RESEARCH PROGRAMME
2022-2023

Programme Leader

Dr. Habib Mohammad Naser
Chief Scientific Officer & Head

Soil Science Division
Bangladesh Agricultural Research Institute
Joydebpur, Gazipur-1701

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on

Soil Management

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P R E F A C E

Restoring soil fertility and sustaining crop productivity are the greatest challenge for the natural resource management researchers. The soil scientists, however, have so far developed many technologies on fertilizer recommendation for BARI mandate crops and cropping patterns, combating physiological disorders related to macro & micronutrient deficiencies, irrigation scheduling and tillage management, isolation and preparation of biofertilizers etc. Soil Science Division is also working on many problems related to degraded soils. Impact of climate change on soil health and crop production is also in active consideration of soil management research.

There are 30 soil related problems have been identified so far, which have been considered in the programs of 2022-2023. Besides, a significant number of research programs have been designed in laboratory and greenhouse for basic work. However, Bangladesh is still way behind the developed world regarding Information Technology and the researchers do not have adequate training in the field of computer modeling. This area is under active consideration of Soil Science Division. In this regard conduction of laboratory and field experiments on crop modeling are going on.

The Soil Science Research Programs are grouped into four major areas namely; Physical Aspects, Chemical Aspects, Micronutrient Aspects and Microbiological Aspects of Soil Management. Soil Chemistry Section develop programme on waste management and biochar. Soil Physics Section recently extended its research area to conservation agriculture, and management of saline, drought prone and hill soils. Soil Micronutrient Section designs a programme emphasizing on use of Nano scale zinc oxide particles for crop production. Microbiology Section takes up studies on mycorrhiza, azotobacter, and phosphate solubilizing bacteria which are evaluated as the basic and most advanced research of the time. This Division proposed about 88 experiments for the next year including some project activities.

Dr. Habib Mohammad Naser
Chief Scientific Officer & Head

PROJECT I

PHYSICAL ASPECTS OF SOIL MANAGEMENT
Project Leader: Dr. A.T.M.A.I. Mondol

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Project Leader: Dr. M M Masud

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Project Leader: Dr. Mohammad Eyakub Ali

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PROJECT-I

PHYSICAL ASPECTS OF SOIL MANAGEMENT

Project Leader: Dr. ATMAI Mondol

01.	Programme	:	Soil Management
02.	Project	:	Physical Aspect of Soil Management
03.	**Experiment 01**	**:**	**Determination of crop coefficient values of cauliflower through lysimetric studies**
04.	Objective	:	i. To find out the crop coefficient values (Kc) and evapotranspiration (Et) using lysimeter ii. To observe yield performance
05.	Rationale	:	Lysimeter is an important tool in soil-plant-atmosphere research because it can directly measure evapotranspiration and facilitate water, fertilizer and solute balance studies. Reliable measurements of drainage quantity and loss of nutrients through leaching are difficult to measure in field conditions but easier using lysimetric study. For instance, water percolation through the root zone may be collected and analyzed. Water requirement of capsicum changes depending upon soil and climatic conditions. Improvement of water use efficiency is an important task under the present contexts of resource conservation agriculture. Crop coefficient (Kc) values of capsicum are not available in the literature under Bangladesh situation. Therefore, it is necessary to determine growth phase wise Kc values in order to find out water requirement of crop. Again, leaching loss of nutrients need to assess for the minimization of ground water pollution.
06.	Materials and Methods		
	Crop/variety	:	Cauliflower/ Snow white
07.	Design	:	RCB
		:	i) Replication 03 (three)
	Treatments	:	ii) Treatments 4 (four)
			T_1: Irrigation up to FC at every 5 days interval T_2: Irrigation up to FC at every 10 days interval T_3: Irrigation up to FC at every 15 days interval T_4: Irrigation up to FC at every 20 days interval
08.	Plot size	:	1 m x 1 m (micro plot)
09.	Planting system	:	Transplanting method
	Spacing	:	Row to row 60 cm and plant to plant 50 cm

10.	Seed rate	:	Cauliflower (seedlings)
11.	Fertilizer dose and methods of application	:	As per STB Full dose of organic manure and half K, entire quantity of P, S, Zn, B will be applied as basal during final land preparation. Remaining nitrogen as urea will be applied as three equal splits and half MoP will be applied at vegetative stage (20 DAT) as ring method under moist soil condition and mixed thoroughly with the soil.
12.	Irrigation/rainfed	:	Irrigated
13.	Data to be recorded	:	Soil texture, BD, PD, Porosity, FC, moisture monitoring pH, OM, N, P, K, S, Zn and B of soil Weather data, reference crop evapotranspiration Plant: Yield parameters and yield
14.	Investigator(s)	:	A.T.M.A.I. Mondol, M. J. Alam and H. M. Naser
15.	Season	:	Rabi
16.	Initiation	:	November, 2022
17.	Date of completion	:	April, 2024
18.	Expected output/ benefit	:	Growth phase wise crop coefficient values will be determined and leaching loss of plant nutrients will also be quantified
19.	Location	:	Lysimeter block, Gazipur
20.	Status	:	New
21.	Estimated cost	:	Tk. 40,000/-
22.	Source of fund	:	BARI
23.	Priority	:	1st

01.	Programme	:	Soil Management
02.	Project	:	Physical Aspect of Soil Management
03.	**Experiment 02**	**:**	**Response of mustard to fertilizer management under zero tillage in mustard-fallow-B. Aman cropping pattern in Cumilla region**
04.	Objective(s)	:	i. To observe the effects of zero tillage on mustard yield in Mustard-Fallow-B. Aman Cropping Pattern, and ii. To develop balanced fertilizer recommendations for maximizing the yield of mustard in zero tillage conditions.

05.	Rationale	:	Mustard is an important oilseed crop and is widely cultivated in the Rabi season in Bangladesh. It occupies the first position on the list in respect of area and production among the oilseed crops grown in this country. It contributes a lion's share to the total edible oil production in the country. In the Cumilla region, there is a potential area for cultivating mustard after the harvest of Aman rice. Farmers cultivated this crop in some pocket areas of the Cumilla region. They usually use the seeds that are available in the market. However, the conventional seeds available in the market cannot give the desired yield. In Nabinagar Upazila of Brahmanbaria district, farmers cultivate mustard, coriander, and black cumin after harvesting Aman rice. They usually cultivate mustard after harvesting Aman rice. They don't go for boro rice and cultivate mustard under zero tillage conditions. They don't have any recommended fertilizer dose for mustard crops under zero tillage conditions. Keeping in this view, the present experiment has been undertaken toreplace the traditional cultivars with a high-yielding BARI-released mustard variety.
06.	Materials and method	:	
07.	Crop/variety	:	BARI Sharisha-18
08.	Design	:	RCB
	Treatments (4)	:	T_1 = 75% of BARI RDCF for mustard T_2 = 100% of BARI RDCF for mustard T_3 = 125% of BARI RDCF for mustard T_4 = Farmers' practice
	Replications	:	3 (Three) dispersed
09.	Plot size	:	10m ×10m
10.	Planting system /spacing	:	Broadcasting
11.	Fertilizer dose and methods of application	:	All chemical fertilizers except nitrogenous fertilizer will be applied as a blanket dose following BARI recommended chemical fertilizer (RDCF) for mustard. Nitrogenous fertilizer will be applied in 2-3 splits. Urea, TSP, MoP, Gypsum, Boric acid, and Zinc Sulfate monohydrate will be used as a source of N, P, K, S, B, and Zn.
12.	Irrigated/rainfed	:	Irrigated
13.	Data to be recorded	:	Date of seed sowing, date of fertilizer application, date of all intercultural operations, plant height, date of flowering, branch plant^{-1}, pods plant^{-1}, wt. of seed pod^{-1}, 1000 seed wt., date of harvest, yield, grain, and straw nutrient content, hourly labor cost.

14.	Season	:	Rabi
15.	Investigator(s)	:	MM H Bhuiyan, M A H Kahan, H M Naser, and M O Kaisar
16.	Date of initiation	:	October 2022
17.	Date of completion	:	June 2024
18.	Expected output/benefit	:	Nutrients required for a high yield goal of mustard grown under zero tillage in mustard-fallow-B. Aman cropping pattern will be determined.
19.	Location	:	Nabinagar, Brahmanbaria
20.	Status	:	New
21.	Estimated cost	:	50,000/-
22.	Source of fund	:	BARI
23.	Priority	:	1st

01.	Programme	:	Soil Management
02.	Project	:	Physical Aspect of Soil Management
03.	**Experiment 03**	**:**	**Response of sunflower to fertilizer management under zero tillage in sunflower-fallow-B. Aman cropping pattern in Cumilla region**
04.	Objective(s)	:	i. To observe the effects of zero tillage on sunflower yield in Sunflower-Fallow-B. Aman Cropping Pattern, and ii. To develop balanced fertilizer recommendations for maximizing the yield of sunflower in zero tillage conditions.
05.	Rationale	:	Sunflower is an important promising oilseed Rabi crop in Bangladesh. Its area and production are increasing day by day and it can be grown throughout the country. It can contribute to the total edible oil production of the country. In the Cumilla region, there is a potential area for cultivating sunflowers after the harvest of Aman rice. Farmers cultivated this crop scattered in somepocket areas of the Cumilla region. They usually use the hybrid seeds that are available in the market. In Nabinagar Upazila of Brahmanbaria district, farmers cultivate mustard, coriander, and black cumin after harvesting Aman rice. They usually cultivate sunflowers after harvesting Aman rice. They don't go for boro rice and cultivate sunflower under zero tillage conditions. They don't have any recommended fertilizer dose for the sunflower crop under zero tillage conditions. Keeping in this view, the present experiment has been undertaken to replace hybrid variety with BARI release OP

sunflower variety with fertilizer management package.

06.	Materials and method	:	
07.	Crop/variety	:	BARI surjamukhi-3
08.	Design	:	RCB
	Treatment (4)	:	T1 = 75% of BARI RDCF for Sunflower T2 = 100% of BARI RDCF for Sunflower T3 = 125% of BARI RDCF for Sunflower T4 = Farmers' practice
	Replications	:	3 (Three) dispersed
09.	Plot size	:	10m ×10m
10.	Planting system /spacing	:	Line sowing
11.	Fertilizer dose and methods of application	:	All chemical fertilizers except nitrogenous fertilizer will be applied as a blanket dose following BARI recommended chemical fertilizer (RDCF) for sunflower. Nitrogenous fertilizer will be applied in 2-3 splits. Urea, TSP, MoP, Gypsum, Boric acid, and Zinc Sulfate monohydrate will be used as a source of N, P, K, S, B, and Zn.
12.	Irrigated/rainfed	:	Rainfed
13.	Data to be recorded	:	Date of seed sowing, date of fertilizer application, date of all intercultural operations, plant height, date of flowering, branch plant-1, head size, no. of seed head-1, wt. of seed head-1, 1000 seed wt., date of harvest, yield, grain, and straw nutrient content, hourly labor cost.
14.	Season	:	Rabi
15.	Investigator(s)	:	M M H Bhuiyan, M A H Kahan, H M Naser, and M O Kaisar
16.	Date of initiation	:	October 2022
17.	Date of completion	:	June 2024
18.	Expected Output/benefit	:	Nutrients required for a high yield goal of sunflower grown under zero tillage in sunflower-fallow-B. Aman cropping pattern will be determined.
19.	Location	:	Nabinagar, Brahmanbaria
20.	Status	:	New

21. Estimated cost : 50,000/-

22. Source of fund : BARI

23. Priority : 1st

01. Programme : Soil Management

02. Project : Physical Aspect of Soil Management

03. **Experiment 04 : Synchronization of different aged compost to crop demand, nutrient release and their contribution to the production of red amaranth**

04. Objective(s) :
i. To determine the nutrient releasing trend of compost of different ages
ii. To synchronize the optimum age of compost for maximum benefit of the crop at its peak demand
iii. To observe the changes in soil physical, chemical and biological properties

05. Rationale : Soil fertility is a decisive factor in determining the productivity of all farming systems (Badgley, et al., 2007). Crop and vegetable production is usually coupled with the use of nitrogen-rich fertilizers that result in high N release to soil (up to 150 kg N ha^{-1}) (Chaves et al., 2005). When organic matter decomposes, N usually experiences two different stages of mineralization and immobilization. A high C/N ratio in compost will promote N immobilization. If the plant material has a C/N ratio greater than 25, the microbial population will use available soil N to decompose the residue. If the C/N ratio of the fresh plant material is less than 25, the microbial population will release additional available nitrogen (mineralization). Nutrient release pattern from decomposing organic manures involves three major phases (Swift et al. 1979 and Berg and McClaugherty 2008): (1) an initial phase where leaching and nutrient release dominate; (2) a net immobilization phase where nutrients increase due to the presence of microbes; and (3) a net release phase where the nutrient mass decreases. The immobilization phase could be absent, particularly in litter with high N concentrations (Berg and Laskowski, 2006). Moreover, N and P dynamics can also be characterized by an early immobilization followed by net release (Vitousek and Sanford 1986). But most importantly, the amount and timing of mineralization determines N availability (Watson, et al., 2002). Synchrony of N release and crop uptake is another important thing to consider for organic matter addition to soils. Hence, addition of plant residues/organic materials has become a pivotal strategy for soil fertility improvement and sustainability of land use. In order to

optimize the benefits of plant residue/organic manures on soil quality improvement, it is critical to synchronize the release of nutrients from residue decomposition with patterns of plant nutrient uptake, which may minimize the loss of available nutrients via leaching, runoff and erosion. The amount of N taken up by the crop has a major impact on overall crop growth rate. Maximizing N recovery by the growing crop is of paramount importance in organic systems. This requires synchrony of N release from incorporated plant material with crop N demand (Wagger, 1989). Since N is not stable in soil and becomes less available for crop uptake over time, application timing and age of compost is important. Much of the N uptake occurs in a relatively short time period. If nitrogen is insufficient during this period, yield loss will occur. Applying nitrogen immediately before or during this period will result in higher uptake by the crop and less nitrate lost to leaching or transformations to unavailable forms and ultimately in greater yields. In practice, the pathways by which plant-available forms of N are released from organic residues and taken up by the growing crops is complex. Research conducted in this regard is very sporadic and the results found in this regard are very minimal to come to a conclusion. So, a methodical research should be conducted to find out a corrected age of organic manure to apply for the growing crops so that it synchronizes with the maximal demand of crops.

06. Materials and Methods :

07. Crop/variety : Red Amaranth (var. BARI Lalshak-1)

08. Design : RCBD

i) Treatment : Age of compost: 5 (Five)
T_1: 30 days aged compost
T_2: 45 days aged compost
T_3: 60 days aged compost
T_4: 75 days aged compost
T_5: No compost

ii) Replications 3 (three)

09. Plot size : 3 m × 2m

10. Planting system/spacing Sowing; seed rate-2.5 kg ha^{-1}
Row to row 20 cm and continuous line

11. Fertilizer dose and methods of application : The fertilizer dose will be estimated on the basis of STB following FRG- 2018.
Conventional compost (rice straw, water hyacinth and cowdung) @ 15 tons ha^{-1} will be applied during final land preparation the rest of

			the nutrient demand will be supplied from chemical fertilizer following IPNS approach. All P, K, S, Zn, B and will be incorporated into soil before sowing. N will be top dressed in two equal splits at 7, 15 Days after germination
12.	Irrigated /rainfed		Irrigated
13.	Data to be recorded	:	Physical: Texture, BD, PD, Porosity, FC, moisture, soil strength Chemical: pH, OC, N, P, K, Ca, Mg, S, Zn, B; CO_2 emission Nutrient contents in applied organic manure Biological: Microbial population Plant data: Yield and yield attributes
14.	Investigator(s)	:	A.T.M.A.I. Mondol, M.J. Alam and H.M. Naser
15.	Season	:	Rabi
16.	Date of initiation	:	November 2021
17.	Date of completion	:	April 2023
18.	Expt. output/ benefit	:	Synchronization of crop nutrient demand and compost age when nutrients are available can be found out. Besides, increase in soil moisture retention, improvement of soil health through enrichment of organic matter and yield sustainability will also be achieved.
19.	Location	:	Gazipur
20.	Status	:	Second year
21.	Estimated Cost	:	Tk. 40,000/-
22.	Source of fund	:	BARI
23.	Priority	:	1st
01.	Programme	:	Soil Management
02.	Project	:	Physical Aspects of Soil Management
03.	**Experiment 05**	**:**	**Integrated nutrient management for cutting of Indian spinach under minimum tillage system**
04.	Objective (s)	:	i. To determine the exact balance fertilization for boosting up crop

production
ii. To observe the soil physico-chemical properties

05. Rationale : Bangladesh with a total land area of about 14.8 million hectares of which net crop area is 7.8 million people and population could be 250 million in 2050, indication more people to share the area for survival. The nation possesses 0.2 hectare per person land man ratio, one of the lowest in the world, which offers difficult to achieve food security (Rahman and Salim 2013). It is generally claimed that in Bangladesh every year over 80,000 ha of agricultural land i.e. near 1 % per is decreased (Planning commission, 2009).

Food security and adequate nutrition are among the basic needs of every human being. In Bangladesh, food production has become more than kept pace with population growth due to intensive cropping, using high yielding varieties, improved technology and soil management practice but most people have not enough nutritious and diverse food. More than 1 in 3 children are still afflicted by stunted growth. There are still important shortfalls in the production of certain cereal crops as well as some non-cereals crop foods relative to demand. Government and partners have planned to achieve Sustainable Development Goal 2 to "end hunger, achieve food security and improved nutrition, and promote sustainable agriculture" by 2030. For that government has emphasized on vegetables and fruits production as well as cereals crops.

For sustaining food production and to ensure nutrition, organic and or IPNS based balanced fertilization under improved cultivation system i.e. conservation agriculture is inevitable weapons as balanced fertilization and conservation based crop establishment practices can improve soil physical health, soil fertility level resulting increases yield and protect the environment under present labour crisis and changing climate.

In Bangladesh, nearly 100 different types of vegetable comprising both local and exotic type are grown in 2.63 percent of cultivable land (BBS, 2015). From this small proportion of the cultivable land area, Bangladesh produces about 1.76 lac metric tons of vegetables annually, of which about 65 percent are produced in winter and the rest in summer (DAE, 2016). However, the availability of vegetable is only about 1/5th of the recommended requirement of 200 g/person/day. In the monsoon, it is difficult to produce vegetables properly through seeds and seedlings due to heavy rainfall and jaw condition of soil and make crisis in the market. Moreover, soil erosion is a problem due to tillage during monsoon. Physical removal of top soil by various environmental agents and /or by human activities is an irreversible process that actually makes our future vulnerable by making soil unfertile, causing economic loss for excess nutrient apply and energy use and eventually occurrence of productivity (Montgomery 2007).

Vegetables like Indian spinach (principal summer leafy vegetable)

are grown smoothly in kharif-1 season but difficult to produce in full monsoon (Late kharif-1). In some cases, stem cutting of Indian is producing in in Bangladesh but tillage is the problem for soil erosion factor in aspect of soil health. On the other hand, there is no appropriate fertilizer recommendation for that practice. In this fact conservation tillage of CA system is a good option to produce Indian spinach through stem cutting under IPNS system to boos up the production and enhance the soil physical status and soil fertility level.

The content of soil organic carbon (SOC) in cultivated soils, mainly in arable soils, is limited by the cropping intensity and depth of cultivation. In addition, increasing SOC through management in agricultural systems is a slow process that is limited by the amount of biomass returned to the soil, the nutrient composition of the biomass (Kirkby et al., 2011) and the degree to which the SOC is exposed or protected from microbial oxidation (Hoyle et al., 2011).

Organic matter management through minimum tillage and fertilizer management practices is subsidiary for increasing soil temperature, moisture, root activation, cation exchange capacity, nutrient use efficiency, resulting increase uptake of nutrient, optimize yield and economic benefits for sustainable crop production. Integrated nutrient management of organic and minerals fertilizer is advocate to meet the nutrient needs, improves soil quality and to obtain technological aspects of crop production system in agriculture (Singh et al., 1997a; Dubey and Lal, 2009; Parihar et al., 2011). It is established fact that conservation tillage increase soil C and N than conventional practices (Koide et al., 2014; Solaiman and Anawar, 2015, Faaborg et al., 2005). Increased stratification of nutrients is generally observed, with enhanced conservation and availability of nutrients near the soil surface under minimum tillage as compared to conventional tillage (Duiker and Beegle 2006, Franzluebbers and Hons 1996).

The choice of appropriate tillage system is crucial for sustainable terming in sub-tropical ecosystem with high levels of organic matter decomposition and nutrient leaching loss in the tropics, conservation tillage and balance fertilizer management becomes an attractive option. Hence, the present study undertaken.

