BWMRI RESEARCH PROGRAM 2019-20

Programme Leader:

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CONTENTS

Scientists of Bangladesh Wheat and Maize Research Institute (BWMRI)

Research Station	Name of the Scientists	Designation	Discipline/Division
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	2 Dr. Md. Abdul Awal	CSO	Agril. Economic
	3 Dr. Md. Abu Zaman Sarker	CSO	Agronomy
	4 Dr. Md. Bodruzzaman	CSO	Soil Science
	5 Md. Mostafa Ali Reza	PSO	Pathology
	6 Dr. Md. Alamgir Miah	PSO	Breeding (Maize)
	7 Dr. Md. Abdul Hakim	SSO	Breeding
	8 Dr. Md. MahfuzBazzaz	SSO	Agronomy
	9 Dr. Md. Muzahid-E-Rahman	SSO	Pathology
	10 Dr. Akbar Hossain	SSO	Agronomy
	11 Mst. Masuma Akhter	SSO	Agronomy
	12 Kishowar-E-Mustarin	SSO	Pathology
	13 Dr. MM Rahman Shah	SSO	Entomology
	14 Dr. Md. Zaherul Islam	SSO	Breeding (Deputed to Japan)
	15 Dr. MSN Mandal	SO	Breeding (Deputed to China)
	16 Dr. MR Kabir	SO	Breeding
	17 Dr. MA Alam	SO	Breeding
	18 Md. Monwar Hossain	SO	Breeding
	19 Md. NurAlam	SO	Agronomy
	20 Asgar Ahmed	SO	Breeding (Maize)
	21 Md. Farhad	SO	Breeding (Deputed to India)
	22 Sariful bin Ekram	SO	Agril. Engineering
	23 Krishna Kanta Roy	SO	Pathology
	24 Rokshana Begum	RA	CRP/ACIAR WB project
	25 Tonusree Roy	RA	CRP/ACIAR WB project
	26 Farjana Bashar	RA	KGF WB project
BWMRIJessore	1 Rabiul Islam	SSO	Breeding
	2. Md. Babul Anower	SO	Pathology
BWMRIJamalpur	1 Dr. Md.Mosharraf Hossain	PSO	Pathology
	2 Md. Mokhlesur Rahman	SSO	Breeding
BWMRI Rajshahi	1 Dr. Md. Illias Hossain	PSO (In-charge)	Agronomy
	2 Dr. Md. Abdullah-Al-Mamun	SSO	Breeding
	3 Dr. AbulAwlad Khan	SO	Breeding
	4 Md. MahbuburRahman	SO	Breeding
	5 S M MahbubulAlam	SO	Soil Science
	6 Md. Zakir Hossain	SO	Agril. Engineering
	7 Mrs. Yasmin Abida	SO	Breeding
BWMRI Joydebpur	1 Dr. GolamFaruq	PSO (In-charge)	Breeding
	2 Md. Mahbubur Rahman	SSO	Breeding
	3 Dr. Md. Mustafa Khan	SO	Agronomy
	4 Md.MahmudulHasan	SO	Breeding
	5 Dr. Nazma Akhter	SO	Agronomy
	6 Most. BilkisBanu	SO	Soil Science
	7 TaslimaJahan	SO	Entomology
	8 Md.Farhad Amin	SO	Breeding
	9 Dr. KhokanKumerSarker	SO	Agril. Engineering
	10 Mohammad Ahsan Ali	FS	Agronomy

Scientific Staff of Bangladesh Wheat and Maize Research Institute (BWMRI)

Research Station	Name of the Scientific staff	Designation
BWMRIDinajpur	Md. Jahan Uddin Chowdhury	Senior Scientific Assistant
	Md. Moniruzzaman	Senior Scientific Assistant
	Md. Kamal Mahamud Sharif	Scientific Assistant
	Md. Anowar Hossain	Scientific Assistant
	Md. Badsha Mia	Scientific Assistant
	Md. Latifur Rahman	Scientific Assistant
	Md. Zillur Rahman	Scientific Assistant
	Md. Arifur Rahman Rubel	Scientific Assistant
	Md. Soriful Islam	Scientific Assistant
	Md. Salamun	Research Assistant
	Md. RokunuzzamanSarker	Research Assistant
	Faruk Hossain	Research Assistant
	Md. Abdul Awal	Laboratory Attendant
	Md. Mamunur Rashid	Laboratory Attendant
	SoponKumer Ray	Laboratory Attendant
	SukamolChandro Ray	Laboratory Attendant
BWMRIJessore	Md. Kamal Hossain	Scientific Assistant
	Swapon Roy	Scientific Assistant
	Md. Alamin	Research Assistant
	Md. Monjurul Islam	Research Assistant
	MrsAnawara Begum	Research Assistant
	Mrs. Nulufar Yasmin	Research Assistant
	Md. Shamser Ali	Laboratory Attendant
BWMRI Jamalpur	Sayeda Akhter Sunny	Scientific Assistant
RARS, Ishurdi	Md. Anwarul Islam	Scientific Assistant
BWMRIRajshahi	Md. Mozahar Ali Mollah	Senior Scientific Assistant
	Sheikh Md. Fazlur Rahman	Senior Scientific Assistant
BWMRIJoydebpur	MstParul Begum	Scientific Assistant

GENERAL INSTRUCTIONS FOR CONDUCTING WHEAT EXPERIMENTS

Fertilizer Rates:

All irrigated and non-irrigated experiments will be fertilized at the rate of 100:26.50:20:5:1 kg/ha of N P K S Zn B and 60:26.50:20:5:1 kg/ha N P K S Zn B, respectively, except in some low fertility trials.

Seed Rates:

All irrigated and non- irrigated experiments will be planted with 120 kg ha^{-1} (having 80% or above germination).

Seed Treatment:

Experimental seeds will be treated with Provax-200 @ 3g kg^{-1} seed at the time of preparing sets.

Weed Control:

Weed should be control at 25-30 DAS through one hand weeding or herbicide (Affinity@ 25 g powder with 10 liters water for 5 decimal areas). For herbicide, spray should be uniform to protect plant injury.

Seeding Time:

The experiments earmarked for optimum (timely sown) and late seeding (late sown) will be followed as November 20-30 and December 25-30, respectively.

Irrigations:

Normally, for irrigated experiments, there will be three irritations at CRI, heading and grain filling stage. One or two extra irritations may be required in sandy soil.

Inoculations:

All segregating populations, screening nurseries and trials will be surrounded by border rows with mixture of varieties susceptible to leaf rust and leaf blight diseases. These border rows will be inoculated by leaf rust/*Bipolaris* spores for creating artificial infection once in a week starting from three weeks after sowing until primary infection is observed.

DATA RECORDING:

Observations needed for wheat breeding experiments have been described hereunder. Data on all the parameters are not required for all the experiments.

Plants/m^2: Plant count after germination at Zadok's GS 14 will determine the seedling and crop establishment. Plant count should be made for number of plants in 1m from each of 5 middle rows in case of yield trials (= plants/m^2) and in 0.33 m from each of 3 rows in case of screening nurseries (plants x 5 = plants /m^2). Counting should be made diagonally of the plot.

Ground cover: Estimate visually the percentage of the soil that is covered by green biomass in each plot, when viewing plots down the rows at an angle of 45 ^{0} to the vertical. Percent ground cover is generally practiced at Zadok's Growth Stage 15 (5 leaf stage) and Growth Stage 65 (at 50% anthesis).

Days to 50% flag leaf emergence (Zadok's 35): Number of days when 50% of the flag leaf ligule is just visible.

Days to heading: Number of days from sowing to the day when base of the 50% of the spikes just come out from the flag leaf sheath.

Days to anthesis: Number of days from sowing to when 50% of the spikes have extruded some anther (Zadok's GS 65).

Visual sterility: Percent of florets remained open for several days after anthesis (whole plot basis). A visual estimate records as 0, 5, 10, 20, 30, 40, 50, 60, 70, 80, and maximum 90%. Plots with no sterility will be 0%.

Bipolaris leaf blight: Leaf blight scoring should be done thrice (unless otherwise mention), at Zadok's growth stage 69-71, 73-75 and 77-83 following double-digit (00-99) scale (CIMMYT pictorial guide).

Leaf rust: Leaf rust scoring should be done thrice (unless otherwise mention), at Zadok's growth stage 69-71, 73-75 and 77-83 following modified Cobb's scale (CIMMYT pictorial guide).

Lodging score: Lodging score will be taken at physiological maturity in percentage on whole plot basis (% plants lodged).

Plant height: Grasp a clump of spikes and measure the distance in cm from the ground to the top most representative spikes (excluding the awn).

Days to maturity: The number of days from seeding to physiological maturity on whole plot basis (Loss of green color from 50% of the ear-bearing culms of a plot).

Spikes/m^2: Count the number of developed and underdeveloped spikes in 5 samples of 1m row in case of yield trials (= spikes/m^2) and 3 samples of 0.33m row in case of screening nurseries (No. of spikes x 5 = spikes/m^2). Counting should be done diagonally at physiological maturity to avoid damage of plants due to walking inside plot.

Spikelets/spike: Mean spikelets of the 10 randomly selected spikes. In general, two underdeveloped basal spikelets and one terminal spikelet of each spike are to be excluded.

Grains/spike: After counting the spikelets of the 10 randomly selected spikes, thresh all 10 spikes and count all the grains of those spikes and divide by ten.

Grain set: Fertility of the spike will be measured by grain set per spikelet. To isolate a sterile floret from pollination by air borne pollens, 10 spikes will be bagged using emasculation bag just after heading and before anthesis to avoid out crossing.

$$\text{Grain set} = \frac{\text{Mean grains/spike}}{\text{Mean spikelets/spike}}$$

Biomass: Cut the plants at ground level at maturity. Dry the plants in the sun for 4 to 5 days. Take the total weight in grams/kilograms of the plants before threshing and record the dry seed weight after threshing to calculate harvest index. In case of green samples oven drying is required.

Harvest Index: Calculate from total biomass and grain yield as follows:

$$\text{Harvest index (\%)} = \frac{\text{Weight of grains}}{\text{Total weight (Biomass)}} \text{ X } 100$$

Yield Adjustment at Standard Moisture: Adjusted yield at expected moisture percent is

$$Yadj = Y_{AC} \text{ X } \frac{(100 - M_{AC})}{(100 - M_{ST})}$$

Where,Yadj= Adjusted yield,Y_{AC}= Yield at actual moisture percent, M_{AC}= Actual moisture percent; M_{ST} = Standard moisture percent

BREEDING METHODOLOGY OF BWMRI

Year	Location	Filial Generation	Selection System
1st year	Din, Jes, Jam, Raj and Joy	Hybridization	Four hundred crosses (200 single, 150 Top and 50 limited back) crosses will be made for major objectives in all locations
2nd year	Din, Jes, Jam, Raj and Joy	F_1	All types of F_1s are to be grown in 2.5m 2 rows in respective stations. All types of F_1s will be space seeded. At least 50 selected spikes from single cross progeny will be harvested in bulk With some negative selection at least 30 spikes from selected plants of top and back cross progeny will be harvested in bulk (**Selected bulk**).
3rd year	Din, Jes, Jam, Raj and Joy	F_2	F_2 is to be space planted in 10m 6 row plots in respective stations. Spikes from around 50 selected plants of selected population will be harvested in bulk (**Selected bulk**). Keep remaining seeds after seeding as remnant.
4th year	Din, Jes, Jam and Joy	F_3	F_3 is to be solid seeded in 5 m 6 rows. Spikes from 30 selected plants of selected family will be harvested in bulk (**Selected bulk**).
5th year	Din, Jes, Jam and Joy	F_4	F_4 is to be solid seeded in 5m 6 row plots at respective stations. Spikes from 30 selected plants of selected family will be harvested in bulk (**Selected bulk**).
6th year	Din, Jes, Jam and Joy	F_5	F_5 is to be space planted in 10m 6 row plots and grow crop with high management (OM + 120kg N/ha). Around 10 plants selected, harvested and thresh individually (around 200 seeds/plant will be obtained) and preserve separately for F_6 (**Pedigree method**).
7th year	Din, Jes, Jam and Joy	F_6	F_6 is to be grown in 2.5m long 4 row plots under high management (OM + 120kg N/ha). Bulk selected whole plots; around 800g seeds will be obtained which will be enough for screening in BWSN next year. All stations will send their seeds to Dinajpur for preparing BWSN sets.
8th year	On-station Multi Loc.	BWSN (F7)	Multi location(3 sites) yield and adaptability testing
9th year	On-station Multi Loc.	PYT (F_8)	Multi location (4 sites) yield and adaptability testing
10th year	On-station Multi Loc.	AYT (F_9)	Multi location yield and adaptability testing + DUS testing
11th year	On-farm and On-station Multi Loc.	OFT (F_{10})	Multi location yield, adaptability and DUS testing at on-station and farmers' field for evaluation by technical committee of SCA/NSB

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VARIETY RELEASE

PROGRAMME: WHEAT IMPROVEMENT

Wheat is the second important cereal crop next to rice in Bangladesh. Wheat has some advantages in its cultivation compared to Boro and other winter crops i.e. less water requirement, echo-friendly, high nutritional value, diversified use, etc. Consumption growth rate of wheat is increasing at the rate of 13% in recent years due to rapid changing of dietary habit and diversified use. Present wheat production is about 1.15 million ton against the annual demand of about 7.0 million ton. The wheat productivity has been increasing in recent years due to adoption of new varieties and recommended production technologies by the farmers and reached to 3.49 t/ha in 2018-19. To meet up the demand of wheat for the growing population of the country, the present national yield level needs to be further raised and subsequently be sustained in the rice-wheat system. The current yield level can be scaled up by eliminating production problems encountered by the farmers. Emphasis has been given to diversify high yielding heat tolerant and disease resistant varieties at farmers' level. Development of bio-fortified wheat variety enriched with Zn and Fe content has also been due emphasized in the programme. Majority of wheat in Bangladesh is sown after rice and many production problems such as late seeding, formation of plough pan due to puddling in transplanted rice, water logging, low organic matter content, boron deficiency and soil acidity, foliar diseases, etc. which affect wheat production. Special research programmes have been undertaken to combat the future threat of wheat blast disease. There is scope to expand wheat production in non-traditional areas of Bangladesh like coastal region, drought prone areas of Rajshahi, Charland, etc. by adopting suitable varieties and production technologies. Current wheat improvement program is undertaken to achieve the national goal by developing high yielding varieties for specific problem areas, appropriate crop and soil management strategies including efficient use of water and other inputs. Introduction and adoption of appropriate machinery like seeder, reaper and thresher at farm level is also emphasized. Priority has also been given to technology transfer activities through variety and block demonstrations, farmers' training, workshops, publications of booklets, folders etc.

A. NATIONAL AND INTERNATIONAL PROGRAMME

PROJECT 1: VARIETY DEVELOPMENT

The project is aimed to develop high yield potential heat and disease resistant/tolerant varieties for different growing environments. Research in this area is based on two major growing environments: irrigated timely sown (ITS-November 20-25) and irrigated late sown (ILS-December 20-25) conditions. Moreover, research programme has also been taken to develop varieties for specific problem areas like sterility, soil salinity, char areas, drought (Barind area). Participatory variety selection (PVS) at farmers' field is another approach where BARI has given research priority. Limited research work on Durum and Triticale is also duly undertaken. Overall modern approach of variety development programme has been undertaken to develop appropriate varieties with higher yield potential, wide and specific adaption and resistant to major wheat diseases. Collaborative programs with International and Regional institutions are being maintained through germplasm exchange, training, visits and personal communication.

SUB-PROJECT 1.1: DEVELOPMENT OF HIGH YIELD POTENTIAL VARIETY

Short maturing wheat variety with high yield potential can be well fitted under the rice-wheat cropping system of Bangladesh. About 80% of wheat in our country is grown under rice-wheat rotation. The objective of this sub-project is to develop a variety with high yield potential, terminal heat tolerance, lodging resistance and resistance/tolerance to foliar diseases to make wheat production more profitable. In future, the area under timely sown condition could be expanded by introducing early maturing T. Aman varieties and appropriate planting and harvesting machinery.

Expt 1.1.1: Hybridization

Objective(s)	**:**	Transfer desirable traits from donor parents to the recipient parent with good agronomic background targeting to develop high yield potential, disease resistant variety with wide adaptation
Rationale	**:**	Hybridization is highly important for creating genetic variability by recombining/transferring desirable genes from different sources and for selecting expected genotypes. Parental lines included in the hybridization program are from different sources having diversified gene combinations. Crossing between selected parents with desirable traits will generate new combination of genes in segregating filial generations. Thus variability will be created which ultimately help making selection of desirable genotypes.
Methods and methods	**:**	Diverse parental wheat lines will be grown at 5 different stations. To facilitate synchronization of flowering the whole set will be seeded thrice on a 7-10 days interval starting from around 15 Nov. Ten to fifteen heads will be emasculated in female parent and pollinated for each single cross and 5 heads for top and limited backcrosses. Crop management practices will be as per recommendation of BWMRI.
Crop/variety	**:**	One hundred and twenty wheat lines arranged in 11 groups (High yielding wheat varieties- 13, Early maturing varieties-11, BpLB tolerant varieties-15, Rust resistant varieties-16, Short height varieties-14, High biomass and high harvest index genotypes-4; Varieties with more grains/spike-5, Varieties with excellent grain filling under late seeding-7, Genotypes with good bread making quality-4,Sterility tolerant genotypes-6, Miscellaneous varieties for further observation-25)
Design	**:**	Non-replicated
Treatment	**:**	Genotype
i. Replication	**:**	Non-replicated
ii. Plot size	**:**	2.5m long X 3 rows
Planting system/ spacing	**:**	Space seeding Row to row distance 30 cm Entry to entry distance 60 cm
Fertilizer dose and methods of application	**:**	The crop will be fertilized with organic manure @ 10ton/ha with NPKS and B @ 120, 26, 50, 20 and 2.5 kg ha^{-1} respectively to ensure proper growth and development. The elements N, P, K, S and B will be applied in the form of Urea, Triple Super Phosphate, Muriate of Potash, Gypsum and Boric acid respectively. Two-third of urea and the entire quantity of other fertilizers will be applied at final land preparation.
Irrigated/rainfed	**:**	Irrigated
Data to be recorded	**:**	Data will be recorded on days to heading, anthesis and maturity; plant height, disease reaction, spike sterility etc. in the parental population for evaluation
Investigators	**:**	MA Hakim, MA Alam, MSN Mandal, MM Hossain, MZ Islam — Dinajpur G Faruq, MM Rahman, MM Hasan, MF Amin — Joydebpur MM Rahman — Jamalpur

Season : Rabi 2019-20

Date of Initiation : 15 November 2019

Date of completion : April 2020

Exp. output/benefit : F_1 plants with desirable gene recombination will be generated

Locations :

Cross	Din	Joy	Jam	Total
Single cross	300	150	60	510
Top cross	30	30	25	85
Back cross	30	20	15	65
Total	360	200	100	660

Status : On-going

Estimated cost :

Location	Land area (m^2)	Cost (Tk.)
BWMRI, Dinajpur	3500	150,000/-
BWMRI, Joydebpur	2500	100,000/-
RARS, Jamalpur	2000	50,000/-
Total	16000	3,00,000/-

Source of Fund : BWMRI, DINAJPUR

Priority : 1

Expt 1.1.2: Confirmation of single and top crosses

Objective(s) :
1. Confirming hybrids derived from crosses between two different parents
2. Generation of F_2 seeds and making top and back crosses utilizing F_1 plants

Rationale : Confirmation in the F_1 hybrids ensures crossing between different parental combinations. Comparing them with their female parents helps to identify if there is any mistake in making crosses and avoid mistake of potential crosses. Confirmed F_1 hybrids are also needed in making top and backcrosses too. Confirmation in F_1 is important step of breeding program which saves time, resource and labor.

Methods and methods : Seven hundred thirty two (601 single, 53 top and 78 limited backcross) F_1s will be evaluated in 2019-20 in respective stations. Two rows of female parent will be grown at the beginning of each set of single cross to compare with the hybrids for confirmation of the crosses. Around 50 spikes from single cross progeny and 30 from top and back cross progeny of selected plants will be harvested in bulk (Selected bulk method)for growing in F_2 generation. Crop management practices will be as per recommendation of BWMRI.

Crop/variety : Wheat

Design : Non replicated

i. Treatment : 557 F_{1s} of wheat

ii. Replication : Non replicated

Plot size	**:**	2.5m long X 2 rows
Planting system/ spacing	**:**	Space seeding Row to row distance 20 cm Entry to entry distance 60 cm
Fertilizer dose and methods of application	**:**	As per BARC recommendations
Irrigated/rainfed	**:**	Irrigated
Data to be recorded	**:**	Data will be recorded on days to heading, anthesis and maturity; plant height, disease reaction, spike sterility etc. in the parental population for evaluation.
Investigators	**:**	MA Hakim, MA Alam, MR Kabir, MSN Mandal, MM Hossain, Dinajpur G. Faruq, MM Rahman, MM Hasan, MF Amin Joydebpur MM Rahman Jamalpur
Season	**:**	Rabi 2019-20
Date of Initiation	**:**	November 2019
Date of completion	**:**	April 2020
Exp. output/benefit	**:**	F_2 seeds with desirable gene recombination
Locations	**:**	Cross Single 439 Top 35 Limited back 31 Total 545
Status	**:**	On-going
Estimated Cost	**:**	Tk.2,00,000/- (Din -100,000/-, Joy-70,000/- and Jamalpur-30,000/-)
Source of Fund	**:**	BWMRI, DINAJPUR
Priority	**:**	1

Plan/Expt 1.1.3: Selection in F_2 to F_6 generations

Objective(s)	**:**	1. Ensuring fixation of desirable additive genes in the advancing filial generations 2. Select desirable families/individual plants in each filial generation following selected bulk method 3. Reaching homozygosity/stability after hybridization
Rationale	**:**	Advancing F_2 - F_6 Generations generate a huge number of variable plants. Most of them don't possess desirable traits combinations. Selection in F_2 - F_6 generation is necessary to discard undesirable plants/crosses which don't have potentiality for improvement. Selection of desirable cross and single plant/head from advancing generations reduces the cost saving time, land and labor. It helps in fixation of desirable genes and finding good potential genotypes.

Materials and methods :

F_2: 542 F_2 populations derived from single, top and backcrosses will be grown. Desirable families will be selected at the beginning and then individual plants within selected families will be tagged on the basis of their field performance. About 30-50 spikes from selected plants will be harvested and threshed in bulk. At least 2000 (about 100g) bulked seeds will be collected from the selected individual 50 spikes. Thirty gram bulked seeds (around 600) will be grown next year in F_3. Remaining seeds will be kept as remnant

F_3: 329 selected F_2 populations will be grown as F_3. 30 spikes will be harvested from selected individual plants from the selected populations at each location. Selected spikes will be threshed in bulk. Around 1200 seeds (60g) will be collected from 30 spikes of which 30g (about 600 seeds) will be used for growing F_4 next near.

F_4 : 226 selected F_3 populations will be grown as F_4. Around 30 spikes will be harvested from selected individual plants from the selected populations at each location. Selected spikes will be threshed in bulk. Around 1200 seeds (60g) will be collected from 30 spikes of which 30g (about 600 seeds) will be used for growing F_5 next near.

F_5 : 184F_4 populations will be grown as F_5. Around 10 vigorous plants (10 sisters) with at least 5 fertile spikes/plants will be selected from each selected population. Each plant will be threshed separately and seeds will be preserved individually (Pedigree method). Minimum 200 seeds will be found from each plant which will be used for growing in F_6 next year.

F_6: 1490Single plant populations selected from 146 (Din-23, Joy-13, Jes-17, Raj-22 and Jam-71) F_5 families will be grown as F_6. A total of 500 populations from selected individual plants will be grown. The plant progeny row plots will be selected based on heading, plant height, tillering, disease and sterility tolerance, yielding ability etc. Rouging, if needed, will be done in selected plots only. Selected whole plots will be harvested. About 800g seeds per plot will be collected (considering yield of 4 t/ha) which will be enough for experiments and testing in BWSN in next year.

Crop/variety : F_2 - F_6 populations of wheat

Design : Non replicated

Treatment : Segregating populations of wheat

Replication : Single

Irrigated/rainfed : Irrigated

Fertilizer dose and methods of application : As per BARC recommendations

Plot size :

Generation	F_2	F_3	F_4	F_5	F_6
Plot	20mX6 r	10mX6 r	10mX6 r	20mX6 r	2.5mX4 r

Planting system/ spacing :

Row to row	30cm	20cm	20cm	20cm	20cm
Entry to entry	60cm	60cm	60cm	60cm	60cm
Seeding	Space	Space	Space	Space	Space
Seed rate (kg ha^{-1})	25	25	25	25	30

Data to be recorded : Data will be recorded on days to heading, anthesis and maturity; plant height, disease reaction, spike sterility etc. in the parental population

for evaluation.

Investigators : MA Hakim, MA Alam, MSN Mandal, MM Hossain, MZ Islam, MR Kabir — Dinajpur
MM Rahman, MM Hasan, MF Amin, G Faruq — Joydebpur
MM Rahman — Jamalpur
MAA Khan, MM Rahman, MA Al Mamun, Y Abida — Rajshahi
MR Islam, and MR Kabir — Jashore

Season : Rabi 2019-20

Date of Initiation : November 2019

Date of completion : April 2020

Exp. Output/Benefit : Desirable genotypes for subsequent generations

Locations : Number of populations (Checks to be included)

Generation	Dinajpur	Joydebpur	Jashore	Jamalpur	Rajshahi
F2	332	151	-	59	-
F3	119	119	-	68	23
F4	54	38	55	47	32
F5	24	28	28	72	32
F6	23	13	17	71	22

Status : On-going

Estimated Cost :

Location	Land area (m^2)	Cost (Tk.)
Dinajpur	15,000	4,50,000/-
Joydebpur	10,000	3,00,000/-
Jashore	5,000	1,50,000/-
Jamalpur	10,000	1,50,000/-
Rajshahi	5,000	1,50,000/-
Total	40,000	12,00,000/-

Source of Fund : BWMRI, DINAJPUR

Priority : 1

Plan/Expt 1.1.4: Germplasm maintenance

Objective(s)

1. Evaluating lines from different national and international sources
2. Maintaining promising lines and preserve for future use

Rationale : A large number of genotypes are usually included in different nurseries and trials. Most of them could not fulfill the present selection criteria and thus fail to get promotion. Many of these (unselected lines) might have some good potential genes. Throwing all such lines into garbage may result in loss of valuable genetic resources. Evaluation and preservation of these genotypes is highly important for future use.

Materials and methods : About 400 potential germplasm collected from foreign sources and the materials not selected from different trials but possesses special features will be included in this nursery. Each entry will be grown in 2.5m long 3 rows with row spacing of 20cm keeping 40cm space between entries.

Crop management practices will be as per recommendation of BWMRI.

Crop/variety	:	Wheat germplasm
Design	:	Non replicated
Treatment	:	Genotype
Replication	:	Non- replicated
Plot size	:	2.5m long X 3 rows
Planting system/ spacing	:	Solid seeding Row to row distance 20 cm Entry to entry distance 40 cm
Fertilizer dose and methods of application	:	As per BARC recommendations
Irrigated/rainfed	:	Irrigated
Data to be recorded	:	Data will be recorded on days to heading and maturity, plant height, disease reaction, visual sterility, 1000-grain weight, physical grain characteristics, grain yield etc.
Investigators	:	MM Hossain, MR Kabir and MSN Mandal
Season	:	Rabi 2019-20
Date of Initiation	:	On-going
Exp. Output/Benefit	:	Preserved genotypes will be used in future for specific purpose.
Locations	:	Dinajpur
Status	:	Started from the beginning of BWMRI
Estimated Cost	:	Tk. 50,000/-
Source of Fund	:	BWMRI, DINAJPUR
Priority	:	1

Plan/Expt. 1.1.5: Bangladesh wheat screening nursery, Set I (BWSN-I)

Objective(s)	:	1. To Evaluating all selected advanced lines from national crossing programme for high yield potential with biotic and abiotic stress tolerance 2. Selecting promising lines for evaluation in preliminary yield trial
Rationale	:	A large number of genotypes are usually selected from different national and international nurseries and trials every year. Handling large number genotypes in yield trials is difficult. So, before yield trials the less important lines are to be discarded. All such selected genotypes is being included in this nursery. Under high selection pressure only the promising lines are selected and promoted for yield testing.
Materials and methods	:	Seventy lines selected from F6 generation 2018-19 along with BARI Gom 30 and BARI Gom 32 as check will be tested in this nursery. On the basis of yield and yield contributing traits, phenology, disease reaction, agronomic score; seed shape, size and quality promising entries will be selected for next evaluation. Crop management practices will be as per recommendation of BARI.
Crop/variety	:	Selected wheat lines

Design	:	8 X 9 Alpha-lattice
Treatment	:	72 developed wheat genotypes/lines
Replication	:	2
Plot size	:	2.5m long X 6 rows
Planting system/ spacing	:	Solid seeding Row to row distance 20 cm Entry to entry distance 40 cm
Fertilizer dose and methods of application	:	As per BARC recommendations
Irrigated/rainfed	:	Irrigated
Data to be recorded		Data will be recorded on days to heading and maturity, plant height, disease reaction, visual sterility, CTD and SPAD reading, 1000-grain weight, physical grain characteristics and grain yield etc. will be recorded.
Investigators	:	MA Alam, MM Hossain, MA Hakim — Dinajpur MM Hasan, MM Rahman, MF Amin, MG Faruq — Joydebpur MR Kabir, and MR Islam — Jashore
Season	:	Rabi 2019-20
Date of Initiation	:	Irrigated timely seeding (ITS)- 20-24 Nov, 2019 and Irrigated late seeding (ILS)- 20-22 Dec, 2019
Date of Completion		April 2020
Exp. Output/Benefit	:	Promising genotypes will be selected for evaluation in PYT
Locations	:	Dinajpur (SM + Exp), Jashore and Joydebpur
Status	:	1st year
Estimated Cost	:	Tk. 2,00,000/- (Tk. 50,000/- for each location and 50,000/ for SM)
Source of Fund	:	BWMRI, Dinajpur
Priority	:	1

Plan/Expt 1.1.6: Bangladesh wheat screening nursery, Set II (BWSN-II)

Objective(s)	:	1. Evaluating all selected genotypes/lines from different national and international nurseries for high yield potential 2. Selecting promising lines for evaluation in preliminary yield trial
Rationale	:	A large number of genotypes are usually selected from different national and international nurseries and trials every year. Handling large number genotypes in yield trials is difficult. So, before yield trials the less important lines are to be discarded. All such selected genotypes is being included in this nursery. Under high selection pressure only the promising lines are selected and promoted for yield testing.
Materials and Methods	:	Seventy advance lines selected from ESWYT, IBWSN, SATYN, HTWYT, SATYT, WYCYT, and SAWYT of 2018-19 along with BARI Gom 21 and BARI Gom 32 as check will be tested. Based on yield and yield contributing traits, phenology, disease reaction, agronomic score; seed shape, size and quality promising entries will be selected for next evaluation. Crop management practices will be as per recommendation of

BARI.

Crop/variety	:	Selected wheat lines
Design	:	8 X 9 Alpha-lattice
Treatment	:	72 developed /selected wheat genotypes/lines
Replication	:	2
Plot size	:	2.5m long X 6 rows
Planting system/ spacing	:	Solid seeding Row to row distance 20 cm Entry to entry distance 40 cm
Fertilizer dose and methods of application	:	As per BARC recommendations
Irrigated/rainfed	:	Irrigated
Data to be recorded		Data will be recorded on days to heading and maturity, plant height, disease reaction, visual sterility, CTD and SPAD reading, 1000-grain weight, physical grain characteristics and grain yield etc. will be recorded.
Investigators	:	MA Hakim, MSN Mandal, MM Hossain, MA Alam Dinajpur MM Rahman Jamalpur A Yasmin, MAA Khan, MAA Mamun, and MM Rahman Rajshahi
Season	:	Rabi 2019-20
Date of Initiation	:	Irrigated timely seeding (ITS)- 20-24 Nov, 2019 and Irrigated late seeding (ILS)- 20-22 Dec, 2019
Date of Completion		April 2020
Exp. Output/Benefit	:	Promising genotypes will be selected for evaluation in Preliminary Yield Trial
Locations	:	Dinajpur (SM + Exp), Jamalpur, and Rajshahi
Status	:	1st year
Estimated Cost	:	Tk. 2,00,000/- (Tk. 50,000/- for each location and 50,000/ for SM)
Source of Fund	:	BWMRI, DINAJPUR
Priority	:	1

Plan/Expt 1.1.7: Preliminary yield trial (PYT)

Objective(s)	:	1. Evaluating yield potential of the promising lines selected from BWSN under different agro climatic conditions 2. Selecting promising lines for Advance Yield Trial
Rationale	:	Best lines from different nurseries may not have the ability to perform well under different environments. Before testing genotypes in Advance Yield Trial over locations the selected promising genotypes which have been selected from BWSN are usually tested in Preliminary Yield Trial (PYT) in different agro climatic conditions. PYT is important to study the adaptation and resistance against biotic and abiotic stresses of the promising lines over locations.
Materials and Methods	:	Thirty advance lines selected from BWSN Set-I, Set- II and 3rdZnWYT of 2018-19 along with three check varieties Shatabdi, BARI Gom 30 and

BARI Gom 32 will be tested in this trial in optimum and late seeding conditions. Promising lines will be selected on the basis of yield and yield contributing traits, phenology, disease reaction, agronomic score; seed shape, size and quality for next trial. Crop management practices will be as per recommendation of BWMRI.

Crop/variety : Selected wheat lines

Design : 5 X 6 Alpha-lattice

Treatment : 30 Promising wheat genotypes

Replication : 2

Plot size : 5m long X 8 rows

Planting system/ spacing : Solid seeding
Row to row distance 20 cm
Entry to entry distance 60 cm

Fertilizer dose and methods of application : As per BARC recommendations

Irrigated/rainfed : Irrigated

Data to be recorded Data will be recorded on days to heading and maturity, plant height, disease reaction, visual sterility, CTD and SPAD reading, 1000-grain weight, physical grain characteristics and grain yield etc.

Investigators : M A Alam, MM Hossain, MSN Mandal, MA Hakim, MM Rahman, Y Abida, MAA Khan, and MAA Mamun — Dinajpur, Rajshahi
MR Islam — Jashore

Season : Rabi 2019-20

Date of Initiation : Irrigated timely seeding (ITS)- 20-24 Nov, 2019 and
Irrigated late seeding (ILS)- 20-22 Dec, 2019

Date of Completion April 2020

Exp. Output/Benefit : Will help to select suitable genotypes for advance yield trial

Locations : Dinajpur (Exp + SM), Jashore and Rajshahi

Status : On-going

Estimated Cost : Tk. 1,50,000/- (Tk. 40,000/- for each set and 30,000/- for SM)

Source of Fund : BWMRI, DINAJPUR

Priority : 1

Plan/Expt 1.1.8: Advance yield trial (AYT)

Objective(s) :
1. Evaluating yield potential of the advance lines under different locations
2. Selecting promising lines for evaluation in Candidate Variety Demonstration

Rationale : Selected lines from PYT are promoted as advance lines every year. Before testing genotypes for evaluation over locations in farmers' fields the selected promising genotypes are usually further tested in Advance Yield Trials (AYT) in different agro climatic conditions to select high yielding, disease resistance/tolerant lines with stable performance under different environmental conditions.

