 kg), TSP (15 kg), MOP (10 kg), Gypsum (10 kg), Zinc Sulphate (1 kg) were applied in the demonstration plots. All fertilizers (except urea) were applied during land preparation Urea was split into three does. Urea was applied 7, 30 and 55 days after seedling transplanting. Pesticides were sprayed as and when necessary to control pests. Data were recorded on crop duration and grain yield.

Locations	**No. of demonstration(s)**	**Durations**		**Yield (t/ha)**		% increase of yield over check
		BINA dhan25	Check (BRRI dhan 50)	BINA dhan25	Check (BRRI dhan 50)	
Manikchari, Khagrachari	1	145	154	7.65	6.1	20.52
Sadar, Khagrachari	1	147	155	7.45	5.9	
Mean		146	154.5	7.55	6.00	

Experiment 8 : Up-scaling of BINA developed varieties of different crops in hill tracts

There are so many local, high yielding and hybrid varieties available in the market as well as in farmer's field. Every variety differs from each other. Demonstrations are needed to be done to specify suitable variety for particular area based on agro-climatic condition. The experiments were conducted in Aman/ kharif-II season, rabi/ Boro season and Aus/ kharif-I season round the year' 2022-23. The objectives were to demonstrate the performance of BINA released different varieties in the farmer's field and increase production and income of the farmers. Area of the demonstration of each plot was 33 decimals.

Variety name	Demonstration (no.)	Districts	Duration (days)	Yield (t/ha)
Binadhan- 12	05	Khagrachari	129.13	4.38
Binadhan- 16	08	Khagrachari, Rangamati	105	4.71
Binadhan- 17	21	Khagrachari, Rangamati	121.5	4.55
Binadhan- 20	05	Khagrachari	119.47	4.02
Binadhan- 22	05	Khagrachari	117.21	5.00
Binadhan- 5	03	Khagrachari	135.8	6.16
Binadhan- 10	11	Khagrachari	138	6.34
Binadhan- 14	03	Khagrachari	123.8	5.36
Binadhan- 24	09	Khagrachari	142.5	6.4
BINA dhan25	25	Khagrachari	143.5	7.63
Binadhan- 19	6	Khagrachari	99.78	4.8
Binadhan- 21	9	Khagrachari	102.52	5.0
Binasarisha- 4	03	Khagrachari	86.88	1.67
Binasarisha- 9	10	Khagrachari	82.55	1.45
Binasarisha- 10	05	Khagrachari	83.61	1.15
Binasarisha- 11	05	Khagrachari	85.50	1.44

Binachinabadam-8	5	Khagrachari	148.3	2.27
Binatil- 2	10	Khagrachari	93.72	1.12

Experiment 9 : Quality seed production of promising BINA released varieties for hill tracts

The program was conducted in Farmers' field and BINA Sub-station farm of Khagrachari during aman/kharif-II, rabi/boro, aus/kharif-I season of the fiscal year 2022-23. The objectives of the program were to supply quality seeds to the farmers and DAE for extension of BINA technologies, to meet the local demand of seed and supply during season for demonstration and research purposes and to sustain the cultivation of BINA released crop varieties. Seeds of some demanding and promising crop varieties of BINA were produced in sub-station and also in the farmer's fields at different locations. For buying seeds from the farmer's government rate were followed. Farmers were provided with partial inputs, subsidies and free seeds or only with free seeds. During the 2022-23 period a total of 30.1 tons seeds of different crop varieties of BINA were produced and procured. Among them rice were about 25.36 tons, mustard = 3.45 tons and lentil = 0.020 tons, blackgram = 0.090 tons, sesame = 0.100 tons and turmeric = 1.080 tons.

Farmer's training, workshop and field day

Six trainings and one workshop were organized on the cultivation techniques, seed production and farmer's motivation for BINA developed crop varieties. Three field days were organized to motivate farmers to adopt BINA developed crop varieties/technologies during 2022-23.

BINA Sub Station, Jamalpur

Experiment 1. Effect of different organic amendments on soil fertility and increased crop production.

Field experiment was conducted to determine the optimum chemical fertilizers using integrated plant nutrient system (IPNS) based organic amendments and chemical fertilizers (CF) in T. aman-Boro rice-mustard cropping pattern at the BINA substation farm, Jamalpur during 2022-23. The treatments used for T.aman rice (Binadhan-17) with organic amendments as follows: T_1: Native soil fertility (Control), T_2: 100% Chemical fertilizers (100% CF), T_3: CF+2.5 t ha^{-1} Rice straw (CF+RS) T_4: CF+4 t ha^{-1} cow dung (CF+CD), T_5: CF+3 t ha^{-1} poultry manure (CF+PM).The experiment was laid out in a randomized block design with three replication. Yields of T. Aman rice were significantly influenced with the application of organic matter and chemical fertilizers. The treatment T_4 (6.50 t ha^{-1}) gave maximum grain yield of T. aman rice followed by the treatment T_3 (6.37 t ha^{-1}), T_5 (5.85 t ha^{-1}), and T_2 (5.65 t ha^{-1}). The treatment T_1 (Native soil fertility) gave significantly minimum grain yield of T. aman rice. Similar results were also observed in case of straw and biological yields of T. aman rice. The result indicated that CF with organic matter (IPNS) gave comparable yield to the sole application of 100% N from CF alone. The physiochemical characteristics of soil vizs i. pH, OM, N%, K (meq100g^{-1}), P (ppm), S (ppm), Zn (ppm), B (ppm) of post-harvest soil were significantly influenced with the application of organic matter and chemical fertilizers. The treatment T_3 gave significantly the highest results in all parameters of post harvest soil.