06. Materials and Methods :

07. Crop/Variety : Indian spinach (stem cutting) (var. BARI Puishak-2)

08. Design : RCBD

i) Treatment : Rate of fertilizer: 6 (Six)
T_1: 100% Recommended dose of chemical fertilizer (RDCF)
T_2: 120% RDCF
T_3: 80% RDCF
T_4 : 80% RDCF + 7.5 t ha^{-1} compost

			T_5: 100% RDCF + 5.0 t ha^{-1} compost T_6: 120% RDCF + 2.5 t ha^{-1} compost
	ii) Replications		3 (three)
09.	Plot size	:	3m ×2.75m
10.	Planting system/spacing		Transplanting Row to row 50 cm and plant to plant 40 cm
11.	Fertilizer dose and methods of application	:	The fertilizer dose will be estimated on the basis of STB following FRG- 2018. Full dose of organic manure and 1/2 K, entire quantity of P, S, Zn, B will be applied as basal during final land preparation. Remaining potassium as MoP will be applied at early vegetative; Nitrogen as urea will be applied in three equal splits 10 DAT, 30 DAT and 50 DAT.
12.	Irrigated /rainfed		Irrigation will be applied as and when necessary
13.	Data to be recorded	:	Physical: Texture, BD, PD, Porosity, FC, moisture, soil strength Chemical: pH, OC, N, P, K, Ca, Mg, S, Zn, B Nutrient contents in applied organic manure Biological: Microbial population Plant data: Yield and yield attributes
14.	Investigator(s)	:	M.J. Alam, A.T.M.A.I. Mondol, M. Sultana and H.M. Naser
15.	Season	:	Late Kharif-1
16.	Date of initiation	:	Late May 2022
17.	Date of completion	:	August 2024
18.	Expt. output/ benefit	:	The efficient crop establishment and nutrient management practices under zero tillage and changing climatic conditions will be explored. In addition, crop production will be increased.
19.	Location	:	Gazipur
20.	Status	:	Second year
21.	Estimated Cost	:	Tk. 40,000/-
22.	Source of fund	:	BARI

23. Priority : 1st

01. Programme : Soil Management

02. Project : Physical Aspects of Soil Management

03. **Experiment 06 : Integrated nutrient management for cutting of kangkong under minimum tillage system**

04. Objective (s) : i. To determine the exact balance fertilization for boosting up crop production

ii. To observe the soil physico-chemical properties

05. Rationale : Bangladesh with a total land area of about 14.8 million hectares of which net crop area is 7.8 million people and population could be 250 million in 2050, indication more people to share the area for survival. The nation possesses 0.2 hectare per person land man ratio, one of the lowest in the world, which offers difficult to achieve food security (Rahman and Salim 2013). It is generally claimed that in Bangladesh every year over 80,000 ha of agricultural land i.e. near 1 % per is decreased (Planning commission, 2009).

Food security and adequate nutrition are among the basic needs of every human being. In Bangladesh, food production has become more than kept pace with population growth due to intensive cropping, using high yielding varieties, improved technology and soil management practice but most people have not enough nutritious and diverse food. More than 1 in 3 children are still afflicted by stunted growth. There are still important shortfalls in the production of certain cereal crops as well as some non-cereals crop foods relative to demand. Government and partners have planned to achieve Sustainable Development Goal 2 to "end hunger, achieve food security and improved nutrition, and promote sustainable agriculture" by 2030. For that government has emphasized on vegetables and fruits production as well as cereals crops.

For sustaining food production and to ensure nutrition, organic and or IPNS based balanced fertilization under improved cultivation system i.e. conservation agriculture is inevitable weapons as balanced fertilization and conservation based crop establishment practices can improve soil physical health, soil fertility level resulting increases yield and protect the environment under present labour crisis and changing climate.

In Bangladesh, nearly 100 different types of vegetable comprising both local and exotic type are grown in 2.63 percent of cultivable land (BBS, 2015).From this small proportion of the cultivable land

area, Bangladesh produces about 1.76 lac metric tons of vegetables annually, of which about 65 percent are produced in winter and the rest in summer (DAE, 2016). However, the availability of vegetable is only about 1/5th of the recommended requirement of 200 g/person/day. In the monsoon, it is difficult to produce vegetables properly through seeds and seedlings due to heavy rainfall and jaw condition of soil and make crisis in the market. Moreover, soil erosion is a problem due to tillage during monsoon. Physical removal of top soil by various environmental agents and /or by human activities is an irreversible process that actually makes our future vulnerable by making soil unfertile, causing economic loss for excess nutrient apply and energy use and eventually occurrence of productivity (Montgomery 2007).

Kangkong (Ipomea aquatica Forsk) or 'Kolmi shak' or 'Water spinach' is being used as a very common, popular leafy vegetable in Bangladesh. Newly introduced cultivated form of entirely commercial type variety named as 'Gimakolmi' (released by BARI) is being used as a popular money-making variety in recent time in Bangladesh (Sitesh, 2021) and also have high nutritional value and due to its medicinal properties (Igwenyi et al. 2011). It is a very cheap source of iron, β-carotene, calcium, lutein, fibre etc. which improves eye health. Since the commercial type kangkong can be grown almost throughout the summer season as home garden vegetables or market garden vegetables and the young shoots as well as leaves can be collected starting from 25-30 days either plants raised from seed sowing or planting of cuttings and after that fresh vegetables can be harvested at 15 days intervals almost 4-5 months profitably by cut-and-come-again process now a days a good number of commercial vegetable growers of Bangladesh are cultivating this nutrient rich water spinach as a fast growing vegetable commodity. Kangkong grow smoothly in kharif-1 season but difficult to produce in full monsoon (Late Kharif-1 due to tillage problem for soil erosion factor in aspect of soil health and jaw condition of the soil. On the other hand, there is no appropriate fertilizer recommendation for that practice. In this fact conservation tillage of CA system is a good option to produce kangkong through stem cutting under IPNS system to boos up the production and enhance the soil physical status and soil fertility level.

The content of soil organic carbon (SOC) in cultivated soils, mainly in arable soils, is limited by the cropping intensity and depth of cultivation. In addition, increasing SOC through management in agricultural systems is a slow process that is limited by the amount of biomass returned to the soil, the nutrient composition of the biomass (Kirkby et al., 2011) and the degree to which the SOC is exposed or protected from microbial oxidation (Hoyle et al., 2011).

Organic matter management through minimum tillage and fertilizer management practices is subsidiary for increasing soil temperature, moisture, root activation, cation exchange capacity, nutrient use efficiency, resulting increase uptake of nutrient, optimize yield and

economic benefits for sustainable crop production. Integrated nutrient management of organic and minerals fertilizer is advocate to meet the nutrient needs, improves soil quality and to obtain technological aspects of crop production system in agriculture (Singh et al., 1997a; Dubey and Lal, 2009; Parihar et al., 2011. No studies have focused on these aspects so far in Bangladesh. A methodological research needs to be conducted for successful crop production and for improve soil health in adverse situation under consecutive climate change.

06. Materials and Methods :

07. Crop/Variety : Kangkong (stem cutting) (var. BARI Gima kalmi-1)

08. Design : RCBD

i) Treatment : Rate of fertilizer: 6 (Six)
T_1: 100% Recommended dose of chemical fertilizer (RDCF)
T_2: 120% RDCF
T_3: 80% RDCF
T_4 : 80% RDCF + 7.5 t ha^{-1} compost
T_5: 100% RDCF + 5.0 t ha^{-1} compost
T_6: 120% RDCF + 2.5 t ha^{-1} compost

ii) Replications 3 (three)

09. Plot size : 3m ×2.75m

10. Planting system/spacing Transplanting
Row to row 30 cm and continuous line

11. Fertilizer dose and methods of application : The fertilizer dose will be estimated on the basis of STB following FRG- 2018.
Full dose of organic manure and, entire quantity of P, K, S, Zn, B will be applied as basal during final land preparation. Nitrogen as urea will be applied in three equal splits 7 DAT, 25 DAT and 40 DAT.

12. Irrigated /rainfed Irrigation will be applied as and when necessary

13. Data to be recorded : Physical: Texture, BD, PD, Porosity, FC, moisture, soil strength
Chemical: pH, OC, N, P, K, Ca, Mg, S, Zn, B
Nutrient contents in applied organic manure
Biological: Microbial population
Plant data: Yield and yield attributes

14. Investigator(s) : A.T.M.A.I. Mondol, M.J. Alam, M. Sultana and H.M. Naser

15. Season : Late Kharif-1

16. Date of initiation : Late May, 2022

17. Date of completion : August, 2024

18. Expt. output/ benefit : The efficient crop establishment and nutrient management practices under zero tillage and changing climatic conditions will be explored. In addition, crop production will be increased.

19. Location : Gazipur

20. Status : Second year

21. Estimated Cost : Tk. 40,000/-

22. Source of fund : BARI

23. Priority : 1st

01. Programme : Soil Management

02. Project : Physical Aspect of Soil Management

03. **Experiment 07** **Requirement of nitrogen for Mustard- Okra- T.aman cropping systems based on Conservation Agriculture practices**

04. Objectives :
   i. To determine the optimum rate of nitrogen fertilizer for the intensive Mustard-Okra-T. Aman cropping system under CA practice,
   ii. To evaluate the effects of crop residue and nitrogen on soil physico-chemical properties and component crop productivity,
   iii. To assess the system productivity in the aforesaid cropping system.

05. Rationale : Well-managed soil under minimum till condition with crop residue retention can support sustainable crop production through improved soil quality with higher soil organic carbon, available nutrients and addition of crop residue have essential roles in improving the enzymatic activity of soil that are important for nutrient cycling, as well as increasing crop productivity (Rajkumara et al. 2014; Wei et al. 2015). Conservation agriculture (CA) is characterized by three linked principles, namely, minimal soil disturbance, permanent organic soil cover and crop rotations (Kassam, 2010; FAO, 2010). CA is already occurring and gathering momentum worldwide as a

new paradigm shift for the 21st century to ensure sustainable food production and maintain environmental integrity.

Tillage, residue management and crop rotation have a significant impact on nutrient distribution in soils (Galantini et al. 2000; Etana et al. 1999). Distribution of nutrients in a soil under minimum tillage is different to that in tilled soil. Increased stratification of nutrients is generally observed, with enhanced conservation and availability of nutrients near the soil surface under minimum tillage as compared to conventional tillage (Duiker and Beegle 2006; Franzluebbers and Hons 1996).

The adoption of CA in rice-based cropping systems with traditional nutrient management may have discouraging results. In addition, the fertilizer recommendation guide is also developed only for conventional farming systems (BARC 2018). The fertiliser recommendation guide is therefore should be improved with fertiliser recommendations for CA based cropping systems. The budget and dynamics of nutrients should also be studied in soils under CA based cropping systems. However, the information on effect of crop residue, minimal soil disturbance and nutrient management in mustard-maize-T. Aman cropping system is lacking. Hence, the present study is undertaken.

06. Materials and Methods :

07. Cropping pattern/ Variety : Mustard (BARI Sarisha-14), Okra (BARI Dheros-1), T. Aman rice (BRRI Dhan-57)

08. Design

RC B

i) Replication 03 (three)
ii) Treatments : 12 (Twelve)

Factor A: Crop establishment methods- 3 (main plots)
T_1: Conventional method (Tillage + residue retention)
T_2: Strip tillage for upland crops + Non-puddling for rice crops with residue retention
T_3: Zero tillage for upland crops + Non-puddling for rice crops with residue retention

Factor B: N dose- 5 levels (sub-plot)
N_1: 100% of recommended N
N_2: 125% of recommended N
N_3: 50% of recommended N
N_4: 75% of recommended N

09. Plot size : 4.2 m × 3.0 m

10. Planting system/ Spacing : Line sowing/Transplanting

Mustard (row to row 30 cm continuous in line); Okra (row to row 45 cm × seed to seed 30 cm); Rice (row to row 20 cm × hill to hill 20 cm)

11.	Seed rate	:	Mustard (14 kg ha^{-1}); Okra (5 kg ha^{-1}); T. aman (30 kg ha^{-1})
12.	Fertilizer dose	:	As per STB; Except N fertilizer, all other fertilizer will be applied as blanket dose
	Application method	:	In case of mustard, all required fertilizers except urea will be applied as basal dose whereas the urea will be applied in three equal splits at 10, 25, and 40 DAS, respectively, matching with critical growth stages. For Okra, all required fertilizers except urea will be applied as basal dose whereas 3 N splits will be applied at 15, 35 and 55 DAS, respectively. For rice, all other fertilizers, except urea, will be applied during final land preparation. Urea will be applied in three equal splits- the 1st split (25%) will be applied at 5 DAT, the second split (50%) of urea was broadcast at tillering stage (20 DAT) and the third split (25%) before PI stage (35 DAT).
13.	Data to be recorded	:	Physical: Texture, Bulk density, Field capacity (FC), particle density, porosity, Soil strength Chemical: pH, SOM, TN, Available P, K, Ca, Mg, S, Zn, B contents Plant data: Yield and yield attributes
14.	Investigators	:	M. J. Alam, A.T.M.A.I. Mondol and H. M. Naser
15.	Season	:	Year round
16.	Initiation	:	Mustard (November-2020), Okra (March-2021) and T. aman (July-2021)
17.	Completion	:	November 2024
18.	Expected output	:	Nutrient management for CA based cropping systems; Improvement of soil health through enrichment of organic matter and production sustainability, updating fertilizer recommendations
19.	Location	:	Gazipur
20.	Status	:	Second year
21.	Estimated cost	:	Tk. 80,000/-
22.	Source of fund	:	BARI
23.	Priority	:	1st

01.	Programme	:	Soil Management
02.	Project	:	Physical Aspect of Soil Management
03.	**Experiment 08**	**:**	**Effect of crop establishment practices and IPNS based nutrient management on cabbage-Indian spinach- T. aman cropping system and soil physico-chemical properties**
04.	Objectives	:	1) To investigate the performance of crops in vegetable based triple crops cropping system under the crop establishment and organic fertilizer application practices 2) To study the soil health under crop establishment and organic

dominant IPNS in the cropping system.

05. Rationale : Judicious and timely crop establishment practices and appropriate nutrient management are very important for successful production of crops in vegetable based cropping systems under changing climatic conditions. Conservation agriculture practice like strip planting performs well in establishing crops along with yield, economics, soil health and environment. But sometimes increased residue retention can't be affordable due to different use of residues in rural households. On the other hand, soil, soil organic matter and soil health are the foundation of agriculture and human civilization on the earth because without improving soil health, no breeding or biotechnological approach of sustainable crop production would work. In order to improving soil health and ensuring sustainable crop production, alternative approach of soil health improvement should therefore be explored.

06. Materials and Methods

Crops and Variety : Cabbage (Atlas 70)-Indian Spinach (BARI puishak-2)-T. Aman rice (BRRI dhan57)

07. Design : RCB (Split plot)

: i) Replication: 3 (Three)
ii) Treatments : 6 (six)

Tillage methods-
T_1:Strip tillage
T_2: Conventional tillage

Nutrient management
NM_1: 100 % Organic manure
NM_2: 60 % CF and 40 % Organic manure
NM_3: 100 % Chemical fertilizer (CF)

08. Plot size : 4.8 m × 3.15 m

09. Planting system/ Spacing : Cabbage-Transplanting; Indian spinach-sowing & T.aman-Transplanting method
Cabbage - 60 cm × 45 cm; Indian Spinach-60 cm × 45 cm; T.Aman rice-20 cm × 20 cm

10. Seed rate : Cabbage (Seedling), Indian Spinach (Seedlings), T.Aman (30 kg ha^{-1})

11. Fertilizer dose and methods of application : As per INPS and STB (FRG-2018)
In strip tillage, 100 % OM will be localized application. In conventional practice, organic manure will be broadcasted. In other cases, full dose of organic manure and 1/2 K, entire quantity of P, S, Zn, B will be applied as basal during final land preparation. Remaining potassium as MoP will be applied at early vegetative; Nitrogen as urea will be applied in three equal splits 7 days after germination/DAT, vegetative stage and before flowering stage

12. Irrigation : Supplemental irrigation will be applied as and when necessary.

13.	Data to be recorded	:	Soil texture, BD, PD, Porosity, FC, Soil strength pH, OM, N, P, K, S, Zn and B of soil, CO_2 emission Yield parameters and yield
14.	Investigators	:	M. J. Alam, ATMAI Mondol, H. M. Naser
15.	Season	:	Year round
16.	Initiation	:	Cabbage (December, 2019), Indian spinach (March, 2020) and T.aman (July,2020)
17.	Completion	:	Long – term
18.	Expected output	:	The efficient crop establishment and nutrient management practices under CA and changing climatic conditions will be found out. In addition, increased crop production will be ensured.
19	Location	:	Central FARM, Soil Physics Section, SSD, BARI, Gazipur
20.	Status	:	Fourth year
21.	Estimated cost	:	Tk. 80,000/-
22.	Source of fund	:	BARI
23.	Priority	:	1st

PROJECT-II

CHEMICAL ASPECTS OF SOIL MANAGEMENT
Project Leader: Dr. MM Masud

01.	Programme	:	Soil Management
02.	Project	:	Chemical Aspects of Soil Management
03.	**Experiment 01**	**:**	**Nutrient management for sustaining soil fertility and yield of Wheat-Mungbean-T.Aman cropping pattern**
04.	Objective(s)	:	i. To find out judicious fertilizer recommendation for Wheat-Mungbean-T.Aman cropping pattern for sustainable yield; ii. To monitor soil health after each cropping cycle of the pattern; and iii. To estimate the uptake of different major nutrients and make a balance sheet for each of the nutrients.
05.	Rationale	:	Wheat-Mungbean-T.Aman is an important cropping pattern in Bangladesh. Intensive cropping with such cropping patterns coupled with application of imbalanced fertilizer lead to soil fertility depletion and has serious negative impact on soil organic matter. Judicious fertilizer application and addition of organic matter may improve and sustain soil fertility and crop yield. Integrated nutrient management essentially means the use of available organic and inorganic sources of plant nutrients for crop production. Incorporation of mungbean residue from the pattern can improve soil fertility and crop productivity of the pattern.
06.	Materials and Methods	:	The experiment will be conducted at RARS, Rahmatpur, Barishal experimental field. Seedling are transplanted in August 2021 with spacing of 1m × 1.5m.
07.	Crop/variety	:	Wheat/BARI Gom-30 Mungbean/BARI Mung-6 T. Aman rice/BINA dhan-7
08.	Design	:	RCB
	i) Treatment	:	6 (Six) For Wheat: T1 = 125% of recommended dose T2 = 100% of recommended dose ($N_{120}P_{35}K_{75}S_{20}Zn_5$ kg ha^{-1}) T3 = 75% of recommended dose T4 = 50% of recommended dose T5 = Farmer's practice T6 = Native fertility For Mungbean : 20 kg N will be applied all treatments except T6 i.e. native fertility For T. Aman :

			T1 = 125% of NPK of recommended dose T2 = 100% of recommended dose (N100P40K60 kg ha-1) T3 = 75% of recommended dose T4 = 50% of recommended dose T5 = Farmer's practice (N60P18K30 kg ha-1) T6 = Native fertility Sulphur @ 10 kg ha-1 will be applied in all treatments except absolute control treatment.
	ii) Replications		3 (three)
09.	Plot size	:	6 m × 5m
10.	Planting system/spacing		For Wheat : Row to row- 20 cm, Plant to plant continuous in line For Mungbean : Row to row 30 cm, Plant to plant 10 cm For T.Aman : Row to row 20 cm, Plant to plant 20 cm
11.	Fertilizer dose and methods of application	:	For Wheat: All PKSB and half of N will be applied at the time of final land preparation and remaining half of N will be applied before booting stage. For Mungbean: All N will be applied at the time of final land preparation For T. Aman: All PKS will be applied at the time of final land preparation and N will be applied in two equal installments i.e. 15-20 days and 40-45 days after transplanting.
12.	Irrigated /rainfed		For Wheat : Three, one each at CRI stage, booting stage and grain filling stage For Mungbean: Rainfed For T.Aman : Irrigation will be provide when necessary
13.	Data to be recorded	:	For Wheat : Plant height, no. of spike m-2, no. of filled & unfilled grains spikelet-1, 1000 grain weight, grain & straw yield (t ha-1) For Mungbean: Plant height, plant population m-2, no. of filled & unfilled grains pod-1, 1000 grain weight, grain & stover yield (t ha-1) For T. Aman : Plant height, no. of effective tillers plant-1, no. of filled & unfilled grains penicle-1, 1000 grain weight, grain & straw yield (t ha-1)
14.	Investigator(s)	:	Md. Nasir Uddin Mahmud, SSO, RARS, Jashore Md. Touhidur Rahman, SSO, RARS, Ishurdi
15.	Season	:	Round the year
16.	Date of initiation	:	November, 2000 (long term)
17.	Date of completion	:	
18.	Expt. output/ benefit	:	Soil health will be improved

19. Location : Ishurdi and Jashore

20. Status : 21th year

21. Estimated Cost : Tk. 15,000/- for each crop

22. Source of fund : BARI

23. Priority : 1st

01. Programme : Soil Management

02. Project : Chemical Aspects of Soil Management

03. **Experiment 02 : Nutrient management for sustaining soil fertility and yield of Mustard-Mungbean-T. Aman cropping pattern**

04. Objective (s) : I. To find out judicious fertilizer recommendation for Wheat-Mungbean-T.Aman cropping pattern for sustainable yield;
II. To monitor soil health after each cropping cycle of the pattern; and
III. To estimate the uptake of different major nutrients and make a balance sheet for each of the nutrients.