Materials and methods : Eleven advance lines selected from PYT (2018-19) along with Shatabdi,

		BARI Gom 26 and BARI Gom 30 will be tested in this trial in optimum and late seeding conditions. Promising lines will be selected on the basis of yield and yield contributing traits, phenology, disease reaction, agronomic score; seed shape, size and quality for next trial. Crop management practices will be as per recommendation of BARI.	
Crop/variety	**:**	Selected wheat lines	
Design	**:**	RCBD	
Treatment	**:**	11 promising wheat genotypes and 3 checks	
Replication	**:**	3	
Plot size	**:**	5 m long X 8 rows	
Planting system/spacing	**:**	Solid seeding Row to row distance 20 cm Entry to entry distance 60 cm	
Fertilizer dose and methods of application	**:**	As per BARC recommendations	
Irrigated/rainfed	**:**	Irrigated	
Data to be recorded		Data will be recorded on days to heading, maturity, plant height, visual sterility, disease reactions, TGW, grain yield and visual grain quality etc. under optimum and late seeding conditions.	
Investigators	**:**	MR Kabir, MA Hakim, MA Alam and MM Hossain	Dinajpur
		G Faruq, MM Rahman, MF Amin	Joydebpur
		MM Rahman	Jamalpur
		MR Islam	Jashore
		MAA Mamun,Y Abida, MM Rahman and MAA Khan	Rajshahi
Season	**:**	Rabi 2019-20	
Date of Initiation	**:**	Irrigated timely seeding (ITS)- 20-25 Nov, 2019, Irrigated late seeding (ILS)- 20-25 Dec 2019 and	
Date of Completion		April 2020	
Exp. Output/Benefit	**:**	Will help to select suitable genotypes for candidate variety demonstration	
Locations	**:**	Dinajpur (Exp + SM), Joydebpur, Jashore, Jamalpur, and Rajshahi	
Status	**:**	On-going	
Estimated Cost	**:**	Tk. 5,00,000/- (Tk. 75,000/- for each set and 50,000/- for SM)	
Source of Fund	**:**	BWMRI, DINAJPUR	
Priority	**:**	1	

Plan/Expt 1.1.9: Candidate variety demonstration (CVD)

Objective(s)	:	1. Evaluating performances of the promising advance lines in large plots 2. Selecting candidate varieties for on farm and on station multi-location testing.
Rationale	:	This study is the last step for the breeders to evaluate a line before applying to NSB for release as a new variety. Candidate varieties need evaluation by the technical committee of NSB before release. So, the promising candidate varieties selected from AYT will be tested finally at research stations at different growing environments. This program also provides good amount of quality seed of the upcoming variety.
Materials and methods	:	Nine advanced lines selected from AYT (3) and CVD (3) of 2018-19 along with 2 check varieties Shatabdi and BARI Gom 26 will be tested under this trial at 2 locations. Selected line(s) will be released as new variety. Crop management practices will be as per recommendation of BWMRI.
Crop/variety	:	Shatabdi, BARI Gom 26 and 7 advanced lines
Design	:	Non-replicated
Treatment	:	Genotypes
Replication	:	Non-replicated
Plot size	:	5m long X 20 rows
Planting system/spacing	:	Solid seeding Row to row distance 20 cm Entry to entry distance 60 cm
Fertilizer dose and methods of application	:	As per BARC recommendations
Irrigated/rainfed	:	Irrigated
Data to be recorded	:	Data will be recorded on days to heading, days to maturity, plant height, disease reaction, spikes per sq. m, grains/spike, TGW, test wt. and grain yield.
Investigators	:	MA Hakim, MA Alam, MR Kabir, MM Hossain and MSN Mandal Dinajpur MR Islam Jashore
Season	:	Rabi 2019-20
Date of Initiation	:	Irrigated timely seeding (ITS)- 20-24 Nov 2019 and Irrigated late seeding (ILS)- 20-22 Dec 2019
Date of Completion	:	April 2020
Exp. Output/Benefit	:	Performance of the candidate varieties over location and environment will be known.
Locations Status	:	Dinajpur and Jashore
Status	:	On-going
Estimated Cost	:	Tk. 1,00,000/- (Tk. 30,000/- per location and 40,000 for SM)
Source of Fund	:	BWMRI, DINAJPUR
Priority	:	1

Plan/Expt 1.1.10: Distinctness, uniformity and stability (DUS) Test

Objective(s)	:	1. Studying the identifying characters of advance lines before release 2. Studying the uniformity and stability of the identifying characters 3. Establishing distinctness of the candidate varieties from the existing varieties with at least one character
Rationale	:	DUS test is a requirement of National Seed Board to release a variety. The candidate varieties must be proved to be distinct from the existing varieties by at least one character. This is also important to establish Breeder's right. So, DUS test of the promising candidate varieties will be performed for two years over locations to study the uniformity of the line and assess the stability in their performance under different environment and management practices.
Materials and methods	:	DUS test will be performed with 15 lines/varieties in collaboration with SCA. Two sets of experiments will be conducted at the experimental farm of BARI, Dinajpur and SCA, Joydebpur. Unit plot size: 5m x 6 rows, 2 sets at 15 days interval. Other management practices will be as per recommendation of BWMRI.
Crop/variety	:	Eight advanced lines and 7 varieties
Design	:	RCB
Treatment	:	15 wheat Genotypes/varieties
Replication	:	Non replicated
Plot size	:	5m X 6 rows
Planting system/spacing	:	Solid seeding Row to row distance 20 cm Entry to entry distance 60 cm
Fertilizer dose and methods of application	:	As per BARC recommendations
Irrigated/rainfed	:	Irrigated
Data to be recorded	:	Data to be recorded 29 morphological/botanical characters as per procedure and agreement with SCA
Investigators	:	MR Kabir, MA Alam, MM Hossain, MA Hakim — Dinajpur Respective personnel from SCA — Gazipur
Season	:	Rabi 2019-20
Date of Initiation	:	20-30 Nov 2019
Date of Completion	:	April 2020
Exp. Output/Benefit	:	Distinctness of the new variety will be established.
Locations	:	BWMRI Dinajpur and SCA, Gazipur
Status	:	On-going
Estimated Cost	:	Tk. 60,000/- (Tk. 20,000/- per location)
Source of Fund	:	BWMRI, DINAJPUR
Priority	:	1

Plan/Expt. 1.1.11: Adaptive trial with advance wheat lines at MLT sites

Objective(s) : 1. To see the yield of new wheat lines in comparison to the widely grown check variety in different agro-ecological zones.
2. Evaluate the advance lines by the field evaluation committee of the National Seed Board (NSB).

Rationale : It is necessary to know the performance of new wheat lines in different agro-ecological zones and to evaluate those by the members of field evaluation committee of NSB, under farmers' conditions before release as variety.

Materials and methods : The trial will be conducted at wheat growing 10 agricultural regions: Dinajpur, Rajshahi, Jashore, Mymensingh, Dhaka and Comilla One set will be grown at the BARI station of the respective region except Comilla and 1 set at farmers' fields. Seeds will be sown during 20-30 November. Recommended managements will be followed to raise the crop.

Crop/variety : BARI Gom 32, BAW 1147and BAW 1243

Design : RCB

Treatment : Varieties/Genotypes-03

Replication : 3

Plot size : 4m X 5m

Planting system/ spacing : Solid seeding
Row to row distance 20 cm
Entry to entry distance 60 cm

Fertilizer dose and methods of application : As per BARC recommendations

Irrigated/rainfed : Irrigated

Data to be recorded : Data will be recorded on days to heading and maturity, disease reactions, visual sterility (%), grains spike^{-1}, 1000 grain weight, visual grain characteristics, grain yield (from 1m x 1m of 5 samples = 5 m^2), etc.

Investigators :

MA Alam, MM Hossain, MA Hakim,	Dinajpur
MG Faruq, MM Rahman, MM Hasan andMF Amin	Joydebpur
M M Rahman and MM Hossain	Jamalpur
MR Islam and MB Anwar	Jashore
MM Rahman, Y Abida, MAA Khan, MAA Mamun and KH Alam	Rajshahi
Respective OFRD scientist	Tangail

Season : 2019-2020

Date of Initiation : 20-30 Nov. 2019

Date of Completion : April 2020

Exp. Output/Benefit : Selection of appropriate line(s) for release as variety through testing in farmers' fields under wide ranges of environments will be more adaptable and give more yields. These varieties will help increase wheat yields and production in the country.

Locations :

District	Research Station	Farmer's field	Total trial
Dinajpur	1	1	2
Rajshahi	1	1	2
Jashore	1	1	2
Jamalpur	1	1	2
Joydebpur	1	0	1
Tangail	0	1	1

Status : On-going

Estimated Cost : Tk. 4,00,000/-

Source of Fund : BWMRI, DINAJPUR

Priority : 1

Plan/Expt 1.1.12: On-station demonstration (OSD)

Objective(s)	:	Demonstrating wheat varieties to the visitors under optimum and late seeding conditions
Rationale	:	Maintaining seed of all BARI released varieties has historical and scientific importance. Demonstrating comparative performance of the old and newly varieties to the visitors is very important to realize the improved features of the new varieties. This program also provides opportunity to the researchers to monitor the performance of the old and current varieties over the years. Thus it helps making quick decision to maintain or replace a variety.
Materials and methods	:	Twenty-three bread wheat varieties along with one triticale and one durum varieties will be demonstrated at 5 regional stations of BARI across the country. Crop management practices will be as per recommendation of BWMRI.
Crop/variety	:	BWMRI released wheat varieties
Design	:	Non-replicated
Treatment	:	Varieties-25
Replication	:	Non-replicated
Plot size	:	5m X 6 rows
Planting system/spacing	:	Solid seeding Row to row distance 20 cm Entry to entry distance 60 cm
Fertilizer dose and methods of application	:	As per BARC recommendations
Irrigated/rainfed	:	Irrigated
Data to be recorded	:	Data will be recorded on Heading, Plant height, maturity, spikes/sq.m, grains/spike, TGW and disease scores etc.
Investigators	:	MM Hossain, MA Alam — Dinajpur MF Amin — Joydebpur MM Rahman and MM Hossain — Jamalpur MAA Mamun, MAA Khan, A Yasmin, MM Rahman — Rajshahi
Season	:	Rabi 2019-20
Date of Initiation	:	Irrigated timely seeding (ITS)- 20-24 Nov 2019 and Irrigated late seeding (ILS)- 20-22 Dec 2019
Date of Completion	:	April 2020
Exp. Output/Benefit	:	Performance of the wheat varieties over location will be known.
Status	:	On-going
Estimated Cost	:	Tk. 2,00,000/-
Source of Fund	:	BWMRI, DINAJPUR
Priority	:	1

Plan/Expt 1.1.13: Genetic gain of wheat varieties in Bangladesh

Objective(s)	:	To compare the yield performance of recently released wheat varieties with previous mega varieties
Rationale	:	Wheat is the second most important staple food crop in Bangladesh after rice and its consumption is increasing 10% per year. BARI has so far developed 32 wheat varieties till 2017. Rapid adoption of new varieties and other improved production technologies causing a substantial yield increase in recent years, and the ever-highest national average yield of 3.10 t/ha. This yield increase was realized by significant contributions in both genetic values of the varieties used and improved agronomy, irrigation and fertilization. It is important to document the genetic gains in grain yield of recently released varieties under sprayed and unsprayed with Irrigated Timely Sown (ITS) and Irrigated Late Sown (ILS) conditions to assist in developing future breeding strategies.
Materials and methods	:	Eight wheat varieties (Sonalika, Kanchan, Shatabdi, Prodip, BARI Gom 26, BARI Gom 28, BARI Gom 30 and BARI Gom 32) will be used in this study to evaluate under sprayed (Fungicide) and unsprayed (control) conditions. Each entry will be grown in 5m long 6rows with row spacing of 20cm keeping 60cm between varieties and 1m between blocks. The experiment will be laid out in split plot design with spray in the main plot and varieties in the sub plot with 3 replications. The same trial will be conducted both in ITS and ILS conditions. Fertilizer will be applied @ 120-60-40-20 NPKS kg/ha. Two-third of N and all others fertilizes will be applied as basal before final land preparation. Rest one-third of N will be top dressed at CRI stage (17-21 DAS) with light irrigation. Recommended managements will be followed to raise the crop. Data will be recorded on days to heading, maturity, plant height, grains/spike, diseases, 1000-grain weight and yield.
Crop/variety	:	Wheat mega verities and new varieties
Investigators	:	MA Alam, MA Hakim, MSN Mandal, MM Hossain, MA Reza, MZ Islam
Season	:	2019-20
Date of Initiation	:	November, 2019
Date of completion		April, 2020
Exp. Output/Benefit	:	To know the yield potential of newly released wheat varieties which will help to plan new research program for developing new wheat varieties under sprayed and unsprayed conditions.
Locations	:	Bangladesh Wheat and Maize Research Institute, (BWMRI), Dinajpur
Status	:	New
Estimated Cost	:	Tk. 5,00,000/-
Source of Fund	:	BWMRI, DINAJPUR
Priority	:	1

SUB-PROJECT 1.2: DEVELOPMENT OF HEAT TOLERANT WHEAT GENOTYPES

In Bangladesh, most of the wheat (>60%) is grown under late sowing condition (December sowing) that exposes the plants in high temperature at reproductive stage. This exposure to late heat causes abortion of the florets and forces ripening of the underdeveloped kernels. Late planting also results in acceleration of leaf senescence and low kernel weight and subsequently, low grain yield is observed. In some areas farmers are interested to sow wheat early i.e. 1st week of November to save utilize residual soil moisture that causes early heat stress. Therefore, major emphasis has been given to develop late/terminal heat tolerant varieties in the Wheat Breeding Programme. However, recently due attention has also been given to develop early heat tolerant varieties.

Plan/Expt. 1.2.1	**:**	**7th Early heat tolerance wheat screening nursery (7th EHTWSN)**
Objective(s)	**:**	1. Evaluating selected promising genotypes for early heat tolerance and high yield potential in early seeding 2. Selecting promising lines for inclusion in preliminary yield trial and/or using as parent
Rationale	**:**	A large amount of wheat growing lands become available for sowing in late October to early November due to expansion of short duration rice varieties. But seeding of wheat at this period has not been recommended yet. Temperature remains comparatively high at this period which has detrimental effect during germination and crop establishment stages causing considerable yield loss. Heat stress during early crop growth is called "Juvenile heat stress" which causes less biomass, less tillering i.e. poor crop stand, shortened vegetative period i.e. early heading with less number of grains per spike and reduced spike length. Sometimes optimum sown wheat also suffers from early heat stress. Usually, farmers don't like to hold their land empty for long time to avoid loss of residual soil moisture. Variability for heat tolerance exists in spring wheat. Development of early heat tolerant wheat line/variety has great potential to increase the area and productivity of wheat
Materials and methods	**:**	PYT lines with 3 checks (Shatabdi, BARI Gom 30 &BARI Gom 32). Materials will be tested at 2 locations. The crop will be grown using BARI recommended management technologies.
Crop/variety	**:**	Wheat
Design	**:**	5X6 Alpha-lattice, 2 reps.
Treatment	**:**	30 wheat genotypes/varieties
Plot size	**:**	2.5m X 4 rows
Planting system/spacing	**:**	Solid seeding, row to row distance 20 cm Entry to entry distance 40 cm
Fertilizer dose and methods of application	**:**	As per BARC recommendations
Irrigated/rainfed	**:**	Irrigated Early seeding (IES)- 20 Oct- 7 Nov 2019
Data to be recorded	**:**	Data will be recorded on days to heading and maturity, plant height, early vigor, initial plant population, EGC, biomass, disease reaction, visual sterility, CT and SPAD value, NDVI, number of spikes m^{-2}, spikelet per spike, grain per spike, 1000-grain weight, physical grain characteristics and grain yield etc. Soil moisture from sowing to tillering will be monitored.
Investigators	**:**	MM Hossain, MA Hakim, MA Alam Dinajpur

	MAA Mamun, Y Abida ,MM Rahman, and MAA Khan	Rajshahi
Season	: Rabi 2019-20	
Date of Initiation	: October 2019	
Date of Completion	: April 2020	
Exp. Output/Benefit	: Will help to select promising high yielding genotypes suitable for early sowing.	
Locations	: Dinajpur and Rajshahi	
Status	: On-going	
Estimated Cost	: Tk. 1,00,000/- (Tk. 50,000/- per location)	
Source of Fund	: BWMRI, DINAJPUR	
Priority	: 1	

Plan/Expt. 1.2.2	: **Heat tolerant wheat yield trial (HTWYT)**
Objective(s)	: Evaluating selected promising genotypes for late heat tolerance and high yield potential in late seeding.
Rationale	: Heat stress is one of the major environmental constraints for wheat production worldwide. High temperature during grain filling in wheat leads to a significant reduction in yield. The mean temperature increasing due to global warming causes the wheat production down globally. Heat stress during the heading stage most severely reduces floret fertility and thereby yield. Crop failures and yield reduction due to heat stresses are predicted to increase due to increasingly variable climate and the frequency of severe weather events. It is therefore important to develop wheat varieties with tolerance to heat stress.
Materials and methods	: 30 advanced line including 3 checks (BARI Gom 26, BARI Gom 30&BARI Gom 32) will be tested at three locations for late heat stress.
Crop/variety	: Wheat
Design	: 5X6 Alpha-lattice, 2 reps.
Treatment	: 30 wheat genotypes/varieties
Plot size	: 2.5m X 4 rows
Planting system/spacing	: Solid seeding, Row to row distance 20 cm Entry to entry distance 40 cm
Fertilizer dose and methods of application	: As per BARC recommendations
Irrigated/rainfed	: Irrigated Late seeding (IVLS)- 01-10Jan2020
Data to be recorded	: Data will be recorded on days to heading and maturity, plant height, early vigor, initial plant population, EGC, biomass, disease reaction, visual sterility, CT and SPAD value, NDVI, number of spikes m^{-2}, spikelet per spike, grain per spike, 1000-grain weight, physical grain characteristics and grain yield etc. Soil moisture from sowing to tillering will be monitored.
Investigators	: MA Hakim, MA Alam — Dinajpur MM Rahman, G Faruq — Joydebpur MR Islam — Jashore

Season	:	Rabi 2019-20
Date of Initiation	:	November 2019
Date of Completion	:	April 2020
Exp. Output/Benefit	:	Will help to select promising high yielding genotypes suitable for early sowing.
Locations	:	Dinajpur, Joydebpur and Jashore
Status	:	On-going
Estimated Cost	:	Tk. 1,00,000/- (Tk. 50,000/- per location)
Source of Fund	:	BWMRI, DINAJPUR
Priority	:	1

SUB-PROJECT 1.3 : DEVELOPMENT OF DROUGHT TOLERANT WHEAT GENOTYPES

Experiment 1.3.1. : 7th Drought tolerant yield trial

Objectives :
1. To evaluate new exotic lines against drought under Bangladesh condition.
2. To identify the appropriate germplasms tolerant to drought stress

Rationale

Drought is a serious problem for agriculture all around the world and water shortage is now becoming the number one ecological predicament facing mankind. It appears that about 90% of total wheat area in the country is irrigated and the rest are cultivated under rain-fed condition (BBS, 2012). The BWMRI has so far developed 28 high yielding varieties those are suitable for irrigated condition. Potentiality may exist among these cultivars and other advanced lines for further genetic manipulation for dry environments. But efforts to identify drought tolerant varieties and then incorporate the tolerance characters into varieties for improvement have so far not been made at least systematically in Bangladesh. New varieties need to be developed that can withstand adverse climatic condition, particularly the soil moisture stress in order to produce satisfactory yield per unit are. An emphasis should be given to collect and evaluate of new exotic lines against drought under Bangladesh condition. This study will help to identify the appropriate germplasms tolerant to drought stress and also will help in designing future improvement program for the development of drought tolerant varieties.

Materials and methods : Selected lines from 36th SAWSN along with 2 check varieties will be included in this trial.

Crop/variety : Wheat

Design : Alpha lattice

i. **Treatment :** Selected wheat genotypes/varieties including 2 checks

ii. **Replication :** 2

Plot size : 5m X 6 rows

Planting system/spacing : Solid seeding
Row to row distance 20 cm
Entry to entry distance 40 cm

Fertilizer dose and methods of application	**:**	As per BARC recommendations.
Irrigated/rainfed	**:**	The trial will be conducted under Irrigated and rain-fed conditions. Irrigated plots will be watered as per recommendation of BWMRI (CRI, awn peeping and grain filling stage). Non-irrigated plots will be grown under rain-fed condition. All the experiments fields will be well watered after sowing to ensure germination.
Season	**:**	Rabi, 2019-20
Date of initiation	**:**	November, 2019
Date of completion	**:**	April 2020
Exp output/benefit	**:**	This study will help to identify the appropriate germplasms tolerant to drought stress and also will help in designing future improvement program for the development of drought tolerant varieties.
Location	**:**	Rajshahi
Investigators		MM Rahman, MAA Khan, A Yasmin, MAA Mamun
Status	**:**	On-going
Estimated cost	**:**	Tk. 80,000/-
Source of fund	**:**	BWMRI, DINAJPUR
Priority	**:**	1

Plan/Exp. 1.3.2.	**:**	**Evaluation of drought tolerant advanced lines in Barind area**
Objectives	**:**	To identify the appropriate elite genotypes that tolerant to drought stress environment.
Rationale	**:**	New wheat varieties need to be developed that can withstand adverse climatic condition, particularly the soil moisture stress in order to produce satisfactory yield per unit area Emphasis should be given to collect and evaluate of new exotic lines against drought under Bangladesh condition. This study will to select appropriate elite genotypes tolerant to drought stress environment.
Materials and methods	**:**	Selected lines from last year DYT and check variety
Crop/variety	**:**	Drought tolerant wheat genotypes
Design	**:**	Dispersed RCB
i. Treatment	**:**	Selected wheat genotypes
ii. Replication	**:**	3 (on farm)
Plot size	**:**	5m X 6 rows
Planting system/spacing	**:**	Solid seeding Row to row distance 20 cm Entry to entry distance 40 cm
Fertilizer dose and methods of application	**:**	100:27:50: 20:1 NPKSB Kg/ha
Irrigated/rainfed	**:**	The trial will be conducted under rain-fed condition.

Data to be recorded	**:**	Soil characteristics data along with Initial plant population, plant height, days to anthesis, days to maturity, ground coverage, no. of spikes/m^2, no. of grains/spike, peduncle length, spike length, weight of spike, biomass at harvest, RWC%, % Dry matter, 1000-grain weight and grain yield.
Season	**:**	Rabi, 2019-20
Date of initiation	**:**	November 2019
Date of completion		April, 2020
Location	**:**	On-station, Saphahar, Godagari Upa-zillas
Investigators		MAA Mamun, AA Khan, MM Rahman, MA Hakim
Expected output	**:**	This study will help to identify the appropriate germplasms tolerant to drought stress and to develop drought tolerant varieties.
Status	**:**	On-going
Estimated cost	**:**	Tk. 1,00,000/-
Source of fund	**:**	BWMRI, DINAJPUR
Priority	**:**	1

SUB-PROJECT 1.4 : MOLECULAR AND DOUBLE HAPLOID BREEDING

Plan/Exp. 1.4.1 : Production of wheat double haploids

Objective(s) :
1. To develop immediate homozygosity of segregated lines.
2. To reduce breeding time for variety release.
3. To improve efficacy and efficiency in screening for resistance.

Rationale : Haploids are of great interest as breeding tools in cereal improvement, especially in wheat breeding programme. One goal of recent biotechnology research is to obtain doubled haploid plants which offer complete homozygosity and phenotypic uniformity in one generation. Another advantage is a substantial reduction in the cost and the time required to produce breeding lines by conventional system. Haploid plants can be obtained from male or female gametic cells. Plant breeders are increasingly using this system in their mainstream programs in a large number of major crops.

Materials and Methods : Ten F1 hybrids will be used as experimental materials. Major steps to be followed:

- ✓ Crossing between F_1 wheat ovary x maize pollen
- ✓ Application of growth hormone to enhance embryo-growth
- ✓ Embryo rescue
- ✓ Regeneration of haploids through tissue culture
- ✓ Production of doubled haploids

Investigators	**:**	MF Amin, MG Faruq, MM Rahman, and MA Hakim
Season	**:**	Rabi, 2019-20
Date of Initiation	**:**	November2019
Date of completion		November2020

Exp. Output/Benefit	**:**	With DH system, homozygosity will be achieved in a single generation and thus reduce breeding time for variety release
Locations	**:**	RS research field, Biotechnology division lab & green house, BWMRI, Joydebpur
Status	**:**	On-going
Estimated Cost	**:**	Tk. 1,50,000/-
Source of Fund	**:**	BWMRI, DINAJPUR
Priority	**:**	1

Plan/Exp. 1.4.2	**:**	**Screening of wheat double haploid lines**
Objective(s)	**:**	To screen and evaluate wheat double haploid lines developed from wheat x maize crossing.
Rationale	**:**	Haploids are of great interest as breeding tools in cereal improvement, especially in wheat breeding programme. Plant breeders are increasingly using this system in their mainstream programs in a large number of major crops. Most of them don't possess desirable traits combinations. Selection in the double haploid generation is necessary to discard undesirable plants which don't have potentiality for improvement. Selection of desirable plant/head from advancing generations reduces the cost saving time, land and labor.
Materials and Methods	**:**	Produced double haploid lines and Check variety of wheat.
Investigators	**:**	MF Amin and G Faruq — Joydebpur MR Kabir, MA Hakim and MA Alam — Dinajpur
Season	**:**	Rabi, 2019-20
Date of Initiation	**:**	Nov, 2019
Date of completion		Nov, 2020
Exp. Output/Benefit	**:**	DH selected lines
Locations	**:**	Research field at BWMRI, Dinajpur and Joydebpur
Status	**:**	On-going
Estimated Cost	**:**	Tk. 1,50,000/-
Source of Fund	**:**	BWMRI, DINAJPUR
Priority	**:**	1

Plan/Expt 1.4.3	**:**	**Molecular characterization of wheat advanced lines using SSR markers**
Objective(s)	**:**	1. To study genetic variation among wheat varieties using chromosome specific SSR markers 2. To find genetically most diverse genotypes of wheat which can further be used in hybridization programs to create genetically diverse germplasm.
Rationale	**:**	In order to sustain high levels of wheat production in Bangladesh, the most important requirements are the maintenance of a diverse pool of wheat cultivars where 'superior' gene/alleles can be obtained for genetic improvement programs. Intensive activities aimed at

improving wheat crop such as selection of cultivars with desirable attributes have led to a reduced genetic diversity over time.

Microsatellite markers also called simple sequence repeats (SSR) or short tandem repeats (STR) are among the most popular molecular markers used in genetic diversity studies. This type of markers is characterized by its high efficiency, reproducibility, codominant nature and high degree of polymorphism. Microsatellites are vital in cultivar identification and also offer an advantage during pedigree analysis as they are genus specific. Several studies conducted to identify the genetic diversity of wheat cultivars using SSRs, had shown consistent results with the polymorphism expressed being significantly more reliable than that reported using other types of markers.

Materials and methods **:** 54 wheat genotypes will be used in this study. Ten seeds of each wheat genotype will be grown in pot and DNA will be extracted from 15 days old wheat seedlings using CTAB method. About fifty SSR markers will be selected covering each of the seven linkage groups. PCR will be performed. SSR protocol for 6% poly-acrylamide gel electrophoresis (PAGE) will be performed. The gel glass will be stained in 1500 ml of water containing 3 g silver nitrate solution. Thereafter, the alleles will be enhanced in 2000 ml of water solution containing 3 ml of 37% formaldehyde (H2CO) and 30 g sodium hydroxide. All clearly amplified alleles on the genotypes will be treated as a single locus. Scoring will be based on presence and absence of the alleles.

Bivariate 1 and 0 data matrices obtained from the stained gel will be used to construct a dendrogram based on the genetic similarity coefficient. Sahn-clustering of un-weighted pair-group method with arithmetic average (UPGMA) will be applied using the software NTSYSpc 2.1 (Numerical Taxonomy and Multivariate Analysis System), version 2.1. Polymorphism information content (PIC) will be calculated using the following formula:

$$Hi = 1 - \sum_{j=1}^{n} x^2 ij$$

Where $x^2 ij$ is the frequency of the j th allele for marker i and summation extends over n alleles

Investigators **:** MA Alam, MM Hossain, MA Hakim, MR Kabir

Season **:** Rabi 2019-20

Date of Initiation **:** October 2019

Exp. Output/Benefit **:** Characterization and assessment of the genetic diversity of Bangladeshi wheat varieties. Providing useful information for the conservation of genetic resources and the enhancement of wheat breeding.

Locations **:** BWMRI, Dinajpur

Status New

Estimated Cost **:** Tk. 5,00,000/-

Source of Fund **:** BWMRI, DINAJPUR

Priority **:** 1

Plan/Expt 1.4.4 : **Molecular screening of blast resistance wheat genotypes using 2NS markers**

Rationale : Wheat blast is a serious disease caused by a host-specialized population of the ascomycete *Magnaporthe oryzae* B.C. Couch and L.M. Kohn (synonym *Pyricularia oryzae*). It was first reported on wheat (*Triticum aestivum* L.) in 1985 in Paraná, Brazil and has since spread throughout many of the important wheat-producing areas of Brazil and to the neighboring countries of Bolivia and Paraguay. Blast is now considered a major threat to wheat production in South America. In February 2016, a new fungal disease was spotted in wheat fields across eight districts in Bangladesh. The epidemic spread to an estimated 15,000 hectares, about 16 % of the cultivated wheat area in Bangladesh, with yield losses reaching up to 100 %. Cultivars derived from the CIMMYT line Milan appear to contain high levels of resistance under field conditions (Kohli et al., 2011). The genetic basis of the resistance in Milan has not yet been established (Kohli et al., 2011). Other cultivars with this resistance source are now being widely deployed, but it remains to be seen how long this resistance will be effective (Kohli et al., 2011). Thus, there is a critical need for identification of new sources of resistance to wheat blast. The blast resistance genes come from *Aegilops ventricosa* (Zhuk.) Chennav on wheat. This translocation carries a 25 to 38 cM distal segment of chromosome arm 2NS from *Aegilops ventricosa* to the distal region of chromosome arm 2AS in wheat. The *Ae. ventricosa* 2NS/2AS translocation carries resistance genes *Rkn3* against root-knot nematodes (*Meloidogyne* spp.), *Cre5* against the French pathotype *Ha12* of the cereal cyst nematode (*Heterodera avenae* Wollenweber), and *Lr37, Sr38,* and *Yr17* against some races of wheat leaf, stem and stripe rust.

Materials and methods : Materials: One thousand wheat genotypes collected from international wheat screening nursery will be used in this study.

Methods:

Genomic DNA extraction: To amplify 2NS translocation genomic DNA will be extracted from 10 days old wheat seedlings using CTAB method.

PCR Amplification and gel electrophoresis: Two PCR primers (VENTRUIP-F/LN2-R and Yr17-F/Yr17-R) will be used for screening wheat blast resistance genes in 2NS segment of wheat germplasms. PCR will be performed in a volume of 10 µL using a Verity Thermal Cycler (Applied biosystems, USA). The reaction mixture will be contained 40 to 100 ng of genomic DNA, 2× PCR master mix, 10 µM each Primer and ddH_2O up to 10 µL. The amplification program of VENTRUIP-F/LN2-R will be as follows: 94°C for 3 min (enzyme activation); 30 cycles of 94°C for 45 sec (melting), 65°C (depending on the specific primers) for 30 sec (annealing) and 72°C for 60 sec (extension); and a final extension at 72°C for 7 min. The amplification program of Yr17-F/Yr17-R will be as follows: 94°C for 3 min (enzyme activation); 26 cycles of 94°C for 45 sec (melting), 57°C (depending on the specific primers) for 45 sec (annealing) and 72°C for 45 sec (extension); and a final extension at 72°C for 8 min. . PCR products (10 µl each) will be run on 1.5% agarose gel and will be stained with ethidium bromide.

Investigators : MA Alam, MR Kabir, MA Hakim, MM Hossain

Season : Rabi

Date of Initiation : November 2019

Exp. Output/Benefit : Research findings of this experiment will be helpful for detecting 2NS translocated wheat genotypes for developing high yielding wheat varieties with resistance to blast through markers assisted selection.

Location : Breeding lab. of BWMRI

Status : On-going
Estimated Cost : Tk. 200000/-
Source of Fund : BWMRI
Priority : 1

Plan/Expt 1.4.5 : **Selection of blast resistant individuals from different filial generations through MAS**

Rationale : Wheat blast is a serious disease caused by a host-specialized population of the ascomycete *Magnaporthe oryzae* B.C. Couch and L.M. Kohn (synonym *Pyricularia oryzae*). It was first reported on wheat (*Triticum aestivum* L.) in 1985 in Paraná, Brazil and has since spread throughout many of the important wheat-producing areas of Brazil and to the neighboring countries of Bolivia and Paraguay. In February 2016, a new fungal disease was spotted in wheat fields across eight districts in Bangladesh. The epidemic spread to an estimated 15,000 hectares, about 16 % of the cultivated wheat area in Bangladesh, with yield losses reaching up to 100 %. The blast resistance genes come from *Aegilops ventricosa* (Zhuk.) Chennav on wheat. This translocation carries a 25 to 38 cM distal segment of chromosome arm 2NS from *Aegilops ventricosa* to the distal region of chromosome arm 2AS in wheat. The *Ae. ventricosa* 2NS/2AS translocation carries resistance genes *Rkn3* against root-knot nematodes (*Meloidogyne* spp.), *Cre5* against the Frenchpathotype *Ha12* of the cereal cyst nematode (*Heterodera avenae* Wollenweber), and *Lr37*, *Sr38*, and *Yr17* against some races of wheat leaf, stem and stripe rust. Therefore, this is important to select blast resistant individuals in different filial generation (F_1 to F_6) using 2NS primers.

Materials and methods : Materials: Individuals of different filial generation (F_1 to F_6) will be used in this study.

Methods:

Genomic DNA extraction: To amplify 2NS translocation genomic DNA will be extracted by CTAB method.

PCR Amplification and gel electrophoresis: Two PCR primers (VENTRUIP-F/LN2-R and Yr17-F/Yr17-R) will be used for selecting 2NS translocated individuals from different filial generations. PCR will be performed in a volume of 10 µL using a Verity Thermal Cycler (Applied biosystems, USA). The reaction mixture will be contained 40 to 100 ng of genomic DNA, 2× PCR master mix, 10 µM each Primer and ddH_2O up to 10 µL. The amplification program of VENTRUIP-F/LN2-R will be as follows: 94°C for 3 min (enzyme activation); 30 cycles of 94°C for 45 sec (melting), 65°C (depending on the specific primers) for 30 sec (annealing) and 72°C for 60 sec (extension); and a final extension at 72°C for 7 min. The amplification program of Yr17-F/Yr17-R will be as follows: 94°C for 3 min (enzyme activation); 26 cycles of 94°C for 45 sec (melting), 57°C (depending on the specific primers) for 45 sec (annealing) and 72°C for 45 sec (extension); and a final extension at 72°C for 8 min. . PCR products (10 µl each) will be run on 1.5% agarose gel and will be stained with ethidium bromide.

Investigators	**:**	MA Alam, MR Kabir, MA Hakim, MM Hossain, MZ Islam, MSN Mandal
Season	**:**	Rabi
Date of Initiation	**:**	November 2019
Exp. Output/Benefit	**:**	Research findings of this experiment will be helpful for selecting individuals from 2NS X Non-2NS and 2NS X 2NS cross to develop high yielding wheat varieties with resistance to blast through markers assisted selection (MAS).
Location	**:**	Breeding lab. of BWMRI
Status	**:**	New
Estimated Cost	**:**	Tk. 400000/-
Source of Fund	**:**	BWMRI
Prirority	**:**	1

Expt 1.4.6	**:**	**Improving drought tolerance using marker-assisted recurrent selection**
Objective(s)	**:**	To develop and deliver wheat varieties to the wheat growers with enhanced levels of tolerance to drought stress controlled by many minor genes and QTLs.
Rationale	**:**	Most identified QTL for drought tolerance represents only a small portion of phenotypic variability, with many minor genes contributing to the plant response to the stresses. Attempting to combine these genes and QTL using traditional breeding strategies have generally proven ineffective, and therefore novel breeding strategies are required to more efficiently transfer resistance and tolerance into adapted backgrounds. Using a marker assisted recurrent selection (MARS) strategy can assist with pyramiding these many minor genes together. This technique has been successfully applied to cross pollinated crop like sunflower, soybean and maize to bring desirable alleles into single elite lines, and it is proposed that a MARS strategy would also be effective in pyramiding the many minor genes controlling the drought response.
Materials and Methods	**:**	Diverse parental wheat lines providing some extent of tolerance to drought stress will be grown. To facilitate synchronization of flowering the whole set will be seeded thrice on a 7-10 days interval starting from around 15 Nov. Five heads will be emasculated in female parent and pollinated for each single cross and 5 heads for top. Crop management practices will be as per recommendation of BWMRI. A (base) population will be derived from a top cross between three resistant parents. This population will be advanced to the F2 generation, where plants will be selected from a bulk population on the basis of BpLB and agronomic adaptability. These selected plants will be grown as F2:3 single rows in the following generation and genotyped using a 90K Single Nucleotide Polymorphism (SNP) platform. A resistant and tolerant phenotype will be produced in F2:4 and F2:5 using adult plant field data. An association analysis will be completed, estimating marker affects for key loci controlling tolerance. On the basis of these marker effects, simple and complex crosses will be made amongst selected progeny containing corresponding marker alleles. These inter crosses derived progeny will be genotyped for the previously identified

significant makers using a KASP marker panel of significant markers.
Plants accumulating significant markers for resistance and tolerance from the recombination will be used to produce double haploids (DH), using the wheat-maize system, to fix all loci. These double haploid derived lines will be phenotyped for drought tolerance and compared against both the recombinant parents and parents of the base population, to assess whether accumulating minor genes has influenced plant response to drought stress.

Crop/variety : Drought tolerant wheat genotypes

Design : As required

i. Treatment : Genotype and inoculum

ii. Replication : As required

Plot size : As required

Planting system/spacing : As required

Fertilizer dose and methods of application : The crop will be fertilized with organic manure @ 10ton/ha with NPKS and B @ 120, 26, 50, 20 and 2.5 kg ha-1 respectively to ensure proper growth and development. The elements N, P, K, S and B will be applied in the form of Urea, Triple Super Phosphate, Muriate of Potash, Gypsum and Boric acid respectively. Two-third of urea and the entire quantity of other fertilizers will be applied at final land preparation.