Experiment 2. Determination of profitable cropping pattern in farmers' fields at Jamalpur region

Sustainable crop production in Bangladesh through improvement of cropping pattern in rice-based cropping system is regarded as increasingly important in national issues such as food security, poverty alleviation and create job opportunities. It is a great opportunity to increase cropping intensity by developing three crops-based cropping pattern. The main challenge of the new millennium is to increase per unit yield by at least 50% through manipulating the limited land resource. The present experiment was therefore, undertaken to study the economic feasibility of growing three crops in a year in a piece of land by incorporating mustard in the existing two crops-based cropping pattern. The experiment was conducted at the two locations (Farmers field Sadar, Jamalpur and Melandah, Jamalpur) during 2022-23. The existing cropping pattern T. Aman (var. Binadhan-17)- Fallow- Boro (var. BRRI Dhan-29) was improved by the inclusion of Mustard (var. Binasarisha-9) between T. Aman all Boro rice at Sadar Upazila of Jamalpur during the year of 2022-23. In Kharif-II, T. Aman was grown both in existing and improved cropping pattern and the yield was higher in improved cropping pattern (6.45 t ha^{-1}) than existing cropping pattern (6.35 t ha^{-1}). The gross margin Tk. 1,72,525/- ha^{-1} obtained from improved cropping pattern, which was higher than existing cropping pattern (Tk. 1,13,850/- ha^{-1}). BCR of improved cropping pattern (1.55) was 6.89% higher than existing cropping pattern (1.45). The existing cropping pattern T. Aman (var. Swarna)-Fallow- Boro (var. BRRIdhan- 29) was improved by inclusion of T. Aman (var. Binadhan-11)-Mustard (var. Binasarisha-9)- Boro (var. Binadhan-14) at Melandha Upazila of Jamalpur during the year of 2022-23. In Kharif-II, T. Aman was grown both in existing and improved cropping pattern and yield was higher in improved cropping pattern (5.4 t ha^{-1}) than existing cropping pattern (3.75 t ha^{-1}). The gross margin Tk. 1,65,000/- ha^{-1} obtained from improved cropping pattern, which was higher than existing cropping pattern (Tk. 92,452.5 ha^{-1}). BCR of improved cropping pattern (1.57) was 7.53% higher than existing cropping pattern (1.46).

Results of demonstrations of different BINA varieties in the year (2022-23) at different locations in Jamalpur and Tangail regions

A total of 188 demonstrations for BINA varieties like rice, mustard, groundnut, and sesame were successfully carried out at different locations in Jamalpur & Tangail regions during 2022-23. For conducting the demonstrations seeds and with some other input costs provided to the selected farmers**.** During 2022-23 in Aman season, among all tested aman varieties in Jamalpur Binadhan-17 took 112 days to mature with an average yield of 6.5 tha^{-1}. On the other hand, Binadhan-20 produced grain yield 4.4 t ha^{-1} with its maturity period of 128 days. Binadhan-11 and Binadhan-16 had the maturity period of 115 and 100 days by producing the yield of 5.4 and 4.9 tha^{-1}, respectively. In Rabi season, Binachinabadam-6 & Binachinabadam-8 had 140 & 145 days to get its maturity along with the average yield of 2.2 tha^{-1} & 2.7 tha^{-1} at different charland of Jamalpur. Other oil seed crops, Binatil-2 and Binatil-4 produced the average seed yield of 1.3 tha^{-1} taking the maturity period of 95 days. Binasarisa-9 took 85 days to mature having the average yield of 1.9 tha^{-1}.

Seeds produced/purchased, (Breeder/TLS) during 2022-23

A total of 4.5 tons of Breeder seeds of different BINA varieties produced on station with proper inspection by SCA officials during reporting period. Due to limited farm area, a little amount of the production of TLS performed on different BINA varieties. A total of 17.67 tons TLS seed were stored of which maximum amount purchased from expert farmers. In case of farmer's field, partial input subsidies and free seeds or only free seeds provided to the farmers.

Training on the use of BINA developed technologies

During 2022-23, in order to disseminate BINA varieties, four trainings were conducted at BINA sub-station Jamalpur and at different UAO office. For performing these training programmes UAOs, SAAOs and farmers from different upazilas were trained up and it was covered the number of 26 SAAOs and 235 farmers (male & female).

Field Days (2022-23)

During 2022-23, five (05) field days were successfully completed for different popular varieties. To conduct these field days the crop varieties were considered as Binadhan-11, Binadhan-16, Binadhan-17, Binasharisha-9 and Binatil-2. The DAE personnel along with print and electronic media were present during the crop cutting and field day.