05. Rationale : Mustard-Mungbean-T.Aman is an important cropping pattern in Bangladesh. Intensive cropping with such cropping patterns coupled with application of imbalanced fertilizer lead to soil fertility depletion and has serious negative impact on soil organic matter. Judicious fertilizer application and addition of organic matter may improve and sustain soil fertility and crop yield. Integrated nutrient management essentially means the use of available organic and inorganic sources of plant nutrients for crop production. Incorporation of mungbean residue from the pattern can improve soil fertility and crop productivity of the pattern.

06. Materials and Methods :

07. Crop/Variety : Mustard/BARI Sharisa-14
Mungbean/BARI Mung-6
T.Aman rice/BINA dhan-7

08. Design : RCBD

i) Treatment : 8 (eight)
For Mustard:
T_1 = 80-36-70-40-3-1 kg, N P K S Zn B ha^{-1}
T_2 = 120-36-70-40-3-1 kg, N P K S Zn B ha^{-1}
T_3 = 160-36-70-40-3-1 kg, N P K S Zn B ha^{-1}
T_4 = 120-18-70-40-3-1 kg, N P K S Zn B ha^{-1}
T_5 = 120-54-70-40-3-1 kg, N P K S Zn B ha^{-1}

T_6 = 120-36-35-40-3-1 kg, N P K S Zn B ha^{-1}
T_7 = 120-36-105-40-3-1 kg, N P K S Zn B ha^{-1}
T_8 = Native fertility

For Mungbean :
25 kg N and 10 kg P ha^{-1} uniformly in all treatments except control plot

For T.Aman :
T T_1 = 80-36-70-10 kg, N P K S ha^{-1}
T_2 = 120-36-70-10 kg, N P K S ha^{-1}
T_3 = 160-36-70-10 kg, N P K S ha^{-1}
T_4 = 120-18-70-10 kg, N P K S ha^{-1}
T_5 = 120-54-70-10 kg, N P K S ha^{-1}
T_6 = 120-36-35-10 kg, N P K S ha^{-1}
T_7 = 120-36-105-10 kg, N P K S ha^{-1}
T_8 = Native fertility

ii) Replications 4 (four)

09. Plot size : 5m × 6m

10. Planting system/spacing
For Mustard: Row to Row 30 cm continuous in line
For Mungbean: Row to row 30 cm, Plant to plant 10 cm
For T.Aman: Row to row 20 cm, Plant to plant 20 cm

11. Fertilizer dose and methods of application : For Mustard: All PKSZn, Cowdung and half of N will be applied at the time of final land preparation and remaining half N will be applied before flowering.
For Mungbean: All N and P will be applied at the time of final land preparation
For T.Aman: All PKS will be applied at the time of final land preparation and N will be applied in two equal installments i.e. 15-20 days and 40-45 days after transplanting.

12. Irrigated /rainfed
For Mustard : Three, one each at vegetative stage, flower initiation stage and seed filling stage
For Mungbean: Rainfed
For T.Aman : Irrigation will be provide when necessary

13. Data to be recorded : For Mustard: Plant height, plant population m^{-2}, no. of filled & unfilled grains pod^{-1}, 1000 grain weight, grain & straw yield (t ha^{-1})
For Mungbean: Plant height, plant population m^{-2}, no. of filled & unfilled grains pod^{-1}, 1000 grain weight, grain & stover yield (t ha^{-1})
For T. Aman: Plant height, no. of effective tillers $plant^{-1}$, no. of filled & unfilled grains $penicle^{-1}$, 1000 grain weight, grain & straw yield (t ha^{-1})

14. Investigator(s) : Md. Nasir Uddin Mahmud, SSO, RARS, Jashore
Md. Touhidur Rahman, SSO, RARS, Ishurdi

15. Season : Round the year

16. Date of initiation : November, 2000 (long term)

17. Date of completion :

18. Expt. output/ benefit : Soil health will be improved

19. Location : Ishurdi and Jashore

20. Status : 21th year

21. Estimated Cost : Tk. 15,000/- for each crop

22. Source of fund : BARI

23. Priority : 1st

01. Programme : Soil Management

02. Project : Chemical Aspects of Soil Management

03. **Experiment 03 : Long-term integrated nutrient management for sustaining soil fertility and yield of Maize-Mungbean-T.Aman cropping pattern**

04. Objective (s) : i. To find out judicious fertilizer recommendation for Maize-Mungbean-T.Aman cropping pattern for sustainable yield;
ii. To monitor soil health after each cropping cycle of the pattern; and
iii. To estimate the uptake of different major nutrients and make a balance sheet for each of the nutrients.

05. Rationale : Maize and T.Aman are two important field crops in Bangladesh. Both the crop harvested huge amount of nutrient from soil. Intensive cropping with such cropping patterns coupled with application of imbalanced fertilizer lead to soil fertility depletion and has serious negative impact on soil organic matter. Judicious fertilizer application and addition of organic matter may improve and sustain soil fertility and crop yield. Integrated nutrient management essentially means the use of available organic and inorganic sources of plant nutrients for crop production. Incorporation of mungbean in the pattern and ploughing down of mungbean residue from the pattern can improve soil fertility and crop productivity of the pattern.

06. Materials and Methods :

07. Crop/Variety : Maize/BARI Hybrid Maize-9
Mungbean/BARI Mung-6
T.Aman rice/BINA dhan-7

08. Design : RCB

i) Treatment : 6 (Six)

For Maize:

T_1 = Native fertility

T_2 = 75% of STB chemical fertilizer dose + CD (5 t ha^{-1})

T_3 = 100% of STB fertilizer dose

T_4 = 100% of STB fertilizer dose + CD (5 t ha^{-1})

T_5 = 100% of STB fertilizer dose + PM (3 t ha^{-1})

T_6 = 75% of STB chemical fertilizer dose

For Mungbean :

20 kg nitrogen will be applied all treatments except T_1 i.e. native fertility

For T. Aman :

T_1 = Native fertility

T_2 = 75% of STB chemical fertilizer dose + CD (5 t ha^{-1})

T_3 = 100% of STB fertilizer dose

T_4 = 100% of STB fertilizer dose + CD (5 t ha^{-1})

T_5 = 100% of STB fertilizer dose + PM (3 t ha^{-1})

T_6 = 75% of STB chemical fertilizer dose

ii) Replications 4 (four)

09. Plot size : 6m × 5m

10. Planting system/spacing

For Maize : Row to row- 60 cm, Plant to plant 20 cm
For Mungbean : Row to row 30 cm, Plant to plant 10 cm
For T.Aman : Row to row 20 cm, Plant to plant 20 cm

11. Fertilizer dose and methods of application : For Maize : All PKSZnB and 1/3rd N will be applied at the time of final land preparation and remaining N will be applied in two equal splits at 35 and 75 DAS.
For Mungbean: All N will be applied at the time of final land preparation
For T. Aman : All PKS will be applied at the time of final land preparation and N will be applied in two equal installments i.e. 15-20 days and 40-45 days after transplanting.

12. Irrigated /rainfed

For Maize : Irrigation will be provide when necessary
For Mungbean : Rainfed
For T.Aman : Irrigation will be provide when necessary

13. Data to be recorded : For Maize : Plant height, no. of cobs $plant^{-1}$, 1000 grain weight, grain & straw yield (t ha^{-1})
For Mungbean : Plant height, plant population m^{-2}, no. of filled & unfilled grains pod^{-1}, 1000 grain weight, grain & stover yield (t ha^{-1})
For T.Aman : Plant height, no. of effective tillers $plant^{-1}$, no. of filled & unfilled grains $penicle^{-1}$, 1000 grain weight, grain & straw yield (t ha^{-1})

14. Investigator(s) : R. Khatun, SSO, Soil Chemistry Section

15. Season : Round the year

16. Date of initiation : November, 2007 (long term)

17. Date of completion :

18. Expt. output/ benefit : Soil health will be improved

19. Location : Joydebpur

20. Status : 14th year

21. Estimated Cost : Tk. 15,000/- for each crop

22. Source of fund : BARI

23. Priority : 1st

01. Programme : Soil Management

02. Project : Chemical Aspects of Soil Management

03. **Experiment 04 : Efficacy of different form of urea on nitrogen availability and yield of maize**

04. Objective (s) :
i. To find out use efficiency of different form of urea.
ii. To find out the yield and yield components of maize as influenced by different form of urea.
iii. To analyze cost and return of maize produced from different form of urea.

05. Rationale : Urea is the main nitrogenous fertilizer used in all over the world. Different form urea are available in Bangladesh and neighboring country India. Prilled urea is widely used in Bangladesh which can easily spread in crop field but crop can uptake only 35% of nitrogen. Urea Super Granule is also available in Bangladesh which use efficiency is 60% but labour cost to apply in the field is high. Neem coated urea is becoming popular in neighboring country India. About 60% of total urea consumed in India are neem coated. Its use efficiency is higher compared to prillied urea and application cost is lower to urea super granule. There is a need to verify their (Prillled urea, Urea Super Granule & Neem Coated Urea) performance in Bangladesh soil condition growing different crops.

06. Materials and Methods

07. Crop/variety : Maize/ BARI Hybrid Maize-9

08. Design : RCB

	Treatment	:	4 (four) T_1 = N-control T_2 = RD of nitrogen (225 kg ha^{-1}) in the form of Prilled urea T_3 = Application of 200 kg nitrogen/ha in the form of urea super granule (USG) T_4 = Application of 205 kg nitrogen/ha in the form of neem coated urea Blanket dose of P, K, S, Zn & B will be applied
09.	Replication	:	3 (Three)
10.	Plot size	:	4 m × 5 m
11.	Planting system/spacing	:	Maize will be sown in line at 60 cm apart and plant to plant distance will be 20 cm.
12.	Method of fertilizer application	:	For prilled urea and neem coated urea, 1/3rd of urea will be applied before sowing. Remaining 2/3rd urea will be applied in two installments; one at 40 days after sowing another at 75 days at sowing. For USG, whole urea was applied as band placement before sowing.
13.	Irrigated/ rainfed	:	Irrigated
14.	Data to be recorded	:	1. Dates of all operations 2. Grain/stover yield of maize 3. All the yield contributing characters of maize 4. Cost of inputs and price of output 5. Soil, grain and plant sample will be collected after the harvest of crops and will be analyzed in the laboratory.
15.	Investigator (s)	:	M.M. Masud, SSO, SSD, BARI H.M. Naser, CSO, SSD,BARI A. Barman, SO, SSD, BARI
16.	Season	:	Rabi
17.	Date of initiation	:	November, 2022
18.	Date of completion	:	April, 2023
19.	Expected output	:	Highly efficient urea form will be find out, nitrogen loss will be minimized and soil fertility and crop productivity will be increased.
20.	Location	:	BARI central farm, Gazipur
21.	Estimated cost	:	Tk. 25,000/-
22.	Source of fund	:	BARI
23.	Priority	:	1st
01.	Programme	:	Soil Management

02. Project : Chemical Aspects of Soil Management

03. **Experiment 05 : Nutrient management of sesame in Barishal region**

04. Objective (s) : i. To develop nutrient management package for sesame in Barishal region.
ii. To increase the yield of sesame through fertilizer management.

05. Rationale : Sesame is the third highest edible oil of Bangladesh. It contained 42-45% oil and 20% of protein. It has also medicinal value. In Bangladesh sesame was cultivated both rabi and kharif season. Mostly cultivated in kharif season. It requires medium high land because stagnant water damages sesame. It is a short durated crop. Farmers of this region interested to cultivated sesame. Sometimes the land is fallow in this region in mid February to mid April. So they can harvest a short durated crop in this time. Fertilizer management is a big factor for crop production. Farmers do not know the actual fertilizer dose for sesame cultivation. So this experiment is under taken to determine the fertilizer dose for sesame cultivation in Barishal region.

06. Materials and Methods

07. Crop/variety : BARI Til -4

08. Design : RCB
Treatment : Rate of fertilizer: 5 (Five)
T_0 : Native fertility
T_1 : 75:30:40:15:2:1 kg ha^{-1} NPKSZn & B (FRG-2018)
T_2 : 50% of T_1 + CD 3 t ha^{-1}
T_3 : 75% of T_1 + CD 3 t ha^{-1}
T_4 : 125% of T_1

09. Replication : 4 (four)

10. Plot size : 3 m x 3 m

11. Planting system/spacing : Line sowing
Line to line: 30 cm; Plant to plant: 5 cm.

12. Method of fertilizer application : As source of nutrients, nitrogen and phosphorus will be applied in the forms of urea and TSP; potassium as muriate of potash, sulphur as gypsum, Zn as zinc sulphate and boron as boric acid to increase the nutrient use efficiency of the crop. N fertilizer was applied in two equal installments as final land preparation and 25-30 DAS. The whole amount of all other plant nutrients (P-K-S-Zn-B) will be applied as final land preparation.

13. Irrigated/ rainfed : Irrigated

14.	Data to be recorded	:	Phenological parameters, yield and yield components, biomass etc.
15.	Investigator (s)	:	M. R. Islam, M. S. Alam and R. Khatun
16.	Season	:	Kharif
17.	Date of initiation	:	Mid February, 2020
18.	Date of completion	:	June, 2023
19.	Expected output	:	Optimum fertilizer dose for sesame will be find out
20.	Location	:	RARS, Rahmatpur, Barishal
21.	Estimated cost	:	1st year
22.	Source of fund	:	Tk. 35,000/-
23.	Priority	:	1st

01. Programme : Soil Management

02. Project : Chemical Aspects of Soil Management

03. **Experiment 06 : Effect of different form and dose of urea fertilizer on nitrous oxide emission, nitrogen use efficiency and yield of broccoli**

04. Objective(s) :
1. To determine nitrous oxide emission from cauliflower field as influenced by different form, application method and dose of urea.
2. To increase nitrogen use efficiency by cauliflower. decrease CO_2 gas emission from soil thus mitigating GHG emission
3. To find out suitable form, application method and optimum dose of urea for cauliflower yield.

05. Rationale : Nitrogen (N) is an important plant nutrient and is the most limiting one due to its high mobility and different types of losses. Urea Super Granule is available in Bangladesh which use efficiency is 60% but labour cost to apply in the field is high. Neem coated urea is becoming popular in neighboring country India. About 60% of total urea consumed in India are neem coated. Its use efficiency is higher compared to prillied urea and application cost is lower to urea super granule. The farmers of Bangladesh usually use prilled urea (PU) for cultivation of crops. To improve fertilizer use efficiency, different types of fertilizer materials are becoming available day by day. Urea Super Granule (USG) is one of the nitrogenous fertilizers that is now available in our country and the farmers are using it for Boro rice and banana cultivation (Nazrul et al., 2007). It was found that USG as an alternative source of N than PU in terms of efficiency in wetland rice (Eusuf et al., 1993 and 1995). The loss of N by leaching and volatilization is minimal

in USG & NCU and it supplies more N to crops than PU. The volatilization loss of PU is very high and farmers lose a huge amount of money for N fertilizer. To control this loss, USG and NCU application may be a good option to minimize production cost as well as to increase yield. Nazrul et al. (2007) reported that 5-8 cm depth placement of USG in cabbage cultivation could be saved 20% N than PU. Cauliflower is grown in upland as well as medium land and the cultivation is increasing day by day due to its high profitability. Therefore, it is needed to evaluate the performance of USG, Neem coated Urea and PU on different upland vegetable crops in AEZ-28.

06. Materials and Methods :

07. Crop/variety :

08. Design : RCB (Factorial)

i) Treatment : The experiment comprised of ten (10) treatments which are as follows:

Factor A: Form and application method of urea
T_1= Prilled urea as broadcast
T_2= Neem coated urea as broadcast
T_3= USG as localized placement

Factor B: Dose of urea
D_0= No urea
D_1= 200 kg urea ha^{-1}
D_2= 240 kg urea ha^{-1}
D_3= 280 kg urea ha^{-1}
Treatment combination: Do, T_1D_1, T_1D_2, T_1D_3, T_2D_1, T_2D_2, T_2D_3, T_3D_1, T_3D_2, T_3D_3
Recommended dose of P, K, S, Zn, B will be applied as basal.

ii) Replications 3 (three)

09. Plot size : 4 m × 3 m

10. Planting system/spacing 50 cm × 40 cm

11. Fertilizer dose and methods of application : Phosphorous, potassium, sulphur, zinc & boron will be applied as basal during final land preparation. Prilled urea will be applied as top dress in three equal splits at 15 DAT, 30 DAT and 60 DAT with irrigation. Whole neem coated urea will be applied as top dress at 15 DAT. Whole USG will be dibbled at 15 DAT.

12. Irrigated /rainfed Irrigated

13. Data to be recorded :
- Initial soil nutrient status
- Rate of N_2O gas emission after 7 days interval
- Dates of all operations

- Yield and yield contributing characters
- Nutrient status of post harvest soil
- Plant nutrient uptake
- Major disease and insect incidence

  Cost and returns analysis

14. Investigator(s) : Mst. Rokeya Khatun, SSO,SSD, BARI
M. M. Masud, SSO, SSD, BARI
A. Barman, SO, SSD, BARI
F. A. Anik,,SO,SSD,BARI
H.M. Naser, CSO, SSD,BARI

15. Season : Rabi

16. Date of initiation : November, 2020

17. Date of Completion :

18. Expt. output/ benefit : N_2O gas emission will be reduced. Utilization of nitrogen by cauliflower will be increased and thereby reducing nitrogen loss. Cauliflower yield will be increased.

19. Location : Central Research Farm, BARI, Gazipur

20. Status : 2nd year

21. Estimated Cost : 60,000/-

22. Source of fund : BARI

23. Priority : 1st

01. Programme : Soil Management

02. Project : Chemical Aspects of Soil Management

03. **Experiment 07 : Effect of different organic manures on carbon accumulation in soil and yield of crops in Mustard-Mungbean-T.aman cropping pattern**

04. Objective(s) : I. i) To increase soil organic carbon and improve soil fertility
I. ii) To increase yield of Mustard-Mungbean-T.aman

05. Rationale : Mineralization of different organic materials varies with soil types and crop husbandry. Accumulation of carbon in soil would vary with different organic materials levels during decomposition process. Moreover, proper management of such organic materials coupled with inorganic fertilizer may improve soil biodiversity, microaggregation, and reduction in CO_2 emission from soil (Rastogi et al., 2002; Lal, 2004; Russell et al., 2005).The CO_2 released from soil through micRabial decomposition of organic materials contributes 99% of the

total emission and thus reduces soil organic pool. Soil organic manures are essential for sustainable agriculture because they help to improve plant growth, crop yield, soil carbon content, and micRabial biomass and activity (Shrestha et al., 2013). Organic manures affect the rate and extent of soil carbon sequestration. Investigating the impacts of type and rate of organic manures on GHG emission is thus important for sustainable agriculture and minimizing the impacts on the GHG emission. Mustard is an important oil seed crop in Bangladesh. It belongs to Cruciferae family. It is a winter season crop grown throughout the world. It is miserable that average yield of mustard is low as compared to its potential yield. Numbers of factors have been responsible for low yield of mustard in our country. Use of organic manures have proved good response in yield of mustard.The primary goal of this research work are to assess the impacts of organic amendment types and rates on the soil carbon accumulation under a green oil seed grown area at AEZ-28. The effects of organic amendments on soil organic carbon and CO_2 emission have received little attention from researchers. Most studies have focused on the impact of organic manures on crop yield, soil characteristics, and soil nutrition (Antonlous et al., 2014). Few studies have been conducted to examine the impact of types and rates of organic manures on soil organic carbon content and CO_2 emission.