Irrigated/rainfed : As required

Data to be recorded : Traits conferring tolerance

Investigators : MM Rahman, MAA Khan, MA Hakim, MR Kabir

Season : Rabi 2019-20

Date of Initiation : 15 November 2019

Date of completion : April 2020

Exp. output/benefit : Desirable gene recombination will be generated

Locations :

Cross	Raj
Single cross	24
Top cross	-
Total	24

Status : New

Estimated Cost :

Location	Land area (m^2)	Cost (Tk.)
RWRC, Rajshahi	1000	80,000/-

Source of Fund : BWMRI and BARC

Priority : 1

SUB-PROJECT 1.5	**:**	**DEVELOPMENT OF BLAST RESISTANT/TOLERANT VARIETY**
Plan/Expt 1.5.1	**:**	**Development of blast resistant/tolerant variety**
Objective(s)	**:**	To develop blast resistant/tolerant variety through 2NS and Non 2NS crossing.
Materials and methods	**:**	Fifty 2NS X Non 2NS cross and 12 2NS X 2NS crosses will be done in BWMRI Dinajpur. Blast resistant/tolerant wheat lines containing 2NS segment will be crossed with adapted wheat varieties and lines. The F1 generated from the cross will be evaluated next year in Jashore for Blast resistance and will be confirmed for the presence 2NS segment at molecular level.
Crop/variety	**:**	BARI Gom 33, BARI Gom 30, BAW 1254, BAW 1280 and 4 advanced lines
Design	**:**	N/A
i. Treatment	**:**	Wheat varieties/lines
ii. Replication & Plot size	**:**	N/A
Planting system/spacing	**:**	N/A
Fertilizer dose and methods of application	**:**	N/A
Irrigated/rainfed	**:**	N/A
Data to be recorded	**:**	N/A
Investigators	**:**	MA Hakim, MA Alam, and MR Kabir
Season	**:**	2019-20
Date of Initiation	**:**	Nov. 2019
Date of completion		April, 2020
Exp. Output/Benefit	**:**	F1 will be generated for wheat blast resistance/tolerance
Locations	**:**	BWMRI, Nashipur, Dinajpur
Status	**:**	New
Estimated Cost	**:**	Tk. 50,000/-
Source of Fund	**:**	BWMRI, Dinajpur
Priority	**:**	1

Plan/Expt 1.5.2	**:**	**Confirmation and evaluation of 2NS X Non 2NS and 2NS X 2NS F_1 in Jashore**
Objective(s)	**:**	To confirm the crosses, generate F_2 seeds and making top and back crosses utilizing the F1 populations.
Materials and methods	**:**	F1 of target crossed
Crop/variety	**:**	F_1 from 2NS X Non 2NS cross and 2NS X 2NS cross
Design	**:**	N/A

Treatment	**:**	Wheat varieties/lines	
Replication & Plot size	**:**	N/A	
Planting system/spacing	**:**	N/A	
Fertilizer dose and methods of application	**:**	N/A	
Irrigated/rainfed	**:**	N/A	
Data to be recorded	**:**	N/A	
Investigators	**:**	MR Islam and MR Kabir	Jashore
		MA Hakim, and MA Alam	Dinajpur
Season	**:**	2019-20	
Date of Initiation	**:**	Nov. 2019	
Date of completion		April, 2020	
Exp. Output/Benefit	**:**	F1 will be confirmed and F_2 seed will be generated for top and back cross	
Locations	**:**	BWMRI, RARS, Jashore, and Bangladesh Wheat and Maize Research Institute, BWMRI, Dinajpur	
Status	**:**	New	
Estimated Cost	**:**	Tk. 50,000/-	
Source of Fund	**:**	BWMRI, DINAJPUR	
Priority	**:**	1	

Expt. 1.5.3 **: Accelerating wheat breeding program through cutting-edge genomics and Phenomics technologies**

Objective(s) : 1. Early generation selection for grain yield and quality using genomic prediction and high-throughput phenotyping in the wheat breeding program.
2. Improved prediction models for multi-environment predictions within national programs.
3. Increased breeding capacity of national wheat breeding programs.

Rationale : Wheat remains one of the most important food crops, providing protein and calories as a second staple for millions throughout Bangladesh. Implementation of advanced breeding approaches in the national wheat programs for capacity development and delivery, enable breeders to select from a much larger set of materials can increase the overall rate of genetic gain, leading to faster development of superior new varieties.

Materials and Methods :

Crop/variety : Each season six hundred advanced wheat lines will be collected from CIMMYT, Mexico.

Design : Alpha lattice

Replications : 2

Plot size : 5 sq.m (Jamalpur), 2 sq.m (Dinajpur) and hill plots of $0.6m^2$ (Jashore)

Fertilizer dose and : 100-26-50-20-5-1 kg ha-1 N-P-K-S-Zn-B for wheat in irrigated

method of application	condition. Two-third of N and whole amount of other nutrients will be applied as basal and rest of N will be top-dressed after irrigation at CRI stage.	
Irrigated/Rainfed	Irrigated	
Data to be recorded	: All crop phonological data including NDVI and CT using UAV.	
Investigator(s)	: MM Rahman	Jamalpur
	MA Hakim	Dinajpur
	R Islam	Jashore
Season	: 2019-20	
Date of Initiation	: November 2019	
Date of completion	: April 2023	
Exp. Output/Benefit	: Increased genetic gain and faster variety development	
Locations	: RARS, Jamalpur, Jashore, and BWMRI, Dinajpur.	
Status	: New	
Estimated Cost	: 40,00,000/-	
Source of Fund	: USAID/BWMRI	
Priority	: 1	
Remarks	:	

Expt 1.5.4 **: Improving wheat blast resistance and/or tolerance using marker-assisted recurrent selection**

Objective(s) **:** To develop and deliver wheat varieties to the wheat growers with enhanced levels of resistance and tolerance to wheat blast controlled by many minor genes and QTLs.

Rationale **:** Attempting to combine many minor genes and QTL using traditional breeding strategies have generally proven ineffective, and therefore novel breeding strategies are required to more efficiently transfer resistance and tolerance into adapted backgrounds. Using a marker assisted recurrent selection (MARS) strategy can assist with pyramiding these many minor genes together. This technique has been successfully applied to cross pollinated crop like sunflower, soybean and maize to bring desirable alleles into single elite lines, and it is proposed that a MARS strategy would also be effective in pyramiding the many minor genes controlling the blast resistance/tolerance.

Materials and Methods **:** Diverse parental wheat lines providing some extent of resistance to wheat blast (4 parents having 2NS based resistance, 2 parents with non 2NS based resistance) will be grown. To facilitate synchronization of flowering the whole set will be seeded thrice on a 7-10 days interval starting from around 15 Nov. Five heads will be emasculated in female parent and pollinated for each single cross and 5 heads for top. A total 10 crosses will be made. Crop management practices will be as per recommendation of BWMRI.

A (base) population will be derived from a top cross between three resistant parents. This population will be advanced to the F_2 generation, where plants will be selected from a bulk population on

the basis of BpLB and agronomic adaptability. These selected plants will be grown as $F_{2:3}$ single rows in the following generation and genotyped using a 90K Single Nucleotide Polymorphism (SNP) platform. A resistant and tolerant phenotype will be produced in $F_{2:4}$ and $F_{2:5}$ using adult plant field data.

An association analysis will be completed, estimating marker affects for key loci controlling wheat blast resistance and tolerance. On the basis of these marker effects, simple and complex crosses will be made amongst selected progeny containing corresponding marker alleles. These inter crosses derived progeny will be genotyped for the previously identified significant makers using a KASP marker panel of significant markers.

Plants accumulating significant markers for resistance and tolerance from the recombination will be used to produce double haploids (DH), using the wheat-maize system, to fix all loci. These double haploid derived lines will be phenotyped for wheat blast and compared against both the recombinant parents and parents of the base population, to assess whether accumulating minor genes has influenced plant response to biotic and abiotic stresses.

Crop/variety : Wheat (Blast resistant and tolerant wheat genotypes)

Design : As required

i. Treatment : Genotype and inoculum

ii. Replication : As required

Plot size : As required

Planting system/spacing : As required

Fertilizer dose and methods of application : The crop will be fertilized with organic manure @ 10ton/ha with NPKS and B @ 120, 26, 50, 20 and 2.5 kg ha^{-1} respectively to ensure proper growth and development. The elements N, P, K, S and B will be applied in the form of Urea, Triple Super Phosphate, Muriate of Potash, Gypsum and Boric acid respectively. Two-third of urea and the entire quantity of other fertilizers will be applied at final land preparation.

Irrigated/rainfed : As required

Data to be recorded : Traits conferring resistance and tolerance

Investigators : MM Rahman, MAA Khan, MA Hakim , MA Alam

Season : Rabi 2019-20

Date of Initiation : 15 November 2019

Date of completion : April 2020

Exp. output/benefit : Desirable gene recombination will be generated

Locations :

Cross	Raj
Single cross	10
Top cross	-
Total	10

Status : New

Estimated Cost :

Location	Land area (m^2)	Cost (Tk.)
RBWMRI, Rajshahi	1000	80,000/-
Jashore	-	-
Total	1,000	80,000/-

Source of Fund : BWMRI

Priority : 1

Plan/Exp. 1.5.6	**:**	**Double haploid in wheat blast breeding**
Objective(s)	**:**	1. To achieve homozygous pure line in one generation compared to 6 to 7 generations required by the traditional system of breeding. 2. To develop wheat varieties, particularly blast resistant varieties very quickly, in 5 to 6 years, compared to more than 8 years required by the traditional methods. 3. To use doubled haploids in basic important genetic studies.
Rationale	**:**	Traditional breeding techniques require 6 to 7 generations of inbreeding to stabilize desired yield, quality, disease resistance and other agronomic traits. On the other hand, doubled haploid technique, also known as speed breeding, allows wheat breeders to stabilize the desired traits in a single generation (10 months) and thus reduces variety development time by up to 5 years. This technique also reduces the volume of breeding works by many folds. It requires only 200 DH lines per cross at the initial stage of breeding, compared to around 4,000 F2 lines by the traditional system. Doubled haploids have also been extensively used in genetic studies, including gene/QTL mapping and GWAS. The University of Sydney Plant Breeding Institute developed a highly successful DH technique, which has already produced and released as many as 10 wheat varieties for commercial cultivation. Most of the wheat breeding programs now use this technique in Australia. It is therefore, justified to undertake research work on this technique, which should enable wheat breeders to produce varieties very quickly, particularly when a new disease poses a threat to wheat production.
Materials and Methods	**:**	Ten F1 hybrids will be used as experimental materials. Major steps to be followed: ➢ Crossing between F_1 wheat ovary x maize pollen ➢ Application of growth hormone (2,4-D) to enhance embryo growth ➢ Embryo rescue ➢ Regeneration of haploids through tissue culture ➢ Application of colchicine to haploid plants for chromosome doubling ➢ Production of doubled haploids
Investigators	**:**	MM Rahman, F Amin, MA Hakim (Bangladesh), NU Ahmed and R Trethowan (The University of Sydney, Australia)
Season	**:**	Rabi, 2019-20
Date of Initiation	**:**	Oct, 2019
Date of completion		June, 2020
Exp. Output/Benefit	**:**	100% homozygous DH lines will be achieved 100 % homozygous very quickly
Locations	**:**	RWRC, Rajshahi
Status	**:**	New
Estimated Cost	**:**	Tk. 20,00,000/-
Source of Fund	**:**	BMWRI/BARC
Priority	**:**	1

Plan/Expt 1.5.6	**:**	**Evaluation of selected blast resistant line in PPP**
Objective(s)	**:**	To select blast resistant/tolerant lines for utilizing in BWMRI breeding programme.
Materials and methods	**:**	Three hundred wheat lines selected from 17 international nurseries planted in PPP, 2018-19. These lines will be further evaluated in PPP for blast resistance.
Crop/variety	**:**	Three hundred wheat lines with BARI Gom 33 and BARI Gom 26 as check
Design	**:**	N/A
i. Treatment	**:**	Wheat varieties/lines
ii. Replication & Plot size	**:**	2
Planting system/spacing	**:**	1m 2rows plot
Fertilizer dose and methods of application	**:**	As per BARC recommendation.
Irrigated/rainfed	**:**	N/A
Data to be recorded	**:**	Heading, plant height and blast incidence and severity
Investigators	**:**	MR Kabir, MR Islam, Babul Anwar, KK Roy, R Begum, T Roy and MMA Reza
Season	**:**	2019-20
Date of Initiation	**:**	December 2019
Date of completion		April, 2020
Exp. Output/Benefit	**:**	Blast resistance/tolerance wheat lines
Locations	**:**	RARS, Jashore
Status	**:**	New
Estimated Cost	**:**	Tk. 50,000/-
Source of Fund	**:**	BWMRI, Jashore
Priority	**:**	1

SUB-PROJECT 1.6: COLLABORATIVE STUDIES WITH INTERNATIONAL ORGANIZATIONS

Germplasm exchange programme between BARI and international organizations is established as a part of collaborative study. The materials are mainly received from CIMMYT, Mexico; Nepal and other countries. Materials are being developed in Bangladesh are also being sent to different institutions to test their performance and future use in their programme. The following international experiments are expected to be conducted this year (2019-20).

Name of the experiment	Seeding time	Source	Experimental locations	Investigators
A Bread Wheat				
1.6.1 40th ESWYT (1 set)	ITS	CIMMYT	Dinajpur	MZ Islam, MM Hossain
1.6.2. 52th IBWSN (1 set)	ITS	CIMMYT	Dinajpur	MM Hossain, MA Hakim, ZI Sarker
1.6.3. 18th HTWYT (3 sets)	ILS	CIMMYT	Din, Joy and Jas	MR Kabir, MA Hakim, MF Amin, MR Islam
1.6.4. 27th SAWYT (1 set)	RTS	CIMMYT	Rajshahi	MAA Mamun, AA Khan, A Yasmin
1.6.5. 37th SAWSN (1 set)	RTS	CIMMYT	Rajshahi	MAA Khan, Y Abida
1.6.6. 8th WYCYT (3 sets)	ITS	CIMMYT	Raj, Din, Joy	Y Abida, MF Amin, MA Hakim,
1.6.7 2nd CWYT	ITS	CIMMYT	Raj, Din, Joy	Y Abida, MF Amin, MA Hakim,
1.6.8. 9th SATYN (3 sets)	RTS	CIMMYT	Joy, Din, Raj	MAA Khan, G Faruq, MA Hakim, MM Rahman
1.6.9 10th HPYT (3 sets)	ITS	CIMMYT	Joy, Din	MM Hossain, MA Hakim, MM Rahman, MF Amin
1.6.10 11th HPAN				
1.6.11 19th SABWGPYT (10 sets)	ILS	CIMMYT	Jam, Din, Jas	MM Rahman, MA Hakim
1.6.12 27thHRWYT				
B. Durum Wheat				
1.6.13 51st IDYN	ITS	CIMMYT	Dinajpur	MN Alam and MM Hossain
Total cost = Tk.12,00,000/-				

SUB-PROJECT 1.7	**:**	**BIO-FORTIFICATION IN WHEAT**
Plan/Exp. 1.7.1	**:**	**6th Zinc-enrich wheat yield trial (6th ZnWYT)**
Objective(s)	**:**	To evaluate the potentiality of developing bio-fortified wheat line(s) & to identify promising genotypes with higher levels of Zinc content
Rationale	**:**	Zinc and Fe deficiencies are a growing public health and socio-economic issue, particularly in the developing world. Recent reports indicate that nearly 500,000 children under 5 years of age die annually because of Zn and Fe deficiencies (Black *et al.* 2008). In South Asia, more than 26 per cent of the population is Zn deficient due to low dietary intake of Zn and Fe. Genetic biofortification to improve Zn and Fe concentrations in major staples including bread wheat (*Triticum aestivum* L.) could greatly reduce micronutrient malnutrition. Development of genetically enriched wheat varieties through breeding is considered as a promising and cost-effective approach for diminishing malnutrition problem. Recently CGIAR initiated program on biofortification of staple crops to develop crop varieties with high micronutrient contents. Under this initiative CIMMYT is developing high yielding bread wheat genotypes with enhanced levels of Zn and Fe primarily targeting people of South-East Asian countries. Bio-fortification has been defined as the process of increasing bio-available concentrations of essential elements in edible portion of crop plants through genetic selection or agronomic interventions. Bio-fortification of wheat is viable as adequate genetic variation for Zn (25-56 mg/kg; average 37mg/kg) and Fe (25-65 mg/kg; average 35 mg/kg) is being reported in the wheat gene pool which allows selection of nutritionally improved breeding materials. By combining the high micronutrient density trait with high yield is possible to develop high yielding wheat with enhanced Zn and Fe concentrations. This program will help to identify wheat genotypes with enhanced levels of Zn and Fe content which will facilitate future breeding program to develop bio-fortified wheat variety.
Materials and methods	**:**	Twenty-five selected entries from 6th HPYT & 7th HPAN including a check
Crop/variety	**:**	Wheat
Design	**:**	5 X 5 alpha lattice, 2 replications
Treatment	**:**	Selected lines will be sown in irrigated timely sown (ITS) and irrigated late sown (ILS) condition
Plot size	**:**	5m x 8 rows
Planting system/spacing	**:**	20cm spacing between rows
Fertilizer dose	**:**	As per recommendation
Irrigated/rainfed	**:**	Irrigated
Investigators	**:**	MM Hossain, MA Alam and MA Hakim
Season	**:**	Rabi 2019-20
Date of Initiation	**:**	November 2019
Exp.Output/Benefit	**:**	High micronutrient (Zn) density wheat germplasm will be identified which will be further evaluated in the next season for releasing as new variety and/or will be used in future breeding program.

Location	**:**	Dinajpur, Joydebpur, Jamalpur
Status	**:**	On-going
Estimated Cost	**:**	Tk. 1,00,000/-
Source of Fund	**:**	BWMRI
Priority	**:**	1

SUB-PROJECT 1.8: PARTICIPATORY VARIETY SELECTION (PVS)

Scientists are developing good number of varieties, but many of those are not being adopted by the farmers in expected rate. Some of the major causes of low adoption may be lack of knowledge about the varieties due to inadequate extension activities, improper selection situation (i.e well fertilized and good management conditions) that does not match well with the most farmers' growing conditions, lack of specifically adapted varieties etc. By this time participatory variety selection (PVS) and participatory plant breeding (PPB) were found to be very effective in addressing many of those problems. Moreover, PVS farmers grow the crop by their own management in their agro-economic conditions and select the varieties according to their socio-economic needs. Participatory research could be very useful to identify farmers'-preferred new varieties and thereby overcome the constraints that cause farmers to grow land races, old or obsolete varieties. Moreover, participatory research increases the job efficiency of the scientists and farmers' knowledge that enables seeds to be retained effectively from year to year and encourages the poor to refrain from buying seeds each year. Research costs can be reduced, and adoption rates increase if farmers are allowed to participate in variety testing and selection process (Joshi, et al., 1995). In-addition, production increases when farmers adopt new varieties identified through participatory research. PVS is a research and extension approach. Seed dissemination through farmers to farmers is more rapid than conventional approach through BADC. In this method about 5 years is needed to start seed delivery to the farmers after release of a new variety. By this time many varieties may start degenerating.

Plan/Expt 1.8.1	**:**	**PVS: Mother and baby trials and informal seed dissemination**
Objective(s)	:	1. Demonstrating the performance of the rust resistant promising advanced lines and new varieties to the farmers under their own management conditions. 2. Providing scope to the farmers for selecting the varieties/lines suitable for their own socio-economic conditions. 3. Exploit G x E interaction by growing genotypes in diverse production environments to increase selection efficiency 4. Enhancing seed production and dissemination at farmers' level.
Rationale	:	All new wheat varieties are not disseminating rapidly in Bangladesh like many other countries and old varieties are occupying vast areas despite, good technology transfer activities. Literature revealed that inadequate extension effort, lack of specifically adapted varieties, improper selection/screening situation in conventional plant breeding and some other causes may be responsible for poor adoption. By this time participatory variety selection (PVS)-mother and baby trials has been found to be very effective to overcome many of those problems. So, conducting PVS-mother and baby trials in farmers' fields for selection, as well as, seed production and dissemination of new of varieties by farmers are very important.
Materials and methods	:	Eight genotypes (2 varieties and 6 advance lines) will be grown in mother trials (MT) at farmers' fields of Thakurgaon, Rajshahi, Jashore, Jamalpur and Tangail.

There will be one village in all locations. There will be two sets of the trial in each village, which will be treated as dispersed replication. Unit plot size for each genotype will be 20m2. Fertilizers and seeds will be supplied to the farmers. Other managements will be used as farmers' practices of the respected areas to raise the crop. Scientists of BARI and DAE personnel will supervise the experiments. A focus group discussion (FGD) will be organized before seeding, where farmers, as well as, village coordinators will be selected, and seeds will be distributed. Variety evaluation will be organized two times; one at physiological maturity and the other at post-harvest stages to collect farmers' preference scores about the genotypes.

Data Collection: Data will be recorded on yield, TGW, heading and maturity, visual sterility and farmers' preference scores about the genotypes for different characters and overall preference etc. Farmers and scientist's preference scores from each MT will be taken on: height, maturity, tillering, disease infection, spike length, expected yield and overall preference (at physiological maturity stage), grain yield, grain physical characteristics (size, colour etc.), black point in seed and overall preference score (at post-harvest stage). The data within location will be analyzed in RCBD considering each MT as dispersed replication and that of over locations by RCBD one factor combined over locations.

Baby Trial

Three advanced lines will be tested in baby trial (BT) with BARI Gom 28 at 2 farmers' fields per village. So, in total, there will be 06 BT per village per location. Only 1 kg seed per advanced genotype and 1kg seed of BARI Gom 28 will be supplied to each farmer. After harvest, a house hold level questionnaire (HLQ) will be supplied to evaluate the genotypes of BT. Yield data will be taken from farmers and compared by paired t-test.

Investigators	:	MM Hossain, MN Alam	Dinajpur
		MAA Mamun, MM Rahman, and AA Khan	Rajshahi
		MR Islam	Jashore
Season	:	Rabi 2019-20	
Date of Initiation	:	November 2019	
Exp. Output/Benefit	:	Farmers will be able to select varieties and advance lines according to their socio-economic needs.	
Locations	:	Dinajpur, Jashore, Rajshahi	
Status	:	On-going	
Estimated Cost	:	Tk. 1,50,000/- (50,000/- per village/location)	
Source of Fund	:	BWMRI, DINAJPUR	
Priority	:	1	
Remarks	:	Farmers-preferred varieties will be identified	

SUB-PROJECT 1.9 : DEVELOPMENT OF DURUM AND TRITICALE VARIETY

Plan/Expt 1.9.1 : **Durum Yield Trial (DYT)**

Objective(s) : 1. Selection of promising durum lines for higher grain yield
2. Advancing promising durum lines for further improvement

Rationale : Durum wheat has strong gluten content although its life span is relatively longer as compared to bread wheat. Due to its strong gluten content and other industrial quality it is extensively used for commercial production of noodles, pasta, spagati and macaroni. In Bangladesh consumption of these food products are increasing day by day. There are some food industries in Bangladesh which are producing these food items by importing durum wheat from abroad. There is a good potentiality to grow durum wheat in cooler northern parts of Bangladesh which can be eventually be used in producing these food items. Therefore, the present study was undertaken to evaluate and select promising durum lines for releasing them as variety.

Materials and methods : 9 genotypes selected from IDYN (2018-19) and DYT (2018-19) plus Morocco 2 and BDW-8 as checks will be included in this trial. Each entry will be grown in 5m long 6rows with row spacing of 20cm keeping 60cm between entries in 4x7 alpha-latice design with 3 replications. Fertilizer will be applied @ 100-30-50-20 NPKS kg/ha. Two-third of N and all others fertilizes will be applied as basal before final land preparation. Rest one-third of N will be top dressed at CRI stage with light irrigation. Recommended managements will be followed to raise the crop. Data will be recorded on days to heading, maturity, plant height, grains/spike, diseases, 1000-grain weight and yield.

Investigators : MN Alam, MSN Mandal, MM Hossain

Season : Rabi 2019-20

Date of Initiation : November 2019

Exp. Output/Benefit : Suitable genotypes will be identified for adaptive trial

Locations : BWMRI, Dinajpur

Status On-going

Estimated Cost : Tk. 20,000/-

Source of Fund : BWMRI, DINAJPUR

Priority : 1

Plan/Expt 1.9.2 : **Triticale Yield Trial (TYT)**

Objective(s) : 1. To identify genotypes with good adaptation
2. Selecting promising triticale lines for both forage and grain

Rationale Triticale is called man made cereal which is evolved from crossing of wheat and rye. It is used both for forage and grain purposes. In Bangladesh there is scarcity for forage for dairy cattle. Triticale grain can largely be used as poultry and fish feed. Its flour which has high protein content can be mixed up with wheat flour for human consumption. Triticale has a good potentiality to be used as forage for cattle and grain in poultry industry. So, the present study has been undertaken to evaluate and select triticale lines with high forage and grain yield potentiality.

Materials and methods : Two genotypes selected from TYT (2018-19) along with BARI Triticale-1,

BARI Triticale-2 as checks will be included in the trial. Each entry will be grown in 5m long 8 rows with row spacing of 20cm keeping 60cm between entries. The experiment will be planted in RCB design with 3 replications. Fertilizer will be applied @ 120-30-50-20 NPKS kg/ha. Half of N and all others fertilizes as basal dose before final land preparation. One-fourth of N as first top dress at CRI stage with irrigation.

Data collection: Data will be recorded on days to heading, maturity, plant height, disease reaction, grain weight, green biomass at 40 DAS, grain yield.

Investigators : MN Alam,MSN Mandal, MM Hossain

Season : Rabi 2019-20

Date of Initiation : November 2019

Exp. Output/Benefit : Suitable genotypes will be identified for Advanced Yield Trial

Locations : BWMRI, Dinajpur

Status : On-going

Estimated Cost : Tk. 25,000/-

Source of Fund : BWMRI, Dinajpur

Priority : 1

SUB-PROJECT 1.10 : VARIETY MAINTENANCE AND BREEDER SEED PRODUCTION

Plan/Expt 1.10.1 : **Maintenance of first and second year lines of recommended varieties**

Objective(s) : 1. To maintain purity of nucleus seeds of newly released varieties
2. To produce pure seeds for breeder seed production

Rationale : The maintenance purity of a variety is important for nucleus seed stock of varieties required for future demand to produce breeder seed. It is also necessary to carry out initial purification of new varieties/candidate varieties to meet up requirements for varietal distinctness, uniformity and stability, and establish their characteristics before release. The variety maintenance is a procedure to be used for varietal purification. Purified seed will be used to produce healthy seed for breeder seed production.

Materials and methods : 1st year line

Varieties : BARI Gom 25, 26, 27, 28, 29, 30, 31, 32, &WMRI 1

Unit plot size : 5m long single row, No. of seeds/plot : 100

BARI Gom 30, 32, 33 and WMRI 1 will be planted by hand in 200 rows while rest varieties will be planted by hand in 100 rows. It is noted that from the 200 rows 50 uniform rows will be selected and from the 100 rows 25 uniform rows will be selected. From each selected lines 5 single plants will be uprooted as a stock for next year's 1st yr line. The selected 50/25 rows will be harvested separately as a stock of next year's 2nd year line.

2nd year line

Varieties : BARI Gom 25, 28, 29, 30, 31, 32 and 33

Unit plot size: 6 rows 11m long with 2 replications. Plot of BARI Gom 30, 32 and 33 will be 100 while BARI Gom 25, 28, 29 and 31 will be 50. Seed will be sown by hand. The 2nd year plots will be planted around the 1st year lines. A system of record keeping will be maintained so that the family relationship between 1st and 2nd year plots is identified.

Data to be recorded on grain yield and disease reaction

Investigators : MN Alam, MSN Mandal, MM Hossain

Season : Rabi 2019-20

Date of Initiation : November 2019

Exp. Output/Benefit : Seed stock will be used in breeder seed production

Locations : BWMRI, Dinajpur

Status : On-going

Estimated Cost : Tk. 2,00,000/-

Source of Fund : BWMRI, DINAJPUR

Priority : 1

Plan/Expt. 1.10.2 : **Breeder seed production of recommended wheat varieties**

Objective(s) : To produce breeder seed for BADC and private enterprises.

Rationale : To maintain the purity of a variety, a regular supply of breeder seeds to BADC/NGO and registered growers is needed for production of quality seeds as foundation stock which in turn produces certified seeds. Breeder seed of commercially cultivated varieties is regularly supplied to the concerned organizations. Breeder seed is genetically pure and free from admixture with other crops and varieties. This pure seed is used for production of good quality seed.

Materials and methods : Varieties: BARI Gom 25, BARI Gom 28, BARI Gom 29, BARI Gom 30, BARI Gom 31, BARI Gom 32, &BARI Gom 33.

Area: 25 ha (BG 25: 1 ha, BG 28: 1 ha, BG 29: 1 ha, BG 30: 6 ha, BG 31: 2 ha, BG 32: 5 ha and BG 33: 9 ha)

Seed rate : 100 kg/ha

Fertilizer dose : 100 : 30 : 50 : 20 NPKS kg/ha

Time of sowing : Nov. 20-30 (optimum)

Irrigation : 3 (at CRI, Booting, Grain filling stage)

Data to be recorded on grain yield and diseases

Investigators : MN Alam, MSN Mandal, MM Hossain and MI Hossain, MAA Khan (Raj)

Season : Rabi 2019-20

Date of Initiation : November 2019

Exp. Output/Benefit : Pure and quality seed will help for increased wheat production

Locations :

Location	Variety	Land area (ha)
WRSS, Debiganj	BARI Gom 30	6
	BARI Gom 32	4
WRSS, Thakurgaon	BARI Gom 33	3
ARSS, Thakurgaon	BARI Gom 33	2
RWRC, Rajshahi	BARI Gom 33	2
BWMRI, Dinajpur	BARI Gom 33	2
	BARI Gom 28	1
	BARI Gom 29	1
	BARI Gom 25	1
	BARI Gom 32	1

ARS, Rajbari	BARI Gom 31	2
Total		25

Status : On-going

Estimated Cost : Tk. 44,00,000/- (2,00,000/- per hectare)

Source of Fund : BWMRI, DINAJPUR

Priority : 1

Experiment 1.10.3 : **Multiplication of pre-released wheat varieties**

Objective(s) :
1. produce good quality seeds for using in up-scaling
2. multiply seeds of pre-release varieties for quick dissemination soon after release
3. quick replacement of old varieties

Rationale : Wheat is the second most important cereal crop in Bangladesh and the availability of rust resistant, higher -yielding wheat varieties is essential to Bangladesh food security. Rapid multiplication and dissemination of resistant seed in Bangladesh has tremendous impact on improving wheat productivity. One key factor is the multiplication of promising pre-released lines, rather than waiting until they were approved for varieties, a much longer process. Also key was growing the lines in multiple, scattered locations, rather than a centralized location through participatory variety selection and seed multiplication. So, farmers could readily see the benefit of adopting the new lines. Moreover, this seed could be utilized for up-scaling the seed to the farmers through variety demonstration.

Materials and methods : Materials: Advanced wheat lines
Seed rate -100 kg/ha
Irrigation - 3 (at CRI, Booting and Grain filling stages)
Planting method - machine planting

Investigators : MA Hakim, M Israil Hossain

Season : Rabi 2019-20

Date of Initiation : November 2019

Exp. Output/Benefit : One ton seed of each candidate varieties will be available just after official release

Locations : Dinajpur

Estimated Cost : Tk 1,00,000/-

Source of Fund : BWMRI, DINAJPUR

Priority : 1

Plan/Expt. 1.10.4 : **Seed increase of recommended varieties and the lines included in the nurseries and trials of wheat, triticale and durum**

Objective(s) : To produce good quality seeds for use in the nurseries/ yield trials for next year experiments and demonstrations.

Rationale : For growing next year's experiment and demonstration we need to have pure seeds. For that reason, seed production programme was developed.

Materials and methods : Materials: Recommended varieties and advance lines
Seed rate 100 kg/ha
Irrigation 3 (at CRI, Booting and Grain filling stages)
Planting method machine planting.
Data to be recorded on disease infection, sterility etc.

Investigators : MA Hakim, MR Kabir, MM Hossain, MM Bazzaz, MI Hossain, MSN Mandal, G. Faruq, MM Rahman, MA Ali, MR Islam, MM Hossain,

MM Rahman, MA Zaman.

Season : Rabi 2019-20

Date of Initiation : November 2019

Exp. Output/Benefit : Pure seed production for the next year

Locations :

Location	Variety	Land area (ha)
Dinajpur	BARI Gom 25, 28, 29, 30, 31, 32 & 33, Advanced wheat lines, durum & triticale	06
Debiganj	BARI Gom 28, 29 & 30	01
Rajshahi	BARI Gom 30	02
Joydebpur	BARI Gom 25, 28 & 30	03
Jamalpur	BARI Gom 25, 28, 29, 30, 31, 32 & 33	04
	Total	16

Status : On-going

Estimated Cost : Tk 30,00,000/- (Tk. 2,00,000/- per ha)

Source of Fund : BWMRI, Dinajpur

Priority : 1

B. REGIONAL PROGRAMME

PROJECT 1: VARIETY DEVELOPMENT

SUB-PROJECT 1.11: DEVELOPMENT OF SALINITY TOLERANT VARIETY

There are huge lands remain unexploited in semi-saline coastal areas of southern Bangladesh after harvest of T Aman. Out of 2.85 million hectares of the coastal and offshore areas about 0.83 million hectares are arable lands. This is 30% of the total arable land. If, wheat breeders can select wheat varieties suitable for these lands, a vast area will be possible to bring under wheat cultivation. Therefore, this sub-project for development of salinity tolerant variety was initiated.

Plan/Exp. 1.11.1 : **Wheat variety/line screening in saline area**

Objective(s) :

1. Select the suitable wheat varieties/lines for saline areas
2. Identify and select sources of resistance.

Rationale : A vast potential agricultural land in the coastal belt of Bangladesh remains fallow in Rabi season. Fallow land in southern Bangladesh during winter was estimated to be more than 400,000ha which is suitable for growing wheat (Rawson et. al. 2011). High yielding, heat tolerant wheat variety having moderate level of tolerance to salinity could be adapted in this area to increase the volume of domestic wheat basket. Earlier studies showed that the salinity level in those areas ranges from 2 to beyond 20 dS/m from November to March. Generally, it was observed that salinity level increased with the increase of soil dryness. Wheat can be grown in the semi saline belt but for successful cultivation, it needs to identify suitable variety/genotypes capable to avoid/tolerate the salinity

Materials and methods : Eight genotypes selected from last years' trial along with 6 varieties will be included in this trial. The experiment will be conducted in RCBD design with 4 replications in the farmers' field of Shatkhira and Patuakhali. Plot size will be 2.5m long 4 rows with 20 cm spacing. Fertilizer will be applied as per recommendation.

Data to be recorded:

Data will be recorded on soil salinity at sowing and 15 days interval, climatic data, initial plant population, days to heading, maturity, plant height, biomass, spikes per sq. meter, 1000-grain weight, grains/spike, grain yield, disease reaction, visual sterility, physical grain quality etc.