Sub-Station, Noakhali

Improvement of local groundnut germplasm for problem areas through hybridization

Groundnut (*Arachis hypogaea* L.) is self-pollinating allotetraploid legume crop belonging to the Fabaceae family. Groundnut seeds are source of edible oil (35–56%), protein (25– 30%), carbohydrates (9.5–19.0%), minerals (P, Ca, Mg and K) and vitamins (E, K and B). The existing groundnut varieties in Bangladesh are mostly two seeded and salt susceptible. (BINA) has salt tolerant (up to 8 dS/m^2) variety named Binachinabadam-6 which is two seeded. The southern part of Bangladesh has huge char and saline areas which remain fallow in over the year. There is a scope to introduce high saline tolerant and 3-4 seeded variety for those areas. Therefore, the experiment was conduct to improve the existing varities with local germplasm which have unique traits to reach the goal. The primary gene pool of the cultivated groundnut is very narrow for some important characteristics such as resistance to salt and insect pests (e.g. thrips). Local germplasm may offer wide variability, particularly for biotic and abiotic stress breeding. Utilization of local wild groundnut germplasm in breeding program has been restricted by reproductive barriers between wild and cultivated species. This presented technical difficulties in making large numbers of crosses due to flowering time, humidity, temperature, rainfall etc. More successful crosses between wild and cultivated species can be achieved in controlled condition like glass house.

The field study was conducted at the BINA substation, Noakhali during Kharif-2 season of 2022-2023. Total five (05) genotypes were used in this experiment, among them three (Balibadam, Chakbadam and Lalibadam) was local germplasm and another two were Binachinabadam-4 and Binachinabadam-6. The experiment was laid out in half diallel matting design without replication in pot condition.

Table 1. Crossing detail with success percentage

Female parent	Male parent	Emasculation and pollination (no)	Number of success	Success (%)
Balibadam	Chakbadam	42	9	21.4
Balibadam	Lalibadam	39	7	17.9
Balibadam	Binachinabadam-4	47	10	21.2
Balibadam	Binachinabadam-6	36	6	16.6
Chakbadam	Lalibadam	38	8	21.1
Chakbadam	Binachinabadam-4	53	10	18.8
Chakbadam	Binachinabadam-6	46	8	17.3
Lalibadam	Binachinabadam-4	53	11	20.7
Lalibadam	Binachinabadam-6	51	11	21.5
Binachinabadam-4	Binachinabadam-4	44	9	20.4

The successful rate of the experiment was 17-22% due to uneven rainfall and humidity. Those F_1 seeds were harvested and will be evaluated in the next season.

Growing of collected rice germplasm for seed multiplication and evaluation

Landraces are the valuable source of different gene pool that enriches biodiversity. In Chattogarm region there have over 80 local landraces that cultivate in different location like saline area, hilly area, flood prone area or others. The area coverage of these landraces is very minimal and generally cultivated by some marginal farmers. The yield of these local landraces is very poor compare to the HYV or hybrid variety. Nevertheless, these landraces are more tolerant to disease, pest and in problematic soil. So, a study was conducted on collection of popular local landraces having good character that helps to selects potential landrace for future breeding program.

The field study was conducted at the BINA substation, Noakhali region during Aman season of 2022-2023. Six (06) local rice landraces (Shorna, Parijat, Shaita, Chalmoni, Shondakosturi and Gigos) were collected from farmer fields of Noakhali and some morphological data were recorded.

Table 2: Yield contributing parameters of shorna, parijat, shaita, chalmoni, sondakosturi, gigos and Binadhan-17 during Aman season 2022-23

Genotypes	Days to 50% flowering	Days to maturity	Plant height (cm)	Effective tillers hill^{-1} (no)	Filled grains panicle^{-1} (no)	Unfilled grains panicle^{-1} (g)	1000 seed weight (g)	Grain yield tha^{-1}
Shorna	71.3a	136.0a	123.3c	12.0ab	121.7b	10.9c	21.6d	6.8b
Parijat	68.3b	128.2b	137.3ab	14.7ab	105.7bc	13.3bc	25.4ab	6.4b
Shaita	54.6e	102.2e	103.6d	9.4c	52.5e	13.4bc	26.7a	3.4d
Chalmoni	67.3b	127.6b	130.3bc	10.1bc	73.4de	18.4a	23.5c	3.6d
Sondakosturi	62.3c	134.0a	149.2a	12.7a	89.8cd	13.1bc	25.1b	5.5c
Gigos	63.3c	123.6c	136.6ab	9.5c	51.9e	11.7bc	25.7b	2.8e
Binadhan-17 (Check)	60.0d	119.3d	102.3d	10.6a-c	163.2a	15.7ab	20.7d	7.5a
CV(%)	1.81	1.24	5.82	10.58	14.61	17.31	3.60	4.45

The check Binadhan-17 showed best yield performance (7.5 tha^{-1}) followed by shorna (6.8 tha^{-1}) and gigos (6.4 tha^{-1}). Most of the yield attributing data is higher in shorna and gigos. Those germplasms need further molecular and biochemical analysis to select as a parent.

Development of a suitable cropping pattern in the farmer's field of noakhali

In Bangladesh total cropped area is 85,05,278.14 hectare where 38, 20,637.14 hectare land is double cropped. These lands are remaining fallow in a cropping season in a year. If there is a crop can fit in these huge area may produce the large amount of food. In Noakhali 106638 ha of land are double cropped and in these cropping pattern Aman-Groundnut-Fallow is a major pattern. So we conducted an experiment to fit a crop in this fallow season like aus rice. Thus, the adoption of improved aus rice variety (Binadhan-19) in new cropping pattern at the farmer's level plays an important role to increase rice production.