06. Materials and Methods :

07. Crop/variety : Mustard / BARI Sharisa 17
Mungbean/BARI Mung-6
T.Aman rice/BINA dhan-7

08. Design : RCB

i) Treatment : The experiment comprised of 9 treatments which are as follows:

For Mustard & T. Aman

T_1= Vermocoppost @ 5 t ha^{-1} + IPNS based inorganic fertilizer
T_2= Vermicompost @ 7.5 t ha^{-1} + IPNS based inorganic fertilizer
T_3= Bioslurry @ 5 t ha^{-1} + IPNS based inorganic fertilizer
T_4= Bioslurry @ 7.5 t ha^{-1} + IPNS based inorganic fertilizer
T_5= Compost @ 5 t ha^{-1} + IPNS based inorganic fertilizer
T_6 = Compost @ 7.5 t ha^{-1} + IPNS based inorganic fertilizer
T_7= Poultry manure @ 5 t ha^{-1} + IPNS based inorganic fertilizer
T_8= Poultry manure @ 7.5 t ha^{-1} + IPNS based inorganic fertilizer
T_9= Control

For Mungbean :
20 kg nitrogen will be applied all treatments except T_9 i.e. native fertility

ii) Replications 3 (three)

09.	Plot size	:	2m×3 m
10.	Planting system/spacing		For Mustard : Row to row- 30 cm, For Mungbean : Row to row 30 cm, Plant to plant 10 cm For T.Aman : Row to row 20 cm, Plant to plant 20 cm
11.	Fertilizer dose and methods of application	:	For Mustard: All of organic manure, ½ nitrogen, phosphorous, potassium, sulphur , zinc & boron will be applied as basal during final land preparation. 1/2 of Nitrogen will be applied as top dress at 20-25 days after emergence of seedling i.e. before flowering. For Mungbean: All N will be applied at the time of final land preparation For T. Aman : All PKS will be applied at the time of final land preparation and N will be applied in two equal installments i.e. 15-20 days and 40-45 days after transplanting.
12.	Irrigated /rainfed		For Mustard : Irrigation will be provide when necessary For Mungbean : Rainfed For T.Aman rice : Irrigation will be provide when necessary
13.	Data to be recorded	:	● Initial soil status including C content in soil ● Soil organic carbon content in post soil ● MicRabial biomass carbon ● Yield and yield contributing characters of crops ● Nutrient status of post harvest soil ● Nutrient uptake of crops ● Major disease and insect incidence ● Cost and returns analysis
14.	Investigator(s)	:	Mst. Rokeya Khatun, SSO,SSD, BARI A.Barman, SO, SSD, BARI M. Farid Ahmed Anik,SO,SSD,BARI M. M. Masud, SSO, SSD, BARI
15.	Season	:	Rabi
16.	Date of initiation	:	15 November, 2019
17.	Date of Completion	:	10 March, 2023
18.	Expt. output/ benefit	:	Increasing soil organic carbon through determining suitable dose of organic fertilizer management practice thus will be maximizing the yield of crops in Mustard –Mungbean- T. Aman croping pattern
19.	Location	:	Central Research Farm, BARI, Gazipur and RARS, Jamalpur
20.	Status	:	2nd year
21.	Estimated Cost	:	60,000/-
22.	Source of fund	:	BARI

23. Priority : 1st

01. Programme : Soil Management

02. Project : Chemical Aspects of Soil Management

03. **Experiment 08** : **Effect of different substrate composition on yield of dragon fruit in an extensive green roof**

04. Objective(s) : i) Find out suitable substrate media for maximize dragon fruit yield.
ii) Improvement of the substrate physicochemical properties.

05. Rationale : Rooftop garden plays an important role in the mental well-being of the gardeners as well as in amelioration of the physical environment. The production of fresh fruits and vegetables of the rooftop garden can increase nutritional status of household members of the urban citizens and it will make a positive contribution to the environment. Many studies worldwide have investigated the potential benefits achievable by transforming brown roofs of buildings to green roofs.

Green roof substrates are an artificial mixture of compounds designed to provide proper conditions for plant growth. When fresh or even composted organic materials are added to soil, usually a fast oxidation is observed, and it is therefore difficult to increase the soil organic matter content. Bangladesh is experiencing such problem particularly due to its warm-humid climatic condition. Therefore, most soils of Bangladesh contain 1.7-2.0% organic matter and some soils have even less than 1.0% (BBS, 2017) whereas a good soil should contain more than 3.5% organic matter. This low organic matter content has been considered as one of the main reasons for low productivity of many of our soils as well as rooftop substrate.

This could be overcome through addition of pyrolysed organic materials into soil i.e. biochar. Biochar is charred biomass, produced under limited oxygen supply or in the absence of oxygen at a high temperature. Being rich in aromatic carbon, biochar can persist for hundreds or thousands of years in soil. Considering this fact, a trial was designed with soils amended through biochar addition to assess the improvement of soil properties and crop yield in an extensive green roof.

06. Materials and Methods :

07. Crop/variety : BARI Dragon fruit 1

08. Design : Factorial RCBD

i) Treatment : Factor A: Four vermicompost- 0%, 30%, 40% and 50% (v/v)
Factor B: Four biochar amendments- 0%, 30%, 40% and 50% (v/v)

			Vermicompost and biochar with above percentage will be mixed with soil to prepare substrate. Each treatment will receive initial blanket dose of P, K, S @ 20g, 25 g and 9 g respectively. Each pot will be top dressed 3 times per year with 50 g N, 20 g P and 25 g K
	ii) Replications		3 (three)
09.	Plot size	:	1m×1 m
10.	Planting system/spacing		Height 50 cm and diameter 50 cm of a plastic drum
11.	Fertilizer dose and methods of application	:	Each pot will be top dressed with 50 g N, 20 g P and 25 g K
12.	Irrigated /rainfed		Irrigated
13.	Data to be recorded	:	1. Yield and growth parameter 2.Water holding capacity of substrate 3. Pre and post trial substrate nutrient status.
14.	Investigator(s)	:	M. A. Rahman SSO, F. S. Shikha SO and M. Yasmin SO
15.	Season	:	Rabi
16.	Date of initiation	:	1st week of October, 2020
17.	Date of Completion	:	1st week of April, 2023
18.	Expt. output/ benefit	:	Generate a sustainable green roof substrate.
19.	Location	:	Rooftop of Laboratory building, RARS, Jamalpur
20.	Status	:	2nd year
21.	Estimated Cost	:	50,000/-
22.	Source of fund	:	BARI
23.	Priority	:	1st
01.	Programme	:	Soil Management
02.	Project	:	Chemical Aspects of Soil Management

03. **Experiment 09** : **Efficacy of different form of urea on nitrogen availability and yield of panikachu**

04. Objective(s) :
i. To find out use efficiency of different form of urea.
ii. To find out the yield and yield components of panikachu as influenced by different form of urea.
iii. To analyze cost and return of panikachu produced from different form of urea.

05. Rationale : Urea is the main nitrogenous fertilizer used in all over the world. Different form urea are available in Bangladesh and neighboring country India. Prilled urea is widely used in Bangladesh which can easily spread in crop field but crop can uptake only 35% of nitrogen. Urea Super Granule is also available in Bangladesh which use efficiency is 60% but labour cost to apply in the field is high. Neem coated urea is becoming popular in neighboring country India. About 60% of total urea consumed in India are neem coated. Its use efficiency is higher compared to prillied urea and application cost is lower to urea super granule. There is a need to verify their (Prillled urea, Urea Super Granule & Neem Coated Urea) performance in Bangladesh soil condition growing different crops.

06. Materials and Methods :

07. Crop/variety : Panikachu/ BARI Panikachu-1

08. Design : RCB

i) Treatment : 4 (four)
T_1 = N-control
T_2 = RD of nitrogen (180 kg/ha) in the form of Prilled urea
T_3 = Application of 160 kg nitrogen/ha in the form of urea super granule (USG)
T_4 = Application of 165 kg nitrogen/ha in the form of neem coated urea
Blanket dose of P, K, S, Zn & B will be applied

ii) Replications 4 (four)

09. Plot size : 4m × 5m

10. Planting system/spacing Panikachu will be sown in line at 60 cm apart and plant to plant distance will be 45 cm.

11. Fertilizer dose and methods of application : For prilled urea and neem coated urea, 1/6th of urea will be applied before planting. Remaining $5/6^{th}$urea will be applied in five installments at 15 days interval. For USG, whole urea was applied as band placement before transplanting.

12. Irrigated /rainfed Irrigated

13. Data to be recorded : 1. Dates of all operations

2. Stolon yield of Panikachu
3. All the yield contributing characters of Panikachu
4. Cost of inputs and price of output
5. Soil, stolon and plant sample will be collected after the harvest of crops and will be analyzed in the laboratory.

14. Investigator(s) : A. Barman, SSO, SSD, BARI
M.M. Masud, SSO, SSD, BARI
M. Samsul Alam, SSO, TCRC, BARI
H. M. Naser, CSO, SSD, BARI

15. Season : Rabi

16. Date of initiation : March, 2021

17. Date of Completion : April, 2023

18. Expt. output/ benefit : Highly efficient urea form will be find out, nitrogen loss will be minimized and soil fertility and crop productivity will be increased.

19. Location : BARI central farm, Gazipur

20. Status : 2nd year

21. Estimated Cost : 25,000/-

22. Source of fund : BARI

23. Priority : 1st

01. Programme : Soil Management

02. Project : Chemical Aspects of Soil Management

03. **Experiment 10 : Effect of co-composting biochar on Cabbage-Indian spinach-T.aman productivity**

04. Objective(s) : i. To find out the soil health improvement after amendment.
ii. To accelerate the sustainable carbon sequestration in to soil.
iii. To develop a low-cost biochar-based fertilizer dose.

05. Rationale : Momentous increase in global population accompanied with urbanization and industrial progress has directly increased the generation of complex solid waste. Wastes, such as sewage sludge, agricultural wastes, municipal solid waste (MSW), food and kitchen waste, garden wastes, agro-industrial wastes, animal wastes, etc. can be generally classifed as solid organic wastes comprising of organic biodegradable fraction with a moisture content below 85-90%. Integrated waste management hierarchy ascertains agricultural recycling of organic wastes to be more sustainable and eco-friendly

approach than traditional methods of waste disposal and energy recovery. In accordance with principles of resource/nutrient recovery and recycling, scientific conversion (via. composting, biochar) and utilization of organic wastes for agronomic purposes can provide benefcial plant nutrients for enhancing growth and improve soil fertility as well. Biochar, a highly stable and recalcitrant form of organic matter produced by pyrolysis. The use of biochar as a soil amendment may effective for soil health regarding to increased yield. However, soil health is the foundation of vigorous and sustainable crop production. However, many studies used high biochar application amounts of >10 t ha^{-1}, which is not economically feasible. Recent research suggested that biochar should be combined with organic amendments to increase soil fertility even when biochar is applied at low (0.5-2 t ha^{-1}) biochar application rates. Co-composting, which consists of mixing biochar with compost with high contents of both nutrients and labile organic carbon before starting an aneRabic composting process, was shown to enhance the agronomic performance of biochar as a soil amendment. The co-composted biochar handpicked from the final biochar-amended compost was shown to promote plant growth beyond the combination of pristine biochar with either mineral fertilizer or mature non-biochar-amended compost. Earths that received anthropogenic input of both nutrient-rich organic matter and pyrogenic carbon centuries ago and eventually for the development of low-cost biochar-based fertilizers that can promote high crop yields with comparably small application doses of biochar need determination.

06. Materials and Methods :

07. Crop/variety : Cabbage (Atlas-70)- Indian Spinach (var. BARI Puishak-1) – T. Aman (BRRI Dhan 89)

08. Design : RCB

i) Treatment : 06 (Six)
T_1= 100% RDCF
T_2= 80% RDCF + Compost @ 5 t ha^{-1}
T_3= 80% RDCF + Biochar @ 5 t ha^{-1}
T_4= 80% RDCF + Compost -1 @ 5 t ha^{-1}
T_5= 80% RDCF + Compost -1 @ 3 t ha^{-1}
T_6= Native fertility
NB: The compost-1 will be enriched with 75% MSW compost and 25% biochar and kept for incubation.

ii) Replications 3 (three)

09. Plot size : 3m × 2m

10. Planting system/spacing Row to row -50 cm
Plant to plant-40 cm

11. Fertilizer dose : Whole compost, rice husk biochar, PSZnB and $^1/_3$rd of N will be

	and methods of application		applied at the time of final land preparation and remaining N will be applied in two installment at 30 and 75 DAS.
12.	Irrigated /rainfed		Irrigated
13.	Data to be recorded	:	Chemical analysis of compost and biochar, soil pH, organic carbon, All nutrient
14.	Investigator(s)	:	M. M. Masud, M. Sultana, F A Anik, J. Alam, SSD, BARI
15.	Season	:	Rabi
16.	Date of initiation	:	November, 2020
17.	Date of completion	:	October, 2022
18.	Expt. output/ benefit	:	Soil acidity will be ameliorated and soil will be suitable for crop production.
19.	Location	:	BARI central farm, Gazipur
20.	Status	:	2nd year
21.	Estimated Cost	:	70,000/-
22.	Source of fund	:	BARI
23.	Priority	:	1st

01.	Programme	:	Soil Management
02.	Project	:	Chemical Aspects of Soil Management
03.	**Experiment 11**	**:**	**Development of fertilizer recommendation for chilli with onion intercropping system**
04.	Objective(s)	:	To find out a suitable and economic fertilizer dose for maximizing the yield of chilli with onion intercropping system
05.	Rationale	:	Intercropping is an important tool for getting higher productivity per unit area by intensifying the use of land particularly densely populated countries which has limited per capita land for crop production. Recently it has been recognized as potentially beneficial system of crop production and evidence suggests that intercropping can provide substantial yield advantage compared to sole cropping (Sing et al., 1992). On the other hand, soil fertility is also reducing due to intensive cultivation of HYV and other improper crop and soil management. Spice crop is now a very important sector. Recent onion production problem arose in Bangladesh which emphasised the need of nutrient management of spice crop.

Chilli is one of the major spices crop in Bangladesh which generally grow in char land as a sole crop. Farmers of different region especially char areas grow chilli as a sole or sometimes intercropping with onion. From the previous research findings of Begum et al. (2015) and Brintha et al. (2012), chilli with onion intercropping system found very productive and profitable for the char land. However, there is still no recommended fertilizer dose for chilli with onion intercropping system. To get the maximum return and crop production, fertilizer management is the most logical way to raise total production. Thus, it is necessary to find out the optimum fertilizer dose for chilli with onion intercropping system.

06. Materials and Methods :

07. Crop/variety : Chilli (BARI Morich-4) and Onion (BARI Piaj-4)

08. Design : RCB

i) Treatment : The experiment comprised of 6 treatments which are as follows:
T_1= 100% RDCF of chilli + 0% RDCF of onion
T_2= 100% RDCF of chilli +10% RDCF of onion
T_3= 100% RDCF of chilli + 20% RDCF of onion
T_4= 100% RDCF of chilli +30% RDCF of onion
T_5= 100% RDCF of chilli +40% RDCF of onion
T_6= 100% RDCF of chilli +50% RDCF of onion

ii) Replications 3 (three)

09. Plot size : 4 m×4 m

10. Planting system/spacing One row of onion between two rows of chilli (line to line spacing of chilli is 40 cm and chilli to onion spacing is 20 cm).
Plant to plant spacing of chilli and onion is 40 cm and 10 cm, respectively.

11. Fertilizer dose and methods of application : The whole amounts of organic manure, phosphorus, sulphur, zinc, boron, and half of nitrogen and potassium should be applied as basal during final land preparation. Remaining nitrogen and potassium should be applied in two equal installments at 30 and 60 days after transplantation from 10-12 cm away from the base of the plant which will be beneficial for the growth and yield of onion.

12. Irrigated /rainfed Irrigated

13. Data to be recorded :
1. Initial soil nutrient staus
2. Dates of all operations
3. Yield and yield attributes
4. Major diseases and pests incidence
5. Cost and return analysis

14.	Investigator(s)	:	I.S.M. Farhad, SO,SSD,BARI Shamol Brahma, SSO, SRC, BARI M.R.Khatun, SSO,SSD,BARI M.M.Masud, SSO,SSD,BARI A.Barman,SO,SSD,BARI
15.	Season	:	Rabi
16.	Date of initiation	:	November, 2020
17.	Date of completion	:	May, 2023
18.	Expt. output/ benefit	:	Optimum fertilizer dose will be developed for maximizing the yield of chilli with onion intercropping system in charland
19.	Location	:	BARI central farm, Gazipur
20.	Status	:	2nd year
21.	Estimated Cost	:	40,000/-
22.	Source of fund	:	BARI
23.	Priority	:	1st

01.	Programme	:	Soil Management
02.	Project	:	Chemical Aspects of Soil Management
03.	**Experiment 12**	**:**	**Effect of kitchen waste compost on broccoli yield and carbon accumulation in soil**
04.	Objective(s)	:	i. To minimize waste disposal problem and increase soil fertility. ii. To improve the stock of organic carbon in the soil. iii. To increase crop yield.
05.	Rationale	:	Enormous amount of wastes are generated from plant, animals and industrial activities in day to day life. A considerable part of which remains unutilized and are either burnt or dumped nearby sites that create pollution, harbours pathogen for diseases and causes severe problem of disposal. Instead of disposing, it can be used as source of organic wastes and effectively recycled for the production of compost to meet the nutritional requirement of crops. Considering growing deficiency of plant nutrients in crop field, higher cost of synthetic fertilizers and poor efficiency of chemical fertilizers, the organic wastes recycling for plant nutrient supply is becoming more essential for replenishment of plant nutrients, sustaining soil health, reducing the pollution problem and creating employment opportunities. The study was aimed to explore the possibility of bioconversion of different organic wastes to utilize the embedded nutrients for supplying enriched

organic manure for better soil health and crop growth, which will not only improve the yield and quality of the produce but also conserve energy, minimize pollution, save foreign exchange and improve the fertilizer use efficiency subsequently that will helps to revitalize and restore the soil fertility and will revive the micRabial activities for sustainable crop production.

06. Materials and Methods :

07. Crop/variety : BARI Broccoli-1/Green Crown

08. Design : RCB

i) Treatment : T_1= 100% RDCF
T_2= 100% RDCF + Kitchen waste compost @ 2.5 t ha^{-1}
T_3= 100% RDCF + Kitchen waste compost @ 5.0 t ha^{-1}
T_4= 80% RDCF + Kitchen waste compost @ 2.5 t ha^{-1}
T_5= 80% RDCF + Kitchen waste compost @ 5.0 t ha^{-1}
T_6= Native fertility

ii) Replications 3 (three)

09. Plot size : 4 m×5 m

10. Planting system/spacing Row to row-50 cm
Plant to plant-40 cm

11. Fertilizer dose and methods of application : FRG-2018
Half of kitchen waste compost and all of P, K, S, Zn and B should be applied as basal. Remaining half kitchen waste compost should be applied in pit before planting of seedlings. N and K should be applied in three equal splits at 15, 30 and 50 days after transplantation as ring method under moist soil condition and mixed thoroughly with the soil as soon as possible for better utilization.

12. Irrigated /rainfed Irrigated

13. Data to be recorded : Yield and yield contributing characters of broccoli, SOC, nutrient content in Kitchen waste compost including organic carbon, initial &post harvest soil analysis, plant sample analysis, Carbon accumulation.

14. Investigator(s) : I.S.M. Farhad, SO,SSD,BARI
H. M. Naser, CSO& Head, SSD,BARI
M.R.Khatun, SSO,SSD,BARI
M.M.Masud, SSO,SSD,BARI
A.Barman,SO,SSD,BARI

15. Season : Rabi

16. Date of initiation : November, 2019

17. Date of completion : March, 2023

18. Expt. output/ benefit : Waste disposal problem will be minimized; soil organic carbon stock will be improved ; crop yield will be increased and soil fertility will be restored.

19. Location : BARI central farm, Gazipur

20. Status : 3rd year

21. Estimated Cost : 60,000/-

22. Source of fund : BARI

23. Priority : 1st

01. Programme : Soil Management

02. Project : Chemical Aspects of Soil Management

03. **Experiment 13 : Effect of nitrogen and potassium on the yield and nutrient uptake of Shahebikachu**

04. Objective(s) : i) To find out effect of nitrogen and potassium on Shahebikachu
ii) To find out optimum dose of nitrogen and potassium for Shahebikachu production

05. Rationale : Aroids is one of the differentiate crop among the highest favourate crops in Bangladesh. There are different types of edible aroids in Bangladesh like, mukhi, panikachuu, panchamukhi, olkachu, mannkachu shahebikachu etc. In Bangladesh 30.92 thousands hectare land was cultivated for aroids and the production was 280.52 thousand tons. Average production was 9.07 t/ha (BBS, 2020). Aroids rich in Iron, calcium, potassium, magnesium, zinc, vitamins and minerals etc. (Sharma et al., 2016). It is also medicinal. Its help to prevent anemia, cancer, rheumatic diseases, high blood pressures well as increased diseases resistance of human being. Aroids were available in all season. After rainy season, the scarcity of vegetables, aroids makeup it and help to manage the nutritional demands of people. Shahebikachu is a favourate and profitable vegetables in the southern region of Bangladesh. Day by day its cultivation was increased.Farmers of this region interested to cultivate Shahebikachu.. Fertilizer management is big factor for crop cultivation. Farmers do not know the actual rate of fertilizer for Shahebikachu cultivation. So this experiment is under taken for the actual rate of fertilizer in this region for Shahebikachu cultivation.

06. Materials and Methods : The experiment will be conducted at RARS, Rahmatpur, Barishal experimental field. Seedling are transplanted in August 2021 with

spacing of 1m × 1.5m.