Investigators	**:**	MM Hasan, MM Rahman, MA Rahman (Shatkhira), SI Khan (Patuakhali)
Season	**:**	Rabi 2019-20
Date of Initiation	**:**	2016
Exp. Output/Benefit	**:**	Farmers will be able to grow suitable wheat varieties for saline areas of Coastal area
Locations	**:**	Patuakhali, Shatkhira (On-station and farmer's field)
Status	**:**	3rd year
Estimated Cost	**:**	Tk. 1,00,000/-(Tk. 50,000/each location)
Source of Fund	**:**	BWMRI, DINAJPUR
Priority	**:**	1

PROJECT 2: MAIZE IMPROVEMENT

Major objectives

- To develop source population and elite inbred lines of maize
- Development of medium statured hybrids with high yield potential of normal and QPM hybrids (yellow and white)
- Development of good quality high yielding hybrid of popcorn, sweet corn and baby corn
- Development of stress tolerant hybrids (drought, heat, salt and excess soil moisture)
- Seed production of parental lines and hybrids through GO and NGOs
- Dissemination and popularization of developed technologies among farmers and private agencies

Sub-project 2.1: Germplasm Collection, Characterization and Maintenance

Programme	**:**	**Enrichment of Gene Pool**
Project	**:**	**Germplasm Collection and Maintenance**
2.1.1.	**:**	**Maintenance and characterization of local and new exotic inbred lines of maize (7 sets)**
Objective(s)	:	To characterize, maintain and evaluation of newly developed inbred lines
Rationale	:	BARI has developed more than 100 inbred lines derived from commercial hybrids. For future breeding program, it is necessary to characterize the inbred lines.
Materials and methods	:	Set I: 981 (27 lines); Set II: 900M (54 lines); Set III: Pacific 60 (62 lines); Set IV: QY11 (136 lines); Set V: 900M Gold (99 lines);Set VI: Pro-Vitamin A (18 lines) Set VII: CIMMYT (17 lines: Fall Army Worm resistant -9 lines and others-8)
Crop/Variety	:	Maize
Design and replication	:	Not applicable
Plot size	:	Single row 4 m long plot
Spacing	:	60cm×25cm, row to row and plant to plant, respectively (single plant/hill)
Fertilizer dose and application method	:	120, 35, 70, 40, 5 and 1.5 kg/ha of N, P, K, S, Zn, B, respectively, will be applied. One third of urea as basal dose and rest of urea in two equal splits at knee height stage (40-45 DAS -1st top dress) and before flowering (2nd top dress).
Irrigation/ rainfed	:	Irrigations were applied as and when necessary
Data to be recorded	:	As per CIMMYT descriptor
Investigator(s)	:	M.A. Miah, A. Ahmed, S. Ahmed and M. Amiruzzaman
Season	:	Rabi
Date of initiation		November, 2019
Date of completion		May, 2020
Expected output	:	Enough selfed seed of each inbred line would be obtained for breeding purpose.
Locations	:	Dinajpur and Joydebpur
Status of the experiment		New
Estimated cost	:	15,000/- per set
Source of fund	:	BARI
Priority	:	First

Sub-project 2.2: Development of source population and inbred lines

Programme	**:**	**Population Development**
Project	**:**	**Source Population Development**
2.2.1.	**:**	**Development of base population in popcorn and field corn (2 Sets)**
Objective(s)	:	To develop source population of popcorn and field corn for the production of desirable elite/superior inbred lines locally
Rationale	:	The source population can be developed through various ways. Plant breeding division also receives many hybrids from abroad through different seed companies. These materials are the important source of valuable genepool. Through exploiting those genes, a good genetic base can be developed using appropriate breeding techniques. Keeping this in mind, this program has been designed to extract new inbreds from available commercial hybrids as per set objectives.
Materials and methods	:	Set I: Field corn (Pool 1: Cycle 3), 500 selected ears obtained from random mated of 47 superior hybrids (viz. Kaveri 18, Kaveri 50, Kaveri 244+, R-64, konok-51, Dadagiri, Palowan-9120, ACI-III, Cornell, Pacific 11, Pacific 60, Pacific 747, Pacific 759, Pacific 984, Elite, PAC 339, Sunshine, CP 808, VA Shaktiman, HP-701, IM 8013, IM 8119, Pioneer 30VO7, 981, NK 40, NK 46, 900M, 900M Gold, Pinacle, Wang 11, Shampan, Pioneer V92, BARI hybrid maize 7, BARI hybrid maize 9, 962, 827K, 717K, 7001K, Prince, Uttaran 2, Arun 2, Arun 4, Deuti, 9120, Titan, 987, and Miracle) in cycle 2 would be grown maintaining isolation in the field. Set II: Popcorn (Pool 2: Cycle 2), equal amount of seeds of 11 superior popcorn varieties (Khoibhutta, Popcorn Burst, ACI Adventa, BRAC popcorn, Pop P622, PCB10, Siddik Seeds, Thai Popcorn, Popcorn Nepal, Swiss Popcorn, American Popcorn),which were grown separately in different alternative lines that repeats fifteen times and each variety was pollinated artificially with the bulk pollen of all the 11 varieties which would confirm maximum recombination, would be grown maintaining isolation in the field.The plants would be allowed for random mating where, selfing also done in some selected plants. During flowering time healthy and disease free plants would be selected based on variation for next year base population and the selfed ears would be maintained separately for advancing to them from $S_0$to S_1 generation.
Crop/Variety	:	Maize
Design and replication	:	Not applicable
Plot size	:	500 m^2per set
Planting spacing	:	60cm×25cm, row to row and plant to plant, respectively (single plant/hill)
Fertilizer dose and application method	:	250, 55, 110, 40, 5 and 1.5 kg/ha of N, P, K, S, Zn, B, respectively will be applied. One third of urea as basal dose and rest of urea in two equal splits at knee height stage (40-45 DAS -1st top dress) and before flowering (2nd top dress).
Irrigation/ rainfed	:	Irrigation should be applied as and when necessary.
Data to be recorded	:	Days to 50% pollen shedding and silking, plant height and ear height, kernel colour and texture, grain yield/plant and disease reaction
Investigator(s)	:	A. Ahmed and M. Amiruzzaman
Season	:	Rabi
Date of initiation	:	November 2019
Date of completion	:	May 2020
Expected output/ benefit	:	Collection of 300 ears from selected plants
Location	:	Dinajpur
Status	:	On-going (2^{nd} and 3^{rd}year)

Estimated cost	:	Tk. 20,000/-
Source of fund	:	BWMRI
Priority	:	First
Programme	**:**	**Population Development**
Project	**:**	**Source Population Development**
2.2.2.	**:**	**Extraction of different single colored maize from its' mixer (7 Sets)**
Objective(s)	:	To develop different single colored cobs for its genetic study, conserve germplasm and also for ornamental purpose.
Rationale	:	The maize germplasm collected different times from hilly area are mainly produce mixture of different colored grains and we know that color is a good source of anthocyanin (carotenoid). Our diplomat also received colored materials as souvenir from different part of the world and they also want to multiply them. Keeping this in mind, this program has been designed to extract or retain the colored materials so that it help us to study the genetic mechanism of color character, conserve germplasm, display them in different occasion and finally utilize them in different high value corn production.
Materials and methods	:	7 different colored grains separated from number of cobs on the basis of color. Half of the seeds of each color would be grown in isolation either time or place and allowed them to random mating. After harvesting, grains would be selected again on the basis of primary color and maintained separately for advancing to the next generation.
Crop/Variety	:	Maize
Design and replication	:	Not applicable
Plot size	:	100 m^2per set
Planting spacing	:	60cm×25cm, row to row and plant to plant, respectively (single plant/hill)
Fertilizer dose and application method	:	250, 55, 110, 40, 5 and 1.5 kg/ha of N, P, K, S, Zn, B, respectively will be applied. One third of urea as basal dose and rest of urea in two equal splits at knee height stage (40-45 DAS -1st top dress) and before flowering (2nd top dress).
Irrigation/ rainfed	:	Irrigation should be applied as and when necessary.
Data to be recorded	:	Days to 50% pollen shedding and silking, plant height and ear height, kernel colour and texture, grain yield/plant and disease reaction
Investigator(s)	:	A. Ahmed and M. Amiruzzaman
Season	:	Rabi
Date of initiation	:	November 2019
Date of completion	:	May 2020
Expected output/ benefit	:	Collection of uniform ears from selected plants
Location	:	Dinajpur
Status	:	On-going (2^{nd}year)
Estimated cost	:	Tk. 20,000/-
Source of fund	:	BWMRI
Priority	:	First
Programme	**:**	**Population Development**
Project	**:**	**Source Population Development**
2.2.3.	**:**	**Advancing S_0 to S_1 generation of maize**
Objective(s)	:	To extract elite/superior inbred lines locally
Rationale	:	Recycling of good hybrids/OPV can be practiced to develop agronomical desirable homozygous lines. Here selfing as well as balanced bulking ot the promising selfed lines/ears will be done upto S3 generation desired traits. Further selfing and improvement of selected lines upto S7

		generation will be done through pedigree method of crop improvement. To fulfill the objective the program is undertaken for developing elite inbred lines locally.
Materials and methods	:	Mukut Seeds of the hybrid would be sown and minimum 1000 plants would be raised. Selected and desirable plants will be selfed by hand pollination.
Crop/Variety	:	Maize
Design and replication	:	Not applicable
Plot size	:	150 m2 (Approx)
Spacing	:	60 cm×25 cm, row to row and plant to plant, respectively (single plant/hill)
Fertilizer dose and application method	:	120, 35, 70, 40, 5 and 1.5 kg/ha of N, P, K, S, Zn, B, respectively, will be applied. One third of urea as basal dose and rest of urea in two equal splits at knee height stage (40-45 DAS-1st top dress) and before flowering (2nd top dress).
Irrigation/rainfed	:	Irrigation should be applied as and when necessary.
Data to be recorded	:	Days to 50% pollen shedding and silking, plant height and ear height, colour and texture, grain yield/plant, disease reaction.
Investigator(s)	:	M.A. Miah and A. Ahmed
Season	:	Rabi
Date of initiation	:	November 2019
Date of completion	:	May 2020
Expected output	:	S1 materials would be obtained
Location	:	Dinajpur
Status	:	New
Estimated cost	:	Tk 20,000/-
Source of fund	:	Improvement and quality seed production of Wheat and Maize Project.
Priority	:	First

Programme	:	Population Development
Project	:	**Development of Elite Inbred Lines**
2.2.4.	:	**Advancing S_6 to S_7 generation of field corn**
Objective(s)	:	To extract superior inbred lines locally
Rationale	:	Extraction of superior inbred line(s) through recycling of hybrid is a popular breeding technique. The program was initiated using field corn, sweet corn and pop corn materials.
Materials and methods	:	S_6 ears of early and dwarf field corn lines (340 lines) - Half of the seeds of each S_6 selfed ears in each set would be grown in the field following ear to row method. Selected plants from each row of each set would be selfed by hand pollination carefully and maintained separately for advancing to them S_8 generation.
Crop/variety	:	Maize
Design and replication	:	Not applicable
Plot size	:	Two rows of 4 m long plot for each line.
Spacing	:	60cm×25cm, Row to row and plant to plant respectively (one plant/hill)
Fertilizer dose and application method	:	120, 35, 70, 40, 5 and 1.5 kg/ha of N, P, K, S, Zn, B, respectively will be applied. One third of urea as basal dose and rest of urea in two equal splits at knee high (40-45 DAS-1st top dress) and at flowering stage (2nd top dress).
Irrigation/rainfed	:	Irrigation should be applied as and when necessary
Data to be recorded	:	Number of selfed plants, days to 50% pollen shedding and silking, plant and ear height and disease reaction.
Investigator(s)	:	A. Ahmedand M. Amiruzzaman

Season	:	Rabi
Date of initiation	:	November 2019
Date of completion	:	May 2020
Status	:	On-going, 7th year
Expected output/ benefit	:	S_7 Materials would be obtained.
Location	:	Dinajpur
Estimated cost	:	Tk.25,000/-
Source of fund	:	Improvement and quality seed production of wheat and maize project
Priority	:	First

2.3: Evaluation of inbred lines

Programme	**:**	**Hybrid Development**
Project	**:**	**Testing of Inbred Lines**
2.3.1.	**:**	**Evaluation of pro-vitamin A enriched inbred lines of field corn through line × tester method (2 Sets)**
Objective(s)	:	i) To test the GCA of the inbred lines and SCA of crosses and selection of desirable best cross(es). ii) To find out heterotic patterns and heterotic partners of inbred lines.
Rationale	:	Testing of the developing inbred lines in early generation helps to identify better lines (combiners) and discard of low combining lines. In hybrid maize development program, this practice is usually done. Based on the study and analysis, heterotic patterns and heterotic partners (parents) can be identified tested and could be utilized for hybrid development.
Materials and methods	:	Set I: 42 = 27 F_1+ 9 lines+3 testers+3 checks Set II: 35 = 21 F_1+ 7 lines +3 testers +4 checks All the materials in each set would be evaluated along with the commercial checks following alpha lattice design. Each entry will be sown in 2 rows plot.
Crop/variety	:	Maize
Design and replication	:	Alpha lattice with 3 replications.
Plot size	:	Two rows 4 m long per entry.
Spacing	:	60 cm×25 cm, Row to row and plant to plant respectively (single plant/hill).
Fertilizer dose and application method	:	250, 55, 110, 40, 5 and 1.5 kg/ha of N, P, K, S, Zn, B, respectively will be applied. One third of urea as basal dose and rest of urea in two equal splits at knee height stage (40-45 DAS -1st top dress) and before flowering (2nd top dress).
Irrigation/ rainfed	:	Irrigation should be applied as and when necessary.
Data to be recorded	:	Days to 50% pollen shedding, days to 50% silking and maturity, plant and ear height, root and stalk lodging (%), husk cover, No. of plants harvested, no. of ear harvested, field wt. (kg), grain moisture (%), shelling (%), yield (t/ha), disease reaction and 1000-grain wt.
Investigator(s)	:	A. Ahmed, S.Ahmed and M. Amiruzzaman
Season	:	Rabi
Date of initiation	:	November 2019
Date of completion		May 2020
Expected output/ benefit	:	Better performing cross combinations would be selected. Good combiner parent lines and testers would also be identified on desirable traits.
Location	:	Dinajpur
Status	:	New
Estimated cost	:	Tk. 30,000/- per set
Source	:	BWMRI
Priority	:	First

Programme	**:**	**Hybrid Development**
Project	**:**	**Development of Hybrid Variety**
2.3.2.	**:**	**Study of combining ability and heterosis in field corn**
Objective(s)	:	i) To study general combining ability (gca) of parents, specific combining ability (sca) effects of the crosses. i) To estimate standard heterosis and selection of better cross (es).
Rationale		Single cross hybrid production and selection based on heterosis and combining ability is an important process. Based on combining ability and heterotic patterns heterotic partners of inbred lines can be identified and at the same time better performing single cross hybrid(s) may also be identified. Therefore, the experiments were conducted.
Materials and methods	:	40 = 28 F_1+ 8 parents + 4 checks
Crop/variety	:	Maize
Design and replication	:	Alpha lattice with 2 replications
Plot size	:	Two rows 4 m long per entry.
Spacing	:	60cm×25cm, Row to row and plant to plant respectively (single plant/hill)
Fertilizer dose and application method	:	250, 55, 110, 40, 5 and 1.5 kg/ha of N, P, K, S, Zn, B, respectively will be applied. One third of urea as basal dose and rest of urea in two equal splits at knee height stage (40-45 DAS -1st top dress) and before flowering (2nd top dress).
Irrigation/rainfed	:	Irrigation should be applied as and when necessary.
Data to be recorded	:	Days to 50% pollen shedding, days to 50% silking and maturity, plant and ear height, root and stalk lodging (%), husk cover, no. of plants harvested, no. of ear harvested, field wt. (kg), grain moisture (%), shelling (%), yield (t/ha), disease reaction, no. of rows per cob, no. of seed per row, no. of grains/ear, cob length, cob diameter and 1000-grain wt.
Season	:	Rabi
Investigator(s)	:	A. Ahmed and M. Amiruzzaman
Date of initiation	:	November 2019
Date of completion	:	May 2020
Expected output	:	Better performing hybrid(s) would be selected from different sets and good combiner parents would be selected from different sets.
Location	:	Dinajpur
Status	:	New
Estimated cost	:	Tk. 20,000/-
Fund source	:	BWMRI
Priority	:	First

Programme	**:**	**Hybrid Development**
Project	**:**	**Testing of Inbred Lines**
2.3.3. Title	**:**	**Evaluation of inbred lines of field corn through line × tester method (4 Sets)**
Objective(s)	:	i) To test the GCA of the inbred lines and SCA of crosses and selection of desirable best cross(es). ii) To find out heterotic patterns and heterotic partners of inbred lines.
Rationale	:	Testing of the developing inbred lines in early generation helps to identify better lines (combiners) and discard of low combining lines. In hybrid maize development program, this practice is usually done. Based on the study and analysis, heterotic patterns and heterotic partners (parents) can be identified tested and could be utilized for hybrid development.

Materials and methods	:	Set I: 180=116 F_1+ 58 lines+2 testers+4 checks Set II: 150=96 F_1+ 48 lines+2 testers+4 checks Set III: 70=42 F_1+ 21 lines+2 testers+5 checks Set IV: 180=118 F_1+ 59 lines+2 testers+1 checks All the materials in each set would be evaluated along with the commercial checks following alpha lattice design. Each entry will be sown in 2 rows plot.
Crop/variety	:	Maize
Design and replication	:	Alpha lattice with 2 replications.
Plot size	:	Single row 4 m long per entry.
Spacing	:	60 cm×25 cm, Row to row and plant to plant respectively (single plant/hill).
Fertilizer dose and application method	:	250, 55, 110, 40, 5 and 1.5 kg/ha of N, P, K, S, Zn, B, respectively will be applied. One third of urea as basal dose and rest of urea in two equal splits at knee height stage (40-45 DAS -1st top dress) and before flowering (2nd top dress).
Irrigation/ rainfed	:	Irrigation should be applied as and when necessary.
Data to be recorded	:	Days to 50% pollen shedding, days to 50% silking and maturity, plant and ear height, root and stalk lodging (%), husk cover, No. of plants harvested, no. of ear harvested, field wt. (kg), grain moisture (%), shelling (%), yield (t/ha), disease reaction and 1000-grain wt.
Investigator(s)	:	S. Ahmed, A.H. Akhi, M.A. Miah, R. Islam and A. Ahmed (Set-I), S.S. Alom, M.A. Miah, R. Islam and A. Ahmed (Set-II), M.M. Hoque , H.Z. Raihan, M.A. Miah, R. Islam and A. Ahmed (Set-III), A.N.M.S. Karim, M.A. Miah, R. Islam and A. Ahmed (Set-IV)
Season	:	Rabi
Date of initiation	:	November 2019
Date of completion		May 2020
Expected output/ benefit	:	Better performing cross combinations would be selected. Good combiner parent lines and testers would also be identified on desirable traits.
Location	:	Joydebpur, Jashore and Dinajpur
Status	:	New
Estimated cost	:	Tk. 30,000/- per set/location
Source	:	BARI
Priority	:	First

2.4**: Evaluation of single cross hybrids**

Programme	**:**	**Maize Improvement**
Project	**:**	**Development of Hybrid Variety**
2.4.1.	**:**	**Evaluation of locally developed test cross maize hybrids**
Objective(s)	:	To test the performance of locally developed single cross hybrid(s).
Rationale	:	Single cross is always higher yielder than other crosses. Some promising hybrids developed in rabi 2018-19 need to be evaluated in rabi 2019-20.
Materials and methods	:	30 = 27 F1 + 3 checks To avoid border effect, one border rows at both end of each replication will be planted.
Crop/variety	:	Maize
Design and replication	:	RCBD with 3 replications
Plot size	:	Two rows 4 m long plot for each entry.
Planting system/spacing	:	60cm×25cm, Row to row and plant to plant respectively.
Fertilizer dose and	:	250, 55, 110, 40, 5 and 1.5 kg/ha of N, P, K, S, Zn, B, respectively will be

application method		applied. One third of urea as basal dose and rest of urea in two equal splits at knee height stage (40-45 days emergence-1st top dress) and before flower (2nd top dress).
Irrigation/rainfed	:	Irrigation should be applied as and when necessary
Data to be recorded:	:	Days to pollen shedding, days to silking and maturity, plant and ear height, root and stalk lodging (%), husk cover, No. of plants harvested, No. of ear harvested, field wt. (kg), grain moisture (%), shelling (%), disease reaction, no. of rows per cob, no. of seed per row, no. of grains/ear, cob length and breadth and 1000-grain wt. and yield (t/ha)
Investigator(s)	:	A. Ahmed and M. Amiruzzaman
Season	:	Rabi
Date of initiation	:	November 2019
Date of completion		May 2020
Expected output/ benefit	:	Better performing hybrid(s) would be selected.
Location	:	Dinajpur
Status	:	New
Estimated cost	:	Tk. 20,000/-
Source of fund	:	BWMRI
Priority	:	First
Programme	:	Hybrid Development
Project	:	Development of Hybrid Variety
2.4.2.	:	Study of combining ability and heterosis in field corn over location (2 Sets)
Objective(s)	:	i) To study general combining ability (gca) of parents, specific combining ability (sca) effects of the crosses. ii) To estimate standard heterosis and selection of better cross (es).
Rationale		Single cross hybrid production and selection based on heterosis and combining ability is an important process. Based on combining ability and heterotic patterns heterotic partners of inbred lines can be identified and at the same time better performing single cross hybrid(s) may also be identified. Therefore, the experiments were conducted.
Materials and methods	:	Set I : 25= 21 F_1's + 4 checks Set II : 20= 15 F_1's + 5 checks
Crop/variety	:	Maize
Design and replication	:	Alpha lattice with 3 replications
Plot size	:	Two rows 4 m long per entry.
Spacing	:	60cm×25cm, Row to row and plant to plant respectively (single plant/hill)
Fertilizer dose and application method	:	250, 55, 110, 40, 5 and 1.5 kg/ha of N, P, K, S, Zn, B, respectively will be applied. One third of urea as basal dose and rest of urea in two equal splits at knee height stage (40-45 DAS -1st top dress) and before flowering (2nd top dress).
Irrigation/rainfed	:	Irrigation should be applied as and when necessary.
Data to be recorded	:	Days to 50% pollen shedding, days to 50% silking and maturity, plant and ear height, root and stalk lodging (%), husk cover, no. of plants harvested, no. of ear harvested, field wt. (kg), grain moisture (%), shelling (%), yield (t/ha), disease reaction, no. of rows per cob, no. of seed per row, no. of grains/ear, cob length, cob diameter and 1000-grain wt.
Season	:	Rabi
Investigator(s)	:	M.A. Miah and R. Islam (Set-I) ; A. H. Akhi and S. Ahmed (Set- I & II); A. Ahmed (Set- I & II) and B. Sarker (Set-II)
Date of initiation	:	November 2019
Date of completion	:	May 2020

Expected output	:	Better performing hybrid(s) would be selected from different sets and good combiner parents would be selected from different sets.
Location	:	Joydebpur, Dinajpur, Jashore and Burirhat
Status	:	New
Estimated cost	:	Tk. 20,000/- per set/location
Fund source	:	BARI
Priority	:	First

Programme	:	Maize Improvement
Project	:	**Development of Hybrid Variety**
2.4.3.	:	**Evaluation of promising hybrids of field corn and baby corn hybrids at different agro-ecological regions (5 sets)**
Objective(s)	:	To test the performance of locally developed single cross hybrids at different agro-ecological zones in Bangladesh and select widely adapted hybrids.
Rationale	:	Single cross is always higher yielder than other crosses. Better performing single crosses selected from previous year need to be further evaluated in different agro-climatic zones.
Materials and methods	:	Set I: 15= 12 selected single cross and 3 checks- Field corn Set II: 18= 16 selected single cross and 2 checks- Field corn Set III: 16= 15 Selected single cross and1 check- Baby corn Set IV: 5= 4 Selected single cross and1 check- Baby corn Set V: 15= 12 selected single cross and 3 checks- Field corn To avoid border effect, one border rows at both end of each replication will be planted.
Crop/variety	:	Maize
Design and replication	:	Alpha lattice design with 3 replications
Plot size	:	Two rows 4 m long plot for each entry.
Spacing	:	60cm×25cm, Row to row and plant to plant, respectively (single plant/hill)
Fertilizer dose and application method	:	250, 55, 110, 40, 5 and 1.5 kg/ha of N, P, K, S, Zn, B, respectively will be applied. One third of urea as basal dose and rest of urea in two equal splits at knee high (40-45 DAS-1st top dress) and at flower (2nd top dress).
Data to be recorded	:	For field corn: Days to pollen shedding, silking and maturity, plant and ear height, root and stalk lodging (%), husk cover, no. of plants harvested, no. of ear harvested, field weight (kg), grain moisture (%), shelling (%), yield (t/ha), no. of rows/cob, no. of seed/row, no. of grains/ear, cob length, cob breadth and 1000-grain weight and disease reaction. For pop corn: Popping percentage. For baby corn, days to pollen shedding, tasseling, plant height, upper and lower ear height, no. of cobs per plant, cob yield and green fodder yield per plant, days to first and last cob harvest, data to be taken for each cob (eg: cob harvest date, wt of cob with and without husk, cob length and diameter of cob without husk
Irrigation/rainfed	:	Irrigation should be applied as and when necessary
Investigator(s)	:	M.A. Miah, S.S. Alam, R. Islam, A. Islam, N. Jahan and B. Sarker (Set-II); A.H. Akhi, S. Ahmed, R. Islam, B. Sarker , N.Jahan and M.A. Miah (Set-I); S.S. Alam, B. Sarker, N. Jahan and S. Hossain and A. Ahmed (Set-III); S.S. Alam, B. Sarker, N. Jahan and A. Ahmed (Set-IV); M.M. Hoque, M.A. Miah, R. Islam, M.A. Islam, A. Ahmed, N. Jahan (Set-V)
Season	:	Rabi
Date of initiation	:	November 2019
Date of completion	:	May 2020
Expected output	:	Better performing hybrid(s) would be selected
Location	:	Joydebpur, Dinajpur, Jashore, Rahmatpur, Burirhat, Hathazari and

	:	Jamalpur
Status	:	New
Estimated cost	:	Tk. 20,000/- per set / location
Source of fund	:	Improvement and quality seed production of wheat and maize project
Priority	:	First

Programme	**:**	**Maize Improvement**
Project	**:**	**Development of Hybrid Variety**
2.4.4.	**:**	**Large plot observation trial of maize**
Objective(s)	:	To observe the performance of locally developed of hybrids in large plot.
Rationale	:	One of the greatest challenges to maize breeder is to develop hybrids with high mean yield and the widest possible adaptation to the various environments. The program is therefore undertaken to find out better performing new hybrids in large plots.
Materials and methods	:	6 advanced crosses of field corn and 4 checks. To avoid border effect, one border row at both end of each replication will be planted with any suitable variety.
Crop/variety	:	Maize
Design and replication	:	Non-replicated
Plot size	:	Ten rows 4 m long per entry
Fertilizer dose and application method	:	250, 55, 110, 40, 5 and 1.5 kg/ha of N, P, K, S, Zn, B, respectively will be applied. One third of urea as basal dose and rest of urea in two equal splits at knee height stage (40-45 DAS -1st top dress) and before flowering (2nd top dress).
Planting spacing	:	60 cm×25 cm, Row to row & plant to plant respectively (single plant/hill)
Irrigation/rainfed	:	Irrigation would be applied as and when necessary
Data to be recorded	:	Days to flowering and maturity, plant and ear height (cm), lodging percentage, poor husk cover (%), grain yield per plot (kg) and grain yield (t/ha) and disease reaction.
Investigators	:	M.A. Miah and A. Ahmed (Din); H.Z. Raihan and Dr. M. Amiruzzaman (Joy); A. Islam (Jam); R. Islam (Jas); N. Jahan (Hat)
Season	:	Rabi
Date of initiation	:	November 2019
Date of completion	:	May 2020
Expected output	:	Better performance hybrid varieties will be identified
Location	:	Jashore, Joydebpur, Dinajpur, Jamalpur and Hathazari
Status	:	New
Estimated cost	:	Tk. 40,000/- per location
Source of fund	:	BARI
Priority	:	First

2.5**: Stress breeding - Abiotic stress tolerant variety development**

Programme	**:**	**Stress Breeding**
Project	**:**	**Development of Saline Tolerant Hybrid**
2.5.1.	**:**	**Evaluation of dwarf and lodging tolerant maize experimental hybrids**
Objective(s)	:	To identify better performing dwarf and lodging tolerant hybrids.
Rationale	:	Most of the commercial hybrids are tall in nature. There is no maize variety which is lodging tolerant. So, it is necessary to develop hybrids which are dwarf and lodging tolerant with high yield goal. Therefore, the program is initiated to develop maize hybrids of respective objectives.
Materials and	:	15 hybrids + 3 checks

methods		
Crop/variety	:	Maize
Design and replication	:	RCBD with 3 replications
Plot size	:	4 rows 4 m long per entry
Spacing	:	60cm×25cm, Row to row and plant to plant respectively (one plant/hill)
Fertilizer dose and application method	:	250, 55, 110, 40, 5 and 1.5 kg/ha of N, P, K, S, Zn, B, respectively will be applied. One third of urea as basal dose and rest of urea in two equal splits at knee height stage (40-45 DAS -1st top dress) and before flowering (2nd top dress).
Irrigation/rainfed	:	Irrigation should be applied as and when necessary
Data to be recorded	:	Days to pollen shedding, silking and maturity, anthesis-silking interval, leaf rolling, SPAD value plant, plant and ear height, number of kernels/ear, 1000-kernel weight, kernel yield/plant, yield/entry (kg), yield (t/ha), disease reaction.
Investigator(s)	:	A. Ahmed (Din), A.N.M.S. Karim (Joy) and N. Jahan (Hat).
Season	:	Rabi
Date of initiation	:	November 2019
Date of completion	:	June 2020
Expected output/	:	Desirable promising single cross combination(s) would be selected.
Location	:	Joydebpur, Dinajpur and Hathazari
Status	:	New
Estimated cost	:	TK. 30,000/- per location
Fund source	:	Improvement and quality seed production of wheat and maize project
Priority	:	First

Programme	**:**	**Stress Breeding**
Project	**:**	**Development of Excess Soil Moisture Tolerant Hybrid**
2.5.2.	**:**	**Evaluation of excess soil moisture tolerant single cross experimental maize hybrids**
Objective(s)	:	To find out better performing hybrids in excess soil moisture.
Rationale		In kharif season, it is difficult to avoid excess soil moisture condition in one or more stages of crop growth due to erratic rain, contingent flooding and continuous rainfall coupled with inadequate drainage or high moisture table. Therefore, it is essential to find out early maturing and high yielding excess soil moisture tolerant maize hybrid. Consequently, the experiment would be conducted to develop excess soil moisture tolerant maize.
Materials and methods	:	15 (Approx.) At knee height stage of the plants (V6-V7 stage) (55-60 days after sowing) water would be imposed for 144 hrs (6 days) at ponding depth of 15-20 cm.
Crop/variety	:	Maize
Design and replication	:	Alpha lattice with 2 replications
Plot size	:	Two row 4m long per entry.
Planting system/spacing	:	60cm×20cm, Row to row and plant to plant respectively (one plant/hill)
Fertilizer dose and application method	:	250, 55, 110, 40, 5 and 1.5 kg/ha of N, P, K, S, Zn, B, respectively will be applied. One third of urea as basal dose and rest of urea in two equal splits at knee height stage (40-45 days emergence-1st top dress) and before flower (2nd top dress).
Irrigation/ rainfed	:	Irrigation would be imposed at knee-high stage for 7 days.
Data to be recorded	:	Days to tasseling, silking and maturity, anthesis-silking interval, plant and ear height, no. of kernels/ear, 1000-kernel weight, kernel yield/plant,

		yield (t/ha), disease reaction, leaf rolling, SPAD value, number of nodes with brace root and senescence score.
Investigator(s)	:	A. Ahmed, M.M. Hoque and S. Ahmed
Season	:	Kharif-I
Date of initiation	:	February, 2020
Date of completion	:	July, 2020
Expected output/ benefit	:	Better performing parent and tester would be identified on desirable trait.
Location	:	Joydebpur and Dinajpur
Status	:	New
Estimated cost	:	TK. 30,000/-
Fund source	:	BARI
Priority	:	First
Programme		**Maize Improvement**
Project		**Abiotic stress tolerant variety**
2.5.3.	**:**	**Phenotyping of the HTMA hybrids under heat stress (16 Sets)**
Objective(s)	:	i) To develop high-yielding and heat tolerant maize hybrids ii) To compare the performances of test crosses under optimal and heat Stress condition.
Rationale	:	The vast majority of heat stress research has been conducted on temperate maize germplasm for high production areas. Therefore, limited breeding progress has been made in the development of improved maize germplasm with specific tolerance to elevated temperatures especially for the tropical/subtropical regions. Most of the tropical maize germplasm were highly susceptible to reproductive stage heat stress. Heat tolerant accessions from Asia and other regions are being intercrossed to produce populations that can be used to develop new cultivars with improved heat tolerance (Zaidi and Cairns, 2011); however, considerable efforts will be required to enhance hybrid yield potential of these genotypes in climate change vulnerable environment, such as South Asia and similar ecologies around the world. Maize production in heat stress areas of Bangladesh through development of heat tolerant hybrid variety is important for increasing income and food security. Therefore, the present study under Heat Tolerant Maize for Asia (HTMA) project will be conducted to find out heat tolerant hybrid maize variety for sustainable production for the problem areas.
Materials and methods	:	Approx. 1300 hybrids including 2-6 checks in each set (TBD). To avoid border effect, one border rows at both end of each replication will be planted.
Crop/Variety	:	Maize
Design and replication	:	Alpha lattice with 2 replications
Plot size	:	Single row 4 m long plot per entry
Spacing	:	60cm×25cm, Row to row and plant to plant respectively (single plant/hill)
Fertilizer dose and method of application	:	250, 55, 110, 40, 5 and 1.5 kg/ha of N, P, K, S, Zn, B, respectively will be applied. One third of urea as basal dose and rest of urea in two equal splits at knee height stage (40-45 DAS -1st top dress) and before flowering (2nd top dress).
Irrigated/rainfed	:	Irrigation should be applied as and when necessary
Data to be recorded	:	Days to pollen shedding (50% male flower begins pollen shedding), days to silking (50% ear have silks of 2-3 cm length) and days to maturity (black layer formed at the base of kernels of 80% ears per plot), plant and ear height, lodging (stalk and root), number of plants harvested, number of ears harvested, field weight, grain weight, grain moisture (%), shelling

		%, yield (t/ha).
Investigator(s)	:	A. Ahmed (Din) and A. Miah and R. Islam (Jas)
Season	:	Kharif I
Date of initiation	:	March 2020
Date of completion	:	July 2020
Expected output	:	Suitable hybrid maize variety would be selected for heat stress condition
Locations	:	Dinajpur and Jashore
Status	:	New
Estimated cost	:	Tk: 35,000/- per set/ location
Source of fund	:	HTMA project Phase -II
Priority	:	First

2.6. Production of New Hybrids

Programme	**:**	**Stress Breeding**
Project	**:**	**Development abiotic stress tolerant hybrid**
2.6.1.	**:**	**Seed Production of single cross field corn hybrids through diallel mating design (2 sets)**
Objective(s)	:	i) To produce test cross hybrids for evaluation of inbred lines ii) To find out heterotic patterns and heterotis patterns of inbred lines
Rationale	:	Hybridization of inbred line and evaluation of the single crosses is a continuous process in maize breeding program. So, these experiments were undertaken to find out better performing single crosses as well as inbred lines with good general combining ability (gca).
Materials and methods	:	Set I: 8×8 diallel fashion excluding reciprocal Set II: 8×8 diallel fashion excluding reciprocal (yellow)
Crop/variety	:	Maize
Design and replication	:	Not applicable
Plot size	:	8 rows 4 m long for each inbred line.
Spacing	:	60cm×25cm, Row to row and plant to plant respectively (one plant/hill)
Fertilizer dose and application method	:	120, 35, 70, 40, and 5 kg/ha of N, P, K, S and Zn, respectively. Boron @ 1.5 kg/ha may be applied in boron deficient soil. One third of urea as basal dose and rest of urea in two equal splits at knee height stage (40-45 DAS - 1st top dress) and before flowering (2nd top dress).
Irrigation/ rainfed	:	Irrigation should be applied as and when necessary.
Data to be recorded	:	Days to pollen shedding and silking, plant and ear height, amount of F_1 seed produced in each hybrid
Investigator(s)	:	A. Ahmed (Set II) and A.H. Akhi and S. Ahmed (Set I).
Season	:	Rabi
Date of initiation	:	November 2019
Date of completion	:	May 2020
Expected output/ benefit	:	Sufficient F_1 seeds of each cross combinations in each set would be obtained for next year evaluation.
Locations	:	Dinajpur and Joydebpur
Status	:	New
Estimated cost	:	Tk. 20,000/-per set/location
Source of fund	:	BARI

Programme	**:**	**Stress Breeding**
Project	**:**	**Development abiotic stress tolerant hybrid**
2.6.2.	**:**	**Seed Production of selected single cross hybrids of short stature, lodging tolerant, heat tolerant, excess soil moisture and saline tolerant maize (7 Sets)**
Objective(s)	:	To increase hybrid seeds of selected promising hybrids for their testing in multilocation trial
Rationale	:	The seeds of the selected single crosses from last year's trials need to further increase for verifying them in wider agro-ecological zones. Hence the program is initiated to produce sufficient amount of seeds from the selected different crosses.
Materials and methods	:	Set I : 6 Selected - Short statured-lodging tolerant hybrids; Set II : 5 Selected- Saline tolerant hybrids; Set III: 6 Selected- Excess soil moisture,4 selected saline tolerant and 6 selected short statured hybrids; Set IV : 8 Selected- Excess soil moisture tolerant hybrid; Set V : 10 Selected- Field corn hybrid Set VI : 3 Selected- Popcorn hybrid Set VII : 7 Selected- Baby corn hybrid Seed production would be done carefully by hand pollination. Sowing time of females and males will be adjusted for synchronization of flowering. Undesirable plants from both male and female lines will be rouged out at seedling, vegetative and pre-flowering stages for controlling genetic purity.
Crop/variety	:	Maize
Design and replication	:	Not applicable
Plot size	:	2 rows 4 m long (for each cross, 2 rows female and 1 row male)
Spacing	:	60cm×25cm, Row to row and plant to plant respectively (one plant/hill)
Fertilizer dose and application method	:	120, 35, 70, 40, and 5 kg/ha of N, P, K, S and Zn, respectively. Boron @ 1.5 kg/ha may be applied in boron deficient soil. One third of urea as basal dose and rest of urea in two equal splits at knee height stage (40-45 DAS - 1st top dress) and before flowering (2nd top dress).
Irrigation/ rainfed	:	Irrigation should be applied as and when necessary.
Data to be recorded	:	Days to pollen shedding and silking, plant and ear height, amount of F_1 seed produced in each hybrid
Investigator(s)	:	A. Ahmed (Set-I) A. Ahmed, A. Miah (Set II and III), H.Z. Raihan and M.M.Hoque (Set IV),S.H. Omy, A H. Akhi and S Ahmed (Set V) T.A. Mujahidi and S.S. Alam (Set VI) ; S.S. Alam and S.H. Omy (Set VII)
Season	:	Rabi
Date of initiation	:	November 2019
Date of completion	:	May 2020
Expected output/ benefit	:	About 2 kg F_1 seeds of each cross combinations in each set would be obtained.
Locations	:	Dinajpur, Joydebpur and Jashore
Status	:	New
Estimated cost	:	Tk.20,000/- per set/location
Source of fund	:	BARI
Priority	:	First

Programme	**:**	**Hybrid Seed Production**
Project	**:**	**Seed Production of BARI Maize Hybrids**
2.6.3.	**:**	**Seed production of selected promising hybrids of field corn, popcorn and baby corn in isolation (6 Sets)**
Objective(s)	:	i) To increase hybrid seeds of last year and previously selected crosses in each set and ii) To observe the performance of the hybrids in different locations.
Rationale	:	Seed is pre-requisite for popularizing the released maize hybrids to the farmers and maize growers. For conducting demonstrations throughout the country, large scale of hybrid seed is needed. Therefore, the program is under taken.
Materials and methods	:	6 sets (Set I- TCRC, Bogura; Set II- RHRC, Narshindhi; Set III- OFRD, Sherpur; Set IV- Debigonj; Set V- RARS, Ishwardi and Set VI- BWMRI, Dinajpur) of promising early and dwarf high yielding maize hybrid). Sowing of female and male parent of specific hybrid should be done in isolation (time/space) maintaining a ratio of 4 female rows alternate with 2 male rows (4:2). Sowing time of females and males will be adjusted for synchronization of flowering. Male parent will be sown in two different dates for synchronization of flowering. At flowering time all-female plants will be detasseled properly before pollen shedding. Undesirable plants of both male and female will be rouged out at seedling, vegetative and pre-flowering stages. Male plants should be harvested from the field 3-5 days before female. (Time isolation: 1 month or Space/distance isolation: 400m).
Crop/variety	:	Maize
Design and replication	:	Not applicable
Plot size	:	600 m^2 (Set I-VI)
Planting Spacing	:	60cm×25cm, Row to row and plant to plant respectively (one plant/hill)
Fertilizer dose and application method	:	120, 35, 70, 4 and 5 kg/ha of N, P, K, S and Zn, respectively. Boron @ 1.5 kg/ha may be applied in boron deficient soil. One third of urea as basal dose and rest of urea in two equal splits at knee height stage (40-45 DAS -1^{st} top dress) and before flowering (2^{nd} top dress).
Irrigation/ rainfed	:	Irrigation should be applied as and when necessary.
Data to be recorded	:	Days to pollen shedding and silking, plant height, ear height, seed yield (t/ha) and disease reaction.
Investigator(s)	:	M.A. Miah (Set-VI); M.M.Hoque, J. H. Prodhan (Set-I); M. Rohman (Set-II); M.S. Rahman (Set-III); N. Amin (Set-IV) and M.A. Zaman (Set-V).
Season	:	Rabi
Date of initiation	:	July 2019 (Set I-III) and November 2019 (Set IV-VI)
Date of completion	:	November 2019 (Set I-III) and May 2020 (Set IV-VI)
Expected output/ benefit	:	Sufficient F_1 seeds of respective hybrid(s) in each set would be obtained.
Locations	:	BWMRI, Dinajpur; RHRS, Narsingdi; TCRC, Bogura; OFRD, Sherpur; Debigonj and RARS, Ishwardi.
Status	:	New
Estimated cost	:	Tk. 20,000/- per location
Source of fund	:	BARI
Priority	:	First