The field experiment was conducted at the Subarnachar upazila under Noakhali district during Aman, Rabi and Aus season of 2022-2023. Two cropping pattern (CP) *viz.* CP_1: T. Aman (Binadhan-17)-Groundnut (Binachunabadam-4)-Fallow; CP_2: T. Aman (Binadhan-17)-Groundnut (Binachunabadam-4) - T. Aus (Binadhan-19) were used as treatments. The experiment was laid out in a Randomized Complete Block (RCB) design with three replications. The unit plot size was 1 bigha. As per treatment T. Aman (Binadhan-17) was grown during the Aman season and it was the 1st crop of the proposed crop sequence. Seedling was grown in seedbed in a separate plot. 20 days old seedlings of Binadhan-17 was transplanted with 20 cm × 15 cm spacing on 16 July, 2022. Fertilizer management and intercultural operation like weeding, mulching etc. were done as and when necessary.

Result from the Table 1 revealed that in CP1 the harvested seeds and straw yields of Binadhan-17 were 5.6 and 5.3 t ha^{-1} and Binachinabadam-4 were 2.2 and 4.5 t ha^{-1} respectively. In CP2 the harvested seeds and straw yields of Binadhan-17 were 5.8 and 5.0 t ha^{-1} , Binachinabadam-4 were 2.2 and 4.1 t ha^{-1} and Binadhan-19 were 3.5 and 4.0 t ha^{-1} respectively. Total productivity of two cropping pattern was determined by rice equivalent yield (REY) which was calculated from yield component of crops. Rice equivalent yield was different in different cropping sequence. The highest REY (19.65 t ha^{-1}) was

recorded from the cropping pattern Aman-Groundnut-Aus and the lowest REY (15.08 t ha^{-1}) was obtained from the cropping pattern Aman-Groundnut-Aus.

Table 3. Performance of different crops under three crops based cropping pattern during 2022-2023 at Subarnachar

Item	CP1			CP2		
	Aman	Groundnut	Fallow	Aman	Groundnut	Aus
Variety	Binadhan-17	Binachinabadam-4	-	Binadhan-17	Binachinabadam-4	Binadhan-19
Sowing	25 July	05 January	-	25 June	01 November	18 March
Transplanting	16 August	-	-	16 July	-	-
Crop duration	116	140	-	116	135	102
Harvest	20 November	15 May	-	20 October	15 March	28 June
Grain yield (t ha^{-1})	5.6	2.2	-	5.8	2.2	3.5
Straw yield (t ha^{-1})	5.3	4.5	-	5.0	4.1	4.0
REY (t ha-1)	6.15	8.93	-	6.6	8.91	4.14
Total REY		15.08			19.65	

market price (Tk. Kg^{-1}): Groundnut: (non seed-100 & straw-2), Rice: (non seed-25 & straw-4)

From the result it may be concluded that three crops based cropping pattern like CP_2: Aman-Groundnut-Aus (Binadhan-17-Binachinabadam-4-Binadhan-19) is may be economically profitable compared to the existing cropping pattern like Aman-Groundnut-Fallow. For final conclusion this experiment need to be conducted next two or three years.

Block farming of aman rice at subarnachar uapzila under noakhali district in 2022-23

Nowadays, block farming is becoming a popular cultural practice for the farmer to get higher economic benefits. Production in large area can attract buyers and make a reputed place on the market. Farmer use optimum fertilizer and know-how to do it. In block farming, optimum irrigation, weeding, mulching and other intercultural operation may easy for the farmer. Soybean is valuable oil seed crop that can easily cultivate in a large area due to less intercultural operation with the consideration of higher market demand.

A study of variety-wise soybean block farming was conducted at Subarnachar uapzila under Noakhali district during Aman season of 2022-2023. There was three BINA released rice variety (Binadhan-16, Binadhan-17 and Binadhan-23) and check (BRRI dhan 95) cultivated were in 41 Bigha of land (Table 2). The seeds were sown at 10 July, 2022 and harvested on 30 October 2022. Fertilizer management and intercultural operation like weeding, fertilizer application, irrigation etc. were done according to the recommendation.

Result from the Table 2 revealed that the yield of Binadhan-17 and Binadhan-23 were 6.7 and 5.5 t ha^{-1} respectively where the check (BRRI dhan95) was 5.2 t ha^{-1}. The duration of the Binadhan-16, Binadhan-17 and Binadhan-17 were 105, 116 and 122 days respectively, where the check shows 125 days.

Table 4. Performance of aman rice under block farming during 2022-2023 at Kamalnagar under Lakhsmipur district

Name of variety	Districts	Total area (Bigha)	Blocks (no.)	Duration (Days)		Yield (t/ha)	Remarks
				Variety	Check		
Binadhan-16	Noakhali	10	1	105	-	5.1	Binadhan-17 and Binadhan-23 showed higher yield performance than the check variety (BRRI dhan95)
Binadhan-17	Noakhali	15	1	116	-	6.7	
Binadhan-23	Noakhali	12	1	122	-	5.5	
BRRI dhan95	Noakhali	4	1	-	125	5.2	
Total		**41**	**4**	**-**	**-**	**-**	**-**

From the result it may be concluded that block farming with BINA released Binadhan-17 and Binadhan-23 may provide better yield with short duration. This may help the farmer to catch-up next season for same crop or another crop.