07.	Crop/variety	:	BARI Shahebikachu-1
08.	Design	:	RCBD
	i) Treatment	:	Rate of fertilizer: 16 (sixteen) 4 levels of N - 0, 50, 100 and 150 kg ha^{-1} 4 levels of K - 0, 50, 100 and 150 kg ha^{-1}
	ii) Replications		3 (three)
09.	Plot size	:	3 m × 4m
10.	Planting system/spacing		1m × 1.5m
11.	Fertilizer dose and methods of application	:	According to treatments. As source of nutrients, nitrogen and phosphorus will be applied in the forms of urea and TSP; potassium as muriate of potash, sulphur as gypsum. N fertilizer was applied in two equal installments as before and after rainy season. The whole amount of all other plant nutrients (P-K-S) will be applied as final land preparation
12.	Irrigated /rainfed		Mainly rainfed. Irrigated as and when necessary
13.	Data to be recorded	:	Phenological parameters, yield and yield components, biomass etc.
14.	Investigator(s)	:	M.R. Islam and M.A. Rahman
15.	Season	:	Summer
16.	Date of initiation	:	Mid August, 2021
17.	Date of completion	:	June, 2024
18.	Expt. output/ benefit	:	Developed rate of nutrient requirement for Shahebikachu
19.	Location	:	RARS, Rahmatpur, Barishal
20.	Status	:	2nd year
21.	Estimated Cost	:	Tk. 40,000/-
22.	Source of fund	:	BARI
23.	Priority	:	1st

01. Programme : Soil Management

02. Project : Chemical Aspects of Soil Management

03. **Experiment 14 : Effect of different nutrients on Betel nut (Areca catechu) in southern region of Bangladesh**

04. Objective (s) : i) To find out the effect of different fertilizer on betelnut production.
ii) To find out the optimum dose of fertilizer for betelnut production.

05. Rationale : Betelnut or areca nut is an important cash crop in the Southern and South Western parts of Bangladesh. Supply of nutrients helps to get good harvest in each and every year. Fertilizer is the most important and costly input to enhance yield (Baloch et al., 2004). Rawther and Abraham (1974) reported that betel nut yields were greatly enhanced by NPK along with irrigation. $N_{100}P_{15}K_{100}S_{10}Zn_2$g/plant gave better yield and economic for betelnut cultivation (Rahman et al., 2009). The farming community has limited idea about the fertilizer application on betel nut. There was a little information on fertilizing of betel nut in Bangladesh. Fertilizer requirements varied from variety to variety and region to region in same crops. Considering the important of fertilizer application an experiment taken for appropriate amount of fertilizer for betel nut cultivation. The proper combination of organic and chemical fertilizers can enhance the growth and yield of the crop.

06. Materials and Methods : The experiment will be carried out at RARS, Rahmatpur, Barishal in a established betelnut garden with spacing of 1m.

07. Crop/Variety : Line AC001 and Line AC002

08. Design : RCBD

i) Treatment : Rate of fertilizer: 14 (fourteen)
4 levels of N - 0, 50, 100 and 150 g plant^{-1}
4 levels of P - 0,10, 20 and 30 g plant^{-1}
3 levels of K - 0, 50 and 100 g plant^{-1}
3 levels of S - 0,10 and 20 g plant^{-1}
3 levels of Cow dung 0, 10 and 20 kg plant^{-1}

ii) Replications 3 (three)

09. Plot size : 4m× 1.0m

10. Planting system/spacing 1m × 1.m

11. Fertilizer dose and methods of application : According to treatments. As source of nutrients, nitrogen and phosphorus will be applied in the forms of urea and TSP; potassium as muriate of potash, sulphur as gypsum. The whole amount of P, S, Zn, B, CD and 1/2 K will be applied at the time before rainy season and the remaining 1/2 K and N will be applied after rainy season.

12. Irrigated /rainfed Mainly rainfed. Irrigated as and when necessary

13.	Data to be recorded	:	Bunch/plant, betel bunch/plant, green weight of betelnut , length of nut, dia of nut, dry weight with husk, dry weight without husk etc.
14.	Investigator(s)	:	M.R. Islam and M.A. Rahman
15.	Season	:	Summer
16.	Date of initiation	:	October, 2021
17.	Date of completion	:	June, 2024
18.	Expt. output/ benefit	:	Developed integrated nutrient management technology for betelnut
19.	Location	:	RARS, Rahmatpur, Barishal
20.	Status	:	2nd year
21.	Estimated Cost	:	Tk. 40,000/-
22.	Source of fund	:	BARI
23.	Priority	:	1st
01.	Programme	:	Soil Management
02.	Project	:	Chemical Aspects of Soil Management
03.	**Experiment 15**	**:**	**Integrated nutrient management for pineapple in Barishal region**
04.	Objective (s)	:	i) To find out the effect of different fertilizer on pineapple production. ii) To find out the optimum dose of fertilizer for maximizing pineapple yield.
05.	Rationale	:	Pineapple is a nutritious and delicious fruit. About 14.4 thousand hectare of land cultivation under pine apple and the production was 2 lack and 12 thousand metric ton (KPHB, 2019). Average production was 14 to 15 t/ha. In Bangladesh, it is mostly cultivated in greater Sylhet, Chittagong, Chittagong hill tract, and Tangail region as a commercial fruit. It is also cultivated in Dhaka, Narsingdi, Comilla and Dinajpur districts. It is a medicinal fruits and contained vitamin A, vitamin B and vitamin C and minerals like potassium, calcium, magnesium and iron. It is also a source of bromelain a digestive enzyme. There are different types of pineapple in Bangladesh. In Bangladesh, three varieties of pineapple are mostly grown. The three varieties are: Giant Kew, Honey Queen and Ghurasal. Jaldubi, Madupuri and Calendula also cultivated in Bangladesh. Farmers of this region interested to cultivated pineapple. Fertilizer management is big factor for crop cultivation. Farmers do not know the actual rate of

fertilizer for pineapple cultivation. So this experiment is under taken for extension of this fruit crop as well as the actual rate of fertilizer in this region for pineapple cultivation.

06. Materials and Methods : The experiment will be conducted at RARS, Rahmatpur, Barishal experimental field. Seedling are transplanted in August 2021 with spacing of 60cm × 60cm.

07. Crop/Variety : Giant que

08. Design : RCBD

i) Treatment : Rate of fertilizer: 13 (thirteen)
3 levels of N - 0, 50 and100 kg ha^{-1}
4 levels of P - 0,10, 20 and 30 kg ha^{-1}
3 levels of K- 0,50 and 100 kg ha^{-1}
3 levels of S- 0,10 and 20 kg ha^{-1}
3 levels of CD - 0, 2 and 4 t ha^{-1}

ii) Replications 3 (three)

09. Plot size : 3m× 2m

10. Planting system/spacing 60cm × 60cm

11. Fertilizer dose and methods of application : According to treatments. As source of nutrients, nitrogen and phosphorus will be applied in the forms of urea and TSP; potassium as muriate of potash, sulphur as gypsum. N fertilizer was applied in two equal installments as before and after rainy season. The whole amount of all other plant nutrients (P-K-S) will be applied as final land preparation.

12. Irrigated /rainfed Irrigated as and when necessary

13. Data to be recorded : Phenological parameters, yield and yield components, biomass etc.

14. Investigator(s) : M.R. Islam , M.A. Rahman and M.R. Uddin

15. Season : Summer

16. Date of initiation : August, 2021

17. Date of completion : June, 2024

18. Expt. output/ benefit : Developed nutrient requirement for pineapple in Barishal region.

19. Location : RARS, Rahmatpur, Barishal

20. Status : 2nd year

21. Estimated Cost : Tk. 45,000/-

22. Source of fund : BARI

23. Priority : 1st

01. Programme : Soil Management

02. Project : Chemical Aspects of Soil Management

03. **Experiment 16 : Integrated potash management for mustard**

04. Objective (s) : i. To find out judicious application of potassium fertilizer for maximum production of mustard.
ii. To estimate the uptake of nutrients and make a balance sheet of nutrients.

05. Rationale : Mustard is a leading oil crop in Bangladesh, covering about 80% of the total oilseed area and contributing to more than 60% of the total oilseed production. Considering its importance, it is necessary to uplift its fertilizer recommendation and the production level.
The general recommendation of K fertilizer for mustard is often less than the requirement causes mining of soil K. Nutrient balance study indicated a negative balance for K and the mining of K from Bangladesh soil is now in alarming situation. Judicious fertilizer application and addition of organic matter may improve and sustain soil fertility and crop yield. Seed yield and productivity of mustard can be further improved by judicial use of potassium fertilizer. Integrated nutrient management essentially means the use of available organic and inorganic sources of plants for crop production. Seed yield and productivity of mustard can be further improved by judicial use of potassium fertilizer and use of potash containing eco-friendly substances. These substances have a great potentiality in agriculture due to its efficiency to modify soil health and presence of some essential plant nutrients. So, the present study aimed to develop a guideline for judicious application of potassium fertilizer for maximum production of mustard.

06. Materials and Methods :

07. Crop/Variety : BARI sarisha-14

08. Design : RCBD

i) Treatment : T_1 = control
T_2 = STB fertilizer dose
T_3 = STB + 1 t ha^{-1} rice husk ash
T_4 = STB + 2 t ha^{-1} rice husk ash
T_5 = STB + 3 t ha^{-1} rice straw incorporation

T_6 = STB + 5 t ha^{-1} rice straw incorporation
Note: organic substances should be applied with chemical fertilizer as IPNS basis.

ii) Replications : 3 (three)

09. Plot size : 4 m x 3 cm

10. Planting system/spacing : 30 cm x continuous in line

11. Fertilizer dose and methods of application : Fertilizer dose: On the basis of soil test value, following Fertilizer Recommendation Guid, (FRG) – 2018.
Methods of application: Half of N and all of P, K, S, Zn and B should be applied as basal during final land preparation. Remaining half of N should be applied as top dress at the time of flower initiation stage (25 days after sowing). Organic residue should be applied during final land preparation as IPNS basis.

12. Irrigated /rainfed : Irrigated

13. Data to be recorded : 1.Yield and yield components
2. Disease and insect infestations
3. Nutrient status of initial and post harvest soil.
4.Cost and return analysis

14. Investigator(s) : M.Yasmin, SO ; F. S.Shikha, SO and M. A. Rahman , SSO

15. Season : Rabi

16. Date of initiation : 1st week of November, 2021

17. Date of completion : 1stweek of February, 2023

18. Expt. output/ benefit : Judicial use of potassium fertilizer and soil health will be improved.

19. Location : RARS, Jamalpur

20. Status : 2nd year

21. Estimated Cost : Tk. 30,000/-

22. Source of fund : BARI

23. Priority : 1st

01. Programme : Soil Management

02. Project : Chemical Aspects of Soil Management

03. **Experiment 17** : **Application of vermiwash on yield and nutritional quality of tomato**

04. Objective (s) : i. To investigate the foliar application of vermiwash on yield and nutrient uptake of tomato
ii).To improve nutritional quality of tomato by effective and organic vermiwash application.

05. Rationale : Agriculture farming, previously dominated by production, currently has diverse objectives. The study of the balanced use of fertilization, increased nutritional quality, reduced costs of production are among the main objectives of modern agriculture. Improving nutrition sits at the core of global development and is central to achieving the Sustainable Development Goals.
Biological agriculture is an element of the system for sustainable agriculture and an alternative to traditional approaches in agriculture. Biological agriculture (vermicompost) is the products obtained as a result of composting of organic waste with the help of various types of earthworms. Vermiwash is a low cost, environment friendly, brownish-red liquid extract collected during vermicomposting of organic waste. Vermiwash can also serve as a valuable foliar spray because it is a combination of earthworm mucous discharges, nutrients, microorganisms and plant growth promoting materials. So, the present study aimed to investigate the role of vermiwash for increasing the yield and nutritional quality of tomato.

06. Materials and Methods

07. Crop/Variety : BARI Tomato – 21

08. Design : RCBD

i) Treatment : 5 levels of Vermiwash rate (v/v)
T_1 = Foliar spray of distilled water (control)
T_2 = Foliar spray of 10% vermiwash
T_3 = Foliar spray of 20% vermiwash
T_4 = Foliar spray of 30% vermiwash
T_5 = Foliar spray of 40% vermiwash
Blanket dose : $N_{150}\ P_{38}\ K_{50}\ S_{20}\ Zn_2\ B_1$ kg ha^{-1} (FRG-2018)

ii) Replications 3 (three)

09. Plot size : 4 m × 3 cm

10. Planting system/spacing 60 cm × 40 cm

11. Fertilizer dose and methods of : Fertilizer dose : $N_{150}\ P_{38}\ K_{50}\ S_{20}\ Zn_2\ B_1$ Kg ha^{-1} (FRG-2018)
Methods of application :

	application		All of P, K, S, Zn, B and $^1/_3$ N will be applied at final land preparation and the remaining $^2/_3$ will be applied in two equal installments at 25 and 45 DAT. Urea, TSP, MoP, Gypsum, Zinc sulphate and Boric acid will be used as the source of NPKSZn and B. Vermiwash application : The treatments were comprised of 4 levels of vermiwash rate (10%, 20%, 30 %, 40 %, v/v). Vermiwash was mixed with water to get the desired concentration. Plants were sprayed 3 times (at flowering, at fruiting and 30 days after first fruiting).Foliar sprays will be applied using a hand sprayer.
12.	Irrigated /rainfed		Irrigated
13.	Data to be recorded	:	1.Yield and yield components 2. Disease and insect infestations 3. Nutrient status of initial and post harvest soil 4.Nutritional quality of fruits 5.Cost and return analysis
14.	Investigator(s)	:	M.Yasmin, SO ; F. S. Shikha, SO and M. A. Rahman , SSO
15.	Season	:	Rabi
16.	Date of initiation	:	1st week of November, 2021
17.	Date of completion	:	4th week of April, 2023
18.	Expt. output/ benefit	:	Increased use of vermiwash in tomato production for improving yield and nutritional quality.
19.	Location	:	RARS, Jamalpur
20.	Status	:	2nd year
21.	Estimated Cost	:	Tk. 50,000/-
22.	Source of fund	:	BARI
23.	Priority	:	1st
01.	Programme	:	Soil Management
02.	Project	:	Chemical Aspects of Soil Management
03.	**Experiment 18**	**:**	**Development of permanent block for identifying nutrient deficiencies symptom of crops round the year**
04.	Objective (s)	:	i. Development of a demonstration site in RARS Jamalpur for the farmers, extension personnel and researcher round the year. ii. Create visual materials for lecture and discussion.

iii. Identify the complexity of symptoms caused by nutrient deficiencies along with pest attack

05. Rationale : Plants obtain nutrients from the soil substrate. Nutrients may be lost when soil leaches or when plant tissues are removed during mowing operation. In addition, nutrients in the soil may also be converted to forms that are unavailable for plant uptake under suboptimal soil conditions. Therefore, it is important to apply fertilizers to replace the nutrients lost after several regular mowing regimes or ameliorate the soil conditions to make nutrients available. However, it is imperative to know the critical nutrients status of soil substrate before and after symptom visualization.

06. Materials and Methods

07. Crop/Variety : Tomato (BARI tomato-9) – maize (BARI hybrid maize-13) – groundnut (BARI chinabadam-8)

08. Design : RCBD

i) Treatment : 8 (Eight)
Each plot with absent of one element except T_0
T_0=N P K S Ca Mg Fe CuMn ZnB Cl Mo
T_1= T_0-N
T_2= T_0-P
T_3= T_0-K
T_4= T_0-S
T_5= T_0-Mg
T_6= T_0-Zn
T_7 = T_0-B

ii) Replications 2 (two)

09. Plot size : 2m × 2m

10. Planting system/spacing Line sowing

11. Fertilizer dose and methods of application : Soil test based

12. Irrigated /rainfed Irrigated

13. Data to be recorded : Photograph, growth and yield parameters

14. Investigator(s) : M A Rahman, F S Shikha and M Yasmin

15. Season : Rabi and Kharif

16.	Date of initiation	:	10 November 2021
17.	Date of completion	:	As par each crop duration
18.	Expt. output/ benefit	:	Development of visual materials for deficiency symptoms of plant nutrients.
19.	Location	:	RARS, Jamalpur
20.	Status	:	2nd year
21.	Estimated Cost	:	Tk. 60,000/-
22.	Source of fund	:	BARI
23.	Priority	:	1st
01.	Programme	:	Soil Management
02.	Project	:	Chemical aspects of soil management
03.	**Experiment 19**	**:**	**Development of fertilizer recommendation for linseed groundnut intercropping system**
04.	Objective (s)	:	To find out a suitable and economic fertilizer dose for maximizing the yield from the intercropping system.
05.	Rationale	:	Multiple cropping is defined as growing two or more crops in the same space or in the same time (Zandstra, 1979). Recently intercropping has been recognized as potentially beneficial system of crop production and evidence suggests that intercropping can provide substantial yield advantage compared to sole cropping (Singh et al., 1992). These advantages may be especially important because they are achieved not by means of costly inputs but by the simple expedient of growing crops together (Willey, 1979). Groundnut (Arachis hypogaea L.) is one of the world's most popular crops cultivated throughout the tropical and subtropical areas and it's a major crop for Jamalpur char area. Linseed can easily grown in between groundnut rows. Intercropping of groundnut linseed was found suitable under different combinations but the nutrient requirement information about intercropping system is very scanty. Thus, this experiment has been planned to carry out at Jamalpur.
06..	Materials and methods	:	
07.	Crop / Variety	:	Main crop : Ground nut (BARI chinabadam 9) Companion crop: Linseed (Neela)

08.	Design	:	RCBD
	i)Treatments	:	7 (Seven) F_1 = 100% RDCF of Groundnut + 0% RDCF of Linseed F_2 = 100% RDCF of Groundnut + 10% RDCF of Linseed F_3 = 100% RDCF of Groundnut + 20% RDCF of Linseed F_4 = 100% RDCF of Groundnut + 30% RDCF of Linseed F_5 = 100% RDCF of Groundnut + 40% RDCF of Linseed F_6 = 100% RDCF of Groundnut + 50% RDCF of Linseed F_7 = 100% RDCF of Groundnut + 60% RDCF of Linseed
	ii) Replication		3
09.	Plot size		3 m × 4 m
10.	Planting system /spacing	:	One rows of linseed in between two rows of groundnut (60 cm X 15 cm)
11.	Fertilizer dose and methods of application	:	As per treatment
12.	Irrigated/Rainfed	:	Irrigated
13.	Data to be recorded	:	1.Yield and yield attributes 2.Infestation of pest and diseases 3.Time of harvesting 4.Nutrient content of soil before sowing and after harvesting 5.Nutrient content of pod at harvest 6.Cost and return analysis
14.	Investigators	:	F S Shikha, SO , M Yasmin, SO, and M A Rahman , SSO
15.	Season	:	Rabi
16.	Date of initiation	:	1st week of November, 2021
17.	Date of completion	:	1st week of April, 2023
18.	Expected output / benefit	:	15-20 % yield increase from the intercropping system applying 10-15 less fertilizer.
19.	Location	:	RARS, Jamalpur
20.	Status	:	2nd year
21.	Estimated cost	:	50,000/-
22.	Source of fund	:	BARI

23. Priority : 1st

01. Programme : Soil Management

02. Project : Chemical aspects of soil management

03. **Experiment 20 : Development of fertilizer recommendation for maize with knolkhol intercropping system**

04. Objective (s) : To find out a suitable and economic fertilizer dose for maximizing the yield from the intercropping system.

05. Rationale : Multiple cropping is defined as growing two or more crops in the same space or in the same time (Zandstra, 1979). Recently intercropping has been recognized as potentially beneficial system of crop production and evidence suggests that intercropping can provide substantial yield advantage compared to sole cropping (Singh et al., 1992). These advantages may be especially important because they are achieved not by means of costly inputs but by the simple expedient of growing crops together (Willey, 1979). Maize is the top yielder cereal crop requires high amount of fertilizer, particularly nitrogenous, which is one of the problems for marginal farmers of Bangladesh.

Maize is a tall crop plant. Between the maize rows, vegetables and spices crops can easily grown. Knolkhol is one of the important vegetable crops which can be grown in between maize rows. Intercropping of maize (hybrid) with knolkhol was found suitable under different combinations but the nutrient requirement information about intercropping system is very scanty. To increase the yield as well as maintain/improve the soil fertility it is felt necessary to use an integrated approach i.e. combination of organic and inorganic fertilizers. Thus, this experiment has been planned to carry out in Joydebpur.