2.7: Maintenance and seed increase of parental/inbred lines

Programme	**:**	**Hybrid Seed Production**
Project	**:**	**Seed Production of BARI Maize Hybrids**
2.7.1	**:**	**Maintenance and seed increase of the parental lines of BARI maize hybrids**
Objective(s)	:	i) To maintain purity of the parental lines and hybrids ii) To produce and increase of pure seeds of the parental lines of BARI maize hybrids for future use
Rationale	:	Seed is pre-requisite for popularizing the released maize hybrids to the farmers and maize growers. For conducting demonstrations throughout the country, large scale of hybrid seed is needed. Therefore, the program is under taken.
Materials and methods	:	23 parents: (BIL-20, BIL-22, BIL-28, BIL-29, BIL-31, BIL-77, BIL-79, BIL-106, BIL-110, BIL-113, BIL-114,BIL-157, BML-36, BIL-210, BIL-211, BIL-212, BIL-213, BIL-214, BIL-215, BIL-216,BIL-217, BML-59 and BML-71) The parental lines will be maintained carefully through selfing of selected plants by hand pollination.
Crop/variety	:	Maize
Design and replication	:	Not applicable
Plot size	:	Each parent line would be grown in 2 rows 4 m long plot.
Planting	:	60cm×25cm, Row to row and plant to plant respectively (one plant/hill)
Fertilizer dose and application method	:	120, 35, 70, 4 and 5 kg/ha of N, P, K, S and Zn, respectively. Boron @ 1.5 kg/ha may be applied in boron deficient soil. One third of urea as basal dose and rest of urea in two equal splits at knee height stage (40-45 DAS - 1st top dress) and before flowering (2nd top dress).
Irrigation/ rainfed	:	Irrigation should be applied as and when necessary.
Data to be recorded	:	Days to pollen shedding and silking, plant height, ear height, seed yield (t/ha) and disease reaction.
Investigator(s)	:	A. Ahmed and M.A. Miah
Season	:	Rabi
Date of initiation	:	November 2019
Date of completion	:	May 2020
Expected output/ benefit	:	True to type seeds of the parent lines of different BARI maize hybrid would be obtained for future use.
Locations	:	Dinajpur
Status	:	On-going
Estimated cost	:	Tk.40,000/- per location
Source of fund	:	BARI
Priority	:	First

Programme	**:**	**Hybrid Seed Production**
Project	**:**	**Seed Production of Promising Maize Hybrids**
2.7.2	**:**	**Maintenance and seed increase of the parental line of Promising maize hybrids**
Objective(s)	:	i) To maintain purity of the parental lines and hybrids ii) To produce and increase of pure seeds of the parental lines of Promising maize hybrids for future use
Rationale	:	Seed is pre-requisite for popularizing the released maize hybrids to the farmers and maize growers. For conducting demonstrations throughout the country, large scale of hybrid seed is needed. Therefore, the program is under taken.
Materials and methods	:	2 parents: (PNL-19-2-1-1-3-1-3 and BIL-28) The parental lines will be maintained carefully through selfing of selected

		plants by hand pollination.
Crop/variety	:	Maize
Design and replication	:	Not applicable
Plot size	:	PNL-19-2-1-1-3-1-3 would be grown in 20 rows and BIL -28 10 rows 4 m long plot.
Planting Spacing	:	60cm×25cm, Row to row and plant to plant respectively (one plant/hill)
Fertilizer dose and application method	:	120, 35, 70, 4 and 5 kg/ha of N, P, K, S and Zn, respectively. Boron @ 1.5 kg/ha may be applied in boron deficient soil. One third of urea as basal dose and rest of urea in two equal splits at knee height stage (40-45 DAS -1st top dress) and before flowering (2nd top dress).
Irrigation/ rainfed	:	Irrigation should be applied as and when necessary.
Data to be recorded	:	Days to pollen shedding and silking, plant height, ear height, seed yield (t/ha) and disease reaction.
Investigator(s)	:	M.A. Miah and A. Ahmed
Season	:	Rabi
Date of initiation	:	November 2019
Date of completion	:	May 2020
Expected output/ benefit	:	True to type seeds of the parent lines of maize hybrid would be obtained for future use.
Locations	:	Dinajpur
Status	:	On-going
Estimated cost	:	Tk.40,000/- per location
Source of fund	:	BARI
Priority	:	First

2.8: Technology Transfer Activities

Programme	:	**Transfer of technology**
Project	:	**Technology dissemination through demonstration**
2.8.1.	:	**Validation trial of BARI maize hybrids through DAE**
Objective(s)	:	To observe the performance of locally developed hybrids at farmers' field.
Rationale	:	One of the greatest challenges to maize breeder is to developed hybrids with high mean yield and the widest possible adaptation to the various environments. The program is therefore undertaken to find out better performing BARI developed new hybrids at farmers field through DAE.
Materials and methods	:	BHM-9, BHM-16 and BHM-17
Crop/variety	:	Maize
Plot size	:	1000 m^2/farmer
Fertilizer dose and application method	:	250, 55, 110, 40, 5 and 1.5 kg/ha of N, P, K, S, Zn, B, respectively will be applied. One third of urea as basal dose and rest of urea in two equal splits at knee height stage (40-45 DAS -1st top dress) and before flowering (2nd top dress).
Planting spacing	:	60 cm×25 cm, Row to row & plant to plant respectively (single plant/hill)
Irrigation/rainfed	:	Irrigation would be applied as and when necessary
Data to be recorded	:	Days to flowering and maturity, plant and ear height (cm), lodging percentage, poor husk cover (%), grain yield per plot (kg) and grain yield (t/ha) and disease reaction.
Investigators	:	M.A. Miah, A. Ahmed, M.M. Hoque, S. Ahmed, A.N.M.S. Karim, M. Amiruzzaman and respective DAE personnel.
Season	:	Rabi
Date of initiation	:	November 2019
Date of completion	:	May 2020

Expected output	:	Better performance hybrid varieties will be identified
Location	:	Jamalpur, Jashore, Dinajpur, Thakurgaon, Rangpur, Rajshahi, Faridpur, Barishal and Cumilla
Status	:	New
Estimated cost	:	Tk. 4000/- per location
Source of fund	:	BARI/DAE
Priority	:	First
Programme	:	Transfer of technology
Project	:	Technology dissemination through adaptive trial
2.8.2.		Field days on the performance of BARI maize hybrids
Objective(s)	:	To popularize BARI maize hybrids among the farmers and private agencies.
No. of field days	:	20 Field days (approx.)
Materials and methods	:	BHM-7, BHM-9, BHM-12, BHM-13, BHM-14, BHM-15, BHM-16 and BHM-17
Crop/variety	:	Maize
Design and replication	:	Not applicable
Investigator(s)	:	A. Ahmed and M.A. Miah, RARS, ARS, OFRD scientists in respective stations of BARI and concerned DAE personnel's.
Date of initiation	:	December 2019
Date of completion	:	May 2020
Expected output/ benefit	:	BARI hybrid maize varieties would be popular among the farmers and seed producers.
Locations	:	About twelve field days would be conducted demonstration, at different locations.
Status	:	On-going
Estimated cost	:	Tk.20,000/- per field day
Source of fund	:	Improvement and quality seed production of wheat and maize project
Priority	:	First
Programme	:	**Transfer of Technology**
Project	:	**Technology Dissemination Through Demonstration/Field Days/ Training/workshop**
2.8.3.		**Training/Conference/Workshop**

- Farmers training on hybrid maize production technology (30 Batches; 30 Participants/batch; Duration-01 day).
- Officers training for DAE Personnel on Hybrid maize production technology (02 Batches; 30 Participants/batch; Duration-01 day).
- Officers training on hybrid maize seed production and parent lines maintenance technology for BADC, NGOs and Seed Co. officers and other maize scientists (02 Batches; 30 Participants/batch; Duration-01 day).
- TOT on Hybrid maize production technology for SAAO, SSA, SA and NGO officials (02 Batches; 30 Participants/batch; Duration-01 day).

Objective(s)	:	To train-up scientists, BADC & DAE officers, NGO and different Seed company personnels, field staff on molecular technology, seed production and hybrid maize production technology.

Rational	:	To produce hybrid seed, it is important to know the techniques of hybrid seed production. Trained people will be able to produce hybrid seeds locally. Therefore, the training program is undertaken. On the other hand, molecular tools are important to improve maize. Therefore, scientists will be trained-up on molecular technology.
Investigator(s)	:	A. Ahmed and M.A. Miah
Date of initiation	:	October 2019
Date of completion	:	June 2020
Expected output	:	Skill on hybrid seed production will be increased.
Locations	:	Rajshahi regions, Joydebpur, Jamalpur, Jessore, Rangpur and Hathazari.
Status	;	New
Estimated cost	:	Tk.6,32,000/-
Source of fund	:	Improvement and Quality Seed Production of Wheat and Maize Project

PROJECT 2: CROP AND SOIL MANAGEMENT

SUB-PROJECT 2.1: CROP MANAGEMENT

A: NATIONAL PROGRAMME

1.Programme	**:**	Wheat Improvement
2.Project 3	**:**	Crop and Soil Management
Sub-Project 3.1	**:**	Crop Management
Sub-Sub-Project 3.1.1	**:**	**Resource Conservation**
3.Plan/Expt. 3.1.1.1	**:**	**Long-term bed planting trial for improving crop and soil productivity in rice-wheat-mungbean cropping pattern**
4.Objective(s)	**:**	i. Increasing cropping intensity and soil fertility ii. Determining N-use efficiency iii. Creating a suitable cropping pattern within the rice-wheat system, and iv. Study the profitability of this pattern.
5.Rationale	**:**	With the introduction of high yielding varieties of rice and wheat, a significant change has been made in crop management. Inefficient use of fertilizer, irrigation water, light etc. might be the major cause of yield gap between research and farmers' fields. High yielding varieties are highly nutrient responsive. Bed planting has shown to improve water distribution and efficiency, fertilizer use efficiency, reduced weed infestation, reduce lodging and it also reduces seed rate without sacrificing yield (Hobbs et al., 1998). It also reduces cost of cultivation, soil erosion and degradation, increases soil organic matter and is more beneficial for bioactivity. An additional advantage of bed planting becomes apparent when beds are "Permanent" i. e. when they are maintained over the medium term and not broken down and reformed for every crop. It may be an interesting alternative for Bangladesh. The project has been undertaken with the hypothesis that, bed planting will not only increase crop yield but also save money and increase soil health over the long run.
6.Materials/Methods	**:**	Treatments: Factor A: Methods of cultivation (horizontal treatment) i) Conventional ii) Bed planting Factor B: Straw management (vertical treatment except mungbean) i) 30% straw ii) 0% straw Factor C: Nitrogen levels in sub-sub plot i) 0 ii) 40 iii) 80 v) 100 and vi) 120% N as recommended dose In Rice recommended dose of PKSZn should be used In Wheat recommended dose of PKS should be used
Variety	**:**	Wheat- BARI Gom 24, Rice- BRRI dhan 49 & Mungbean- BARI Mung 6
Design	**:**	Strip split plot with 3 replications
Plot size	**:**	10×3m
Planting system and spacing	**:**	Bed & conventional planting with 20 cm spacing
Fertilizer dose and method of application	**:**	Recommended fertilizer will be applied in each crop as follows:

Wheat: $N_{120}P_{30}K_{50}S_{20}B_{1.5}$

Maize: $N_{210}P_{60}K_{100}S_{40}Zn_5B_{1.5}$

Rice: $N_{90}P_{30}K_{50}S_{20}$

Irrigated/Rainfed : Irrigated

Data to be recorded :

i. Physical and chemical properties of the soil (0-15 and 15-30 cm)
ii. Composite soil nutrient status at initial stage
iii. Weed species and their biomass after1st irrigation
iv. Grain growth parameters
v. Yield and yield components, harvest index and biomass
vi. Grain and straw samples analysis after each crop harvested
vii. Economic analysis after completion the work
viii. Weather parameters

7.Investigator : MI Hossain, MK Gathala, TP Tiwari and McdonaldAndraw

8.Season : 2019-2020

9.Date of initiation : November 2019

10.Date of completion : April 2020

11.Expected outputs : It will improve productivity of all crops and the pattern due to efficient utilization of nitrogen, irrigation water and other inputs. Exploitation of the advantages of high fertility in bed planting will be possible, as it enhances lodging resistance. Soil organic matter may be increased after inclusion of mungbean crop and other residues.

12.Location : RWRC, Shyampur, Rajshahi

13.Status : On-going (16^{th} year)

14.Estimated cost : Tk. 1,50,000/-

15.Source of Fund : BWMRI

16.Priority : 1

17.Remarks :

1.Programme : Wheat Improvement

2.Project 3 : Crop and Soil Management

Sub-Project 3.1 : Crop Management

Sub-Sub-Project 3.1.1 : **Resource Conservation**

3.Plan/Expt. 3.1.1.2 : **Effect of different tillage options and residue management on productivity of wheat-maize-rice cropping pattern**

4.Objective(s) :

i. Examining the productivity of wheat-maize- rice cropping pattern under different CA practices.
ii. Changing in soil properties due to shifting from conventional to CA practices.

5.Rationale : Rice-wheat is the major cropping pattern in Bangladesh which occupies about 87% area (Morshed *et al.* 2001). Maize is third cereal crops which area and production is increasing day by day. Now maize is also expanding after harvest of rabi crops especially after harvest of potato. Maximum farmers in potato growing area are cultivated maize after harvest of potato due to get good market prize and more yields over other Kharif 1 crops. Besides this some area are under wheat rice system and we include another crops between two cereals and thus the wheat-fallow-rice cropping in being shifted to maize-fallow-rice system. The system has practical significance of horizontal expansion of all crops and also the vertical expansion of system productivity. Bed planting has

shown to improve water distribution and efficiency, fertilizer use efficiency, reduced weed infestation, reduce lodging and it also reduces seed rate without sacrificing yield (Hobbs et al., 1998). It also reduces cost of cultivation, soil erosion and degradation, increases soil organic matter and is more beneficial for bioactivity. An additional advantage of bed planting becomes apparent when beds are "Permanent" i. e. when they are maintained over the medium term and not broken down and reformed for every crop. Crop residues are an important source of soil organic matter vital for the sustainability of agricultural ecosystems. About 25% of N and P, 50% of S and 75% of K uptake by cereal crops is retained in crop residues, making them valuable nutrient sources (Singh 2003). However, straw retention is not a common practice in the RW systems of Bangladesh, as is also the case elsewhere in South Asia. Wheat and rice straw are usually removed from fields for use as cattle feed and for purposes such as livestock bed ding, thatching material for houses or for fuel, leaving little for incorporation into the soil. As a result, soil organic matter levels have declined in these cropping systems, and optimization of nutrient uptake and absorption efficiency has become one of the most important goals in crop production strategies. Talukder et al. (2002) reported that N use efficiency was highest in permanent raised beds, giving higher yields than a conventional system. Limon-Ortega et al. (2000) observed that permanent beds with straw retention had the highest mean wheat grain yields (5.57 t/ha), N use efficiency (28.2 kg grain/kg of N supply) and total N uptake (133 kg/ha), with positive implications for soil health.

The project has been undertaken with the hypothesis that, bed planting will not only increase crop yield but also save money and increase cropping intensity and productivity.

7.Materials/Methods : Factor A (main plot): Tillage options

1. Permanent bed
2. Strip tillage
3. Conventional practice

Factor B (sub-plot): Residue management

1. 30% residue retention with standing way
2. 0% residue retention

Variety **:** Wheat- BARI Gom 30, Rice- BRRI Dhan 71 and Maize- NK-40

Design **:** Split-plot with three replications

Plot size **:** 3×5m

Planting system and spacing **:** As per treatments.

Fertilizer dose and method of application **:** Recommended fertilizer will be applied in each crop as follows.
Wheat: N120P30K50S20B1.5
Maize: N210P60K100S40Zn5B1.5
Rice: N90P30K50S20

Irrigated/Rainfed **:** Irrigated

Data to be recorded **:** (1) Soil nutrient status at initial and final stage, (2) Soil physical and chemical properties (3) Yield and yield attributes, (3) Plant nutrient uptake and use efficiency (5) Soil moisture monitoring at 15 days interval (6) Relevant cost and return analysis

8.Investigator(s) **:** MI Hossain and MNA Siddique

9.Season **:** 2019-20

10.Date of Initiation : November 2019

11.Date of completion April 2020

12.Exp. Output/Benefit : Higher productivity can be obtained from bed planting and soil fertility will be increased.

13.Locations : RWRC, Shyampur, Rajshahi

14.Status : On-going (3rd year)

15.Estimated Cost : Tk. 1,00,000/-

16.Source of Fund : BWMRI

17.Priority : 1

18.Remarks :

1.Programme : Wheat Improvement

2.Project 3 : Crop and Soil Management

Sub-Project 3.1 : Crop Management

Sub-Sub-Project 3.1.1 : **Resource Conservation**

3.Plan/Expt. 3.1.1.3 : **Effect of different tillage options with recently released varieties for sustainable Crop Production in Wheat-Maize-Rice Cropping Pattern**

4.Objective(s) :
i. Toobserved the performance of different tillage options on wheat-maize-rice cropping pattern
ii. To get sustainable potential yield in that systems

5.Rationale : Resource conserving technologies (RCT) are being introduced among the farmers and the farmers are showing interest to grow crop with RCT because, it reduces cultivation cost, protects degrading soil and saves water without any yield sacrifice. Also RCT offers the opportunity to plant wheat timely. Delayed wheat planting reduces yield @ 1.3% per day after Nov. 30. Due to scarcity and high cost of labor and for reducing cultivation cost, RCT is essential for farming. Zero-till, bed planting strip tillage and PTOS tillage options are known as RCT. However, for getting expected crop yields with RCT a full package of production technologies especially fertilizer management should be provided. Broadcasting fertilizer enhances losses of fertilizer and reduces fertilizer use efficiency in RCT tillage options especially in zero-till and bed planting practices. On the other hand, there are many evidences that fertilizer placement increases fertilizer use efficiency than broadcast. The work on fertilizer management with RCT is rare in this country. So, the experiment was undertaken to find out the best fertilizer management practice in RCT tillage options.

6.Materials/Methods : Treatments:
Factor A: Main plot (Tillage options)
1. Zero tillage
2. Strip tillage
3. Raised-bed
4. Conventional

Factor B: Subplot (new varieties)
Wheat- Five varieties
Maize- Five varieties
Rice-Five varieties

Design : Split plot with 3 replications

Plot size : 10×3m

Fertilizer dose and method of application	**:**	Recommended fertilizer will be applied
Irrigated/Rainfed	**:**	Irrigated
Data to be recorded	**:**	i) Physical and chemical properties of the soil *(0-15* and 15-30 cm) ii) Composite soil nutrient status at initial stage iii) Weed species and their biomass after 1 St irrigation iv) Grain growth parameters v) Yield and yield components, harvest index and biomass vi) Grain and straw samples analysis after each crop harvested vii) Economic analysis after completion the work viii) Weather parameters
7.Investigator	**:**	M.Ilias Hossain, T.P Tiwari, M.K. Gathala
8.Status	**:**	On going
9.Date of initiation	**:**	November 2019
10.Date of completion	**:**	April 2020
11.Expected outputs	**:**	It will improve productivity of all crops and the pattern due to efficient utilization of nitrogen, irrigation water and other inputs. Exploitation of the advantages of high fertility in bed planting will be possible, as it enhances lodging resistance. Soil organic matter may be increased after inclusion of mungbean crop and other residues.
12.Location	**:**	RWRC, Rajshahi
13.Status	**:**	On-going (3rd year)
14.Estimated cost	**:**	Tk. 1,50,000/-
15.Source of Fund	**:**	BWMRI
16.Priority	**:**	1
17.Remarks		

1. Programme	**:**	Wheat Improvement
2. Project 3	**:**	Crop and Soil Management
Sub-Project 3.1	**:**	Crop Management
Sub-Sub-Project 3.1.2	**:**	**Rice-Wheat System**
3. Plan/Expt. 2.1.2.1.	**:**	**Increasing wheat yield through integrated management**
4. Objective(s)	**:**	i) to improve existing management technologies for boost up wheat yield ii) to increase wheat yield iii) to increase wheat production of Bangladesh
5. Rationale	**:**	Increasing crop yields is one of the major ways for mitigating the demand of food for burgeoning population from decreasing land of Bangladesh. There was an increasing trend of area and production of wheat up to 1999-2000 and then both were decreasing. Despite a little bit increasing trend in grain yield, farmers became interested to grow more profitable crops (mainly maize and potato) instead of wheat. In recent past years the national average grain yield was reported around 3 t ha^{-1} but the on-station research results revealed that the yield was 3.5-5 t ha^{-1} in different experiments. The yield gap between research and farmers' management and variation in yield in research field can be minimized through proper agronomic and soil and/or fertilizer management. If the grain yield can be boosted up at least close to its potential or maximum achievable yield in Bangladesh condition, wheat will be more profitable since its cultivation cost is less than other *rabi* crops and farmers will be interested again in

wheat. A number of varieties of spring wheat were developed for cultivation in Bangladesh. The yields of irrigated spring wheat of other countries such as China, India and Egypt are higher than Bangladesh wheat. The primary reason is the short winter. The second and main reason is lacking of adequate and improved technologies for achieving more yields in changing climate (or weather) and degrading soil condition. The existing technologies for wheat cultivation were developed in long past, and those were not reached to or are not followed by the farmers properly. The new varieties are of different characters; some have bold, some have medium bold and some have small grains. One the other hand some can produce profuse tillers and some cannot. For obtaining the expected yield of a variety seed rate should be optimum and it is dependent on seed (grain) size and tillering ability. The transformation (or development) of a tiller to an effective tiller (spike) is dependent on soil and fertilizer management. For obtaining higher yield optimum seed rate, proper soil and fertilizer management and other agronomic management should be followed. Seed rate and fertilizer dose should be determined for different new varieties and degrading soil through experimentation. It is necessary to improve wheat production technologies on the basis of experiments' results, and to observe the effect of application those in farmers' fields.

6. Procedure/Methods : On-station experiments will be conducted in 1st 3 years. Optimum seed rate for some new varieties will be determined through conducting experiment in consecutive 1st 2 years. Five varieties/lines will be selected from 8 varieties (BARI Gom 25-32) and some promising lines. The selected varieties and lines will be grown at different seed rate (100, 120, 140 and 160 kg ha^{-1}) in recommended management, and 2-3 varieties will be selected from 1st year's results. This experiment will be repeated in 2nd year for confirmation. In 2nd and 3rd year soil sample from research field will be collected and analyzed before wheat season. If needed soil amendment will be done. One fertilizer dose will be selected based on soil analysis results and another dose will be with an extra 25% amount of fertilizers. The selected varieties will be grown at 2 seed rates (optimum and higher) in 2 fertilizer doses in 2nd year. This experiment will be repeated in 3rd year for confirmation. Fertilizer dose and seed rate for wheat will be determined on the basis of experiment results. For on-farm demonstration 15 farmers will be selected from 3 Upazillas of Thakurgaon district in 4th year. Soil sample from selected farmers' fields will be collected and analyzed before wheat season. Training for the selected farmers will be conducted. An area of 20 decimal from each farmer will be sown with a seed rate and fertilizer dose for higher yield of wheat. Other proper soil and agronomic management will be followed. Three field days will be organized just before harvesting to show the results of demonstration.

First Year (2017-18):

Design:RCB with 3 replications
Factor A: Wheat variety/line-
BARI Gom 25, 26, 28, 30/32 and BAW 1260
Factor B: Seed rate-
120, 140 and 160 kg ha^{-1}
Unit plot size: 4×5 m
Data to be recorded: Yield and yield attributes

Second Year (2018-19):

1st experiment: Repetition of the 1st year experiment.
2nd experiment:
Design: Split-split-plot with 3 replications
Factor A (main plot): Wheat variety/line- 2/3
Factor B (sub-plot): Fertilizer management- (1) 100% of recommended fertilizers + CD (5 t ha^{-1}), and (2) 125% of recommended fertilizers + Zn + CD (10 t ha^{-1}).
Factor C: Seed rate- will be selected from 1st year.
Unit plot size: 3×4 m
Data to be recorded:(1) Nutrient status and (2) Yield and yield attributes

Third Year (2019-20):
Repetition of the 2nd year experiment of 2nd year.
Fourth Year (2020-21):
On-farm demonstration of the results against farmers' management.

7. Investigator(s) : M.A.Z. Sarker, Akbar Hossain and M. Israil Hossain (Dinajpur), M. Asaduzzaman (RARS, Jamalpur)

8. Season : *Rabi*, 2017-18 to 2020-21

9. Date of Initiation : November, 2018

10. Exp. Output/Benefit : It will be possible to determine optimum seed rate for a variety and fertilizer dose for expected/more wheat yield. New technologies for wheat production can be familiar through demonstration. 10-26% higher yield will be obtained from improved production technologies than farmers' management.

11. Locations : BWMRI, Dinajpur& RARS, Jamalpur (2018-19 to 2019-20) and On-farm, Thakugaon (2020-21)

12. Status : On-going

13. Estimated Cost : Tk. 1,00,000/- (3rdyear)

14. Source of Fund : BWMRI

15. Priority : 1

16. Remarks :

1. Programme : **Wheat Improvement**

2. Project 3 : **Crop and Soil Management**

Sub-Project 3.1 : **Crop Management**

Sub-Sub-Project 3.1.2 : **Rice-Wheat System**

3. Plan/Expt. 3.1.2.2. : **Evaluation of different herbicides to control weeds in maize field**

Objective (s) : 1. To find out a suitable herbicide for Maize
2. To determine the efficiency of different herbicides

Rationale /justification : Maize (*Zea mays*) stands third in position of consumption among cereal crops in Bangladesh. Hybrid maize has been introduced in Bangladesh due to its yield potentiality, therefore the area and production of hybrid maize is increasing day by day in Bangladesh. Although the potential yield of hybrid maize is high but the yield is lower at farmer's field. Among many reasons, weeds are one of the most important responsible factors limiting maize production in Bangladesh. Weeds cause enormous losses to crops even more than other pest worldwide that on an average, 37.3% of crop produce is damaged if weeds are not controlled in Bangladesh. Weed infestation caused 12.8 to 29.2% yield loss in maize. Therefore, weeding should be done to ensure optimum grain yield. Moreover, during *kharif* (dry)

season weeds grow vigorously and compete with the crop for nutrients, space and solar radiation resulting in yield reduction. So, weed management may help in reducing the crop weed competition and increase opportunity for plant to absorb more nutrients. Thus weed control at proper stage improve the productivity.

Weed control in maize is carried out by mechanical and/or chemical methods. Although both methods are effective in controlling weeds but they increase production costs and have some disadvantages or side effects when applied intensively. Therefore this experiment was carried out to find out the proper agronomic management along with both pre and post emergence herbicides to reduce the costs and risks of intensive weed control in maize field.

Materials and Methods

Crop : Maize

Variety : BARI Hybrid Maize 16

Treatments :
1. Calaris Xtra 27.5 SC @ 6 ml/L
2. G-Maize 50 Sc @ 5 ml/L
3. Joankana @ 5 ml/L
4. Triojin 55 SC @ 4 ml/L
5. Zin Force 80% WFP @ 4 g/L
6. Hand weeding at 25 DAS
7. Weedy check/control

Design : RCB

Replications : 3

Unit plot size : 4 m x 4 m

Fertilizer dose : FRG'12 Recommended dose

Data to be collected : No. of different weed species (broadleaf, sedge and grass), fresh and dry wt./m^2 of different weed species, WCE (%), yield and yield attributes of wheat and economic performance

Expected output : A suitable herbicide will be identified to control weeds for increasing maize yield and quality

Status : New

Date of initiation : November 2019

Date of completion : May 2021

Estimated cost : Tk. 30,000/-

Source of fund : BWMRI

Location(s) : BWMRI, Dinajpur

Investigator(s) : M.M. Bazzaz, M.A.Z. Sarker, A. Hossain and M.M. Akhtar

1. Programme : Wheat Improvement

2. Project 3 : Crop and Soil Management

Sub-Project 3.1 : Crop Management

Sub-Sub-Project 3.1.2 : **Rice-Wheat System**

3. Plan/Expt. 3.1.2.3. : **Development of fertilize recommendation for hybrid maize in Kharif season**

Objective :
i. To find out the optimum and economic fertilizer dose for kharif maize
ii. To sustain the soil fertility and productivity

Rationale : In Bangladesh, hybrid maize is grown mostly in Rabi season during November-April. Recently, the area of Kharif-I (March-June) maize,

mainly after the harvest of potato, is increasing. Most of the farmers grow hybrid maize with improper fertilization in Kharif season. As a result, maize yield varies from one farmer to another. FRG'12 mention that fertilizer dose of Rabi maize can be reduced by 30% when the crop is grown in Kharif season. But farmers who are using higher doses of fertilizer, harvest higher maize yield. However, the highest productivity of maize in sustainable manner without deteriorating the soil and other natural resources could be achieved only by applying appropriate combination of organic and inorganic fertilizers. Therefore, the trial is under taken to determine the nutrient requirement in hybrid maize during Kharif Season.

Materials and Method :
Crop : Maize
Variety : BWMRI Hybrid maize 9
Treatments : T_1 = STB Chemical fertilizer dose for Rabi
T_2 = 85% of T_1 + cowdung 5 t ha^{-1}
T_3 = 70% of T_1 + cowdung 5 t ha^{-1}
T_4 = IPNS of T_2 with 5 t ha^{-1} cowdung
T_5 = IPNS of T_3 with 5 t ha^{-1} cowdung
T_6 = IPNS of T_1 with 5 t ha^{-1} cowdung
Design : RCB
Replications : 3
Unit Plot size : 3 m x 4 m
Spacing : 60 cm x 20 cm
Fertilizer dose andApplication method : As per treatment
Data to be collected : Soil properties, yield and yield contributing attributes, economic performance, disease and insect infestation
Expected output : Economic fertilizer dose for kharif hybrid maize will be identified. Maize yield will be increased.
Status : New
Date of initiation : Kharif season 2019
Date of completion : July 2021
Estimated cost : 40,000/-
Source of fund :
Location (s) : BWMRI, Dinajpur
Investigator(s) : M.M Akhtar, A. Hossain, M.M Bazzaz, M.A.Z Sarker and M.Bodruzzaman

1. Programme : Wheat Improvement
2. Project 3 : Crop and Soil Management
Sub-Project 3.1 : Crop Management
Sub-Sub-Project 3.1.2 : **Rice-Wheat System**
3. Plan/Expt. 3.1.2.4. : **Integrated fertilizer management on soil fertility and productivity of Wheat -T. Aus –T. Aman cropping pattern**
4. Objective(s) :
i. To find out a suitable combination of vermicompost with chemical fertilizers for growth and yield of wheat, and
ii. To sustain the soil fertility and productivity
5. Rationale : In Bangladesh most of the soils have less than 1.5%, and some soils even less than 1% organic matter (FRG 12). As a result, excessive use of chemical fertilizers decline soil and food quality in conventional farming systems (Singh *et al*., 2007; Melero*et al*., 2008; Liu *et al*., 2009). Therefore must be considered a good alternative for these types of fertilizers (Kochaki*et al*. 2008). One solution could be the use of

vermicompost organic manure. Vermicomposts are organic materials broken down by interactions between microorganism and earthworms with low C:N ratios. Vermicompost contains an average of 1.5% - 2.2% N, 1.8% - 2.2% P and 1.0% - 1.5% K. The organic carbon is ranging from 9.15 to 17.98 and contains micronutrients like Sodium (Na), Calcium (Ca), Zinc (Zn), Sulphur (S), Magnesium (Mg) and Iron (Fe). Vermicompost provides all nutrients in readily available form and enhances uptake of nutrients by plants. It improves soil structure, texture, aeration and water holding capacity and prevents soil erosion.

On the other hand, neither inorganic fertilizers nor organic manures alone can improve soil health and productivity. The positive effect of judicious use of organic and inorganic fertilizers on productivity of crops and soil fertility has been reported by many workers (Baishya*et al.*, 2015; Singh *et al*., 2015 and Kundu*et al*., 2016). However, little information is available on suitable combination of vermicompost with chemical fertilizer on the soil fertility, plant growth and yield of component crops in Wheat-T. aus - T. aman cropping patterns. Therefore, the present study was under taken (1) to find out a suitable combination of vermicompost with chemical fertilizers for growth and yield of crops and (2) to sustain the soil fertility and productivity.

6. Procedure/Methods : **Crop:**Wheat, T. Aus and T. Aman

Variety: Wheat var. BARI Gom 30, T. Aus var. BRRI dhan-48, T. Aman var. BRRI dhan-49

Treatments:

T_1 = STB Chemical fertilizers
T_2 = IPNS with 5 t ha^{-1} cowdung based on T_1
T_3 = IPNS with 3 t ha^{-1} poultry manure based on T_1
T_4 = IPNS with 1.0 t ha^{-1} vermicompost based on T_1
T_5 = IPNS with 2.0 t ha^{-1} vermicompost based on T_1
T_6 = IPNS with 4.0 t ha^{-1} vermicompost based on T_1
T_7 = Native fertility/control

Design: RCB with three replications
Plot size: 4 m x 4 m
Fertilizers: As per FRG 2012

Data to be recorded:

Dates of all operation
Soil properties
Yield and yield contributing characters
Major disease and insect incidence

7. Investigator(s) : M.M. Bazzaz, A. Hossain, M.A.Z. Sarker, M.N. Alam and M. Bodruzzaman

8. Season : Rabi 2018

9. Date of Initiation : November 2018

10. Date of completion April 2020

11. Exp. Output/Benefit : Soil fertility and productivity will be increased by using vermicompost. The wheat yield will be increased 10-15% and the production will be economically profitable.

12. Locations : BWMRI, Dinajpur

13. Status : New

14. Estimated Cost : 50,000/-

15. Source of Fund : BWMRI

16. Priority :

17. Remarks :

Project 3	**:**	Crop and Soil Management
Sub-Project 3.1	**:**	Crop Management
Sub-Sub-Project 3.1.3	**:**	**Physiological Studies**
Experiment 3.1.3.1	**:**	**Study the performance of some selected wheat genotypes in southern Bangladesh**
Objective(s)	**:**	To observe the yield performance of wheat genotypes in saline soils
Rationale	**:**	Wheat is the second most important grain crop after rice in Bangladesh grown over an area of about 0.43 million hectares with an annual production of about 1.4 million metric tons which is much less than that of country's need of 5.5 million metric tons. To fulfill current and future demand it is essential to improve wheat productivity and production. Now-a-days, the scope of expanding wheat in traditional area is very limited due to competition with other crops at rabi season. So wheat has to be expanded in non-traditional area. A vast non-traditional area nearly 0.84 million hectares remains fallow in winter in southern Bangladesh affected by varying intensities of salinity. Some part of that non-traditional area may be brought under wheat cultivation at rabi season. Introduction of salt tolerant wheat varieties for overcoming the salinity problem has been considered the most feasible and economic than management and it has recently received much attention. Screening is the most important procedure to find out the salt tolerant genotypes of crops from available germplasm and this screening under field condition is more appropriate because of facing more heterogeneous soil conditions by crops under filed situation.
Materials and methods	**:**	Six trials will be conducted in three locations.
Crop/genotype	**:**	Crop- Wheat, Genotypes-24
Design	**:**	4 x 6 RCB
Plot size	**:**	2.5m x 0.8m
Planting system/spacing	**:**	Line sowing. Row to row distance 20 cm
Fertilizer dose and methods of application	**:**	BARI- recommended
Irrigated/rainfed	**:**	Irrigated
Data to be recorded	**:**	Salinity monitoring, phenology, growth, yield and yield attributes
Investigator(s)	**:**	MM Khan, G. Faruq, MM Rahman, MAZ Sarker, MA Hakim and M Israil Hossain
Season	**:**	Rabi, 2019-2020
Date of Initiation	**:**	November, 2017
Date of completion	**:**	March, 2020
Expt. output/benefit	**:**	Selected genotype will help in salt tolerant variety development
Location	**:**	3 (Patuakhali; Khulna and Satkhira)
Status	**:**	On-going (3rd year)
Estimated cost	**:**	1,50,000/-
Source of fund	**:**	BWMRI
Priority	**:**	1

Programme : Wheat Improvement

Project 3 : Crop and Soil Management

Sub-Project 3.1 : Crop Management

Sub-Sub-Project 3.1.3 : Physiological Studies

Experiment 3.1.3.2 : **Response of newly evolved wheat varieties to sowing dates**

Objective(s) :
i. To examine the impact of inter- and intra- seasonal temperature variation on wheat performance stability
ii. To identify suitable wheat genotypes for appropriate sowing dates considering agronomic performance, yield response, disease incidence, etc.