BINA Sub-station, Sunamganj

Research Highlights

Agronomical traits found satisfactory in F_2 population of BARI Hybrid Tomato-4, BARI Hybrid Tomato-8, Lal bahadur and ACI summer king. (Reverse Breeding, SCA-Specific combining Ability/GCA-general Combining Ability)

At 100 Gy treatments Barshati mistikumra was found 50 % seed were germinated with shorter seedling height and plant length.

Dhanimorich at 150 Gy treatments it was found 75% seed were germinated with shorter seedling height.

The highest REY (8.4 t ha^{-1}) of Aman-Mustard (Binasarisha-9) - Fallow against Aman-Fallow-Fallow (5.3 t ha^{-1}).

The highest REY (8.68 t ha^{-1}) of Aman-Mustard (Binasarisha-9)- Fallow against Aman-Fallow-Fallow (5.98 t ha^{-1}).

The highest REY (13.63 t ha^{-1}) of T. Aman (Binadhan-17)-Mustard (Binasarisha-9)-Boro (Binadhan-14) against T. Aman (Binadhan-7)-Fallow- Boro (10.18 t ha^{-1}).

The highest REY (17.69 t ha^{-1}) of T. Aman (Binadhan-17)-Sesame (Binatil-2)-T. Aus (Binadhan-21) against T. Aman (Binadhan-7)-Fallow-T. aus (10.25 t ha^{-1}).

The highest REY (20.89 t ha^{-1}) of T. Aman (Binadhan-17)- groundnut (Binachinabadam-4)-T. Aus (Binadhan-19) against T. Aman (BR11)-Fallow-T. aus(Binadhan-19) (8.51 t ha^{-1}).

The highest REY (20.19 t ha^{-1}) of T. Aman (Binadhan-17)- groundnut (Binachinabadam-4)-T. Aus (Binadhan-19) against T. Aman (BRRI dhan32)-Fallow- Fallow (4.72 t ha^{-1}).

We executed six farmers' and SAAO/other officials training, eight field days and one workshop during last 2022-2023 year from BINA Sub-station, Sunamganj. Total **194** demonstrations were implemented during 2022-2023 with BINA varieties.

Name of project: Extension of shelf-life and maintain quality of tomato fruits

Screening of BINA and BARI released tomato varieties. Objective was to select the suitable variety for longer shelf-life. Binatomato-11, Binatomato-12, BARI Tomato-18, BARI Tomato-19 with application of four doses of calcium chloride in the morning after fruit initiation along with 0.03% Tween 20 with RCBD 3 replications

and growing season was Kharif-1, 2022-2023 at Horticulture Field, BINA Head Quarter.

Incase of yield performance BARI Tomato-18, BARI Tomato-19 found better compare to Binatomato-11, Binatomato-12, whereas the shelf life of Binatomato-11, Binatomato-12 were higher than BARI Tomato-18, BARI Tomato-19 respectively. Experiment could not conducted properly due to late decision-making and fund availability. For final conclusion this experiment would be conducted for next 3 years.

Development of efficient and climate smart biofertilizers for pulse, oilseed and vegetable production using microbiological, molecular and nuclear techniques

Effects of rhizobia inoculant strains on growth, nodulation and yield of French bean in field conditions.

The objective were observe the effect of rhizobium inoculation on growth, nodulation and dry matter yield of French bean and to determine the nitrogen fixing ability of rhizobia for biofertilizer production with 4 French bean inoculants strains,(T2= FBR-1, T3= FBR-2, T4= FBR-3, T5= FBR-4) 2 level of nitrogen (T6= 15 Kg ,T7= 30 Kg) and control(T1= control) the experiment was conducted through RCBD with 3 replications during rabi, 2022-2023 at BINA Sub-station, Sunamganj research field. The yield was satisfactory. Four rhizobium strains performed better over control and one nitrogen level of N15 (15 Kg nitrogen/ha and four rhizobium strains screened out for biofertilizer for French bean production.

Development of summer tomato lines

Growing of F_2 population of summer tomato with the objective of select best line for summer season with tolerant to biotic and abiotic stress and F1 generation of BARI Hybrid Tomato-4, BARI Hybrid Tomato-8, Summer king, Lal Bahadur the experiment was non replicated and growing season was Kharif-1, 2022-2023 at research field of BINA Sub-station, Sunamganj
From collected data, seed germination rate, Seedling height, Plant height, No. of branch plant-1 and yield were satisfactory in F2 Population of BARI Hybrid Tomato-4, BARI Hybrid Tomato-8, Lal bahadur and ACI summer king. For final conclusion this experiment may be conducted for next 4 generations

Varietal improvement of summer sweet gourd

Growing of **M_2** generation of barshati sweet gourd. The objective was develop variety with high yield potential, tolerant to fruit fly and suitable for summer and winter season Barshati mistikumra and Doses with 0 Gy, 50 Gy, 70 Gy and 100 Gy the experiment was non replicated and growing season was Kharif-1, 2022-2023 at research field of BINA Sub-station, Sunamganj
From recorded data, seed germination rate, Seedling height, Plant length, No. of branch plant-1 and yield were decrease with the increase of doses. In 100 Gy treatments it was found that 50 % seed were germinated with shorter seedling height and plant length. For final conclusion this experiment may be conducted for next 4 generation.