06.. Materials and methods :

07. Crop / Variety : Main crop : Maize (var. BARI Hybrid Maize-9)
Companion crop : Knolkhol (var. AK-03)

08. Design : RCBD

i)Treatments : Seven (Seven)
F_1 = 100% RDCF of Maize + 0% RDCF of Knolkhol
F_2 = 100% RDCF of Maize + 10% RDCF of Knolkhol
F_3 = 100% RDCF of Maize + 20% RDCF of Knolkhol
F_4 = 100% RDCF of Maize + 30% RDCF of Knolkhol
F_5 = 100% RDCF of Maize + 40% RDCF of Knolkhol

			F_6 = 100% RDCF of Maize + 50% RDCF of Knolkhol F_7 = 100% RDCF of Maize + 60% RDCF of Knolkhol RDCF for Maize = $N_{255}P_{50}K_{120}S_{40}Mg_{10}Zn_4B_{1.5}$ kg ha^{-1} RDCF for Knolkhol = $N_{90}P_{25}K_{45}S_{15}Zn_1B_1$ kg ha^{-1} + 5 t CD ha^{-1}
	ii) Replication		3
09.	Plot size		3 m x 4 m
10.	Planting system /spacing	:	One rows of knolkhol in between two rows of maize (60 cm X 20 cm). Plant to plant distance of knolkhol is 40 cm.
11.	Fertilizer dose and methods of application	:	$1/6^{th}$ N and half of all fertilizers will be applied as basal dose during knolkhol planting. Another $1/6^{th}$ N and half of all fertilizers will be applied as basal dose during maize sowing. Rest of urea will be applied at 45 and 75 DAT as band placement in knolkhol and maize rows.
12.	Irrigated/Rainfed	:	Irrigated
13.	Data to be recorded	:	1. Initial soil test value 2. Dates of all operations 3. All the yield contributing characters of individual crops of the plot 4. Biomass/straw and grain/knob yield 5. Cost of inputs and price of output
14.	Investigators	:	I. S. M. Farhad, SSO, SSD, BARI, M.M. Masud, SSO, SSD, BARI
15.	Season	:	Rabi
16.	Date of initiation	:	1st week of November, 2021
17.	Date of completion	:	1st week of February, 2024
18.	Expected output / benefit	:	15-20 % yield increase from the intercropping system and improved soil fertility.
19.	Location	:	BARI Central farm, Joydebpur, Gazipur
20.	Status	:	2^{nd} year
21.	Estimated cost	:	50,000/-
22.	Source of fund	:	BARI

23. Priority : 1st

01. Programme : Soil Management

02. Project : Chemical Aspects of Soil Management

03. **Experiment 21 : Effect of different form of urea and irrigation management on Greenhouse Gas emission on Pani kachu cultivation in Bangladesh**

04. Objective(s) : To compare GHG emissions from different form of urea under two water management conditions

05. Rationale : Panikachu is a popular vegetable in Bangladesh. It is available in the market during the lean period of vegetable production. Like rice, panikachu is a semi aquatic plant. A few centimetre water always stands in the panikachu field. As a result, urea fertilizer management is tough in panikachu field. Nitrogen losses from panikachu field often happen due to ammonia volatilization, denitrification and nitrate leaching. On the other hand, due to submerge condition, organic substances form methane in panikachu filed.

Increasing concentration of greenhouse gases (GHGs) is responsible for global warming and climate change. CH_4 is considered as the second important greenhouse gas after CO_2 which has 25 times more global warming potential (GWP) than carbon dioxide contributing to 16% of the global warming. The concentration of CH_4 in the atmosphere has been increasing in the last 200 yr and has reached 1.77 ppm by volume in 2005, which is over double than that of its pre-industrial value. There are two major sources of methane emissions: one is natural source and another is anthropogenic source. More than 50% of the global annual CH_4 emission is of anthropogenic origin. It is reported that irrigated rice and panikachu are one of the major sources of CH_4 gas. Since irrigated rice and panikachu remains continuously flooded most of the time during crop growing season, this creates the ideal condition for CH_4 emissions.

CH_4 emission fluxes from rice/panikachu fields is significantly affected by water management, organic matter application, soil organic carbon content, soil pH, and climate. It is also influenced by soil type, weather, tillage management, residues, fertilizers, and cultivar. Therefore, manipulation of this factor can help to reduce CH_4 emissions. In order to reduce greenhouse gas emissions from rice cultivation, Alternate Wetting and Drying (AWD), a water saving method developed by IRRI in 1997, helps to reduce water requirement about 30% without any yield reduction. It is reported that intermittently flooded regimes emitted distinctly less CH_4 than the continuously flooded system.

Methane emission can also be affected by fertilizer application. Generally, organic fertilizer increases emissions compared with chemical fertilizer. Application of urea generally increases methane emissions. However, the effects of its application methods such as

broadcast or deep placement on methane emissions are very limited. Urea Deep Placement (UDP) or urea super granule is a fertilizer management technology which helps to increase crop yield (15% - 20%) and reduce nitrogen loss by up to 30 % mainly due to reduced volatilization loss compared with broadcast urea application. It also significantly reduced N_2O emissions during crop growing period compared with broadcast urea. Many work done about GHG emission from paddy field. No work done about GHG emission from panikachu field. Therefore, this study was conducted to compare the GHG emissions from UDP vs. urea broadcast in two water management conditions.

06. Materials and Methods :

07. Crop/variety : Latiraj

08. Design : RCBD

i) Treatment : A. Form of Urea: 4 (Four)
U_1 = No urea
U_2 = Recommended dose of urea in the form of prilled urea
U_3 = Recommended dose of urea in the form of Urea Super Granule
U_4 = Recommended dose of urea in the form of neem coated urea
Recommended dose of urea = 360 kg/ha

B. Water management:
W_1= Continuous standing water (CSW)
W_2 = Alternate wetting and drying condition (AWD)

ii) Replications 3 (three)

09. Plot size : 4 m x 5 m

10. Planting system/spacing Panikachu will be sown in line at 60 cm apart and plant to plant distance will be 45 cm.

11. Fertilizer dose and methods of application : For prilled urea and neem coated urea, 1/6th of urea will be applied before planting. Remaining $5/6^{th}$urea will be applied in five installments at 15 days interval. For USG, whole urea was applied as band placement before transplanting.

12. Irrigated /rainfed Irrigated

13. Data to be recorded : 1. CH_4, CO_2, N_2O emission
2. Dates of all operations
3. Stolon yield of Panikachu
4. All the yield contributing characters of Panikachu
5. Cost of inputs and price of output
6. Soil, stolon and plant sample will be collected after the harvest of crops and will be analyzed in the laboratory.

14.	Investigator(s)	:	Marufa Sultana, R. Sen, M. Shamsul Islam (SSO, TCRC, BARI) and H.M Naser
15.	Season	:	Kharif
16.	Date of initiation	:	March, 2021
17.	Date of Completion	:	November, 2023
18.	Expt. output/ benefit	:	i. Suitable water management practice for Panikachu cultivation will be find out ii. Suitable form of urea for Panikachu cultivation will be find out
19.	Location	:	Central farm, BARI, Gazipur
20.	Status	:	2nd year
21.	Estimated Cost	:	Tk. 40,000/-
22.	Source of fund	:	BARI
23.	Priority	:	1st

01.	Programme	:	Soil Management
02.	Project	:	Chemical Aspects of Soil Management
03.	**Experiment 22**	**:**	**Integrated Nutrient Management of year round four vine crops model for a intensive rooftop garden**
04.	Objective(s)	:	i. To develop fertilizer recommendation for year round 4 vine crops modal for a intensive rooftop garden. ii. To find out the optimum soil and manure ratio as a media for better growth and development of crops under rooftop garden.
05.	Rationale	:	Urban agriculture is a global and growing pursuit that can contribute to economic development, job creation, food security, and community building. It can, however, be limited by competition for space with other forms of urban development, a lack of formalized land use rights, and health hazards related to food contamination. The use of green roof technology in urban agriculture has the potential to alleviate some of these problems, without adversely affecting the benefits provided by urban agriculture. It would not only enable the use of land for development and agriculture, but may facilitate the formation of formal space and water use agreements and enable redistribution of ground level resources among urban farmers (Whittinghill and Rowe 2012). Rooftop gardening is going to popular in urban areas of Bangladesh. Bangladesh is one of the main victims of climate change. A country needs 25% of its land to be occupied by forests to maintain its ecological balance, but here the percentage is less than 8%. Due to the

urbanization, our cultivable lands decrease day by day. As there is limited scope for horizontal expansion of agriculture, vertical expansion is one of the major ways to increase crop production. Rooftop gardening is one of the potential areas for vertical expansion. As it is estimated that, there are about 2 lac house buildings in Dhaka city. A rooftop garden not only can be a source of agricultural production but also can be able to fix CO_2 and some other gases causing greenhouse effect. So, there are many scopes for rooftop gardening. Though some interested people are producing vegetables, fruits and flowers on their rooftop but research information on nutrient management for a rooftop garden is not available. Moreover, extensive literature review showed very little or no information regarding fertilizer trials on rooftop garden. Therefore, there is a possibility to increase the yield of a rooftop garden through integrated nutrient management approach. Proper nutrient management can produce maximum yield of a rooftop garden.

06. Materials and Methods :

07. Crop/variety : Lau (BARI Lau-4), Misty Kumra (BARI Misty Kumra -2), Korola (BARI Korola-1) and Chal Kumra (BARI Chal Kumra -1)

08. Design : CRD

i) Treatment : The experiment comprises 5 treatments which are as follows:
T_1 = 100% STB (Soil Test Based Fertilization)
T_2 = 80% of T_1 + (1:3) Kitchen waste and soil
T_3 = 80% of T_1 + (1:3) Cowdung and soil
T_4 = 80% of T_1 + (1:3) Vermicompost and soil
T_5 = Absolute control

ii) Replications 3 (Three)

09. Plot size : Half dram (Contain 80 kg soil)

10. Planting system/spacing BARI recommended spacing for tested crop

11. Fertilizer dose and methods of application : As per treatment

12. Irrigated /rainfed Irrigated

13. Data to be recorded : 1.Yield and yield attributes
2.Pre and post soil data
3.Crops quality data

14. Investigator(s) : A. Barman, I. S. M. Farhad, M. Sultana, R. Khatun, M. M. Masud, R. Sen and H.M. Naser

15. Season : Rabi and Kharif

16. Date of initiation : 1st week of November 2021

17. Date of Completion : Last week of October 2022

18. Expt. output/ benefit : Sustainable production of rooftop garden.

19. Location : Rooftop of Soil Science Division, BARI

20. Status : 2nd year

21. Estimated Cost : Tk. 50,000/-

22. Source of fund : BARI

23. Priority : 1st

01. Programme : Soil Management

02. Project : Chemical Aspects of Soil Management

03. **Experiment 23 : Study on soil properties variation through the soil profile in saline areas of seven upazilas of Satkhira district**

04. Objective(s) : To evaluate the spatial variability of physico-chemical properties through the soil profile in saline areas of Satkhira.

05. Rationale : The coastal region of Bangladesh occupies 20% area of the country. A number of environmental issues and problems are hindering the development of coastal livelihood. Salinity is one of the most important issue of them, which is expected to aggravate by climate change and sea level rise and eventually affect crop production (Hossain et al., 2015). The Satkhira region is recognized as an agro ecologically disadvantaged region. Soil salinity, water salinity and water-logging are major constraints for higher crop productivity in the south coastal region like Satkhira. In addition, climate change could result in increased soil surface salinity due to long periods of drought in winter season. A recent study indicates that the salinity affected area has increased from 8,330 km 2 in 1973 to 10,560 km 2 in 2009 (Soil Resource Development Institute (SRDI, 2010) in Bangladesh. However, the level of salt accumulation in different depths of soil for all upazillas of Satkhira is not adequately investigated. Through this research, the spatial variability
of salt accumulation through the soil profile will be evaluated.

06. Materials and Methods : Basic laboratory research

07.	Crop/variety	:	-
08.	Design	:	-
	i) Treatment	:	Five Soil Depth: T_1 = 0-15 cm T_2 = 15-30 cm T_3 = 30-45 cm T_4 = 45-60 cm and T_5 = 60-75 cm
	ii) Replications		-
09.	Plot size	:	-
10.	Planting system/spacing		-
11.	Fertilizer dose and methods of application	:	-
12.	Irrigated /rainfed	:	-
13.	Data to be recorded	:	Geographic positioning system (GPS), Soil Texture, Bulk Density, Particle density, pH, EC, ESP,SAR, CECS and Soil Nutrients
14.	Investigator(s)	:	O.A. Fakir, R. Sen, A.T.M.A.I. Mondol and H.M. Naser
15.	Season	:	Rabi
16.	Date of initiation	:	October, 2021
17.	Date of completion	:	April, 2022
18.	Expt. output/ benefit	:	Depthwise soil fertility and soil salinity will be observed which can be the basis of future research for soil scientists in Satkhira region.
19.	Location	:	Seven upazillas of Satkhira
20.	Status	:	2nd year
21.	Estimated Cost	:	Tk. 60,000/-
22.	Source of fund	:	BARI
23.	Priority	:	1st
01.	Programme	:	Soil Management

02. Project : Chemical Aspects of Soil Management

03. **Experiment 24 : Utilization of banana peel on increasing tomato yield and improving soil fertility**

04. Objective(s) : i. To minimize banana peel disposal problem
ii. To find out the effect of banana peel fertilizer on tomato yield
iii. To find out nutrient uptake and to increase soil fertility by the application of banana peel fertilizer

05. Rationale : Banana peels have the highest organic sources of potassium. Potassium aids plants in moving nutrients and water between cells. Potassium strengthens plants stems and also fights off disease. It is especially important to creating flowers, and even makes fruits taste better. Potassium will even make your plants more resistant to drought. In short, potassium helps plants grown for their fruiting and flowering. Banana peels are good fertilizer because of what they do not contain. They contain absolutely no nitrogen. Potassium-rich banana peels are excellent for plants like tomatoes, peppers or flowers. The average nitrogen in protein is 16%, so the 3.5% protein in banana skins is equivalent to 0.6% nitrogen. The potash and phosphate in banana peels is 11.5% and 0.4%. The NPK value for banana skins is 0.6-0.4-11.5. Banana peels also contain calcium, which prevents blossom end rot in tomatoes. The manganese in banana peels aids photosynthesis, while the sodium in banana peels helps water flow between cells. They even have traces of magnesium and sulfur, elements that help make chlorophyll.

Enormous amount of banana peel from rotten banana are generated from banana garden and fruit market in day by day in life. A considerable part of rotten banana & banana peel which remains unutilized and are dumped nearby sites that create pollution, harbours pathogen for diseases and causes severe problem of disposal. Instead of disposing, it can be used as source of organic fertilizers and effectively recycled to meet the nutritional requirement of crops. Considering growing deficiency of plant nutrients in crop field, higher cost of synthetic fertilizers and poor efficiency of chemical fertilizers, the banana peel & rotten banana recycling for plant nutrient supply is becoming more essential for replenishment of plant nutrients, sustaining soil health and reducing the pollution problem. The study was aimed to utilize the banana peel & rotten banana for supplying nutrient to enriched organic manure for better soil health and crop yield, which will minimize pollution and improve the fertilizer use efficiency subsequently that will helps to revitalize and restore the soil fertility for sustainable crop production.

06. Materials and Methods :

07. Crop/variety : BARI Tomato-16

08. Design : RCBD

	i) Treatment	:	6 (six) T_1= 100% RDCF T_2= 100% RDCF + 10% Banana peel manure T_3= 100% RDCF + 20% Banana peel manure T_4= 80% RDCF + 10% Banana peel manure T_5= 80% RDCF + 20% Banana peel manure T_6= Native fertility
	ii) Replications		3 (Three)
09.	Plot size	:	Pot culture
10.	Planting system/spacing		-
11.	Fertilizer dose and methods of application	:	Half of banana peel fertilizer and all of P, K, S,Zn and B should be applied as basal. Remaining banana peel fertilizer should be applied in pot after planting of seedlings. N should be applied in three equal splits at 15, 30 and 50 days after transplantation under moist soil condition and mixed thoroughly with the soil as soon as possible for better utilization.
12.	Irrigated /rainfed		Irrigated
13.	Data to be recorded	:	Plant height, length and diameter of tomato, weight of tomato, tomato yield (t/ha), soil microbial population, SOC, nutrient content in banana peel fertilizer including organic carbon, initial & post harvest soil analysis, plant sample analysis, weather data (max. & min temp, rainfall).
14.	Investigator(s)	:	Dr. M.R.Khatun, SSO,SSD,BARI A.Barman,SO,SSD,BARI Dr. M.M.Masud, SSO,SSD,BARI I.S.M. Farhad, SO,SSD,BARI Dr. H. M. Naser, CSO & Head, SSD,BARI
15.	Season	:	Round the year
16.	Date of initiation	:	November, 2021
17.	Date of completion	:	March, 2023
18.	Expt. output/ benefit	:	Rotten banana disposal problem will be minimized; soil fertility will be improved and crop yield will be increased.
19.	Location	:	BARI, Gazipur
20.	Status	:	2nd year
21.	Estimated Cost	:	Tk. 60,000/-

22. Source of fund : BARI

23. Priority : 1st

01. Programme : Soil Management

02. Project : Nutrient Management for Diversified Cropping in Bangladesh (NUMAN) Project

03. **Experiment 25 : Fertilizer requirements for double cropping (T. Aus –T. Aman rice system) on saline soils at south coastal region of Bangladesh**

04. Objective(s) : (i) To find out optimum rate of fertilizer for growing T.aus and T.Aman rice in double cropping system
(ii) To monitor soil health after each cropping cycle
(iii) To estimate the uptake of N, P, K, S and Zn and make a balance sheet of the nutrients.

05. Rationale : The coastal zone comprises soils where predominantly salinity is a limitation for the Rabi season, and others where predominantly excess wetness is the limitation. Most research in southern Bangladesh has focused on N as the key nutrient limiting crop production but there is growing evidence that other nutrients such as phosphorus, and some micronutrients constrain production (Debnath et al., 2011; Howlader et al. 2013; Liza et al. 2013). Nitrogen was the nutrient most limiting yield, followed by P and then K (Chuan et al. 2013). Micronutrient like-Zn is also very important for crop production. Farmers of this area generally cultivate only T.aman rice due to the salinity problems. In the southern coastal region of Bangladesh there are additional challenges where intensification of cropping from a single low input rice crop to double cropping on difficult soils, requires formulation of profitable and sustainable fertilizer use practices. Double cropping Nutrient management for this area is lacking for the other crops. Detail's study is lacking for nutrient balance sheet for the crop.

06. Materials and methods :

07. Crop/variety : T.Aus rice: BRRI dhan82 and T.Aman rice: BRRI dhan23

08. Design: : RCB

i)Treatment(s) 06 (Six)
T_1: 0 (control),
T_2: 100% RD (STB)
T_3: 120% RD of NPZn (STB)
T_4: 120% RD of N (STB)
T_5: 120% RD of P (STB)
T_6: 120% RD of Zn (STB)
** K and S fertilizers will be applied as blanket dose.

ii) Replications 03 (Four)

09.	Plot size	:	4m X 5m.
10.	Planting system/spacing	:	Transplanting: Row to row:20 cm Hill to hill: 15 cm
11.	Fertilizer dose and methods of application	:	All PKSZN fertilizers except N, will be applied during final land preparation. N will be applied in three equal splits- the 1/3rd will be applied at 5-7 DAT; the second split will be at tillering stage (30-35 DAT) and the third split at 5-7 days before PI stage (45-50 DAT).
12.	Irrigated/rainfed	:	Irrigated
13.	Data to be recorded	:	• Agronomic parameters • Initial soil parameters • Post-harvest soil analysis (Treatment wise) • Youngest fully emerged leaf at maximum tillering (for nutrient concentrations to confirm deficiency diagnosis) • Grain and straw analysis (NPKSZn) (treatment wise) • Partial nutrient budget (fertilizer input minus crop removal)
14.	Season	:	Kharif-I and Kharif II season
15.	Investigator(s)	:	Dr. Sohela Akhter, Director (TCRC), BARI Md. Farid Ahammed Anik, SO, SSD, BARI
16.	Date of initiation	:	2021
17.	Date of completion	:	2023
18.	Expected output/benefit	:	N, P and Zn requirement will be identified for double cropping rice production
19.	Location	:	Khatail, Dacope, Khulna
20.	Status	:	2nd year
21.	Estimated cost	:	40,000 tk per crop
22.	Source of fund	:	ACIAR, KGF
23.	Priority	:	1st

01.	Programme	:	Soil Management
02.	Project	:	Modeling Climate Change Impact on Agriculture (MCCA) (CRP-II) Project

03. **Experiment 26** : **Determination of nitrous oxide emissions from different form of urea in Potato, Wheat and Maize field**

04. Objective(s) : To find out nitrous oxide emission from different form of urea in potato, wheat and maize field

05. Rationale : Nitrogen (N) is an important plant nutrient and is the most limiting one due to its high mobility and different types of losses. Urea Super Granule is available in Bangladesh which use efficiency is 60% but labour cost to apply in the field is high. The farmers of Bangladesh usually use prilled urea (PU) for cultivation of crops. To improve fertilizer use efficiency, different types of fertilizer materials are becoming available day by day. Urea Super Granule (USG) is one of the nitrogenous fertilizers that is now available in our country and the farmers are using it for Boro rice and banana cultivation (Nazrul et al., 2007). It was found that USG as an alternative source of N than PU in terms of efficiency in wetland rice (Eusuf et al., 1993 and 1995). The loss of N by leaching and volatilization is minimal in USG & NPK briquette and it supplies more N to crops than PU. The volatilization loss of PU is very high and farmers lose a huge amount of money for N fertilizer. To control this loss, USG and NPK briquette application may be a good option to minimize production cost as well as to increase yield. Nazrul et al. (2007) reported that 5-8 cm depth placement of USG in cabbage cultivation could be saved 20% N than PU. Nitrous oxide emission from urea is a common phenomenon. Different form of urea emits different quantity of nitrous oxide varying there use efficiency. Potato, wheat and maize are grown in upland as well as medium land and the cultivation is increasing day by day due to its high profitability. Therefore, it is needed to evaluate the performance of USG, NPK briquette and PU on potato, wheat and maize in regard to nitrous oxide emission.