Rationale : In Bangladesh, wheat is ranked as the second most important cereal after rice and plays an important role in meeting the country's target of achieving food security for an ever-increasing population (Timsina et al., 2016). It is grown in large areas of 130,768 ha in 2015-16 in the North-Western part of Bangladesh (BBS, 2016). According to the report of BBS (2016), 1.35 million tons of wheat was harvested from 0.44 million ha in 2015-16, of which 30.65% was in Northern Bangladesh (or Old Himalayan Piedmont Plain only). However, average yield of wheat was only 3.03 t h^{-1} in 2015-16 (BBS, 2016), compared to the global average wheat yield (3.07 t ha^{-1}) for the same year (Statista, 2016).

Optimum seeding time is considered to be an important management strategy for improving wheat grain yield (Hossain and Teixeira da Silva, 2012). This is particularly important because it is under the control of farmers (Slafer and Satorre, 1991; Laghari*et al*., 2011). Optimum time for sowing of wheat in Bangladesh is between mid-November and first week of December (Hossain and Teixeira da Silva, 2012), due to its own definite requirements for temperature and light for emergence, growth and flowering (Hossain *et al*., 2013). But, about 85% of the total wheat area follows previous rice crop (Saunders, 1991) and over 60% of the total wheat crop is cultivated at late sowing conditions (Badruddin*et al*., 1994). In the north-western part of the country, where high lands generally remain fallow after aus rice or jute cultivation, seeding of wheat can be done in early November (which can induce early sowing heat stress condition). In some areas where wheat is followed by transplant aman rice or soil remains wet due to excessive rainfall, seeding is continued up to January (terminal heat stress condition) (BARI 2013).

Too early sowing can produce weak plants with poor root systems. Temperature above optimum leads to irregular germination and the embryo frequently dies and the endosperm may undergo decomposition due to activities of bacteria or fungi. In late planting, the wheat variety should be short duration that may escape from high temperature at the grain filling stage (Phadnawis and Saini, 1992). Ansary*et al.* (1989) reported that a delay in sowing suppressed yield, caused by reduction in the yield contributing traits like number of tillers, number of grains $spike^{-1}$ and grain yield. Rajput and Verma (1994) observed that normal sowing gave higher grain yield than late sowing. Early sowing always produces higher yield than late sowing. Each day delay in sowing from 20th November decreases grain yield @ 39 kg ha^{-1} per day (Singh and Uttam 1999). Ahmed (1986) also reported that about 1.3% reductions in day of December. The adverse effect of temperature could be minimized by adjusting sowing time to an optimum date and to find out

heat tolerant genotypes, which are suitable for late and very early sown conditions to ensure high grain yield.

Recently, some advanced wheat genotypes were released as varieties by Wheat Research Center of Bangladesh Agricultural Research Institute. These varieties were developed for optimum as well as late sown conditions, i.e., these genotypes have some heat tolerant characteristics (BARI, 2016). The newly developed varieties need to be evaluated for their agronomic performance under different environmental conditions. Therefore, the present study was undertaken to evaluate the performance of newly released varieties under different high temperature stress in early and late sown conditions, to find out the suitable variety for optimum and late sown condition, to find out heat tolerant and heat sensitive variety and to find out the optimum sowing time for a specific variety.

Materials and methods :

Crop/genotype : Six wheat genotypes

Design : Split-Plot design with 3 Replications

Main plots: 5 Sowing dates.

Nov. 25, Dec. 05, Dec. 15, Dec. 25 & Jan. 04

Sub plots: 6 Wheat Genotypes.

BARI Gom 26, BARIGom 28, BARI Gom 30, BARI Gom 31, BARI Gom 32, BARI Gom 33, WMRI 1

Plot size : 3x2 m (3m long 10 rows) (6 m^2 each sub plot)

Planting system/spacing : Seeds will be sown continuously at 120 kg ha^{-1} except BARI Gom 33 (140 kg ha^{-1}) with 20 cm row to row distance.

Fertilizer dose and methods of application : Fertilizers will be applied at doses recommended by theBARI: 100-27-40-20-1 kg ha^{-1} of N (nitrogen)-P (phosphorus)-K (potassium)-S (sulphur)-B (boron). Two-thirds of N and a full amount of the other fertilizers will be applied as a basal in final land preparation. The remaining N fertilizer will be applied immediately before the first irrigation {17-21 days after sowing (DAS)}.

Irrigated/rainfed : 3 light irrigations: first irrigation at 17-21 DAS (at crown root initiation), Second and third irrigations will be applied at booting (50-55 DAS) and grain-filling (70-75 DAS) stages.

Data to be recorded :

(1) Previous crop history as well as record (kg/m^{-2}) residue of previous crop

(2) Soil properties, soil nutrient status (before sowing and after harvesting) and moisture status immediately sowing.

(3) **Key phenology dates:** sowing, emergence, crown root initiation, first tiller, booting, flowering/anthesis and physiological maturity

(4) Initial plant population at 12 DAS (80% emergence) as well as tillers m^{-2} at 30 & 45 DAS: These data will be recorded from 1m long 5 marked rows in every plot.

(5) **Biomass cut:**

- 1 m^2 at mid-vegetative, booting/awn-peep stage, anthesis and physiological maturity stage (kg/ha total)
- Mass stems, leaves, storage organs, roots (dead & live)
- Stem number/tillers count
- LAI

(6) **Yield and yield attributes:** Crop will be harvested plot-wise at full maturity while sample plants will be harvested separately. The harvested crop of each plot will be bundled separately, tagged and

threshed on a threshing floor after thoroughly drying the bundles in bright sunshine and weighing them.

Then, data on plant height (cm), spikes m^{-2}, spikelets $spike^{-1}$, grains $spike^{-1}$, 1000-grain weight (g), grain and biomass yield (t ha^{-1}), harvest index (%) will be recorded. To obtain the actual yield of all varieties, grain yield and 1000-grain weight will be adjusted at 12% moisture.

General comments:

1. Management like seed rate, seed source, sowing time, fertilizers rate and application methods, amount of irrigation and time of irrigation, weed management should same for all locations.
2. We have to record/collect pedigree of all genotypes
3. Daily weather data like max and min temperature, rainfall, humidity and sunshine hrs. We have to collect historical weather data (about 30 yrs) for simulation analysis.
4. We have to ensure leaf area meter for LAI and oven for dry biomass
5. For APSIM modeling, we need N data as $NO3^-$ (wet condition) and $NH4^+$ (dry cultivation like wheat)

Investigator(s) : Akbar Hossain, Tim Krupnik (CIMMYT), MAZ Sarker& M. Israil Hossain (BARI, Dinajpur); MI Hossain, AA Khan (RBARI, Rajshahi), Rabiul Islam, Babul Anwar, MS Islam (RARS Jessore)

Season : Rabi, 2019-2020 (with Aman crop management to follow in the next protocol)

Date of Initiation : November, 2019

Date of completion : March, 2020

Expt. output/benefit : Updated data on yield decline rates with different varieties as a function of sowing date. This trial will also permit advanced G × E × M analysis. This information will help to plan new research program for developing wheat varieties, which are able to produce adequate and stable yield under varying climatic conditions with minimum or no disease infection.

Location : BWMRI, Dinajpur; RWRC-BWMRI, Rajshahi; RARS, Jessore

Status : On-going (3rd year)

Estimated cost : 7,50,000/- (2,50,000/-/per location per year, including Aman crop)

Source of fund : CIMMYT-CSRD/BWMRI

Priority : 1

Programme : Wheat Improvement

Project 3 : Crop and Soil Management

Sub-Project 3.1 : Crop Management

Sub-Sub-Project 3.1.3 : Physiological Studies

Experiment 3.1.3.3 : **Screening of wheat genotypes against salinity at seedling stage**

Objective(s) : To select the wheat genotypes tolerant to salinity

Rationale : Salinity is one of the major limitations to wheat production worldwide including southern Bangladesh. Salinity stress exerts a negative influence on wheat production and reduces the yield (Ghane*et al*., 2011; Parida and Das, 2005). There is a lot of demand for wheat in Bangladesh and increasing day by day but production is very low compared to demand. According to BBS (2016), against

the demand of around 6.0 MT, wheat production is only about 1.35 million MT in Bangladesh. Therefore the production needs to be increased to meet the current and future demand. Now-a-days, the scope of expanding wheat in traditional area is very limited due to compete with other crops at rabi season (Rafiq*et al.*, 2005). So, to increase wheat production, we have to go to non-traditional areas. A vast area nearly 0.84 million hectares cultivable land remains fallow in rabi dry season in southern Bangladesh affected by varying intensities of salinity (Karim *et al*., 1990). Rainfed dry season cropping in such lands is dominated by the pulses, nonetheless where limited irrigation is possible, wheat cultivation is profitable low risk option. Therefore, we need salt tolerant wheat varities for overcoming the salinity problem for wheat cultivation which has been considered the most feasible and economic. Wheat is moderately salt tolerant crop (Maas and Hoffmann, 1977; Munns*et al*., 2006) and salt tolerance in wheat may vary with the growth stages (Kingsbury and Epstein, 1984; El-Hendawy*et al*., 2005) and also it is reported that seedling stage is less tolerant against salinity among the growth stages (Maas and Poss, 1989). Screening is the most important procedure to find out the salt tolerant genotypes of crops from available huge germplasms at seedling stage under laboratory condition than field condition. Then we can go for fine tuning against salinity in adaptive trial in coastal region with selected materials from this laboratory trial. Therefore, comparison of large number of genotypes for seedling growth can provide useful information about the salt tolerance potential of screened material which will be useful for breeding salt tolerant cultivar or introducing the screened material for cultivation on salt-affected soils.

Materials and methods : Seedlings will be grown in hydroponic in the laboratory. Seawater will be used as salt solution

Crop/genotype : Crop- Wheat, Genotypes-50

Design : Factorial CRD
Replication: 3
Treatment: 3
Salinity level:
i. Tap water (Control)
ii. 8 dS m^{-1} and
iii. 12 dS m^{-1}
Saline water used will be diluted from sea water

Plot size : N/A

Planting system/spacing : N/A

Fertilizer dose and methods of application : Nutrient application through Hoagland solution

Irrigated/rainfed : N/A

Data to be recorded : Germination percentage, Shoot & Root length, Shoot fresh weight, Shoot & Root dry weight, Na and K concentration in root and shoot

Investigator(s) : MM Khan, G. Faruq, MM Rahman, M A Hakim and M Israil Hossain

Season : Rabi, 2019-20

Date of Initiation : November, 2017

Date of completion : March, 2020

Expt. output/benefit	**:**	Selected genotype will help in salt tolerant variety development
Location	**:**	BWMRI, Joydebpur, Gazipur
Status	**:**	On-going (4th year)
Estimated cost	**:**	50,000/-
Source of fund	**:**	BWMRI
Priority	**:**	1

B: REGIONAL PROGRAMME

Programme : Wheat Improvement
Project 3 : Crop and Soil Management
Sub-Project 3.1 : Crop Management
Sub-Sub-Project 3.1.1 : **Resource Conservation**
Plan/Expt. 3.1.1.4 : **Weed management of Wheat-Mungbean-Rice cropping pattern in CA at drought prone Rajshahi region**

Objective(s) :
i. To find out the effective and sustainable weed control measurements on CA
ii. To get sustainable potential yield for controlling weeds under CA

Rationale : Conservation agriculture (CA) has been said to result in sustainable farming systems because of saving on time economic inputs and preserving natural resources. There has been an increasing trend toward CA to enhance sustainability without compromising land productivity over the last decade in South Asia. However, adoption of CA influences by different weed populations. Weed control is a greater challenge to achieve the success of CA. The behavior of weeds under CA is complex and not fully understood. Generally, in CA weed seed bank remains at the surface soil. Weed seeds at soil surface are more prone to withering. In addition, crop residues are pillar of CA could suppress or delay weed emergence and allow the crop to gain early vigor over weeds. Further, crop residues may also intercept a considerable proportion of pre-emergence herbicides may result in lower herbicide efficacy. However, it is critical to control weed to achieve the success of CA in Bangladesh. Still now less effort has been taken for managing weed and improving crop yields in South Asia.

Materials/Methods : Treatments:

Factor A (Tillage options):
1. Strip tillage
2. Zero tillage
3. Permanent bed
4. Minimum tillage
5. Convention tillage

In case of rice crop, unpuddled transplanting method was used for strip tillage, zero tillage and bed planting. About 30% crop residue was recycled for different tillage treatment.

Factor B: (weed management options):
Weed management options varied in different crops. The weed management treatment combinations was detailed below-

Treatment	Wheat	Mungbean	Rice
WM_1	Pre-plant: Glyphosate	Pre-plant: Glyphosate	Pre-plant: Glyphosate (Roundup)

	(Round- up)	(Roundup) Pre-emergence: Sunrise	Pre-emergence: Bensulfuron methyl+ Acetachlor (Nirmul-18WP)
WM_2	Post emergence: Carfentrazone- ethyle (Affinity)	Post emergence: Fenoxaprop-ethyl (Whisopher)	Post-emergence: Bensulfuronmethyl+Bispyribac Sodium (Sirious Plus 300 WP)
WM_3	Hand weeding at 25-30 DAS	Hand weeding at 15- 20 DAS	Hand weeding at 30-35 DAS
WM_4	Absolute control	Absolute control	Absolute control

Design : Split plot with 3 replications
Plot size : 10m×3m
Fertilizer dose and method of application : Recommended fertilizer will be applied
Irrigated/Rainfed : Irrigated
Data to be recorded : i) Weed species and their biomass after 1st irrigation and 45 DAS
ii) Observation on crops after spraying weedicides if any changes
iii) Phonological parameters
iv) Grain growth parameters
v) Yield and yield components, harvest index and biomass
vii) Economic analysis after completion the work
viii) Weather parameters
Investigator : M IliasHossain, MZ Hossain, TP Tiwari, MKGathala
Season : 2019-20
Date of initiation : November 2019
Date of completion : April 2020
Expected outputs : It will improve productivity of all crops and the pattern to controlling weeds and efficient utilization of nitrogen, irrigation water and other inputs. Increase crops yield through weed management in the pattern.
Location : RWRC, Rajshahi
Status : New
Estimated cost : Tk. 1,00,000/-each location
Source of Fund : BWMRI
Priority : 1
Remarks

Programme : Wheat Improvement
Project 3 : Crop and Soil Management
Sub-Project 3.1 : Crop Management
Sub-Sub-Project 3.1.1 : **Resource Conservation**
Plan/Expt. 3.1.1.5 : **Effect of fertilizer doses with biochar on soil fertility and crop productivity of wheat-maize-rice cropping pattern in drought prone area**
Objective(s) :
i. To determine the optimum doses of wheat-maize-rice cropping pattern with Boichar application
ii. To evaluate the effect of biochar to improving the system productivity and
iii. 3. To study the change in soil properties over time in the intensified cropping patter

Rationale : Biochar is defined simply as charcoal that is used for agricultural purposes. It is created using a pyrolysis process, heating biomass in a low oxygen environment. Once the pyrolysis reaction has begun, it is

self-sustaining, requiring no outside energy input. Byproducts of the process include syngas (H2 + CO), minor quantities of methane (CH4), tars, organic acids - and excess heat. Once it is produced, biochar is spread on agricultural fields and incorporated into the top layer of soil. Biochar has many agricultural benefits. It increases crop yields, sometimes substantially if the soil is in poor condition. It helps to prevent fertilizer runoff and leeching, allowing the use of less fertilizers and diminishing agricultural pollution to the surrounding environment. It retains some moisture, possibly helping plants through periods of drought more easily. Most importantly, it replenishes exhausted or marginal soils with organic carbon and fosters the growth of soil microbes essential for nutrient absorption. Studies have indicated that the carbon in biochar remains stable for millenia, providing a simple, sustainable means to sequester historic carbon emissions that is technologically feasible in developed or developing countries alike. The syngas and excess heat can be used directly or employed to produce a variety of biofuels.

When biochar is created from biomass, approximately 50% of the carbon that the plants absorbed as CO2 from the atmosphere is "fixed" in the charcoal. As a material, the carbon in charcoal is largely inert, showing a relative lack of reactivity both chemically and biologically, and so it is strongly resistant to decomposition. Research scientists have found charcoal particles as old as 400 million years in sediment layers from wildfires that occurred when plant life first began on earth. *(Sediment Records of Biomass Burning and Global Change, James Samuel Clark)* of the many organic and inorganic substances that contain carbon atoms, only diamonds could potentially provide a more permanent carbon store than charcoal. Hence, biochar offers us a golden opportunity to remove excess CO2 from the atmosphere and sequester it in a virtually permanent and environmentally beneficial way.

Land degradation and soil fertility decline are among the main causes of the stagnation and fall of agricultural production in many tropical countries, including those with intensive irrigated cropping systems. Inclusion of maize in the dry-wet transition of rice-wheat cropping system as a third crop may be another options of increasing cropping intensity, soil fertility and productivity of the system. Although the non-rice season across the rice-wheat area is low rainfall, heavy pre-monsoonal rain can have disastrous effects on the third crop, such as maize grown after wheat or before rice, both during establishment and grain filling because of water logging (Timsina and Connor, 2001; Quayyam*et al.,* 2002). Crop residues are an important source of soil organic matter vital for the sustainability of agricultural ecosystems. About 25% of N and P, 50% of S and 75% of K uptake by cereal crops is retained in crop residues, making them valuable nutrient sources (Singh 2003). However, straw retention is not a common practice in the RW systems of Bangladesh, as is also the case elsewhere in SouthAsia. Wheat and rice straw are usually removed from fields for use as cattle feed and for purposes such as livestock bed ding, thatching material for houses or for fuel, leaving little for incorporation into the soil. Due to the limited number of livestock, farmers throughout the IGP have access to very limited amounts of organic manure. As a result, soil organic matter levels have declined in these cropping systems, and optimization of nutrient uptake and absorption efficiency has become one of the most important goals in crop production strategies. Limon-Ortega *et al*. (2000) observed that permanent beds with straw retention

had the highest mean wheat grain yields (5.57 t/ha), N use efficiency (28.2 kg grain/kg of N supply) and total N uptake (133 kg/ha), with positive implications for soil health. Thus, crop residue management along with efficient fertilizers dosess, are likely to be key components of new farming practices that can increase and maintain yields from the intensive RW system in Bangladesh. Potassium is one the key limiting nutrients for plant growth and development. Due to intensive cropping mining of potassium from soil reserves is now a great concern to researchers. Removal of potassium through crop harvest and non-recycling of crop residues is being posed a thread for sustainable crop production in the country. Though silica is not considered as essential plant nutrient, many researches claims that it gives substantial resistance capacity to plants against stress conditions including pest and disease. Kaya et al. (2006) also reported this element helps to improve yield traits and yield of crops through contribution of potential physiological process. Biochar (after burning of crop residues) is now available in Bangladesh is considered a good source of all nutrients and silica. Climate change induces different stress at farming environment.

Materials/Methods : Treatments:
T1=Control
T2=Recommended Fertilizer
T3= 90%+Recommended Fertilizer+ Biochar 1 t/ha
T4= 80%+Recommended Fertilizer+ Biochar 2 t/ha
T5= 70%+Recommended Fertilizer+ Biochar 3 t/ha

Design : RCB with 3 replications
Plot size : 5 m×3m
Fertilizer dose and method of application : Recommended fertilizer will be applied
Irrigated/Rainfed : Irrigated
Data to be recorded : i) Initial soil sample collection and analysis nutrients
ii) Phonological parameters
iii) Grain growth parameters
iv) Yield and yield components, harvest index and biomass
v) Economic and nutrient balance analysis after completion the work
vi) Weather parameters
Investigator : M Ilias Hossain, M Mahbub, M MAlam, M Z Islam, M Gathala
Season : 2019-20
Date of initiation : November 2019
Date of completion : April 2020
Expected outputs : Determine optimum doses of fertilizers with biochar added in the pattern. It will improve soil fertility and productivity of all crops. Improve nutrient balanced and soils
Location : RWRC, Rajshahi
Status : New
Estimated cost : Tk. 1,00,000/-
Source of Fund : BARI, BARI
Priority : 1
Remarks

Programme	**:**	Wheat Improvement
Project 3	**:**	Crop and Soil Management
Sub-Project 3.1	**:**	Crop Management
Sub-Sub-Project 3.1.2	**:**	**Rice-Wheat System**
Expt. 3.1.2.5.	:	**Development of fertilize recommendation for hybrid maize in Kharif season**
Objective	:	iii. To find out the optimum and economic fertilizer dose for kharif maize iv. To sustain the soil fertility and productivity
Rationale	:	In Bangladesh, hybrid maize is grown mostly in Rabi season during November-April. Recently, the area of Kharif-I (March-June) maize, mainly after the harvest of potato, is increasing. Most of the farmers grow hybrid maize with improper fertilization in Kharif season. As a result, maize yield varies from one farmer to another. FRG'12 mention that fertilizer dose of Rabi maize can be reduced by 30% when the crop is grown in Kharif season. But farmers who are using higher doses of fertilizer, harvest higher maize yield. However, the highest productivity of maize in sustainable manner without deteriorating the soil and other natural resources could be achieved only by applying appropriate combination of organic and inorganic fertilizers. Therefore, the trial is under taken to determine the nutrient requirement in hybrid maize during Kharif Season.
Materials and Method	:	
Crop	:	Maize
Variety	:	BARI Hybrid maize 9
Treatments	:	T_1 = STB Chemical fertilizer dose for Rabi T_2 = 85% of T_1 + cowdung 5 t ha^{-1} T_3 = 70% of T_1 + cowdung 5 t ha^{-1} T_4 = IPNS of T_2 with 5 t ha^{-1} cowdung T_5 = IPNS of T_3 with 5 t ha^{-1} cowdung T_6 = IPNS of T_1 with 5 t ha^{-1} cowdung
Design	:	RCB
Replications	:	3
Unit Plot size	:	3 m x 4 m
Spacing	:	60 cm x 20 cm
Fertilizer dose andApplication method	:	As per treatment
Data to be collected	:	Soil properties, yield and yield contributing attributes, economic performance, disease and insect infestation
Expected output	:	Economic fertilizer dose for kharif hybrid maize will be identified. Maize yield will be increased.
Status	:	New
Date of initiation	:	Kharif season 2019
Date of completion	:	July 2020
Estimated cost	:	40,000/-
Source of fund	:	
Location (s)	:	BARI, Dinajpur
Investigator(s)	:	MM Akhtar, MM Bazzaz, MAZ Sarker, M Bodruzzaman

Programme : Wheat Improvement

Project 2 : Crop and Soil Management

Sub-Project 2.1 : Crop Management

Sub-Sub-Project 2.1.2 : **Rice-Wheat System**

Expt. 2.1.2.6. : **Effect of time and pattern of leaf cutting on maize yield**

Objective :
i. To determine the effects of different times of leaf cutting on maize yield
ii. To investigation the role of any part of canopy leaves

Rationale : Corn yield is strongly depended on leaf area index, leaf area duration and leaves efficiency for absorption of solar radiation for photosynthesis process [17]. In addition to leaves other chlorophyll-containing organs such as stems, parts of inflorescences and fruits can also significantly be effective in supplying carbon and thus be able to change pattern of preparation and distribution of materials [24]. Carbohydrates for grain filling supply from current photosynthesis and the transfer of temporary reserves from stems, leaves, cob and ear pods [4]. The above leaves of maize attribute more assimilate to upper organ and below leaves transfer more production to the roots [12]. Middle leaves of the stem have most important role than the other leaves because of greater surface and active participation in the photosynthesis. In this research, defoliation of all leaves was result in the least grain yield compared to control due to decrease in grain weight and filled grain percentage [1]. Borras and Otegui [4] found that hybrids have different ability to maintain seed weight loss in the time of the source to sink ratio change. The aim of this research was to determine the effects of different levels of defoliation on yield components and grain quality of three corn cultivars.

Materials and Method :

Crop : Maize

Variety : BARI Maize 9

Treatments : Treatment
(A) Time of leaf cutting (120, 130 and 140 Days after sowing)
(B) Pattern of leaf cutting -
1. Control (no cutting)
2. All leaves
3. All leaves above the ear
4. All leaves below the ear
5. All leaves except the ear leaf
6. All leaves except the ear leaf and adjacent 2 leaves above the ear
7. All leaves except the ear leaf and adjacent 2 leaves below the ear

Design : RCB

Replications : 3

Unit Plot size : 3m x 3m

Spacing : 60cm × 20cm

Fertilizer dose and Application of fertilizer : Fertilizer will be applied based on FRG'2012

Data to be collected : Fresh forage yield
Yield and yield contributing attributes
Time of physiological maturity

Expected output : Suitable time and pattern of leaf cutting was identified which minimize

the yield loss of maize

Status : New
Date of initiation : November 2017
Date of completion : May 2020
Estimated cost : Tk. 70,000/-
Source of fund : BARI
Location (s) : BARI, Dinajpur
Investigator(s) : M.M. Bazzaz, M. A. Z Sarker, A. Hossain and M.M. Akhtar

SUB-PROJECT 3.2: SOIL MANAGEMENT

Program **:** Wheat Improvement
Project 3 **:** Crop and Soil Management
Sub-Project 3.2 **:** Soil Management
Plan/Expt. 3.2.1 **:** **Effect of different doses of vermicompost in combination with chemical fertilizers in a Wheat-Maize-T. aman rice cropping pattern**
Objective(s) **:** Evaluating the impact of different doses of vermicompost with chemical fertilizers on crop growth and yield.

Rationale : Nutrient management to boost up crop production should be economically viable, environmental friendly and socially acceptable without affecting the gross production. The organic manure is an eco-friendly, economically viable and ecologically sound source of nutrient that had potentials in improving physical, chemical and biological phenomena of soil. Each year, human, livestock and crops produce approximately 38 billion metric tons of organic waste worldwide, which may be an efficient source of organic matter supply in soils. According to a conservative estimation, around 600 to 700 million tons (mt) of agricultural waste (including 272 million tons of crop residues) are available in Bangladesh every year, but most of it remains unutilized. This huge quantity of wastes can be converted into nutrient rich vermicompost for sustainable land restoration practices. The earthworm-processed organic wastes, often referred to as vermicompost, are finely divided peat-like materials with high porosity, aeration, drainage, and water holding capacity. Vermicompost may have potentials as a source of nutrients for field crops if applied in suitable ratios with synthetic fertilizers. Thus the objective of the study is to evaluate the impact of different dozes of vermicompost with chemical fertilizers on growth and yield of wheat and potato.

Materials/Methods **:**
Crop/variety **:** Wheat (BARI Gom 30), Maize (BARI Hybrid Maize 13/14) and T. Aman rice (BRRI Dhan 75).
Design **:** RCB
i) Treatments **:** **8 (Eight)**

1. Absolute control
2. 75% of STB
3. 100% of STB
4. 125% of STB
5. IPNS (2.5 t ha^{-1} vermicompost$_+$ Chemical Fertilizer)
6. IPNS (5 t ha^{-1} vermicompost$_+$ Chemical Fertilizer)
7. IPNS to 125% of STB (2.5 t ha^{-1} vermicompost$_+$ Chemical Fertilizer)
8. IPNS to 125% of STB (5 t ha^{-1} vermicompost$_+$ Chemical Fertilizer)

ii) Replication **:** 3 (Three)

Plot size	**:**	4m x 5m
Planting system/spacing	**:**	Wheat- Continuous seeding in line, Line spacing- 20 cm; Maize- Planting in lime, line to line distance- 60 cm, plant to plant distance-15 cm and Rice- Planting in line, line to line distance- 20 cm and plant to plant distance-15 cm.
Fertilizer dose and methods of application	:	100:27:50:20:04 NPKSZn kg ha^{-1} for wheat, 200:50:100:40:04:02 NPKSZnB kg ha^{-1} for maize and 100:10:39:20:03 NPKSZn kg ha^{-1} for rice. Broadcast as basal and top-dress. Broadcast as basal and top-dress.
Irrigated/rainfed	**:**	Irrigated
Data to be collected	**:**	Soil will be collected initially and after each crop harvest will from individual treatment and analyzed for pH, OM, N, P, K S, Zn, and B. Plant and grain samples will be collected and analyzed for N, P, K, S, Zn and B. Date of emergence and plant population, Yield and yield attributes.
Investigators	**:**	SMM Alam, M Bodruzzaman, and MI Hossain
Season	**:**	2019-2020
Date of Initiation	**:**	November 2019
Date of completion	**:**	2021-2022
Exp. Output/Benefit	**:**	Soil fertility will be improved and crop yield will be increased.
Location	**:**	RBARI, Rajshahi
Status	**:**	New
Estimated Cost	**:**	Tk. 75,000/-
Source of Fund	**:**	BARI/BARI
Priority	**:**	1^{st}
Program	**:**	Wheat Improvement
Project 3	**:**	Crop and Soil Management
Sub-Project 3.2	**:**	Soil Management
Plan/Expt. 3.2.2	**:**	**Effect of different doses of vermicompost in combination with chemical fertilizers in a Wheat-Maize-T. aman rice cropping pattern**
Objectives (s)	:	1. Examining the productivity of Wheat-maize-rice cropping pattern 2. Changing in soil properties due to organic manuring
Ratonale	:	Rice-wheat is the major cropping pattern in Bangladesh which occupies about 87% area (Morshed et al 2001).Maize is thirdcereal and production is increasing day by day. In some area are presently under wheat-fallow-rice is being shifted to maize-fallow-rice system. And in some areas farmers are practising wheat-maize-rice cropping pattern.The pattern has practical significance of horizontal expansion of all crops and also the vertical expansion of system productivity. A good soil should have at least 2.5% organic matter, but in Bangladesh most of the soils have less than 1.5% and some soils even less than 1% organic matter. It is frequently reported that organic matter status is poor in most soils of Bangladesh. Cops residues are an important source of soil organic matter vital for the sustainability of agricultural ecosystems. About 25% of N and P, 50% of S and 75% of K uptake by cereal crops is retained in crop residues, making them valuable nutrient sources (Sing 2003). However, straw retention is not a common practice in the R W systems of Bangladesh, as is also the case elsewhere in South Asia. Wheat and rice straw are usually removed from fields for use as cattle feed and materials for houses or for fuel, leaving little for incorporation into the soil. As a result, soil organic matter levels have declined in these cropping systems, and optimization of nutrient uptake and absorption efficiency has become one of the most important goals in crop production strategies. The project has been undertaken with the hypothesis that, organic manuringwill not only increase soil fertility but also save money and

increaseproductivity.

Materials/Methods : The experiment will be conducted at Regional Wheat Research Centre, BARI

Variety : Wheat-BARI Gom 30, Rice –Binadhan-7 and Maize NK-40

Design : RCBD

Treatments **:**

1. 100% STB
2. 125% STB
3. 100% STB (10t poultry manure to wheat and rest from chemical fertilizer)
4. 100% STB (10t FYM manure to wheat and rest from chemical fertilizer)
5. 100% STB (2/3wheat straw and rest from chemical fertilizer)
6. 100% STB (10t poultry manure to maize and rest from chemical fertilizer)
7. 100% STB (10t FYM to maize and rest from chemical fertilizer)
8. 100% STB (Maize straw and rest from chemical fertilizer)
9. 100% STB (2/3 Rice straw and rest from chemical fertilizer)
10. Control

Replications: 3

Plot size : 3×5m

Planting system and Spacing : As per treatments.

Fertilizer dose and method of application : Fertilizer will be applied in each crop as per treatments

Irrigated/Rainfed : Irrigated

Data to be recorded : (1) Soil nutrient status at initial and final stage, (2) Soil physical and chemical properties (3) Yield and yield attributes, (4) Plant nutrient uptake and use efficiency (5) Relevant cost and return analysis

Investigator (s) : M. B Banu, M M Khan, M Q I Matin, M A Ali, G Faruq, M Bodruzzaman and M Israil Hossain

Season : 2019-2020

Data of Initiation : November 2019

Exp. Output/Benefit : Higher productivity can be obtained from cropping system and soil fertility will be increased.