Varietal improvement of Chili

Growing of M_2 generation of Dhanimorich with the objective of develop variety with high yield potential, Tolerant to anthracnose, foot rot and bacterial wilt and suitable for year round cultivation
Genotype: Dhanimorich and doses were 0 Gy, 70 Gy, 100 Gy and 150 Gy the experiment was non- replicated and growing season was Kharif-1, 2022-2023 at research field of BINA Sub-station, Sunamganj
From recorded data, seed germination rate, Seedling heights were decrease with the increase of doses. In 150 Gy treatments it was found that 75% seed were germinated with shorter seedling height. For final conclusion this experiment may be conducted for next 4 generation.

Adoption of new cropping pattern with BINA released mustard and short duration aman rice varieties for aman season

Currently Bangladesh faces an acute shortage of edible oil where the major source of edible oil is mustard, sesame, ground and sunflower etc. There is very little scope for increasing cultivated land for mustard though there is an ample scope for increasing cropping intensity from 100% to 200% by incorporating short duration crops like Binasarisha-9 and Binadhan-22 in the rice based cropping pattern.

A field experiment was conducted at the Fenibill Sunamganj sadar under Sunamganj district during Aman and Rabi season of 2022-2023. Two cropping pattern *viz.* CP_1: Aman-Fallow-Fallow- (BR22) control; CP_2: Aman-Mustard (Binasarisha-9) - Fallow were used following the unit plot size of 1 bigha. Result revealed that the highest REY (8.4 t ha^{-1}) was recorded from the cropping pattern Aman-mustard - Fallow. The lowest REY (5.3 t ha^{-1}) was obtained from the cropping sequence Aman-Fallow-Fallow.

A field experiment was conducted at the Masimpur Biswamvarpur upazila under Sunamganj district during Aman and Rabi season of 2022-2023. Two cropping pattern *viz.* CP_1: Aman-Fallow-Fallow-

(BRRI dhan49) control; CP_2: Aman-Mustard (Binasarisha-9) - Fallow were used as treatments where the unit plot size was 1 bigha.

Result revealed that the lowest REY (5.98 t ha^{-1}) was obtained from the cropping sequence of Aman-Fallow-Fallow. From the result it may be concluded that two crops based cropping pattern such as CP_2: Aman-Mustard (Binasarisha-9) - Fallow is agronomical feasible and economically profitable compared to the existing cropping pattern viz. Aman-Fallow-Fallow. It was the 1st year experiment and for the final conclusion this experiment may be conducted next two year.

Development of three crop-based cropping pattern with BINA released Mustard, short duration Aman and Boro rice varieties

Due to the acute shortage of edible oil the major source of edible oil is mustard, sesame, groundnut and sunflower in Bangladesh. There is very little scope for increasing cultivated land for sarisha though there is an ample scope for increasing cropping intensity from 200% to 300% by incorporating sarisha and short duration boro rice like Binasarisha-9 and Binadhan-14 in the oil seed crop based cropping pattern.

The field experiment was conducted at the Mouakura of Biswamvarpur upazilla under Sunamganj district during Aman- Rabi-Boro and season of 2022-2023. Two cropping pattern *viz.* CP_1: T. Aman (Binadhan-7)-Fallow- Boro (control); CP_2: T. Aman (Binadhan-17)-sarisha (Binasarisha-9)-Boro (Binadhan-14) were used as treatments. The unit plot size was 1 bigha.

Result revealed that highest REY (13.63 t ha-1) was recorded from the cropping pattern : T. Aman (Binadhan-17)-sarisha (Binasarisha-9)-Boro (Binadhan-14). The lowest REY (10.18 t ha-1) was obtained from the cropping sequence T. Aman(Binadhan-7) -Fallow-Boro(Binadhan-24).

From the result it may be concluded that three crops based cropping pattern such as CP_2: T. Aman (Binadhan-17)-Mustard (Binasarisha-9)-Boro (Binadhan-14) is agronomical feasible and may be economically profitable compared to the existing cropping pattern viz. T. Aman (Binadhan-7)-Fallow-Boro. It was 1st year experiment and for final conclusion this experiment may be conducted next two year.

Development of three crop-based cropping patterns with BINA released sesame, short duration aus and aman rice varieties

The experiment was undertaken to study the feasibility of growing three crops in a year in a piece of land by incorporating sesame and short duration Aus variety in existing two crop based cropping pattern. The field experiment was conducted at the Syedpur of Sadar upazilla under Sunamganj district during Aman, Rabi and Aus season of 2022-2023. Two cropping pattern *viz.* CP_1: T. Aman (Binadhan-7)-Fallow-T. aus (control); CP_2: T. Aman (Binadhan-17)-Sesame (Binatil-2)-T. Aus (Binadhan-21) were used as treatments. The experiment was laid out in a Randomized Complete Block (RCB) design with 5 replications. The unit plot size was 1 bigha.