06. Materials and methods :

07. Crop/variety : Potato: Diamont, Wheat: BARI Gom-30 and Maize: BARI hybrid maize-9.

08. Design: : RCB

i)Treatment(s) 04 (Six)

T_1: N-Control
T_2: 100% RDCF (N applied as prilled urea)
T_3: 100% RDCF (NPK briquette)
T_4: 100% RDCF (N applied as USG)

ii) Replications 03 (Four)

09. Plot size : 4m X 5m.

10. Planting : Potato : Line sowing (60 cm X 25 cm)

	system/spacing		Wheat : Line sowing (20 cm X Continuous in line) Maize : Line sowing (60 cm X 20 cm)
11.	Fertilizer dose and methods of application	:	For prilled urea, 1/3rd of urea will be applied before sowing. Remaining 3/3rd urea will be applied in two installments at vegetative and reproductive stage. For USG and NPK briquette, whole urea was applied as band placement before sowing. For prilled urea and USG, all PKSZnB fertilizers will be applied during final land preparation.
12.	Irrigated/rainfed	:	Irrigated
13.	Data to be recorded	:	• Agronomic parameters • Initial soil parameters • Post-harvest soil analysis (Treatment wise) • Nitrous oxide gas collection and sampling • Grain and straw analysis (treatment wise)
14.	Season	:	Rabi
15.	Investigator(s)	:	Dr. Marufa Sultana, SSO, SSD, BARI Dr. Sohela Akhter, Director (TCRC), BARI
16.	Date of initiation	:	2019
17.	Date of completion	:	2023
18.	Expected output/benefit	:	Suitable form of urea emitting less quantity of nitrous oxide emission will be find out
19.	Location	:	Gazipur
20.	Status	:	2nd year
21.	Estimated cost	:	40,000 Tk per crop
22.	Source of fund	:	KGF
23.	Priority	:	1st

01.	Programme	:	Soil Management
02.	Project	:	Chemical Aspects of Soil Management
03.	**Experiment 27**	**:**	**Sustaining a healthy growth media as influenced by organoponic approach for yield maximization and storability of summer tomato**
04.	Objective (s)	:	i. Development of sustainable organic plant growth media ii. Improvement of physicochemical properties of plant growth media iii. Maximization of crop growth and yield

05. Rationale : Growing media is one of the most widely used materials for growing greenhouse crops. With many different formulations available for growers, it can be a challenge to choose which the best blend to use is. Growing media provide a reservoir for water holding, a nutrient holding and exchange system, a zone for gaseous exchange for the plant root system and anchorage for plant roots. These physical characteristics of a growing medium are determined by the components used and the proportions in which they are blended together. Biochar and vermicompost are the potential processed and pyrolized organic matter for the formulation of a sustainable plant growth media.

The organopony is a form of cultivation in which environmentally friendly materials are used to carry out the agricultural process. This is usually used as an option for sites where the land is not very fertile. With this cultivation system it is possible to produce food in a controlled way. This method can be used at small, medium or large scale depending on the requirements of the farmer. That is, they can be large farms or they can be done in a small space of a garden or on the roof of a building. Considering the above consequences a study would be undertaken to develop a sustainable healthy growth media for yield of summer onions.

06. Materials and Methods :

07. Crop/Variety : BARI piaz-4

08. Design : RCBD

i) Treatment : 8
T_1 = Farmsoil (Native fertility)
T_2 = Farmsoil with blanked dose of CF
T_3 = 80% biochar
T_4 = 80% vermicompost
T_5 = Biochar 40% X vermicompost 40%
T_6 = Biochar 40% X vermicompost 50%
T_7 = Biochar 50% X vermicompost40%
T_8 = Biochar 50% X vermicompost 50%

Note. percent arranged by volume

ii) Replications 3

09. Plot size : 2 m x 1 m (raised bed system)

10. Planting system/spacing : 15 cm x 10 cm

11. Fertilizer dose and methods of application : N_{20} $P_{10}K_{20}S_5$ g m^{-2} (Blanked dose), Half N and full dose of PKS should be mixed at the time of final substrate preparation and rest N to be top dressed at 25 day after planting.

12.	Irrigated /rainfed	:	Irrigated
13.	Data to be recorded	:	1.Yield and yield components 3. Storage duration at ambient temperature 2. Disease and insect infestations 3. Nutrient status of initial and post harvest substrate. 4. Substrate pH and moisture recording at 15 days interval.
14.	Investigator(s)	:	MA Rahman SSO, FS Shikha SO, MYasmin SO and MM Masud SSO
15.	Season	:	Kharif
16.	Date of initiation	:	1st week of February, 2023
17.	Date of completion	:	1stweek of April, 2024
18.	Expt. output/ benefit	:	Sustainable healthy growth media for small, medium or large scale depending on the requirements of the farmer. This technology will best fit for rooftop cultivation
19.	Location	:	RARS, Jamalpur
20.	Status	:	New
21.	Estimated Cost	:	50,000/-
22.	Source of fund	:	BARI
23.	Priority	:	1st
01.	Programme	:	Soil Management
02.	Project	:	Chemical Aspects of Soil Management
03.	**Experiment 28**	**:**	**Effect of different compost on potato productivity and soil health**
04.	Objective (s)	:	i.To reduce the use of chemical fertilizer for potato production by organic manure ii. To improve carbon stock in soil
05.	Rationale	:	Potato (Solanumtuberosum L.) is one of the vital tuber crops and high potential food security crop due to its high yield potential, nutritional quality, short growing period and wider adaptability. Potatoes have a shallow root system and a relatively high demand for many nutrients. A comprehensive nutrient management program is essential for maintaining a healthy potato crop, optimizing tuber yield and quality, and minimizing undesirable impacts on the environment. The use of chemical fertilizers can increase tubers but it has negative effects on tuber quality, environmental pollution, public health and economic losses; starch and sugar contents are reduced in tubers. So, an alternative method must be developed. Integrating compost with

chemical fertilizer is essential for sustainable potato production and improves soil fertility, soil structure and furthermore helps plant in combating pests and diseases. It also reduces the cost of production. So, the present study aimed to compare the performance of different compost in potato production.

06. Materials and Methods :

07. Crop/Variety : BARI Alu-25 (Asterix)

08. Design : RCBD

i) Treatment : 6 (Six)
T_1 = Control
T_2 = 100% Soil Test Based (STB) Fertilizer dose, (FRG 2018)
T_3 =80% STB + Compost @ 2.5 t ha^{-1}
T_4 = 80% STB + Kitchen Waste Compost @ 2.5 t ha^{-1}
T_5 = 80% STB + Vermicmpost @ 2.5 t ha^{-1}
T_6 = 80% STB + Trichocompost@ 2.5 t ha^{-1}
Note: Nutrients of the Treatments will be formulated through IPNS system

ii) Replications 3

09. Plot size : 4 m x 2 cm

10. Planting system/spacing : 60 cm x 25 cm

11. Fertilizer dose and methods of application : $N_{158}\ P_{25}\ K_{113}\ S_{12}\ Zn_3\ B_1$ Kg ha^{-1} (FRG-2018)

12. Irrigated /rainfed : Irrigated

13. Data to be recorded : 1.Yield and yield components
2. Soil organic carbon content in post soil
3. Nutrient status of initial and post harvest soil.
4.Nutrient uptake
5.Disease and insect infestations
6.Cost and return analysis

14. Investigator(s) : M Yasmin, F S Shikha and M A Rahman

15. Season : Rabi

16. Date of initiation : 2nd week of November, 2022

17. Date of completion : 3rd week of February, 2024

18. Expt. output/ : Suitable combination of chemical fertilizer and compost will be find

benefit out and improved soil carbon stock.

19. Location : RARS, Jamalpur

20. Status : New

21. Estimated Cost : 50,000/-

22. Source of fund : BARI

23. Priority : 1st

01. Program : Soil Chemistry

02. Project : Chemical Aspects of Soil Management

03. **Experiment 29 : Nutrient management for watermelon**

04. Objective : To find out suitable fertilizers dose on the yield and quality of watermelon.

05. Rationale : Cucurbits is a popular group of vegetable in many parts of the world, occupy a large area under cultivation in India. Cucumbers, melons, pumpkins, squashes, and gourds belong to the cucurbitaceae family. Among the cucurbits, watermelon (CitrulluslanatusThunb.) is one of the important vegetable crops grown extensively in India and in tropical and sub-tropical countries of Europe and Africa. Watermelon (Citrulluslanatus) is a widely cultivated and most consumed cucurbit in the world (Huh, *et al.*, 2008). Major producers of the crop include China, Turkey, United States, Iran and Republic of Korea (Huh, *et al.*, 2008).
The crop accounts for about 6.8% of the world area devoted to vegetable production (Goreta, *et al.*, 2005). Watermelon grows best on fertile sandy or sandy loam soils with good drainage.

06. Materials and methods :

07. Crops/variety : BARI tormuj 1

08. Design : RCBD

i) Treatments :

	N	P	K	S
		Kg/ha		
T1	0	0	0	0
T2	0	60	50	20
T3	60	60	50	20
T4	120	60	50	20
T5	180	60	50	20
T6	120	0	50	20

T7	120	30	50	20
T8	120	90	50	20
T9	120	60	0	20
T10	120	60	25	20
T11	120	60	75	20
T12	120	60	50	0
T13	120	60	50	10
T14	120	60	50	30

Basal (Common rates for all treatments except control T1): Zn 2 kg/ha, B 2 kg/ha, Mg 15 kg/ha, CD 5t/ha

ii) Replication : 3

09. Plot size :

10. Planting spacing/system : 2 m× 2 m

11. Fertilizer dose and methods of application : As per treatments

12. Irrigated/rainfed : Irrigated

13. Data to be recorded : i) Initial soil sample collection
ii) Post harvest soil sample collection
iii) Yield and yield attributes
iv) Quality characteristics

14. Investigators : Marufa Sultana SSO SSD ,Dr, Md. Idris Ali Hawlader SSO,RHRC, Patuakhali, BARI

15. Season : Robi

16. Date of initiation : October, 2020

17. Date of completion : 2023

18. Expected outcome/benefit : To find out the suitable fertilizers dose forthe yield and quality of watermelon.

19. Location : RHRC, Lebukhali , Patuakhali, BARI

20. Status : 2nd year

21. Estimated cost : Tk. 50,000/Year/location

22. Source of fund : SSD, BARI

23 Priority : 1st

01.	Programme	:	Soil Management
02.	Project	:	Chemical Aspects of Soil Management
03.	**Experiment 30**	**:**	**Development of fertilizer recommendations for onion linseed intercropping**
04.	Objective (s)	:	i. To develop a suitable fertilizer recommendation for onion with linseed intercropping system ii. To increase crop yield and crop diversity
05.	Rationale	:	Inter Intercropping system is considered as the simultaneous cultivation of two or more crops in the same field and is a more sustainable method for enhancing crop yields in comparison with sole cropping systems (Ehrmann and Ritz, 2014; Brooker et al., 2015). Onion is a valuable crop, and ranks second after tomato in the list of worldwide cultivated vegetables (FAO, database, 2012). Linseed is a rich source of protein, dietary fibers, and phytoestrogens. In Bangladesh, the plant is cultivated as rabi crop mostly in the districts of Khulna, Jessore, Dinajpur, Kushtia, Pabna, Dhaka, Mymensingh, Tangail and Faridpur. About 49,000 m tons of seed are produced annually from about 73,000 ha of land. The seed yields 30-38% oil containing about 20% protein. Thus, the experiment is undertaken to evaluate the effect of fertilization rate on the growth, yield and yield components of onion with linseed intercropping.
06.	Materials and Methods	:	
07.	Crop/Variety	:	Onion (BARI Piaj 4) and Linseed (Neela)
08.	Design	:	RCB
	i) Treatment	:	The experiment comprised of 6 treatments which are as follows: T_1= 100% RDCF of Onion T_2= T_1 + 20% RDCF of Linseed T_3= T_1 + 30% RDCF of Linseed T_4= T_1 + 40% RDCF of Linseed T_5= T_1 + 50% RDCF of Linseed T_6 = T_1+ 60% RDCF of Linseed
	ii) Replications		3
09.	Plot size	:	4 m × 3 m
10.	Planting system/spacing	:	Side three row & each row spacing 15 cm for onion Middle two row & each row spacing 30 cm for linseed
11.	Fertilizer dose and methods of application	:	All of organic manure, phosphorous, potassium, sulphur , zinc & boron will be applied as basal during final land preparation. Nitrogen will be applied as top dress in three equal splits at 15 DAS, 30 DAS and 60

DAS with irrigation.

12. Irrigated /rainfed : Irrigated

13. Data to be recorded :
- Initial soil status
- Dates of all operations
- Yield and yield contributing characters
- Nutrient status of post-harvest soil
- Plant nutrient uptake
- Major disease and insect incidence
- Cost and returns analysis

14. Investigator(s) : Dr. Mst. Rokeya Khatun, SSO, SSD, BARI
Dr. M.M. Masud, SSO, SSD, BARI
Dr. M.M. Sultana, SSO, SSD, BARI
A. Barman, SO, SSD, BARI
I. S. M. Farhad, SO, SSD, BARI
Dr. M.A.Rahman, SSO, RARS, Jamalpur

15. Season : Rabi

16. Date of initiation : November, 2022

17. Date of completion : March, 2023

18. Expt. output/ benefit : A suitable fertilizer management practice will be developed for maximizing the yield of Onion with Linseed intercropping

19. Location : Central Research Farm, BARI, Gazipur & RARS, Jamalpur

20. Status : New

21. Estimated Cost : 60000/-

22. Source of fund : BARI

23. Priority : 1st

01. Programme : Soil Management

02. Project : Chemical Aspects of Soil Management

03. **Experiment 31 : Effect of different levels of sulphur and boron on yield and nutrient uptake of sesame**

04. Objective (s) : i.To assess different levels of S and B on growth, yield & nutrient uptake of sesame, and
ii.To increase yield and oil content of sesame

05. Rationale : Sesame is the second edible oilseed crop and produced almost all districts of Bangladesh. Sesame contain 26.25% - 50 % oil, 18-20 %

protein, sulfur-containing amino corrosive methionine, vitamine E and linoleic corrosives that can control blood cholesterol levels. In sesame oil, oleic and linoleic acids are the predominant fatty acids and make up more than 80% of the total fatty acids. Sesame seed flour has a high protein content with high levels of the essential amino acids methionine and tryptophan, contains about 10 to 12% of oil and has three times more calcium than milk (Doutaniya, 2018). The average yield of sesame (550 kg ha-1) in Bangladesh is low as compared with other countries in the world. In recent years, sesame has had a low ranking in the world production of edible oil crop due to several factors including low yield and strong competition from other oil crops such as soybean, sunflower and peanut. Additional sulphur application increases the seed and oil content of the sesame. Boron deficiency can affect pollen viability and abortion of stamen and pistils and toxicity cause lower chlorophyll levels which contribute to low seed set. With this background, the present study was carried out to study the effect of sulphur and boron on yield and nutrient uptake of sesame.

06. Materials and Methods :

07. Crop/Variety : Sesame (BARI Til 4)

08. Design : RCB

i) Treatment : Factor A. Levels of sulphur: 0, 15 & 30 kg ha^{-1}
Factor B. Levels of Boron: 0, 0.5, 1.0,1.5 & 2.0 kg ha^{-1}
The experiment comprised of Nine (9) treatments which are as follows:
$T_1= S_{15} B_{0.5}$
$T_2= S_{15} B_{1.0}$
$T_3= S_{15} B_{1.5}$
$T_4= S_{15} B_2$
$T_5= S_{30} B_{0.5}$
$T_6= S_{30} B_{1.0}$
$T_7= S_{30}B_{1.5}$
$T_8= S_{30}B_{2.0}$
$T_9= S_0B_0$

ii) Replications 3

09. Plot size : 3 m × 4 m

10. Planting system/spacing : Row to row = 30 cm
Plant to Plant = 5 cm

11. Fertilizer dose and methods of application : All of organic manure, phosphorous, potassium, sulphur , zinc, boron and ½ nitrogen will be applied as basal during final land preparation. Half of nitrogen will be applied as top dress at 25 - 30 DAS when starting bud initiation.

12. Irrigated /rainfed Irrigated

13. Data to be recorded :
- Initial soil status
- Dates of all operations
- Yield and yield contributing characters
- Nutrient status of postharvest soil
- Plant nutrient uptake in sesame
- Oil content (%)
- Major disease and insect incidence
- Cost and returns analysis

14. Investigator(s) : Dr. Mst. Rokeya Khatun, SSO, SSD, BARI
Dr. M.M. Masud, SSO, SSD, BARI
Dr.M.M. Sultana, SSO, SSD, BARI
I. S. M. Farhad, SO, SSD, BARI
A. Barman, SO, SSD, BARI
Dr. M.A. Rahman, SSO, RARS, Jamalpur

15. Season : Kharif

16. Date of initiation : February, 2023

17. Date of completion : May,2023

18. Expt. output/ benefit : A suitable fertilizer management practice will be developed for maximizing the yield and quality of Sesame

19. Location : Central Research Farm, BARI, Gazipur& RARS, Jamalpur

20. Status : New

21. Estimated Cost : 60000/-

22. Source of fund : BARI

23. Priority : 1st

01. Programme : Soil Management

02. Project : Chemical Aspects of Soil Management

03. **Experiment 32 : Integrated nutrient management on yield, quality and nutrient uptake of linseed (*linum usitatissimum* l.)**

04. Objective (s) : To find out a suitable and economic fertilizer dose for maximizing the yield of linseed.

05. Rationale : Linseed (Linumusitatissimum L.) is an important oilseed crop and cultivated primarily for oil meant for edible as well as industrial purposes. About 80 per cent of oils is used for paints, varnishes, a wide range of coating oils, linoleum, pad and printing inks, leather finishing, its fiber has more strength and durability which blends very well with wool, cotton, silk etc. So, the yield of linseed can be increased by more than 100% under rainfed condition with proper fertilization. The

reasons for low yield of linseed are poor soil fertility, inadequate use of fertilizer and traditional crop management practices. In this context, present investigation was undertaken to evaluate the organic and inorganic fertilizers on growth, yield and nutrient uptake of linseed

06. Materials and Methods :

07. Crop/Variety : Linseed (BARI Tishi-1 Neela)

08. Design : RCBD

i) Treatment : 07 (Seven)
T_1 = 125% of recommended dose
T_2 = 2 tha^{-1} VC + IPNS CF
T_3 = 3 tha^{-1} VC + IPNS CF
T_4 = 5 tha^{-1} VC + IPNS CF
T_5 = 2 tha^{-1} VC
T_6 = 3 tha^{-1} VC
T_7 = 5 tha^{-1} VC

ii) Replications 3

09. Plot size : 3m × 4m

10. Planting system/spacing : Continuous seeded. 30cm between two row.

11. Fertilizer dose and methods of application : ½ N and half of all fertilizer will be applied as basal dose during linseed sowing. Rest of urea will be applied at 45 and 75 DAS.