Locations : RWRC, BARI

Status : New

Estimated Cost : Tk. 50,000/-

Source of Fund : BWMRI, Dinajpur

Priority : 1

PROJECT 4: PEST MANAGEMENT

Programme	**:**	**Wheat Improvement**
Project 4	**:**	**Pest Management**
Sub-Project 4.1	**:**	**Disease Management**
Plan/Expt. 4.1.1	**:**	**Evaluation of wheat germplasm against Bipolaris leaf blight under field condition**
Objective(s)	**:**	To find out resistant/tolerant lines of wheat against Bipolaris leaf blight under natural disease development.
Rationale	**:**	Bipolaris leaf blight (BpLB) caused by *Bipolaris sorokiniana* is the most important disease of wheat in Bangladesh. Searching for resistance is a continuous process towards development of resistant varieties. High degree of resistance to BpLB disease is not available in the existing cultivars. It is, therefore, essential to screen available germplasms from different sources of diverse genetic background including materials derived from wide-crosses.
Materials and Methods	**:**	About 140 germplasm from different sources of home and abroad along with local and international checks will be evaluated for their response to BpLB under field conditions. The materials will be sown in 2.5m long 2-row plots with 20 cm spacing between rows and 30 cm between entries. The nursery will be surrounded by spreader rows of susceptible varieties. Data on BpLB severity will be recorded three times at Zadok's GS 69-71, 73-75 and 77-83 following double- digit scale (00-99) and AUDPC will be calculated. Data on agronomic characters including thousand grain weight and grain yield will also be recorded.
Investigators	**:**	MM Hossain, MMA Reza, K Mustarin, KK Roy, MME Rahman and B Anwar
Season	**:**	2019-2020
Date of Initiation	**:**	December 2019
Exp. Output/Benefit	**:**	BpLB resistant/tolerant lines will be identified for using in the crossing block in order to incorporate resistance/tolerance in widely adapted high yielding varieties.
Locations	**:**	Dinajpur, Jamalpur and Jashore
Status	**:**	On-going
Estimated Cost	**:**	Tk. 2,30,000/-
Source of Fund	**:**	BARI
Priority	**:**	1
Remarks	**:**	

Programme	**:**	**Wheat Improvement**
Project 4	**:**	**Pest Management**
Sub-Project 4.1	**:**	**Disease Management**
Plan/Expt. 4.1.2	**:**	**Evaluation of wheat genotypes for resistance to Bipolaris leaf blight under inoculated condition**
Objective(s)	**:**	To evaluate adult plant resistance of wheat genotypes against Bipolaris leaf blight under induced disease pressure.
Rationale	**:**	Bipolaris leaf blight caused by *Bipolaris sorokiniana* is the most economically important disease of wheat in Bangladesh. No absolute resistance against this disease is available in the existing germplasm. Lines showing resistance at seedling stage may be susceptible at adult plant stage. Therefore, it is necessary to screen wheat lines against BpLB at adult plant stage under induced disease pressure in the field.
Materials and Methods	**:**	Fifty six lines of wheat will be sown in 1m long 2-row plots. Inoculum will be grown on PDA media and 10^4 conidia/ml of suspension will be

		sprayed after heading stage. The plants will be incubated under polythene cover for 48 hours. Data on disease severity will be recorded as % Diseased Leaf Area (DLA) on flag leaves of 10 main tillers at 20-25 days after inoculation following standard scale. Lines will be graded into different resistance categories based on % DLA.
Investigators	**:**	K Mustarin, MMA Reza, KK Roy and MME Rahman
Season	**:**	2019-2020
Date of Initiation	**:**	December 2019
Exp. Output/Benefit	**:**	Resistant/tolerant lines will be found out in order to develop increased diversity of BpLB resistance.
Locations	**:**	Dinajpur
Status	**:**	On-going
Estimated Cost	**:**	Tk. 80,000/-
Source of Fund	**:**	BARI
Priority	**:**	1
Remarks	**:**	

Programme	**:**	Wheat Improvement
Project 4	**:**	Pest Management
Sub-Project 4.1	**:**	Disease Management
Plan/Expt. 4.1.3	**:**	**Evaluation of wheat genotypes for resistance to leaf rust under inoculated condition**
Objective(s)	**:**	To evaluate adult plant resistance of wheat genotypes against leaf rust under induced disease pressure.
Rationale	**:**	Leaf rust caused by *Puccinia triticina* is one the major constraints to sustainable production of wheat in Bangladesh. It may cause significant yield loss under favourable conditions of disease development. Development of resistant varieties is the most economic and safe approach for disease control and to minimize yield losses. Evaluating lines under induced disease epidemic is a pre-requisite for developing resistant varieties. Therefore, it is necessary to screen wheat lines for leaf rust resistance under induced disease pressure.
Materials and Methods	**:**	Seventy advanced and promising wheat lines along with check varieties will be sown in 1m long 2-row plots. Two rows of susceptible variety Morocco will be planted after every two test entries. The nursery will be surrounded by spreader rows of susceptible varieties. The spreader rows as well as the test lines will be inoculated by spraying with aqueous suspension of urediospores at booting stage to develop leaf rust epidemic. Disease severity will be recorded three times at Zadoks' GS 69-71, 73-75 and 77-83 following modified Cobb scale. The lines will be evaluated for resistance based on relative disease severity.
Investigators	**:**	MMA Reza, K Mustarin, KK Roy and MME Rahman
Season	**:**	2019-2020
Date of Initiation	**:**	December 2019
Exp. Output/Benefit	**:**	Resistant lines will be found out in order to develop increased diversity of leaf rust resistance.
Locations	**:**	Dinajpur
Status	**:**	On-going
Estimated Cost	**:**	Tk. 60,000/-
Source of Fund	**:**	BARI
Priority	**:**	1
Remarks	**:**	

Programme	**:**	**Wheat Improvement**
Project 4	**:**	**Pest Management**
Sub-Project 4.1	**:**	**Disease Management**
Plan/Expt. 4.1.4	**:**	**Efficacy of fungicides in controlling Bipolaris leaf blight of wheat**
Objective(s)	**:**	To evaluate the efficacy of some new fungicides in controlling BpLB of wheat.
Rationale	**:**	Breakdown of resistance due to evolution of new pathotype/race may develop epidemic of BpLB under favourable environmental conditions. In absence of resistance, foliar sprays with fungicides have been considered as an alternative option to reduce the disease under field condition. Among many fungicides Tebuconazole and Propiconazole were reported to be very effective against the disease. The present work will be undertaken to evaluate the efficacy of some new fungicides in controlling BpLB under field condition.
Materials and Methods	**:**	Different fungicides will be tested against the disease of BpLB of wheat. The fungicides will be sprayed twice at 13-15 days interval commencing from heading stage. The susceptible variety Kanchan will be used for this experiment. The experiment will be carried out in RCB design with three replications. Unit plot size will be 2.5 x 1.2 m. Severity of BpLB will be scored as % DLA from flag leaves of 10 main tillers following standard scale. Agronomic data will be recorded on number of spikes/m^2, grains/spike, 1000-grain weight and grain yield. Percent yield increase over control will be calculated.
Investigators	**:**	K Mustarin, MMA Reza, KK Roy and MME Rahman
Season	**:**	2019-2020
Date of Initiation	**:**	December 2019
Exp. Output/Benefit	**:**	Suitable fungicide(s) in controlling BpLB will be found out and increased grain yield of wheat will be obtained.
Locations	**:**	Dinajpur
Status	**:**	On-going
Estimated Cost	**:**	Tk. 50,000/-
Source of Fund	**:**	BARI
Priority	**:**	1
Remarks	**:**	
Programme	**:**	Wheat Improvement
Project 4	**:**	Pest Management
Sub-Project 4.1	**:**	Disease Management
Plan/Expt. 4.1.5	**:**	**Efficacy of fungicides in controlling leaf rust of wheat**
Objective(s)	**:**	To evaluate the efficacy of some new fungicides in controlling leaf rust of wheat.
Rationale	**:**	Breakdown of resistance due to evolution of new pathotype/race may develop epidemic of rust under favourable environmental conditions. In absence of resistance, foliar sprays with fungicides have been considered as an alternative option to reduce the disease under field condition. Among many fungicides Tebuconazole and Propiconazole were reported to be very effective against the disease. The present work will be undertaken to evaluate the efficacy of some new fungicides in controlling leaf rust under field condition.
Materials and Methods	**:**	Different fungicides will be tested against the disease of leaf rust of wheat. The fungicides will be sprayed twice/thrice at 13-15 days interval commencing from first appearance of symptom. The susceptible variety Morocco will be used for this experiment. The experiment will be carried out in the field in RCB design with three replications. Unit plot size will be 2.5m x 1.2m. Severity of leaf rust will be scored from flag leaves of 10 main tillers following modified Cobb scale. Agronomic

		data will be recorded on number of spikes/m^2, grains/spike, 1000-grain weight and grain yield. Percent yield increase over control will be calculated.
Investigators	**:**	K Mustarin, MMA Reza, KK Roy and MME Rahman
Season	**:**	2019-2020
Date of Initiation	**:**	December 2019
Exp. Output/Benefit	**:**	Suitable fungicide(s) in controlling leaf rust will be found out and increased grain yield of wheat will be obtained.
Locations	**:**	Dinajpur
Status	**:**	On-going
Estimated Cost	**:**	Tk. 50,000/-
Source of Fund	**:**	BARI
Priority	**:**	1
Remarks	**:**	

Programme	**:**	**Wheat Improvement**
Project 4	**:**	**Pest Management**
Sub-Project 4.1	**:**	**Disease Management**
Plan/Expt. 4.1.6	:	**Adaptation of wheat genotypes for tolerance to terminal heat stress and Bipolaris leaf blight**
Objective(s)	:	1. To assess the individual and combined effects of terminal heat stress and Bipolaris leaf blight on selected wheat genotypes. 2. To identify genotypes having tolerance to terminal heat stress and Bipolaris leaf blight.
Rationale	:	High temperature prevailing during grain filling period is one of the most important abiotic constraints for sustainable wheat yield in Bangladesh. The increasing temperature after anthesis also favours rapid development and spread of Bipolaris leaf blight that causes significant yield losses. Variability in level of tolerance to heat stress and severity of BpLB exists among different wheat genotypes. Therefore, it is essential to find out genotypes with good level of tolerance to both the stresses in order to improve wheat yield, particularly under late sown condition.
Materials and Methods	:	The experiment will be conducted in Split-split-plot design with two replications. Main plot: 2 sowing dates (Nov. 20-25 & Dec. 20-25), Sub-plot: 2 fungicide protections, and Sub-sub-plot: 12 genotypes including check varieties. Unit plot size will be 2.5m x 1.2m (2.5 m long 6 rows with 20 cm spacing. Disease notes will be recorded 3 times at Zadok's GS 69-71, 73-75 and 77-83 on double digit (00-99) scale, converted to % DLA and AUDPC was calculated. Data on early ground-cover, stay green score, leaf tip necrosis, canopy temperature, biomass, yield and yield components will be recorded.
Investigators	:	KK Roy, MME Rahman, K Mustarin andMMA Reza
Season	:	2019-2020
Date of Initiation	:	November-December 2019
Expt. Output/Benefit	:	Individual and combined effects of heat-stress and BpLB and their interactions with different wheat genotypes will be assessed. Adapted genotypes will be identified and relationships between different traits determined.
Locations	:	Dinajpur
Status	:	On-going
Estimated Cost	:	Tk. 75,000/-
Source of Fund		BARI
Priority	:	1
Remarks	:	

Programme	**:**	**Wheat Improvement**
Project 4	**:**	**Pest Management**
Sub-Project 4.1	**:**	**Disease Management**
Plan/Expt. 4.1.7	:	**Monitoring and evaluation in international wheat disease nurseries**
Objective(s)	:	1) To identify diseases, track pathogens and assess disease severity. 2) To identify and select sources of resistance. 3) To collaborate with the international partners developing global disease management strategies.
Rationale	:	The occurrence and severity of different diseases may vary from location to location and year to year at national and global level depending on environmental conditions. A major disease may become minor and a minor disease may become major because of change in cropping systems, cultural practices, crop varieties and environments. Moreover, new diseases may also appear in different localities, particularly under changed climate. Therefore, regular monitoring and evaluation in different international disease nurseries is essential to know the existing disease situation in the country and finding new sources of resistance.
Materials and Methods	:	Different disease nurseries including specific disease nurseries will be received mainly from CIMMYT. The nurseries will be set up in different 'hot-spot' locations as per the plan supplied for respective nurseries. Normally the entries will be sown in 2.5 m long 2 row-plots with 20 cm spacing. The spreader rows of susceptible varieties will be planted surrounding the nurseries. Recommended agronomic practices will be followed for normal plant growth. Disease notes will be recorded according to standard disease scoring scales. Wherever required, agronomic data will be taken according to the instructions supplied. If any new disease appears, it will be identified locally or the diseased specimen will be sent to specified laboratory for proper identification.
Investigators	:	MM Hossain,MMA Reza, K Mustarin,KK Roy, MME Rahman, B Anwar, F Amin and KH Alam.
Season	:	2019-2020
Date of Initiation	:	December 2019
Expt. Output/Benefit	:	The existing disease situation of wheat in the country will be understood, and new sources of resistance will be found out.
Locations	:	Dinajpur, Joydebpur, Jamalpur, Rajshahi and Jashore
Status	:	On-going
Estimated Cost	:	Tk. 4,00,000/-
Source of Fund		BARI
Priority	:	1
Remarks	:	

Programme	**:**	**Wheat Improvement**
Project 4	**:**	**Pest Management**
Sub-Project 4.1	**:**	**Disease Management**
Plan/Expt. 4.1.8	:	**Surveillance of rusts and blast of wheat in Bangladesh**
Objective(s)	:	1) To identify rust and blast diseases of wheat, track pathogens and assess disease severity in farmers' fields. 2) To collaborate with the international partners developing global rust and wheat blast management strategies.
Rationale	:	Rusts are important diseases of wheat worldwide. The tiny spores of rust pathogens are airborne in nature and can travel long distances often over continents. The virulent stem rust race Ug99 and its variants have posed a serious threat to the important wheat production areas of

the Indian subcontinent and beyond. Another most important disease; wheat blast caused by *Pyricularia oryzae* (teliomorph: *Magnaporthe oryzae*) has been identified in Bangladesh for the first time in late February 2016 causing significant yield losses in several south-western and southern districts of the country. Therefore, regular survey and monitoring becomes inevitable in order to identify signs of emergence of the virulent strains of wheat rust and blast pathogens.

Materials and Methods : The wheat rust and blast surveillance work will cover farmers' fields and trial sites of the major wheat growing areas of Bangladesh. About 200 fields will be investigated. The survey will be conducted through different stations of BARI. Disease assessment will be made following the modified Cobb scale and % spike infection for rust and blast, respectively. The protocols suggested by the BGRI (Borlaug Global Rust Initiative), and CIMMYT will be used during the present survey. Diseased specimens will be collected in brown paper bags and the pathogens will be identified locally or sent to specified laboratory for proper identification and race analysis.

Investigators : MMA Reza, K Mustarin, MME Rahman, KK Roy, MA Alom, MM Hossain, B Anwar, KH Alam, MF Amin and MR Islam

Season : 2019-2020

Date of Initiation : February 2020

Expt. Output/Benefit : The status of the existing rust and blast situation in farmers' fields will be understood for designing proper disease management.

Locations : Major wheat growing areas of Bangladesh

Status : On going

Estimated Cost : Tk. 5,00,000/-

Source of Fund BARI/ACIAR/KGF

Priority : 1

Remarks :

Programme **:** Wheat Improvement

Project 4 **:** Pest Management

Sub-Project 4.1 **:** Disease Management

Plan/Expt. 4.1.9 **:** **Evaluation of wheat germplasm against wheat blast under field/inoculated condition**

Objective(s) **:** To find out resistant/tolerant lines against wheat blast under natural disease development/high disease pressure.

Rationale **:** Wheat blast, a devastating wheat disease caused by *Pyricularia oryzae*, teleomorph:*Magnaporthe oryzae*, emerged for the first time in 2016 in several south-western and southern districts of Bangladesh. Disease severity appeared to vary from 10-100% depending on cultivar and sowing times. Wheat blast was first reported in Brazil in 1985 and then in Bolivia, Paraguay, Argentina and Uruguay. Although, wheat blast can occur on all aerial plant parts but most conspicuous symptom is evident on spike. Severe wheat blast outbreaks have coincided with wet years; warm temperatures and high humidity. Epidemic years are characterized by several days of continuous rains and average temperature 18-25^{0}C during flowering, followed by sunny, hot and humid days. Breeding for resistance is the most economic and reliable approach to control the disease and therefore, it is very essential to screen available germplasm from different sources for resistance to this disease.

Materials and Methods **:** About 500 germplasm will be evaluated for their response to wheat blast under field/inoculated conditions. The materials will be sown in 2.5m/1m long 2-row plots with 20 cm spacing between rows and 30 cm between entries. The nursery will be surrounded by spreader rows of

susceptible varieties. Disease of blast will be recorded based on spike incidence and severity one times at 20-25 days later after heading stage. Data on agronomic characters including thousand grain weight and grain yield will also be recorded.

Investigators : KK Roy, B Anwar, MMA Reza,K Mustarin and MME Rahman
Season : 2019-2020
Date of Initiation : December 2019
Exp. Output/Benefit : Wheat blast resistant/tolerant lines will be identified for using in the crossing block in order to incorporate resistance/tolerance in widely adapted high yielding varieties.
Locations : Dinajpur and Jashore
Status : On-going
Estimated Cost : Tk. 2,50,000/-
Source of Fund : BARI/KGF
Priority : 1
Remarks :

Programme : **Wheat Improvement**
Project 4 : **Pest Management**
Sub-Project 4.1 : **Disease Management**
Plan/Expt. 4.1.10 : **Evaluation of elite wheat lines for resistance to blast under inoculated condition**
Objective(s) : To evaluate advanced wheat lines for resistance to wheat blast under inoculated condition.
Rationale : Wheat blast, a devastating wheat disease caused by *Pyricularia oryzae*, teleomorph: *Magnaporthe oryzae*, emerged for the first time in 2016 in several south-western and southern districts of Bangladesh. Disease severity appeared to vary from 10-100% depending on cultivar and sowing times. Wheat blast was first reported in Brazil in 1985 and then in Bolivia, Paraguay, Argentina and Uruguay. Although, wheat blast can occur on all aerial plant parts but most conspicuous symptom is evident on spike. Severe wheat blast outbreaks have coincided with wet years; warm temperatures and high humidity. Epidemic years are characterized by several days of continuous rains and average temperature 18-25^{0}C during flowering, followed by sunny, hot and humid days. Breeding for resistance is the most economic and reliable approach to control the disease and therefore, it is necessary to screen wheat lines against wheat blast under induced disease pressure in the field condition.
Materials and Methods : About forty (40) elite lines of wheat from different sources will be sown in 1m long 2-row plots. Inoculums' will be grown on OMA media and 20000conidia/ml of suspension will be sprayed at heading stage. The plants will be incubated in seedling and adult stage. Data on spike incidence and severity will be recorded as % diseased severity on spikes of the whole plot at 20-25 days after inoculation following standard scale. Lines will be graded into different resistance categories based on % disease severity.
Investigators : KK Roy, MMA Reza, MME Rahman, B Anwar and K Mustarin
Season : 2019-2020
Date of Initiation : December 2019
Exp. Output/Benefit : Resistant/tolerant lines will be found out in order to develop increased diversity of wheat blast resistance.
Locations : Jashore
Status : On-going
Estimated Cost : Tk. 1,00,000/-
Source of Fund : BARI/KGF

Priority	**:**	1
Programme	**:**	**Wheat Improvement**
Project 4	**:**	**Pest Management**
Sub-Project 4.1	**:**	**Disease Management**
Plan/Expt. 4.1.11	**:**	**Efficacy of foliar fungicides in controlling wheat blast**
Objective(s)	**:**	To evaluate the efficacy of foliar fungicides in controlling wheat blast.
Rationale	**:**	Wheat blast, a devastating wheat disease caused by ascomycetous fungus *Magnaporthe oryzae* B.C. Couch (synonym *Pyricularia oryzae* Cavara) emerged for the first time in 2016 in several south-western and southern districts of Bangladesh. Disease severity appeared to vary from 10-100% depending on cultivar and sowing times. Wheat blast can occur on all aerial plant parts but most conspicuous symptom is observed on spike. Severe wheat blast outbreaks have coincided with wet years; warm temperatures and high humidity. Breakdown of resistance due to evolution of new pathotype/race may develop epidemic of wheat blast under favourable environmental conditions. In absence of resistance, foliar sprays with fungicides have been considered as an alternative option to reduce the disease under field condition. Among many fungicides Tebuconazole, Tryfloxystrobin and Trycyclazole were reported to be very effective against the disease. The present work will be undertaken to evaluate the efficacy of foliar fungicides in controlling wheat blast under field condition.
Materials and Methods	**:**	Different fungicides will be tested against the disease of wheat blast. The fungicides will be sprayed twice at 13-15 days interval commencing from heading stage. The susceptible variety BARI Gom 26 will be used for this experiment. The experiment will be carried out in RCB design with three replications in field conditions. The unit plot size will be 2.5m x 1.2m. Severity of wheat blast will be scored as % from spikes of plot following standard scale. Agronomic data will be recorded on number of spikes/m^2, grains/spike, 1000-grain weight and grain yield. Percent yield increase over control will be calculated.
Investigators	**:**	B Anwar, KK Roy, MM.A Reza, K Mustarin and MME Rahman
Season	**:**	2019-2020
Date of Initiation	**:**	December 2019
Exp. Output/Benefit	**:**	Suitable fungicide(s) in controlling wheat blast will be found out.
Locations	**:**	Dinajpur and Jashore
Status	**:**	On-going
Estimated Cost	**:**	Tk. 60,000/-
Source of Fund	**:**	BARI
Priority	**:**	1
Remarks	**:**	

Programme	:	**Wheat Improvement**
Project 4	**:**	**Pest Management**
Sub-Project 4.1	:	**Disease Management**
Plan/Expt. 4.1.12	**:**	**Efficacy of seed treating fungicides in reducing prevalence of seed-borne *Magnaporthe oryzae* pathotype *triticum* (MoT)**
Objective(s)	**:**	To evaluate the efficacy of seed treating fungicides in reducing prevalence of seed-borne MoT.
Rationale	**:**	Wheat blast, a devastating wheat disease caused by ascomycetous fungus *Magnaporthe oryzae* B.C. Couch (synonym *Pyricularia oryzae* Cavara) emerged for the first time in 2016 in several south-western and southern districts of Bangladesh. Disease severity appeared to vary from 10-100% depending on cultivar and sowing times. Wheat blast can occur on all aerial plant parts but most conspicuous symptom is

observed on spike. Severe wheat blast outbreaks have coincided with wet years; warm temperatures and high humidity. In absence of resistance, seed treatment with fungicides has been considered as an alternative option to reduce the inoculums density in a minimum level. Among many fungicides group Carboxin, Thiram, Iprodione, Mancozeb etc were reported to be very effective against the fungus. The present work will be undertaken to evaluate the efficacy of seed treating fungicides in reducing prevalence of seed-borne *P. oryzae* under laboratory and field condition.

Materials and Methods **:** Different seed treating fungicides will be tested against the fungus. The susceptible variety BARI Gom 26 will be used for this experiment. The experiment will be carried out in Lab and RCB design with three replications in field conditions. Under lab conditions, % reduction of the pathogen & germinations will be noted. Field conditions, unit plot size will be 2.5 x 1.2 m. Severity of wheat blast will be scored as % of spike incidence and severity from whole plot following standard scale. Agronomic data will be recorded on number of spikes/m2, grains/spike, 1000-grain weight and grain yield. Percent yield increase over control will be calculated.

Investigators **:** B Anwar, KK Roy, MMA Reza, K Mustarin and MME Rahman
Season **:** 2019-2020
Date of Initiation **:** December 2019
Exp. Output/Benefit **:** Suitable seed treating fungicide (s) will be found out.
Locations **:** Dinajpur (Lab) and Jashore (Field)
Status **:** On-going
Estimated Cost **:** Tk. 50,000/-
Source of Fund **:** BARI
Priority **:** 1
Remarks **:**

Programme : **Wheat Improvement**
Project 4 **:** **Pest Management**
Sub-Project 4.1 : **Disease Management**
Plan/Expt. 4.1.13 : **Investigation into alternative hosts and cereals of wheat blast pathogen**

Objective(s) : To identify the available winter cereals and weed species harboring *M. oryzae*, the recent thrust of wheat in Bangladesh.

Rationale : Wheat blast, a devastating wheat disease caused by *Magnaporthe oryzae* B.C. Couch (synonym *Pyricularia oryzae* Cavara) emerged for the first time in 2016 in several south-western and southern districts of Bangladesh. Disease severity appeared to vary from 10-100% depending on cultivar and sowing times. Breakdown of resistance due to evolution of new pathotype/race may develop epidemic of wheat blast under favourable environmental conditions. Though seed transmission of the wheat fungus has been demonstrated, seed infection may play an limited role in epidemiology, where spikes are mainly infected by air-borne conidia from host grasses. Several grasses and weeds occur commonly in wheat fields and are secondary host, but their role in epidemiology of wheat blast is not well understood and even less so in Bangladesh, but there is no guarantee that the pathogen is not present in the alternative host. Therefore, it is inevitable to investigate into alternative host in order to identify the wheat blast pathogen.

Materials and Methods : Symptomatic and asymptomatic leaf samples will be collected from winter cereals, weed species others grown in the fields of South-western and southern parts of Bangladesh. The samples will be cut into

1-2 cm pieces, surface sterilized with chlorox and plated on wet blotters. After 2-4 days of incubation at room temperature the specimens will be examined under stereomicroscope for fungal growth. The incidence of *M. oryzae* associated with leaf samples will be calculated and expressed as percentage.

Investigators : MME Rahman, MMA Reza, K Mustarin and KK Roy
Season : 2019-2020
Date of Initiation : February 2020
Expt. Output/Benefit : Alternative hosts of *M. oryzae*causing wheat blast will be identified.
Locations : Major wheat growing areas of Bangladesh
Status : On-going
Estimated Cost : Tk. 1,00,000/-
Source of Fund BARI/ACIAR/CIMMYT
Priority : 1
Remarks :

Programme : **Wheat Improvement**
Project 4 : **Pest Management**
Sub-Project 4.1 : **Disease Management**
Plan/Expt. 4.1.14 : **Determining status of seed-borne fungi including *Magnaporthe oryzae* pathotype *triticum* causing wheat blast**

Objective(s) : To determine prevalent seed-borne fungal pathogens along with wheat blast pathogen present in experimental plot seeds from different locations.

Rationale : Infected or contaminated seeds serve as major source of inoculum for large number of plant pathogens which may infect the seeds and survive as spore or resting structures on or within the seeds (Saberi et al., 2004). Wheat seed harbor several species of fungi, which can reduce seed quality and cause plant disease. Fungi carried on or within seeds reduce seed germination, seedling emergence lead to less vigorous seedling (Anjorin and Mohammed, 2009). Seed-borne fungal pathogen present externally or internally may cause seed abortion, seed rot and seed necrosis (Khanzada et al., 2002). Some plant pathogenic fungi kill seedlings shortly after they emerge, whereas others cause serious disease epidemics after being transmitted from seeds to seedlings. Seed-bone diseases also affect the growth and productivity of wheat (Weber et al., 2001). Seed-borne fungi reported in wheat include *Bipolaris* spp., *Alternaria* spp., *Curvularia* spp. etc.. Unfortunately, Wheat blast, a devastating wheat disease caused by *Magnaporthe oryzae* B.C. Couch (synonym *Pyricularia oryzae* Cavara) emerged for the first time in 2016 in several south-western and southern districts of Bangladesh and also a seed-borne disease. Thus understanding disease epidemiology, its transmission rate and economic threshold, combined with seed health testing in the study areas is very important, as these could help to define the need for seed treatment.

Materials and Methods : Samples of seeds will be collected from different locations of different varieties of Bangladesh. Disease severity will be recorded following standard scale and the associated fungi will be identified and estimated in blotter method according to ISTA rules.

Investigators : MME Rahman, K Mustarin , MMA Reza and KK Roy
Season : 2019-2020
Date of Initiation : May 2020
Exp. Output/Benefit : The status of seed-borne fungi of wheat will be identified in order to take appropriate control measure for the pathogens associated.

Locations	**:**	Dinajpur
Status	**:**	On-going
Estimated Cost	**:**	Tk. 1,00,000/-
Source of Fund	**:**	BARI
Priority	**:**	1
Remarks	**:**	

Programme	:	Wheat Improvement
Project 4	**:**	Pest Management
Sub-Project 4.1	:	Disease Management
Plan/Expt. 4.1.15	**:**	**Molecular detection of wheat blast pathogen *Magnaporthe oryzae* pathotype *triticum* (MoT) collected from different locations of Bangladesh using MoT3 assay**
Objective(s)	**:**	To identify and study of the pathogen at genetic level for confirmation of pathotype using molecular tools.
Rationale	**:**	Wheat blast, an emerging fungal disease caused by *Magnaporthe oryzae* (syn. *Pyricularia oryzae*) pathotype *triticum* (MoT) was first discovered in Brazil in 1985 (lgarashi *et al.* 1986) outside Latin America first incidence of wheat blast was observed in Bangladesh in 2016. Molecular analysis established that the wheat blast observed in Bangladesh was caused by *M. oryzae* pathotype *triticum* (Malaker *et al.* 2016; Islam *et al.* 2016). There are several tools were used for detection of MoT including whole genome sequencing and analysis. Whole genome analysis is costly and not possible in our existing laboratory facilities. However, PCR based assay for MoT specific genes with MoT3 primers developed by Pieck *et al.* (2017) is an easy way to confirm MoT at genetic level. On the other hand, prior to develop management options, as a newly emerged plant pathogen, it is needed to identify and study of the pathogen at genetic level. So, the study has been proposed to standardize a protocol for authentic detection through using molecular tools.
Materials and Methods	**:**	Infected specimens from different hosts viz. wheat, rice, millet and weed/grass species showing blast symptoms will be collected from different locations of Bangladesh. Diseased plant parts will be isolated and will purified by single hyphal tip method using potato dextrose agar (PDA). Then pure cultures of the isolates will characterized up to molecular level at newly established Molecular Laboratory, BARI, Dinajpur. For molecular characterization, total DNA will extracted from the isolates separately using Wizard Genomic DNA Purification Kit (Promega, USA). Pathotype specific gene will amplified and determined by using MoT3F and MoT3R primers supplied by Prof. Mark Farman through CIMMYT. The reaction mixtures using Go Tag G2 Green Master Mix (Promega, USA) will incubated in a PCR Thermal Cycler following the programs: initial denaturation at 94°C for 3 min, followed by 30 cycles of denaturation of 94°C for 1 min, annealing at 62°C for 2 min, polymerization at 72°C for 1 min 30 s, and final elongation at 72°C for 10 min. Presence or absence of amplified DNA will be recorded for confirmation of MoT by standard gel electrophoresis protocol.
Investigators	**:**	MME Rahman, KK Roy, MMA Reza and K Mustarin
Season	**:**	Year round
Date of Initiation	**:**	Year round
Exp. Output/Benefit	**:**	Molecular detection of MoT will standardize and MoT will be confirmed for different isolates collected from different locations.
Locations	**:**	Dinajpur
Status	**:**	On-going

Estimated Cost : Tk. 2,00,000/-
Source of Fund : BARI/KGF
Priority : 1
Remarks :
Programme : **Wheat Improvement**
Project 4 : **Pest Management**
Sub-Project 4.1 : **Disease Management**
Plan/Expt. 4.1.16 : **Integrated management of wheat blast**
Objective(s) : To evaluate the integrated management option to control the wheat blast disease.
Rationale : Wheat blast, an emerging fungal disease caused by *Magnaporthe oryzae*pathotype *triticum* (MoT) was first discovered in Brazil in 1985 and then first incidence of wheat blast was observed in Bangladesh in 2016 as the first Asian country. Though the severity of the disease was less in last two years but disease spotted areas is increasing day by day. The wheat blast disease can be managed by the use of fungicides, resistant cultivars and agronomic practices. It is very difficult to control the wheat blast disease with application of single option. As a climate dependent disease, it is important to control the disease through integrated approaches combining of several options like application of fungicides, use of resistant cultivars, optimizing the sowing time.
Materials and Methods : The experiment will be conducted at RARS, Jashore during 2018-19 crop growing season. Following integrated option/combination will be applied: Treatments' combination as follows-
Main plot: sowing dates: 3 dates (Early, optimum & late)
Sub plot: Varieties: BARI Gom 26 &BARI Gom 33
Sub-sub plot: Fungicides options

I. Seed treatment with foliar spray
II. Apparently healthy seed
III. MoT infected seed

Investigators : MMA Reza, MME Rahman, KK Roy, K Mustarin and B Anwar
Season : 2019-2020
Date of Initiation : November 2019
Exp. Output/Benefit : Integrated management for controlling wheat blast will be developed.
Locations : Meherpur
Status : On-going
Estimated Cost : Tk. 1,00,000/-
Source of Fund : BARI/MoST
Priority : 1
Remarks :

Programme : **Wheat Improvement**
Project 4 : **Pest Management**
Sub-Project 4.1 : **Disease Management**
Plan/Expt. 4.1.17 : **Wheat blast: Precision Phenotyping Platform**
Objective(s) : To screen available germplasms from different sources (national and international) for resistance to this disease.
Rationale : Wheat blast was first time detected in Asia, following reports of a severe outbreak in Bangladesh (Malaker *et al*. 2016). The disease can occur on all aerial plant parts but most conspicuous symptom is evident on spike. Severe wheat blast outbreaks have coincided with wet years, warm temperatures and high humidity. The disease can be managed by the use of fungicides, resistant cultivars, agronomic practices and biotechnological methods (Ribot *et al*., 2008). Breeding for resistance is the most economic and reliable approach to control the disease and

		therefore, it is very essential to screen available germplasm from different sources for resistance to this disease.
Materials and Methods	**:**	The experiment will be conducted at RARS, Jashore during 2019-20 crop growing season. A total of around four thousand five hundred entries will be screened against wheat blast under artificially inoculated condition. The materials will be planted in 1m long 2 row-plots with 20 cm spacing between rows and 30 cm between entries with two different dates on 2nd and 3rd week of December 2019.
Investigators	**:**	KK Roy, MR Kabir, MMA Reza, K Mustarin, B Anwar, MME Rahman, R Begum, T Roy and PK Singh
Season	**:**	2019-2020
Date of Initiation	**:**	December 2019
Exp. Output/Benefit	**:**	Resistant lines against wheat blast will be identified.
Locations	**:**	Jashore
Status	**:**	On-going
Estimated Cost	**:**	10,00,000/-
Source of Fund	**:**	CIMMYT/ACIAR/BARI
Priority	**:**	1
Remarks	**:**	
Programme	:	Wheat Improvement
Project 4	**:**	Pest Management
Sub-Project 4.1	:	Disease Management
Plan/Expt. 4.1.18	**:**	**Surveillance and monitoring of diseases of Maize in Bangladesh**
Objective(s)	**:**	1. To identify diseases of maize, track pathogens and assess disease severity in farmers' fields 2. To know the status of maize diseases depending on variety and location.
Rationale	**:**	Maize is one of the most important cereal crops in the world and ranks third next to wheat and rice. In Bangladesh, it has a good potential as a cereal crop due to its low cost of production, wide adaptability and diversified use. However, disease might be an important bottleneck for sustainable maize production. Now a days, number of maize diseases is increasing day by day. Therefore, regular survey and monitoring becomes inevitable in order to identify signs of emergence of the virulent strains of maize pathogens.
Materials and Methods	**:**	The maize survey will cover farmers' fields and trial sites of the major growing areas of Bangladesh. The survey will be conducted through different stations of BARI. Disease assessment will be made following standard scale. The protocols suggested by the BGRI (Borlaug Global Rust Initiative), and CIMMYT will be used during the present survey. Diseased specimens will be collected in brown paper bags and the pathogens will be identified locally or sent to specified laboratory for proper identification and race analysis.
Investigators	**:**	MMA Reza, K Mustarin, MME Rahman, KK Roy,MM Hossain, B Anwar, KH Alam and MR Islam
Season	**:**	Year round
Date of Initiation	**:**	Year round
Exp. Output/Benefit	**:**	The status of the existing maize situation in farmers' fields will be understood for designing proper disease management.
Locations	**:**	Major maize growing areas of Bangladesh.
Status	**:**	New
Estimated Cost	**:**	Tk. 3,00,000/-
Source of Fund	**:**	BARI
Priority	**:**	1
Remarks	**:**	

Sub-Project 4.2: ENTOMOLOGY

Programme	:	**Wheat Improvement**
Project 4	:	**Pest Management**
Sub-Project 4.2	:	**Insect Management**
Experiment 4.2.1	:	**Survey of insect pests and natural enemies in wheat and determination of damage potential due to insect pests**
Objective(s)	:	i. To document the damage severity of insect pests attacking wheat. ii To identify the natural enemies of insect pests of wheat.
Rationale	:	Wheat is the second most important cereal food crop in Bangladesh. The crop is attacked by a number of insect pests both in field and storage. Among the field insect pests, shoot fly, wire worm and aphids are quite serious and may cause considerable yield loss of the crop. Recent reports indicate that insect-pests may be a potential threat for wheat cultivation in near future. Documentation of damage severity of different insect pests along with their peak infestation periods would enable researchers to take initiative managing the pest problems.
Materials and methods	:	Different wheat growing areas of the country will be visited at seedling, vegetative, and flowering stages of the crop to collect data on insect pests of wheat and their natural enemies. In each location, thirty farmers will also be interviewed using an objective oriented questionnaire to collect information on farmers' perception regarding insect pests of wheat.
Crop/genotype	:	Existing wheat crop in the field
Design	:	-
Plot size	:	-
Planting system/spacing	:	-
Fertilizer dose and methods of application	:	-
Irrigated/rainfed	:	-
Data to be recorded	:	1. Percent insect pest infested plants/ m^2. 2. No. of insect pests/ plant or plant parts. 3. Natural enemy population will be recorded.
Investigator(s)	:	M.M.R. Shah
Season	:	Rabi, 2019-2020
Date of Initiation	:	November, 2019
Date of completion	:	March, 2020
Expt. output/benefit	:	Damage severity of insect pests attacking wheat along with their natural enemies will be documented.
Location	:	Dinajpur, Thakurgaon, Panchagorh, Rajshahi & Gazipur
Status	:	New
Estimated cost	:	Tk. 2,00,000/-
Source of fund	:	BARI/CIMMYT
Priority	:	1

Programme	:	**Wheat Improvement**
Project 4	**:**	**Pest Management**
Sub-Project 4.2	:	**Insect Management**
Experiment 4.2.2	**:**	**Yield loss assessment of wheat due to the aphid infestation**
Objective	**:**	To document yield loss due to aphid infestation in wheat
Rationale	**:**	Wheat is the second staple food crop in Bangladesh after rice. At present, consumption of wheat is increasing due to the awareness about the quality food. As a result, wheat cultivation is in increasing trend to satisfy its demand. Recent observation indicates that wheat is attacked by aphid at different growth stages. But still no data or information is available on yield loss due to aphid infestation on wheat in Bangladesh. Therefore, this experiment has been designed to document the yield loss due to aphid infestation on wheat.
Materials and methods	**:**	
Crop/genotype	**:**	Crop: Wheat, Variety: BARI Ghom 28
Design	**:**	RCB with 3 replications
Plot size	**:**	4m X 5m
Planting system/spacing	**:**	Factor A= Sown at three different times a) 25 November b) 05 December c) 15 December Factor B= T_1= Three Sprays of Spinosad (Success 2.5EC) @ 1.2ml/L of water at 7 days interval from heading T_2= Three Sprays of Matrin (Biotrine 0.5%) @ 1.4ml/L of water at 7 days interval from heading T_3= Three Sprays of water at 7 days interval from heading T_4= Untreated control
Fertilizer dose and methods of application	**:**	As per BARI recommendation
Irrigated/rainfed	**:**	Irrigated
Data to be recorded	**:**	a) No. of aphid/ spike b) Grain Yield/ m^2 c) No. of grain/ Spike d) TGW
Investigator(s)	**:**	M.M.R. Shah
Season	**:**	Rabi, 2019-2020
Date of Initiation	**:**	November, 2019
Date of completion	**:**	May, 2020
Expt. output/benefit	**:**	Yield loss due to aphid infestation in wheat will be determined
Location	**:**	BARI, Dinajpur
Status	**:**	New
Estimated cost	**:**	Tk. 60,000/-
Source of fund	**:**	BARI/CIMMYT
Priority	**:**	1

Programme	:	**Wheat Improvement**
Project 4	:	**Pest Management**
Sub-Project 4.2	:	**Insect Management**
Experiment 4.2.3	:	**Monitoring and scouting of Fall Armyworm (FAW) in maize and its seasonal fluctuation**
Objective(s)	:	To document the prevalence and intensity of FAW attacking maize
Rationale	:	Maize is the third most important cereal crop in Bangladesh. Now-a-days, it is a very crucial crop due to its use as feed in poultry, dairy and fishery farm. But the crop is attacked by a number of insect pests both in the field during cultivation. Among the field insect pests, cut worm, Fall Armyworm (FAW), Armyworm, aphids etc. are quite serious and may cause considerable yield loss of the crop. Recent reports indicate that FAW is a potential threat for maize cultivation in Bangladesh (FAO 2019). Documentation of damage severity of FAW along with its peak infestation periods would enable researchers to take necessary steps to manage the pest problems.
Materials and methods	:	Different maize growing areas of the country will be visited at different growth stages of the crop to collect data of FAW prevalence and intensity through in-situ and pheromone trap. In each location, thirty farmers will also be interviewed using an objective oriented questionnaire to collect information on farmers' perception regarding FAW on maize.
Crop/genotype	:	Existing maize crop in the field
Design	:	-
Plot size	:	-
Planting system/spacing	:	As per BARI recommendation
Fertilizer dose and methods of application	:	As per BARI recommendation
Irrigated/rainfed	:	Irrigated
Data to be recorded	:	1. No. of FAW infested plant(s)/ m^2. 2. No. of FAW larvae/ plant. 3. No. of FAW adult/ trap
Investigator(s)	:	M.M.R. Shah
Season	:	Rabi, 2019-2020 and Kharif-I 2020
Date of Initiation	:	November, 2019
Date of completion	:	May, 2020
Expt. output/benefit	:	Damage severity of different insect pests on maize will be documented. Natural enemies if the insect pests will also be collected and identified.
Location	:	Dinajpur, Thakurgaon, Panchagorh, Rangpur, Jashore, Bogura
Status	:	New
Estimated cost	:	Tk. 2,00,000/-
Source of fund	:	BARI/CIMMYT
Priority	:	1