From the result it may be concluded that three crops based cropping pattern such as CP_2: T. Aman (Binadhan-17)–Sesame (Binatil-2)-T. Aus (Binadhan-21) is agronomical feasible and may be economically profitable compared to the existing cropping pattern viz. T. Aman (Binadhan-7)-Fallow-T. Aus. It was 1st year experiment. For final conclusion this experiment may be conducted next two year.

Development three crop-based cropping pattern with BINA released Groundnut, short duration aus and aman rice varieties

The present experiment was therefore, undertaken to study the feasibility of growing three crops in a year in a piece of land by incorporating groundnut and short duration Aus variety in existing two crop based cropping pattern. The field experiment was conducted at the Muslimpur, Sunamganj sadar upazilla under Sunamganj district during Aman, Rabi and Aus season of 2022-2023. Two cropping pattern *viz.* CP_1: T. Aman (BR11)-Fallow-T. aus(Binadhan-19) control; CP_2: T. Aman (Binadhan-17)- groundnut (Binachinabadam-4)-T. Aus (Binadhan-19) were used as treatments. The experiment was laid out in a Randomized Complete Block (RCB) design with 7 replications. The unit plot size was 1 bigha

Result revealed that highest REY (20.89 t ha^{-1}) was recorded from the cropping pattern T. Aman-groundnut-T. Aus. The lowest REY (8.51 t ha^{-1}) was obtained from the cropping sequence T. Aman-Fallow-T. Aus.

From the result of the study it may be concluded that three crops based cropping pattern such as CP_2: T. Aman (Binadhan-17)- groundnut (Binachinabadam-4)-T. Aus (Binadhan-19) is agronomical feasible and may be economically profitable compared to the existing cropping pattern viz. T. Aman (BR11)-Fallow-T. Aus. It was 1st year experiment. For final conclusion this experiment may be conducted next two year

Generation of three crop-based cropping patterns with BINA released Groundnut, short duration aus and aman rice varieties

There is very little scope for increasing cultivated land for sesame though there is an ample scope for increasing cropping intensity from 100% to 300% by incorporating sesame and short duration Aus rice like Binatil-2 and Binadhan-21 in the oil seed crop based cropping pattern. The present experiment was therefore, undertaken to study the feasibility of growing three crops in a year in a piece of land by incorporating groundnut and short duration Aus variety in existing one crop based cropping pattern. The field experiment was conducted at the Mollapara, Chhatak upazilla under Sunamganj district during Aman, Rabi and Aus season of 2022-2023. Two cropping pattern *viz.* CP_1: T. Aman (BRRI dhan 32)-Fallow- Fallow; control; CP_2: T. Aman (Binadhan-17)- groundnut (Binachinabadam-4)-T. Aus (Binadhan-19) were used as treatments. The experiment was laid out in a Randomized Complete Block (RCB) design with 3 replications. The unit plot size was 10 bigha.

The highest REY (20.19 t ha^{-1}) was recorded from the cropping pattern T. Aman-groundnut-T. Aus. The lowest REY (4.72 t ha^{-1}) was obtained from the cropping sequence T. Aman-Fallow-Fallow.

There were 194 demonstration was conducted during 2022-2023 with BINA released varieties like; Binadhan-16, Binadhan-17(Aman) Binadhan-17(Boro), Binadhan-22, Binadhan-24, Bina dhan25, Binacinabadam-4, Binacinabadam-8, Binasorisha-9, Binasorisha-11, Binatil-2 at Sunamganj sadar upazila Kolaora-Habiganj, Kanaighat- Chhatak, , Jagannathpur, Bishwamvarpur, Jakiganj, Sylhet sadar, Moulvibazar sadar, Rajnagar, Sreemongol upazila, Komolganj, Goanghat, Shantiganj, , Sylhet sadar & Chhatak upazila DowarabazarDowara bazar, Komolganj in Sylhet division

During 2022-2023 fiscal year, there was about 4 tons (3.98 tons) seeds of BINA released varieties like; Binadhan-5, Binadhan-6, Binadhan-7, Binadhan-10, Binadhan-11, Binadhan-12,Binadhan-14 Binadhan-16 (Aman), Binadhan-16 (Boro), Binadhan-17(Aman), Binadhan-17(Boro), Binadhan-20, Binadhan-24, Binadhan-25, Binasarisha-9, Binapatshak-1, Binasharisha-4, Bianchenabadam-4, Bianchenabadam-4(kharif-2), Bianchenabadam-6, Bianchenabadam-8, Binasarisha-11, Binaholud-1, Binamorich-1, Binalebu-1, Binatil-2 at research farm of BINA Sub-station, Sunamganj.

We executed six farmers' and SAAO/other officials training, eight field days and one workshop during last 2022-2023 fiscal year from BINA Sub-station, Sunamganj.

BINA Sub-station, Chapainababganj

Influence of organic residue with alternate wetting and drying irrigation on rice yield, water productivity and soil physicochemical properties

Rice (Oryza sativa L.) is one of the most important staple foods for nearly half of the world's population. Water for agricultural use becomes increasingly scarce due to climate change and farmers are facing a challenge to produce more rice with limited water. Alternate wetting and drying (AWD) irrigation is a water saving irrigation technique in rice production. Application of organic amendments, either for plant nutrient supply or for disposal purposes, improves soil physicochemical properties. In the alternate wetting and drying, incorporation of organic manure significantly increases nutrient uptake by rice plants and facilitates the allocation and transfer of nutrient elements. Many previous literatures found about AWD irrigation techniques on the water productivity and yield of rice but minor findings on proper management of organic amendment for moisture conservation and nutrient dynamics compared to traditional irrigation practices. Hence, the project has been undertaken to achieve the following objectives;

1. To investigate the effects of selected organic residue on rice yield and water productivity under alternate wetting and drying (AWD) irrigation.

2. To determine the changes in soil physicochemical properties influenced by selected organic residue under AWD conditions.

The study was conducted during Boro season in experimental field of BINA sub-station Chapainawabganj. The soil type was clay loam, and the experimental design was a split-plot with three replications.

Factor: A: i. Continuous flooding (CF), ii. Alternate wetting and drying (AWD)

Factor: B: i. Rice straw @ 7ton ha^{-1} + Recommended fertilizer dose (RFD), ii. Legume straw @ 3ton ha^{-1} + RFD and iii. RFD

Rice (Oryza sativa L.) variety (BINA dhan25) was used in the study. Standard agronomic practices, including seeding rate, fertilization, and pest management, were followed throughout the growing season.

Harvested rice grains were measured and converted to grain yield per hectare (kg/ha).

Water input for each treatment was measured using water meters, and water productivity was calculated as the ratio of grain yield to water input.

Soil samples were collected at the beginning and end of the season. Soil pH, organic matter content, and nutrient levels were analyzed using standard laboratory methods.

Data were analyzed using analysis of variance (ANOVA) to assess the effects of organic residue and AWD irrigation on rice yield, water productivity, and soil properties. LSD test was used to determine significant differences between treatment means ($p < 0.05$).

CF irrigation slightly increased grain yield compared to AWD with 61.71% of increased water usage. Moreover, Rice straw and legume straw incorporation with increased 9.67% and 6.7% of grain yield over RFD. Likewise, improved N, P, K and Ca uptakes were observed from CF irrigation, consecutively organic residue also increased nutrient uptake over RFD. Addition of organic residue improved % OC status. While, organic residue management increased nutrient status compared to AWD in CF.

Effect of different weed control methods on rice production

Since the beginning of agriculture up to the Second World War, weed management was based on preventive strategies, through appropriate agronomic practice capable of minimizing the need for subsequent curative measures of crop protection by weed interference. These historical cropping systems, today referred to as "sustainable" is an increasingly requirement to minimize the use of herbicides. Unfortunately, this agronomic simplification, which evolved in the post-war period during the so-called "green revolution" has made the crop protection more vulnerable by the dominance of more aggressive weed species. This is where farmers are highly relying on herbicides which leads to environmental hazards. Stale seedbeds can help reduce the reliance on herbicides for weed control. By eliminating young weeds before planting, farmers can reduce the need for chemical weed control methods, which can be costly and have environmental impacts. That's why a study was carried out to investigate the impact of different methods of weed control on rice yield and benefit-cost ratio (BCR).

The experiment was conducted during aman season of 2022/23 in BINA sub-station, Chapainawabganj field. The experiment involved three treatment groups: herbicide application, stale seed bed (SSB) technique, and a control with no additional interventions. Each treatment was applied to separate plots within a randomized complete block design to minimize bias and maximize statistical power.

Following the completion of the study, the analysis of yield data revealed that the herbicide treatment exhibited the highest crop yield compared to both the stale seed bed and control groups. The herbicide treatment significantly enhanced crop productivity, resulting in increased yield quantities but stale seed bed technique treatment also had good BCR. The findings of this study highlight the potential of herbicide application as an effective agronomic practice for optimizing crop yield in larger enterprises and stale seedbed technique can be implemented in smaller productions. It is exhibited that using herbicide will be more profitable as the mean BCR is 0.45 which is higher than BCR of stale seed bed technique (0.34), though for smaller area stale seed bed technique can be a better option considering the environmental aspects.

Determining optimum water use by BINAdhan-17 using BRRI dhan-71 as check.

Environmental stresses constrain rice production, affecting about 30% of the 700 million poor in Asia alone who live in rainfed rice-growing areas. These stresses can be caused by extreme climatic changes like drought, flooding, or rising sea levels. IRRI aim to develop rice types that can survive in these harsh environments (IRRI). To get valuable information for the breeders about water requirement of different rice varieties of BINA, a study was carried out to determine the precise water use by Binadhan-17 in comparison with BRRI dhan71.

The experiment was conducted during aman season of 2022/23 in BINA sub-station Chapainawabganj field. The experiment involved two factors: Factor A: Variety: (1) BRRI dhan71; (2) Binadhan-17; Factor B: Irrigation: (1) Continuous flooding; (2) Alternate wetting and drying. Each treatment combination was applied to separate plots within a randomized complete block design to minimize bias and maximize statistical power.

Assessing the experiment results, Binadhan-17 emerged as the superior performer. It exhibited the highest yield (5046.67 ha^{-1} and 5286 kg ha^{-1}) while simultaneously demonstrating the lowest water requirements in both Continuous Flooding (CF) (3270 L kg^{-1}) and Alternate Wetting and Drying (AWD) (3050 L kg^{-1}) treatments respectively. BRRI dhan-71 performed statistically on par with Binadhan-17 only in terms of yields but was inferior in terms of water use.