Programme	:	**Wheat Improvement**
Project 4	**:**	**Pest Management**
Sub-Project 4.2	:	**Insect Management**
Experiment 4.2.4	**:**	**Development of management package(s) to control FAW on maize**
Objective	**:**	To develop a eco-friendly and sustainable management package against FAW attacking maize
Rationale	**:**	Maize is the third most important cereal crop in Bangladesh. Recent reports indicate that maize is attacked by Fall Armyworm (FAW), is quite serious and may cause considerable yield loss of the crop in Bangladesh. Therefore, it is necessary to develop a management package to control FAW in Bangladesh climatic condition.
Materials and methods	**:**	T_1= Intercropping maize with mungbean + Pheromone trap + SfNPV + Soil recharge T_2= Intercropping maize with mungbean + Pheromone trap + Spinosad (Success 2.5EC) + Soil recharge T_3= Intercropping maize with mungbean + Pheromone trap + Dusting of ash with sand + Soil recharge T_4= Farmers practice (Sole Spray of Virtako/ Karate on maize) T_5= Untreated control
Crop/genotype	**:**	Maize
Design	**:**	RCB with 3 replications
Plot size	**:**	5m X 6m
Planting system/spacing	**:**	As per BARI recommendation
Fertilizer dose and methods of application	**:**	As per BARI recommendation
Irrigated/rainfed	**:**	Irrigated
Data to be recorded	**:**	1. No. of FAW infested plants/ m^2 2. No. of FAW larva/ plant 3. Yield
Investigator(s)	**:**	M.M.R. Shah
Season	**:**	Rabi, 2019-2020
Date of Initiation	**:**	November, 2019
Date of completion	**:**	May, 2020
Expt. output/benefit	**:**	A management package of FAW on maize will develop
Location	**:**	BARI, Dinajpur
Status	**:**	New
Estimated cost	**:**	Tk. 70,000/-
Source of fund	**:**	BWMRI/CIMMYT
Priority	**:**	1

PROJECT 5: AGRICULTURAL ENGINEERING

1.	**Programme**	**:**	**Wheat Improvement**
2.	**Project 5**	**:**	**Agricultural Engineering**
3.	**Expt. 5.1**	**:**	**Battery operated low cost maize planter cum weeder**
4.	**Objective(s)**	**:**	i. To develop battery operated maize planter cum weeder ii. to test and evaluate the performance of battery operated weeder cum planter on station and in farmers' field iii. to compare the economic performance with conventional method
5.	**Rationale**	**:**	Weeds are plant that competes with crops for water, nutrients and light. Crop production can be reduced drastically due to excessive weed. Depending upon the weed density, 20-30% yield loss is quite usual but if inadequate crop management occurs, yield loss can climb up to 80%. The conventional method of weeding is highly labor intensive, costly and drudgerious. Chemical use of weeding is costly and very hazardous for environment. The battery operated weeder is to reduce drudgery and cost which ensures safe and easy solution to this problem. Mechanical weeding keeps the soil surface loose for ensuring soil aeration and water intake capacity. The weeder can be operated for both the wide row crops and vegetable crops. The design principle of the weeder offers an additional opportunity for it to be operated as a planter as well. The tines can till the soil and the battery operated weeder can also be used as maize planter. This provides an optional use of a single machinery to perform two operations at a time. It will reduce the negative impact of chemical weeding. Two simultaneous operation through a single machine will help the farmer accept mechanical method over the chemical and conventional one. . This will economically help the farmer to reduce production cost by minimizing intercultural operational expenses. Considering these facts the program has been taken.
6.	**Materials and Methods**	**:**	A DC motor operated dry land weeder cum planter will be designed and fabricated. The machine will provide a 48 volt 750 watt motor operated by 48 volt rechargeable dry cell battery. Power will be transmitted through chain and sprocket. Row to row distance will be adjustible. Different types of tines will be attached for it to be operated for wide row crop, vegetable crop as well as for tilling purposes. The machine can also be used as maize planter providing optimal plant to plant distance.
7.	**Crops**	**:**	Wheat, maize and other upland crops etc.
8.	**Data to be recorded**		Weeding index, field capacity, Seed rate, depth of seeding, plant population, area coverage per unit time, yield, and cost data to be recorded.
9.	**Investigators**	**:**	M S B Ekram, M I Hossain,
10.	**Season**	**:**	2019-20
11.	**Date of Initiation**	**:**	September 2019
12.	**Expected Output/Benefit**	**:**	Reduced production cost, minimizing negative impact of chemical weeding, timely weeding and planting, increasing farmers' livelihood
13.	**Locations**	**:**	BWMRI, Dinajpur
14.	**Status**	**:**	New
15.	**Estimated Cost**	**:**	Tk. 1,00,000.00
16.	**Source of Fund**	**:**	BWMRI
17.	**Priority**	**:**	1st

1.	**Programme**	**:**	**Wheat Improvement**
2.	**Project 5**	**:**	**Agricultural Engineering**
3.	**Expt. 5.2**	**:**	**Development of multi nozzle boom sprayer for field crops**
4.	**Objectives**	**:**	i. To develop a cost effective multi nozzle boom sprayer ii. to test and performance evaluate of the sprayer in farmers field and on station iii. to find out the economic performance of the sprayer
5.	**Rationale**	**:**	Spray machine is a very much important equipment to ensure proper application of pesticides as well as to save the crops from damage due to pest infestation. It can contribute remarkably in pest management and substantially increase food production along with saving huge crops worth. In Bangladesh, unrestricted growth of weeds causes damage up to 37 percent crop yield with 32.2 percent loss in food crops including 41.3 percent in cereals, 31.2 percent in pulses, 40.8 percent in oil seed and 39.2 percent in fiber crops. Beside this, 30-50 percent crops are damaged per year by insects and diseases. Considering this, an user friendly and easy operating spray machine is needed through which effective way of using pesticides could be adopted.
6.	**Materials and Methods**	**:**	The machine will be fabricated with locally available materials in the workshop of BWMRI, Dinajpur. The major parts of the machine will be: Front Wheel, Spray Parts, Pumping Shuttle, power source (Petrol Engine). Power Transmission Chain and Sprocket, Speed Control Gear Box, Spray Boom, Spray Nozzles, Re-adjustable Base Frame, etc. A self-pumping mechanism will be function through reciprocating action of the shuttle powered by front wheel. Flat fan nozzles will be attached in the boom for herbicide and hollow cone nozzles will be attached for spraying other pesticides (except herbicides). Multiple nozzles will be used in the boom of this spray machine and spray width will be 120 cm. The boom height will be re-adjustable. After fabrication the machine will be tested in lab first time and further improved, then second time test in field Treatments: T_1 = Newly Developed Boom Sprayer T_2 = Available Boom Sprayer T_3 = Manually operated knapsack sprayer
7.	**Data to be recorded**		The time of operation, Fuel consumption, Spray liquid spraying capacity, spray efficiency, Cost of spraying, yield performance data.
8.	**Investigators**	**:**	M S B Ekram, M I Hossain
9.	**Season**	**:**	Rabi and Kharif 2019-20
10.	**Date of Initiation**	**:**	September 2019
11.	**Expected output/Benefit**	**:**	Reduce spraying time, spray cost, human drudgery and increase spraying efficiency of knapsack sprayer and make user friendly.
12.	**Locations**	**:**	BWMRI, Dinajpur and BWMRI, Rajshahi.
13.	**Status**	**:**	120,000/=
14.	**Estimated Cost**	**:**	September 2019
15.	**Source of Fund**	**:**	BWMRI
16.	**Priority**	**:**	1st

1. Programme	**;**	**Wheat Improvement**
2. Project 5	**;**	**Agricultural Engineering**
3. Expt. 5.3	**:**	**Improvement of two wheel tractoroperated strip till planter for upland crops**
4. **Objective(s)**	**:**	i. to introduce inclined plate seed meter for improving the performance of strip till planter for wheat , maize and pulses cultivation with utilization of residual soil moisture ii. to compare the yield and cost performance of the planter over conventional method
5. Rationale	**:**	Zero tillage is defined as the operation of planting crops in previously unprepared soil by opening a narrow slot or band only of sufficient width and depth to obtain proper seed coverage. Delay planting is one of the major causes of potential yield losses. Generally farmers take 8-11 days turnaround time between the two crops which allow more tillage and more cost. Power tiller operated zero till drill has been developed in WRC, BWMRI and performances was tested in research farm . It is now required on farm validation in the farmer's field for evaluating the performances of crop establishment in terms of energy saving, eliminate delay planting and moisture conservation.
6. **Materials and Methods**	**:**	The working principle of the zero till planter is tilling operation, seeding in line, fertilizing during the seeding operation and seed covering simultaneously at a time in a single operation. All agronomic adjustments such as seed rate control, depth of seeding, line to line distance adjustment, multiple crops seeding are incorporated in the developed tractor driven zero till planter. The zero till planter consists of different functional components, seed and fertilizer box, mainframe, seed and fertilizer metering devices, tilling unit, tine, furrow opener, seed delivery tube, seed covering roller, power transmission chain and sprocket etc.
7. Crops	**:**	Wheat, maize and pulses
8. Data to be recorded	**:**	Seed rate, depth of seeding, plant population, yield and cost data to be recorded.
9. Investigators	**:**	M S B Ekram, M Z Hossain, M I Hossain
10. Season	**:**	2019-20
11. Date of Initiation	**:**	November, 2019
12. Expected output	**:**	Crops can be established timely with residual soil moisture utilization. Delay planting to be overcome. Energy consumption and cultivation cost will be less.
13. Locations	**:**	BWMRI, Dinajpur and BWMRI, Rajshahi.
14. Status	**:**	New (1st year)
15. Estimated Cost	**:**	Tk. 80,000.00
16. Source of Fund	**:**	BWMRI
17. Priority	**:**	1st

1. Programme	**:**	**Wheat Improvement**
2. Project 5	**:**	**Agricultural Engineering**
3. Exp. 5.4	**:**	**Development of tractor (4WT) operated multi crop seeder**
4. Objective(s)	**:**	i. To fabricate a 4 wheel Tractor operated multi-row seeder for up land crops ii. To test the seeder performances both on station and in the farmers' field iii. To compare the cost of seeding with traditional broadcasting method
5. Rationale	**:**	Around 56000 four wheel tractors are already being used in Bangladesh. To get maximum crop production and yield, seeding operation needs to be completed within the recommended period avoiding slackness, time consuming, and costly operation and decreasing turnaround time. These 4 wheel tractors can be used for seeding purpose in addition to its transportation and soil tilling works. Thus, four wheel tractor operated seeding technology development is essential to ensure multidimensional use of four wheel tractors and to give more pace in seeding operation in parallel to the two wheel tractor operated seeding machinery.
6. Procedure/ Methods	**:**	A 4 wheel tractor operated seeder has been fabricated in the Agricultural Engineering Divisional workshop, WRC, Nashipur, Dinajpur during 2017-18. Locally available construction materials were used for fabrication. It was direct seeding type. The spacing between the lines were adjustable. The depth of seeding can be controlled. The performance of the seeder will be further evaluated and check for improvement.
7. Crop/variety	**:**	Wheat, maize, pulses
8. Planting system/spacing	**:**	Line sowing, 20 cm
9. Data to be recorded	**:**	Seed rate, depth of seeding, plant population, area coverage per unit time, yield and cost.
10. Investigators	**:**	M S B Ekram, M I Hossain
11. Season	**:**	2019-20
12. Date of Initiation	**:**	September 2019
13. Exp. Output/Benefit	**:**	Reduced cost and time for seeding in wheat, Interest development in line spacing and intercultural operation.
14. Locations	**:**	BWMRI, Dinajpur
15..Status	**:**	New
16. Estimated Cost	**:**	Tk. 100,000.00
17. Source of Fund	**:**	BWMRI
18. Priority	**:**	1st

PROJECT 6: TECHNOLOGY VALIDATION AND TRANSFER

Wheat is the second important cereal crop in Bangladesh. Its consumption is increasing @ 10% per year. But production is much below than the total requirement. The major causes for low production are low yield due to inadequate and slow technology adoption. The average wheat yield in research station is > 4.0 t/ha but the ever highest national average yield was 3.49 t ha^{-1} in 2018-19 as per DAE. Still there is a yield gap of about 1.0 ton/ha which is due to knowledge gap of the farmers about modern varieties and recommended technologies. In this situation, technology transfer activities are very important to increase wheat yield by improving farmers' knowledge. To improve farmers' knowledge, conducting demonstration, training, field day, workshop, seminar and publicity in mass media is very important.

A. NATINAL PROGRAMME

SUB-PROJECT 6.1: DEMONSTRATION

Demonstration is a very effective tool for disseminating varieties and technologies. Therefore, new varieties, as well as, other new technologies developed by BWMRI (Wheat Research Centre, BARI) need to be demonstrated in farmers' fields for their quick dissemination by replacing old varieties and technologies. Demonstration also helps identify location specific varieties and their expansion in different environments. It also helps BADC for planning future production, preservation and distribution of seeds. Demonstrations are conducted by the farmers in cooperation with DAE and scientists of BWMRI.

Programme	**:**	**Wheat Improvement**
Project 6	**:**	**Technology Transfer**
Sub-Project 6.1	**:**	**Demonstration**
Plan/Expt. 6.1.1	**:**	**Variety demonstration**
Objective (s)	**:**	evaluating new varieties by the farmers comparing with widely grown one preserving and disseminate seeds of farmers'-preferred varieties through farmers to farmers and increasing varietal diversity
Rationale	**:**	Demonstration is an important and efficient way of dissemination of new varieties. It also helps make available the seeds of new varieties and their rapid dissemination to other farmers.
Procedure/Methods	**:**	Six new wheat varieties: BARI Gom 28, BARI Gom 29, BARI Gom 30, BARI Gom 31, BARI Gom 32 and BARI Gom 33 are to be demonstrated (as per seed availability). Plot size of the demonstration will be 400 m^{-2}(10 decimal) per variety. One variety should be given to one farmer. Demonstration kits of seeds, fertilizers and signboard will be supplied to the farmers through corresponding SAAO/SA/SSA immediately after training by November 15, 2019. Number of demonstration will be 1920; 1635 through DAE and 165 through OFRD and 120 through others. Data will be recorded on seeding date, no. of irrigations, yield in kg per 20 m^{-2} and per hectare for each variety, amount of seeds preserved, number of farmers visited and reactions of the farmers, supervising staff and officials to varieties.
Investigators	**:**	M Bodruzzaman, MM Bazzaz, MA Alam, MA Hakim, G Faruq, MM Rahman, MM Hossain, MI Hossain, AA Khan, MR Islam, MI hossain in collaboration with OFRD, DAE & NGOs.
Season	**:**	Rabi 2019-20
Date of Initiation	**:**	November 2019
Exp. Output/Benefit	**:**	Farmers will know the performance of new varieties. They could preserve and sell seeds of new superior variety and earn more money.

Location	**Through DAE (Wheat)**	
	Sl **Name of district**	**Varieties will be used (as per seed availability)** #

Dinajpur&Rangpur Region	01	Dinajpur	BARI Gom 28, 29, 30, 31, 32 & 33	50
	02	Thakurgaon	BARI Gom 28, 29, 30, 31, 32 & 33	100
	03	Panchagarh	BARI Gom 28, 29, 30, 31, 32 & 33	50
	04	Rangpur	BARI Gom 28, 29, 30, 31, 32 & 33	25
	05	Nilphamari	BARI Gom 28, 29, 30, 31, 32 & 33	25
	06	Kurigram	BARI Gom 28, 29, 30, 31, 32 & 33	25
	07	Gaibandha	BARI Gom 28, 29, 30, 31, 32 & 33	25
	08	Lalmonirhat	BARI Gom 28, 29, 30, 31, 32 & 33	25
Sub-total :				**275**
Bogura &Rajshahi Region	09	Joypurhat	BARI Gom 28, 29, 30, 31, 32 & 33	20
	10	Bogura	BARI Gom 28, 29, 30, 31, 32 & 33	25
	11	Rajshahi	BARI Gom 28, 29, 30, 31, 32 & 33	50
	12	Naogaon	BARI Gom 28, 29, 30, 31, 32 & 33	75
	13	Natore	BARI Gom 28, 29, 30, 31, 32 & 33	25
	14	Nawabgonj	BARI Gom 28, 29, 30, 31, 32 & 33	50
	15	Pabna	BARI Gom 28, 29, 30, 31, 32 & 33	30
	16	Sirajgonj	BARI Gom 28, 29, 30, 31, 32 & 33	20
Sub-total :				**295**
Jashore& Khulna Region	17	Kushtia	BARI Gom 33	20
	18	Chuadanga	BARI Gom 33	20
	19	Meherpur	BARI Gom 33	30
	20	Jashore	BARI Gom 33	20
	21	Jhenaidah	BARI Gom 33	40
	22	Magura	BARI Gom 33	20
	23	Narail	BARI Gom 33	20
	24	Satkhira	BARI Gom 33	15
Sub-total :				**150**
Faridpur &Barishal Region	25	Faridpur	BARI Gom 33	20
	26	Rajbari	BARI Gom 33	20
	27	Gopalgonj	BARI Gom 33	20
	28	Madaripur	BARI Gom 33	20
	29	Shariatpur	BARI Gom 33	20
	30	Barishal	BARI Gom 33	25
	31	Bhola	BARI Gom 33	25
Sub-total :				**150**
Mymensingh Region	32	Mymensingh	BARI Gom 28, 29, 30, 31, 32 & 33	15
	33	Netrokona	BARI Gom 28, 29, 30, 31, 32 & 33	20
	34	Kishorganj	BARI Gom 28, 29, 30, 31, 32 & 33	20
	35	Jamalpur	BARI Gom 28, 29, 30, 31, 32 & 33	25
	36	Sherpur	BARI Gom 28, 29, 30, 31, 32 & 33	15
	Sub-total :			**95**
Other Regions	37	Tangail	BARI Gom 28, 29, 30, 31, 32 & 33	50
	38	Sylhet	BARI Gom 28, 29, 30, 31, 32 & 33	25
	39	Manikgonj	BARI Gom 28, 29, 30, 31, 32 & 33	15
	40	Cumilla	BARI Gom 28, 29, 30, 31, 32 & 33	20
	39	Moulovibazar	BARI Gom 28, 29, 30, 31, 32 & 33	25
	40	Habigonj	BARI Gom 28, 29, 30, 31, 32 & 33	25
	41	Sunamgonj	BARI Gom 28, 29, 30, 31, 32 & 33	25
	Sub-total :			**185**
	DAE total :			**1285**
	Others			

	47	OFRD, Mymensingh	BARI Gom 28, 29, 30, 31, 32 & 33	10
	48	OFRD, Sherpur	BARI Gom 28, 29, 30, 31, 32 & 33	10
	49	OFRD, Faridpur	BARI Gom 33	15
	50	OFRD, Patuakhali	BARI Gom 33	20
	51	OFRD, Tangail	BARI Gom 28, 29, 30, 31, 32 & 33	20
	52	OFRD, Gaibandha	BARI Gom 28, 29, 30, 31, 32 & 33	50
	53	OFRD, Jashore	BARI Gom	15
	54	OFRD, Rajshahi	BARI Gom 28, 29, 30, 31, 32 & 33	25
	55	CARITAS, Dinajpur	BARI Gom 28, 29, 30, 31, 32 & 33	25
	56	CIMMYT, Dinajpur	BARI Gom 28, 29, 30, 31, 32 & 33	75
	57	RDRS, Rangpur	BARI Gom 28, 29, 30, 31, 32 & 33	20
			Sub-total:	**285**
Maize demonstrations through DAE				
	58	Dinajpur	BHM 9, 16 & BARI Khoi Bhutta	75
	59	Thakurgaon	BHM 9, 16	25
	60	Panchagarh	BHM 9, 16	25
	61	Rangpur	BHM 9, 16	25
	62	Nilphamari	BHM 9, 16	25
	63	Kurigram	BHM 9, 16	25
	64	Joypurhat	BHM 9, 16	25
	65	Rajshahi	BHM 9, 16	25
			Sub-total:	**250**
Demontrations of wheat and maize with lime through DAE				
	66	Dinajpur	BARI Gom 25, BHM 9, 16	20
	67	Thakurgaon	BARI Gom 25, BHM 9, 16	20
	68	Panchagarh	BARI Gom 25, BHM 9, 16	20
	69	Nilphamari	BARI Gom 25, BHM 9, 16	20
	70	Lalmonirhat	BARI Gom 25, BHM 9, 16	20
			Sub-total:	**100**
			Grand total :	**1920**

Status : On-going
Estimated Cost : Tk. 18,00,000/- (Tk.1500/- per demonstration for kit preparation)
Source of Fund : BWMRI
Priority : 1

SUB-PROJECT 6.2: TRAINING, WORKSHOP AND FIELD DAYS

A. NATIONAL PROGRAMME

Programme : **Wheat Improvement**
Project 6 : **Technology Transfer**
Sub-Project 6.2 : **Training, Workshop and Field days**
Plan/Expt. 6.2.1 : **Training to demonstration farmers and related personnel**
Objective(s) : The objective of the training is to teach variety demonstration farmers and related personnel (five SAAO for 25 demonstrations and one DAE Officer per batch as observer) about the systems of conducting demonstrations, data recording and sending, and wheat production and seed preservation technologies.
Rationale : Farmers' need to know the systems of conducting demonstrations and collecting data. In addition, farmers are less acquainted with modern

production technologies of wheat. This training will help them in conducting demonstrations properly and to improve knowledge on wheat production and seed preservation.

Procedure/Methods : Related farmers and other persons will be invited to a comfortable place and training will be given to them through visual aids, posters, lectures, etc. and a hand out about the demonstration will be supplied.

Investigators : Scientists of BWMRI

Season : Rabi 2019-20

Date of Initiation : November 2019

Exp. Output/Benefit : Demonstration set-up will be perfect and farmers' knowledge on wheat and triticale production will improve

Locations :

Conducted by	Regions	No. Batches
BWMRI, Dinajpur	Rangpur & Dinajpur, Faridp., Barishal	13
RS, BWMRI, Rajshahi	Rajshahi & Bogura	12
RS, BWMRI, Jamalpur	Mymensingh	06
RS, BWMRI, Jashore	Jashore & Khulna	16
RS, BWMRI, Joydebpur	Dhaka & Sylhet	07

Status : On-going

Estimated Cost Tk. 10,80,000/- (Avg. Tk. 20,000/- per batch)

Source of Fund : BWMRI

Priority : 1

Programme : **Wheat Improvement**

Project 6 : **Technology Transfer**

Sub-Project 6.2 : **Training, Workshop and Field days**

Plan/Expt. 6.2.2 : **Training of trainers (TOT) on wheat production and seed preservation**

Objective(s) : to increase the knowledge and skill on wheat production and seed preservation techniques of the progressive farmers

Rationale : Farmers are less acquainted with modern production technologies of wheat. This training will help them to improve knowledge on wheat production and seed preservation.

Procedure/Methods : In each training batch 30 persons (25 large/medium farmers and 5 SAAO) will be invited during wheat growing season. Training will be given through theory and practical classes. Lectures will be presented through audio-visual aids and practical classes will be held in the wheat field. Hand-out of all classes will be supplied to the trainees.

Investigators : Scientists of BWMRI

Season : Rabi 2019-20

Date of Initiation : November 2019

Exp. Output/Benefit : Improve and update knowledge on wheat, its production and seed preservation techniques; which will help increase wheat yield and production in the country

Locations :

Location	No of participants (batch)
BWMRI, Dinajpur	300 (12 batches)
RS, BWMRI, Rajshahi	250 (10 batches)
RS, BWMRI, Jamalpur	150 (6 batches)
RS, BWMRI, Jashore	200 (8 batches)
RS, BWMRI, Joydebpur	300 (12 batches)
Total	1200 (48 batches)

Status : On-going

Estimated Cost : Tk. 9,60,000/-(Tk 20,000/- per batch)
Source of Fund : BWMRI
Priority : 1
Programme : **Wheat Improvement**
Project 6 : **Technology Transfer**
Sub-Project 6.2 : **Training, Workshop and Field days**
Plan/Expt. 6.2.3 : **Training of trainers (TOT) for DAE, BADC and NGO personnel on wheat production and seed preservation**

Objective(s) :
i. update the knowledge and skill on wheat production and seed preservation
ii. acquaint them with the new varieties and their distinguishing characteristics
iii. get the feedback about the causes of wheat area reduction and their provable solutions.

Rationale : BARI, DAE, BADC and NGO personnel are involved in wheat production and seed dissemination systems. Improving knowledge of these personnel about wheat, its production and seed preservation, will greatly help increase wheat yield and production in the country. They could also help disseminating new varieties and technologies.

Procedure/Methods : In each training batch 30 persons will be invited during wheat growing season. Training will be given through theory and practical classes. Lectures will be presented through audio-visual aids and practical classes will be held in the wheat field. Hand-out of all classes will be supplied to the trainees.

Investigators : Senior scientists of BWMRI
Season : Rabi 2019-20
Date of Initiation : November 2019
Exp. Output/Benefit : Improve and update knowledge on wheat, its production and seed preservation techniques; which will help increase wheat yield and production in the country

Locations :

Location	**No of participants (batch)**
BWMRI, Dinajpur	100 (4 batches)
RS, BWMRI, Rajshahi	75 (3 batches)
RS, BWMRI, Jamalpur	50 (2 batches)
RS, BWMRI, Jashore	50 (2 batches)
RS, BWMRI, Joydebpur	100 (4 batches)
Total	375 (15 batches)

Status : On-going
Estimated Cost : Tk. 6,00,000/-(Tk. 40,000/- per batch)
Source of Fund : BWMRI
Priority : 1

Programme	**:**	**Wheat Improvement**
Project 6	**:**	**Technology Transfer**
Sub-Project 6.2	**:**	**Training, Workshop and Field days**
Plan/Expt. 6.2.4	**:**	**Five days training for young scientists on research planning, execution, data recording, analysis and reporting**
Objective(s)	**:**	i. Introduce with the objectives, activities and future strategies of wheat research in Bangladesh ii. Improve the knowledge of wheat research systems, methodologies, data recording, analysis and reporting
Rationale	**:**	Though the young scientists are of agriculture background, they have not got adequate knowledge on wheat and wheat research systems. Furthermore, a good number of scientists also recently posted to WRC. Therefore, it is very important to train them on wheat and wheat research for conducting future research efficiently.
Procedure/Methods	**:**	Training of SSO/SO will be conducted through theory and practical classes. Theory classes will be conducted in the class room followed by practical classed in the wheat fields and laboratories. Handout will be supplied for each lecture. Pre and post evaluation test will be taken to assess the improvement due to training.
Investigators	**:**	Senior scientists of BWMRI and BARI
Season	**:**	Rabi 2019-20
Date of Initiation	**:**	December 2019
Exp. Output/Benefit	**:**	Knowledge of wheat and wheat research system will increase that will ultimately help the young scientists to run their future research activities efficiently.
Location	**:**	BWMRI, Dinajpur
Status	**:**	New
Estimated Cost	:	Tk. 1,50,000/-
Source of Fund	**:**	BWMRI
Priority	**:**	1

Programme	**:**	**Wheat Improvement**
Project 6	**:**	**Technology Transfer**
Sub-Project 6.2	**:**	**Training, Workshop and Field days**
Plan/Expt. 6.2.5	**:**	**Two days training for SSA/SA/LA**
Objective(s)	**:**	. to introduce with the objectives and different activities of wheat research in Bangladesh . to make familiar with different types of experimental design, laboratory protocols and data collection
Rationale	**:**	Each year, a considerable number of field and laboratory staffs join/transfer to different wheat research stations. Furthermore, some new experiments are also taken by the scientists every year. Recently, some molecular research were also included in wheat research programme. Therefore, scientific staffs of different stations of WRC need to be trained regularly to help the scientist in completing their research programme smoothly.
Procedure/Methods	**:**	Training of field and laboratory staffs will be conducted through theory and practical classes. Theory classes will be conducted in the class room followed by practical classed in the wheat fields and laboratories. Handout will be supplied for each lecture. Pre and post evaluation test will be taken to assess the improvement due to training.
Investigators	**:**	Scientists of BWMRI
Season	**:**	Rabi 2019-20
Date of Initiation	**:**	December 2019

Exp. Output/Benefit : Knowledge of wheat and wheat research of the field and laboratory staffs will be increased which will ultimately help them to follow the instructions of the scientists and run the wheat research activities efficiently.

Location : BWMRI, Dinajpur

Status : New

Estimated Cost : Tk. 50,000/-

Source of Fund : BWMRI

Priority : 1

Programme : Wheat Improvement

Project 6 : Technology Transfer

Sub-Project 6.2 : Training, Workshop and Field days

Plan/Expt. 6.2.6 : **Regional Workshop on challenges in wheat production**

Objective(s) : Sharing the knowledge and skills for enhancing wheat production in the countryupdating the knowledge new wheat technologies among the stakeholders.

. get the feedback about the challenges in wheat production and action to be taken to face these challenges.

Rationale : BARI, DAE, BADC, SCA and NGO personnel are the main stakeholders of wheat production and seed dissemination systems. Improving knowledge of these personnel about wheat, its production and seed preservation, will greatly help increase wheat yield and production in the country. They could give fruitful feedback to enhance the wheat productivity in the country.

Procedure/Methods : In each workshop, 60 persons will be invited during wheat growing season. A key note paper will be presented about the present situation of wheat production in Bangladesh. A brief presentation will also be given to update the knowledge about new technologies of WRC. A open-house discussion will be conducted and suggested recommendations will be noted down.

Investigators : Scientists of different research organization, teachers of Agril. Universities and personnel from DAE, BADC, SCA and NGOs

Season : Rabi 2019-20

Date of Initiation : November 2019

Exp. Output/Benefit : updatingthe knowledge ofnew wheat technologies and feedback from different stakeholders will help to enhance the wheat productivity and production in the country

Locations :

Location	No. of workshop	No. of participants
BWMRI, Dinajpur	01	60
RS, BWMRI, Rajshahi	01	60
RS, BWMRI, Jamalpur	01	60
RS, BWMRI, Jashore	01	60
RS, BWMRI, Joydebpur	01	60
Total	05	300

Status : New

Estimated Cost : Tk. 3,00,000/- (Tk 60,000/- per workshop)

Source of Fund : BWMRI

Priority : 1

Programme : Wheat Improvement

Project 6 : Technology Transfer

Sub-Project 6.2 : Training, Workshop and Field days

Plan/Expt. 6.2.7 : **Pre-review, Internal Review and Programme Planning workshops**

Objective(s) : i. to review the reports of research progress 2019-20.

ii. to formulate the research programme for 2020-21.

Investigators : Scientists of WRC
Season : Kharif 2019-20
Date of Initiation : May 2020
Locations :

Title	Location	Participants #
Pre-review Workshop	BWMRI, Dinajpur	30
Internal Review and Programme Planning workshops	BWMRI, Dinajpur	80
Total		110

Status : On-going
Estimated Cost : Tk. 3,00,000/-
Source of Fund : BWMRI
Priority : 1
Programme : Wheat Improvement
Project 6 : Technology Transfer
Sub-Project 6.2 : Training, Workshop and Field day
Plan/Expt. 6.2.8 : **Field days and monitoring of on-farm and on-station research activities in different agricultural regions**
Objective(s) : .showing and explain the performance of the new varieties and
.showing the impact of recommended technologies use in wheat yield
.monitoring of on-station research activities
Rationale : Field days at demonstration farmers' fields are very important to practically show the performance of the varieties comparing with the check one. It is a process of learning by seeing. This process of learning is more efficient than learning by hearing or reading.
Procedure/Methods : More than 100 farmers, DAE, research and NGO personnel will be invited in each demonstration fields and the advantages and disadvantages of the new varieties comparing with the widely grown check variety of the region will be shown.
Investigators : BWMRI and OFRD scientists of BARI and DAE personnel
Season : Rabi 2019-20
Date of Initiation : Rabi 2019
Exp. Output/Benefit : The advantages and disadvantages of the varieties used in demonstration will clearly be known to the farmers. As a result the farmers' will be convinced to accept the good one.
Locations :

Location (Agricultural region)	No. of field days
Rangpur and Dinajpur Region	20
Rajshahi and Bogura Region	15
Jashore, Faridpur and Barisal Region	15
Mymensingh Region	10
Dhaka, Kumilla & Sylhet Region	10
Panchagarh/Lalmoni/Kurigram (Sp. Grant, MoA)	10
	Total : 80

Status : On-going
Estimated Cost : Tk.16,00,000/- (Tk.20,000/- per field day)
Source of Fund : BWMRI
Priority : 1

C. BUDGET FOR RESEARCH PROGRAMME OF BWMRI 2019-20

Sl No.	Project	Number of Experiment			Budget ('000 Taka)		
		National	Regional	Total	National	Regional	Total
1	Wheat Variety Development	37	2	39	19295	200	19495
2	Maize Variety Development	72	9	81	2113	235	2348
2	Crop and soil Management	10	4	14	2205	600	2802
3	Pest Management	18 (Path.)	4 (Entom.)	22	4400	-	4400
4	Agricultural Engineering	04	-	04	200	-	200
5	Technology transfer	11	-	11	10000	-	10000
Total		**152**	**19**	**171**	**38213**	**1035**	**39248**

Comments and suggestions of the reviewers, scientists and other personnel during Regional, Internal and Central Review and Research Planning Workshops 2019

Bangladesh Wheat and Maize Research Institute
Nashipur, Dinajpur

The results of different experiments along with technology developed and research progress made during 2018-19 crop season were presented and discussed in different sessions of Regional, Internal and Central Review Workshops. Valuable comments and suggestions made by the participating scientists, expert members and participants from relevant organizations, farmers' representatives and chairman of the respective sessions were noted and summarized. Major emphasis were given developing high yielding and heat, disease, salinity and drought tolerant early maturing wheat varieties along with appropriate production technologies under the farmers' socio-economic conditions. Sustainability and profitability of wheat farming by popularizing use of farm machinery and adoption of CA based technologies were also emphasized. The salient comments and suggestions made for further improvement of wheat research and development in Bangladesh are outlined below.

	Comments and suggestions	Action taken
	Variety Development and Breeder Seed Production	
1	Hybrid wheat program should start in the new institute to face future challenges.	
2	Heat and drought stress should be considered simultaneously for late sown environment.	
3	Institute should have good publications highlighting findings of the institute	
4	Nano-technology for future agricultural improvement	
5	Farmers' feedback should be considered during program planning	
6	In case of Harvest plus study, data of Zn content should be mentioned and known Zn rich variety should be used as check.	
7	Lodging resistance dwarf wheat varieties are to be developed	
8	Research on Duram wheat to be reduced and rethought to continue.	
9	Climate resilient crop varieties and technologies should be developed.	
10	Characterize all available genotypes and make it available through website for sharing.	
11	Thrust should be given on blast, salinity and heat resistant variety development. Emphasis should also be given for varieties with maximum 110days having yield ≥ 6 t/ha.	
	Crop and Soil Management and Agricultural Engineering	
1	In case of cropping pattern study, field duration of different crops should be mentioned.	
2	Cost benefit analysis should also be done in cropping pattern study like other experiment.	
3	The name of variety including other information should	

Comments and suggestions	Action taken
mentioned in case of all experiments.	
4 Weather data should be incorporated for better interpretation of the results where, required.	
5 Regarding cost benefit ratio analysis, Production cost should be calculated based on actual labor wage and actual price of products and it should be standardized.	
6 Proper experimental design should be followed for designing experiment. In case of drought study, only pot experiment is not enough for clear result. Rather it should be validated through field study.	
7 The term cost return analysis should be used instead of economic analysis. It is needed to calculate MBCR instead of BCR.	
8 For long term experiment, depletion of nutrient elements particularly sulpher should be studied properly and materials and methods should be written in details including previous status for long term experiment.	
9 Salinity should be measured based on crop growth stage and plot wise as salinity differ in different growth stage and different plots. Tolerant varieties should be grouped following international scale.	
10 Mode of action of herbicides should be properly studied and name of weed species should be written in the related experiment.	
11 Pedigree and accession number of the tested genotypes in case of screening trial should be mentioned in the appendix.	
12 To determine the detrimental effects of herbicide agronomist, soil micro-biologist, and eco-toxicologist should work together	
13 Literature should be reviewed from different sources to study the herbicidal effect on soil.	
14 Considering limitations, facilities and capabilities, we should take plan to release variety and technology as per national demand	
Pest Management	
1 Proper and eco-friendly insect-pest and disease management technologies should be developed and extended to farmers.	
2 Location-wise disease data (BpLB, leaf rust & wheat blast) should be incorporated in the report and present accordingly.	
3 Efficiency of MoT3 marker should be verified.	
4 Extensive study on alternate host of wheat blast should be undertaken to know the survival mode of wheat blast pathogen.	
5 Resistant and susceptible check varieties should be used in disease screening nursery.	
6 Differential lines should be developed for identification of different races of wheat blast pathogen in Bangladesh condition. Available susceptible and resistant variety may be used develop RILs by crossing.	

	Comments and suggestions	Action taken
7	Development of disease resistant variety and integrated management should be emphasized including proper fungicide.	
8	Newly emerging disease due to climate change should be under surveillance program like Fusarium head blight.	
9	The histopathology of wheat blast should be studied intensively.	
10	Wheat blast and Fusarium head blight should be distinguished carefully.	

Technology Validation and Transfer

1	Same variety should be used in yield gap demonstration program in farmers field	Suggestion well taken
2	Follow up visits should be continued in block demonstration program conducted with help of DAE	Suggestion well taken
3	Blast resistant variety with production package program should be strengthen in south western part of Bangladesh	Well considered
4	Before wheat season scientists should consult and make plan with DAE, BADC for wheat production	Action taken
5	Wheat should not introduce in such area where production is very low such as saline, haor, hill area etc.	Suggestion well taken
6	Promote T. Aus based cropping pattern with wheat	Suggestion well taken
7	Number of block demonstration programs with newly released varieties should be increased.	Action taken
8	Seed renewal ratio should be increased in farmers field for increasing wheat production area	Suggestion well taken
9	Wheat should be extended in the haor and chalonbil regions	Suggestion well taken