12. Irrigated /rainfed : Irrigated

13. Data to be recorded : Dates of all operations
Biomass/straw
All the yield and quality contributing characters of linseed of the plot
Cost of input and price of out put
Soil, grain and plant sample will be collected after the harvest of crops and will be analyzed in the laboratory

14. Investigator(s) : Dr.M.M. Sultana, SSO, SSD, BARI
Dr. M.M. Masud, SSO, SSD, BARI
Dr. Mst. Rokeya Khatun, SSO, SSD, BARI
I. S. M. Farhad, SO, SSD, BARI

15. Season : Rabi

16. Date of initiation : October, 2022

17. Date of completion : 2025

18.	Expt. output/ benefit	:	Yield and quality increase from improved soil fertility.
19.	Location	:	SSD, BARI, Gazipur.
20.	Status	:	New
21.	Estimated Cost	:	30,000/- per year
22.	Source of fund	:	BARI
23.	Priority	:	1st
01.	Programme	:	Soil Management
02.	Project	:	Chemical Aspects of Soil Management
03.	**Experiment 33**	**:**	**Integrated nutrient management on yield and quality of safflower**
04.	Objective (s)	:	i. To determine the effect of fertilizer application on soil properties ii.To determine the effect of fertilizer on yield and quality of safflower seed
05.	Rationale	:	Safflower is an annual oil crop (İlkdoğan, 2012). Safflower pulp which remains after taking its oil is a good feed source for animal breeding with the crude protein percentage of around 25%. Safflowers include water-soluble carthamidin and red-colored carthamin which is not water soluble. Safflower is also essential because of the substance named tocopherol which has similar properties with vitamin E in the composition of safflower oil (Yılmazlar, 2008). Commonly used vegetable oils are rapeseed, soybean, sunflower, cotton seed, safflower, corn and palm oil (Oğuz et al., 2012). Since organic fertilizers are essential sources providing substance and food formation. Balanced fertilizer use along with organic manures is considered as promising agro-technique to sustain yield, increase fertilizer use efficiency and restore soil fertility (Mishra et al., 2011). In this study, with the scope of organic farming which uses less chemical and which is more environment-friendly than conventional farming (Eckhoffet al., 2005), the effect of organic origin fertilizer on yield and some quality features of safflower will be investigated.
06.	Materials and Methods	:	
07.	Crop/Variety	:	Safflower (BARISaf-1)
08.	Design	:	RCBD
	i) Treatment	:	05 (five) T_1 = RD (FRG 2018) $N_{75}P_{30}K_{60}S_{21}Zn_{2.6}B_2$ T_2=80% RD + IPNS VC

T_3 = 70% RD + IPNS VC
T_4=60% RD + IPNS VC
T_5=Control

ii) Replications 3

09. Plot size : 4m × 5m

10. Planting system/spacing L-L 40cm, P-P continuous

11. Fertilizer dose and methods of application : Organic fertilizers will be used three times with recommended amount and during the different developing periods (rosette formation period, branching and 50% flowering periods).

12. Irrigated /rainfed : Irrigated

13. Data to be recorded : Growth, Yield and Quality attributed parameter will be recorded

14. Investigator(s) : Marufa Sultana, MM Masud, RokeyaKhatun, Alak Barman, ISM Farhad

15. Season : Rabi

16. Date of initiation : 15 November, 2022

17. Date of completion : 2025

18. Expt. output/ benefit : The yield and quality of Safflower seeds condition will be found out. In addition, the soil properties will be ensured.

19. Location : SSD, BARI, Gazipur.

20. Status : New

21. Estimated Cost : 30,000/- per year

22. Source of fund : BARI

23. Priority : 1st

01. Programme : Soil Management

02. Project : Chemical Aspects of Soil Management

03. **Experiment 34 : Effect of integrated nutrient management and plant growth regulator on yield of Tomato**

04. Objective (s) : To find out the suitable combination of organic manure and plant growth regulator to increase soil health and quality tomato production

05.	Rationale	:	Application of chemical fertilizers is very important for crop production. However, the continuous long-term use of chemical fertilizer has led to many unexpected effects like the generation of greenhouse gas, eutrophication in aquatic system and salinization in soil as well as food safety and quality decline problems. Organic manures are considered to improve crop productivity along with ameliorating soil health. Tomato is one of the major vegetable crops. Yield potential of tomato is generally low which can be enhanced through a balanced supply of essential nutrients using organic manure and plant growth regulators. Organic manures contain both macro and micronutrients whose application into soil, results in improved soil condition by significantly increasing the level of N fixation and soil physical properties. On the other hand, plant growth regulators are known to play a positive role in enhancing yield potential in plants. Plant growth regulators (PGRs) are known to influence plant growth and development at very low concentrations. Moreover, plants have the ability to store excessive amounts of exogenously supplied hormones in the form of reversible conjugates which release active hormone when the plants need them during the growth period (Davies 2004). In this study, we investigate the suitable combination of organic manure and plant growth regulator to increase soil health and quality of tomato yield.
06.	Materials and Methods	:	
07.	Crop/Variety	:	BARI Tomato-16
08.	Design	:	RCB
	i) Treatment	:	The experiment comprises 6 treatments which are as follows: T_1 = 100% STB (Soil Test Based) Fertilization T_2 = 75% of T_1 + Compost (3 ton ha^{-1}) + GA 200 ppm@30DAT T_3 = 75% of T_1 + Compost (3 ton ha^{-1}) + GA 400 ppm@30DAT T_4 = 75% of T_1 + VC (2.5 ton ha^{-1}) + GA 200 ppm@30DAT T_5 = 75% of T_1 + VC (2.5 ton ha^{-1}) + GA 400 ppm@30DAT T_6 = Absolute control
	ii) Replications		3
09.	Plot size	:	3m x 4m
10.	Planting system/spacing		Row to row 60cm and plant to plant 40cm
11.	Fertilizer dose and methods of application	:	FRG 2018
12.	Irrigated /rainfed		Irrigated

13.	Data to be recorded	:	1.Yield and yield attributes 2.Pre and post soil data 3.Crops quality data
14.	Investigator(s)	:	A. Barman, I. S. M. Farhad, M. Sultana, R. Khatun, M. M. Masud, N. U. Mahmud, N. Salahin and H. M. Naser
15.	Season	:	Rabi
16.	Date of initiation	:	November 2022
17.	Date of completion	:	March 2023
18.	Expt. output/ benefit	:	Achieving food safety while at the same time will help to improve soil health and increase production.
19.	Location	:	BARI, Gazipur and RARS, Jashore
20.	Status	:	New
21.	Estimated Cost	:	60,000/-
22.	Source of fund	:	BARI
23.	Priority	:	1st
01.	Programme	:	Soil Management
02.	Project	:	Chemical Aspects of Soil Management
03.	**Experiment 35**	**:**	**Fertilizer recommendation for BARI Sarisha-18**
04.	Objective (s)	:	To find out suitable fertilizer dose for growth and yield of BARI Sarisha-18.
05.	Rationale	:	Mustard (Brassica sp.) is one of the most important oilseed crops in Bangladesh. Fertilizer management is big factor for crop production. The decision on fertilizer use requires knowledge of the expected crop yield response to nutrient application, which is a function of crop nutrient needs, supply of nutrients from indigenous sources, and the rate of the fertilizer applied. BARI Sarisha-18 is a new canola type excellent mustard variety. This variety contains 40-42% oil in seed and erucic acid content is only 1.06% in oil while other variety contains 35%-40%. For this, it will be gradually accepted by the farmers of Bangladesh and generating higher income through farming.Considering its importance, it is necessary to estimate its fertilizer recommendation and the production level. So, the present study aimed to estimate optimum fertilizer dose for maximum production of mustard.
06.	Materials and	:	

Methods

07. Crop/Variety : BARI Sarisha-18

08. Design : RCBD

i) Treatment : Rate of fertilizer : 14
(5 levels of N) : 0,100,150 and 200 Kg ha^{-1}
(4 levels of P): 0,30,60 and 90 Kg ha^{-1}
(4 levels of K) : 0,100,120 and140Kg ha^{-1}
(4 levels of S): 0, 10, 20 and 30 Kg ha^{-1}
Treatment combination
$T_1 = N_0P_{30}K_{120}S_{20}$
$T_2 = N_{100}P_{30}K_{120}S_{20}$
$T_3 = N_{150}P_{30}K_{120}S_{20}$
$T_4 = N_{200}P_{30}K_{120}S_{20}$
$T_5 = N_{150}P_0K_{120}S_{20}$
$T_6 = N_{150}P_{30}K_{120}S_{20}$
$T_7 = N_{150}P_{90}K_{120}S_{20}$
$T_8 = N_{150}P_{60}K_0S_{20}$
$T_9 = N_{150}P_{60}K_{100}S_{20}$
$T_{10} = N_{150}P_{60}K_{140}S_{20}$
$T_{11} = N_{150}P_{60}K_{120}S_0$
$T_{12} = N_{150}P_{60}K_{120}S_{10}$
$T_{13} = N_{150}P_{60}K_{120}S_{30}$
T_{14} = Native fertility

ii) Replications 3

09. Plot size : 4 m x 3 cm

10. Planting system/spacing : 30 cm x continuous in line

11. Fertilizer dose and methods of application : Fertilizer dose: According to treatments.
Methods of application: Half of N and all of P, K, S, Zn and B should be applied as basal during final land preparation. Remaining half of N should be applied as top dress at the time of flower initiation stage (25 days after sowing). Organic residue should be applied during final land preparation as IPNS basis.

12. Irrigated /rainfed : Irrigated

13. Data to be recorded : 1.Yield and yield components
2. Disease and insect infestations
3. Nutrient status of initial and post-harvest soil.

14. Investigator(s) : M Yasmin SO, F S Shikha SO, M A Rahman SSO and M M Masud SSO

15. Season : Rabi

16. Date of initiation : 1st week of November, 2022

17. Date of completion : 2nd week of February, 2024

18. Expt. output/ benefit : Optimum fertilizer dose for BARI Sarisha-18will be formulated.

19. Location : RARS, Jamalpur

20. Status : New

21. Estimated Cost : 30,000/-

22. Source of fund : BARI

23. Priority : 1st

01. Programme : Soil Management

02. Project : Chemical Aspects of Soil Management

03. **Experiment 36 : Effect of tricho compost on the yield of chilli.**

04. Objective (s) :
1. To investigate the effect of Tricho compost application in different growth stage
2. To find out suitable dose of Tricho compost application for maximizing the yield of chilli
3. To find out a better way of bio-agent in crop and disease management in chilli production

05. Rationale : Capsicum annuum L. has great importance worldwide for its nutritional characteristics and its antioxidant content. During its growth, it can be affected by biotic factors, such as pests and diseases that negatively affect the production and quality of its fruits, thus making adequate control measures necessary to avoid relevant economic losses. Tricho-compost provides a stable organic matter that improves the physical, chemical, and biological properties of soils, thereby enhancing soil quality and crop production. The detrimental side effects of chemical fertilizers have shifted the current focus to biological management systems. For this reason, tricho compost (enriched with Trichoderma spp.) in sustainable agriculture is one of the important applications to reduce production inputs and to make economic by crop and disease management in agriculture. Trichoderma exert beneficial effects on plants as a bio-control agent. Trichoderma spp. have proven its role in suppressing the growth of pathogenic microorganisms and stimulating the plant growth.Therefore, this study was conducted to find out the effect of tricho compost in chilli to obtain a higher yield sustainable soil health of Jamalpur.

06. Materials and Methods :

07.	Crop/Variety	:	BARI morich 2
08.	Design	:	RCBD
	i) Treatment	:	Treatments: Seven (7) T_1 = 100% RDCF (FRG - 2018) T_2 = Tricho compost @ 1.5 t ha^{-1} + IPNS T_3 = Tricho compost @ 2.5 t ha^{-1} + IPNS T_4 = Tricho compost @ 3.0 t ha^{-1} + IPNS T_5= Tricho compost @ 1.5 t ha^{-1} T_6= Tricho compost @ 2.5 t ha^{-1} T_7= Tricho compost @ 3.0 t ha^{-1} Note: Recommended Dose of Chemical Fertilizer (RDCF)
	ii) Replications		3
09.	Plot size	:	3m x 4m
10.	Planting system/spacing	:	60 cm x 5 0 cm
11.	Fertilizer dose and methods of application	:	N_{120} $P_{30}K_{90}S_{15}Zn_2B_2$ Kg ha^{-1} (FRG-2018) As per treatment.
12.	Irrigated /rainfed		Irrigated
13.	Data to be recorded	:	1.Yield and yield components 2. Soil texture, pH, organic carbon etc. 3. Disease infections (seedling mortality, damping off, root rot, etc.) 4. Nutrient status of initial and post harvest soil. 5.Cost and return analysis
14.	Investigator(s)	:	F S Shikha, M Yasmin, M A Rahman ,M M Masud, M Afroz and H M Naser.
15.	Season	:	Rabi
16.	Date of initiation	:	1st week of November, 2022
17.	Date of completion	:	1stweek of April, 2023
18.	Expt. output/ benefit	:	To find out the suitable dose of tricho compost for chilli production.
19.	Location	:	RARS, Jamalpur
20.	Status	:	New
21.	Estimated Cost	:	50,000/-

22. Source of fund : BARI

23. Priority : 1st

01. Programme : Soil Management

02. Project : Chemical Aspects of Soil Management

03. **Experiment 37 : Effect of variety and phosphorus fertilizer on the yield of lentil**

04. Objective (s) : To find out the response of lentil varieties to levels of phosphorus fertilizer on growth and yield.

05. Rationale : Lentil popularly known as 'masur', is a delicious seed legume in the country. In this country, lentil produced 0.25 million tons from 0.19 million hectares of land with an average yield of 1.3 t ha^{-1} and contributed 27% to the total pulses production during 2018-2019 cropping season (AIS, 2020). Phosphorus fertilizer has a significant effect on lentil yield as it enhances nodulation, which helps to fix more nitrogen from air through their nodules (Datta et al., 2013). In Bangladesh, the low yield of lentil may be attributed to many reasons such as lack of quality optimum seed rate, using local varieties as planting material, appropriate time of sowing, lack of judicious fertilizer application and specially decrease of organic matter in the soil. Moreover, the different doses of phosphorus will help to determine the suitable dose, thereby reducing the misuse of phosphorus fertilizer. Both phosphorus and sulphur can improve the quality and quantity of black gram (Mir et al., 2017). In view of above discussion, the present study was undertaken tofind out the effect of variety and level of phosphorus fertilizer on the growth and yield of lentil.

06. Materials and Methods :

07. Crop/Variety : Lentil varieties

08. Design : RCB

i) Treatment : Treatments:

A. Lentil varieties:
V_1= BARI Masur-3,
V_2= BARI Masur-6 and
V_3= BARI Masur-8

B. Phosphorus levels
F_1 = P-10 kg ha^{-1},
F_2= P-20 kg ha^{-1},
F_3= P-30 kg $ha^{-1}$and
F_4= P-40 kg ha^{-1},

Seed rate: 35 kg ha^{-1}

ii) Replications 03

09. Plot size : 4 m X 3 m

10. Planting : 30 cm apart line

system/spacing

11.	Fertilizer dose and methods of application	:	20-20-10-1.7 kg ha^{-1}N-K-S-B with blanket doses. At a time broadcast after final land preparation.
12.	Irrigated /rainfed	:	No irrigation will be applied
13.	Data to be recorded	:	• Growth traits • Yield and yield contributing characters • Cost and return analysis • Soil analysis
14.	Investigator(s)	:	M.S. Alam, M. R. Khatun, M.M Kamal and M.M. Uddin
15.	Season	:	Rabi
16.	Date of initiation	:	November 2022
17.	Date of completion	:	March 2024
18.	Expt. output/ benefit	:	Suitable phosphorus level will be identified for higher yield in lentil
19.	Location	:	PRC, Ishurdi and BARI, Joydebpur
20.	Status	:	New
21.	Estimated Cost	:	50,000/=
22.	Source of fund	:	BARI Joydebpur, Gazipur
23.	Priority	:	1st
01.	Programme	:	Soil Management
02.	Project	:	Chemical Aspects of Soil Management
03.	**Experiment 38**	**:**	**Nutrient management for sesame variety in Barishal region.**
04.	Objective (s)	:	i). To find out the response of sesame variety to nutrient management. ii) To increase the yield of sesame through fertilizer management.
05.	Rationale	:	In global changing situation the edible oil price rise day by day. It became out of reach to the poor people as well as the lower middle class to middle class family. So it is cry need to increase the production of oil seed crop. So sesame is important oil seed crop to supply edible oil. Sesame is the third highest edible oil of Bangladesh. It contained 42-45% oil and 20% of protein. It has also medicinal value (KPHB, BARI, 2020). In Bangladesh sesame was cultivated both rabi and kharif season. Mostly cultivated in kharif season. It requires medium

high land because stagnant water damages it. It is short durated crop. Latest BARI sesame variety is better variety and its yield is remarkable. Farmers of this region interested to cultivated sesame. Sometimes the land is fallow in this region in mid-February to mid-April. So they can harvest a short durated crop in this time. Local sesame variety production is low and farmers cannot interest to cultivate sesame but latest variety of BARI is appreciable. Farmers wants modern variety of sesame Fertilizer management is big factor for crop production. Farmers do not know the actual rate of fertilizer for sesame cultivation. So this experiment is under taken for the actual rate of fertilizer in this region for different sesame variety cultivation.

06. Materials and Methods : The experiment will be conducted at RARS, Rahmatpur, Barishal experimental field. Seed are sown in mid-February.

07. Crop/Variety : V_1-BARI Tiland BARI Til-5

08. Design : RCBD (Factorial)

i) Treatment : Factor A: Variety:- 2 (V_1-BARI Til - 4 and V_2- BARI Til-5)
Factor B: Fertilizer :- 7 (Seven)
F_1: N_{60} P_{20} K_{50} S_{10} Zn_1 B_2
F_2 : F_1-N
F_3 : F_1 -P
F_4 : F_1 -K
F_5: F_1-S
F_6: F_1-Zn
F_7: F_1-B

ii) Replications 4 (Four)

09. Plot size : 6 m × 5m

10. Planting system/spacing : Line sowing with spacing of 30 cm × 5 cm.

11. Fertilizer dose and methods of application : As source of nutrients, nitrogen and phosphorus will be applied in the forms of urea and TSP; potassium as muriate of potash, sulphur as gypsum Zn as zinc sulphate and boron as the form of boric acid. N fertilizer was applied in two equal installments as final land preparation and 25-30 DAS. The whole amount of all other plant nutrients (P-K-S-Zn-B) will be applied as final land preparation. as final land preparations.

12. Irrigated /rainfed Mainly rainfed. Irrigated as and when needed

13. Data to be recorded : Phonological parameters, yield and yield components, biomass etc.

14. Investigator(s) : M.R. Islam, M. R. Uddin and R. Khatun

15. Season : Summer

16. Date of initiation : March to April , 2023

17. Date of completion : June, 2025

18. Expt. output/ benefit : Developed nutrient management technology for sesame variety in Barishal region..

19. Location : RARS, Rahmatpur, Barishal

20. Status : New

21. Estimated Cost : Tk. 60,000/-

22. Source of fund : BARI

23. Priority : 1st

01. Programme : Soil Management

02. Project : Chemical Aspects of Soil Management

03. **Experiment 39 : Development and performance evaluation of composite fertilizers under different problem soils of Bangladesh**

04. Objective (s) : i). To developed a composite fertilizer using macro and micro nutrient

05. Rationale : Development of composite fertilizers by blending several nutrient elements in a ratio required for plants could be one of the promising technology for Bangladesh. Because, farmers are reluctant to use non-urea fertilizers. It is often challenging since negative interactions between elements could create chemical incompatibility. However, selection of an appropriate sorbent and then blending could resolve this issues. Biochar having versatile functionality could be used to develop such fertilizers. Unfortunately, a comprehensive research on these issues has not been seen yet.

06. Materials and Methods : Laboratory and field works should be done by standard method

07. Crop/Variety : Existing crops / cropping patterns

08. Design : RCBD (Factorial)

i) Treatment : Factor A: formulation (F)

Treatments	Mixer of cation and anions
Physically mixed composite fertilizer (F_1)	N, K and Zn mixing with H_2O_2biochar P, S, B and Mo mixing with FeAlMg biochar

Chemically mixed composite fertilizer (F_2)	N, K and Zn mixed with H_2O_2biochar P, S, B and Mo mixer with FeAlMg biochar Than simultaneous mixing the all solution
Control (F_3)	General practices followed by farmer

Factor B: Stoichiometric ratio (S)

Treatments	Nutrient combination
Combination of macro and micronutrient ration- 1 (S_1)	Standard soil test based NPKSZnBMo:48.2, 11.0, 32.2, 7.7, 0.5, 0.3, 0.1 percent respectively
Combination of macro and micronutrient ration- 2 (S_2)	AEZ based NPKSZnBMo:57.8, 10.9, 25.4, 5.2, 0.5, 0.2, 00 percent respectively
Combination of macro and micronutrient ration- 3(S_3)	Plant tissue analyzed based NPKS: 2.5, 0.35, 2.5, 0.30 percent respectively ZnBMo: 63, 105, 1.1 ppm respectively

Sl No.	Treatments
1	$T_1= F_1 \times S_1$
2	$T_2= F_1 \times S_2$
3	$T_3= F_1 \times S_3$
4	$T_4= F_2 \times S_1$
5	$T_5= F_2 \times S_2$
6	$T_6= F_2 \times S_3$
7	$T_7= F_3 \times S_1$
8	$T_8= F_3 \times S_2$
9	$T_9= F_3 \times S_3$

ii) Replications 3 (Three)

09. Plot size : -

10. Planting system/spacing : -

11. Fertilizer dose and methods of application : -

12. Irrigated /rainfed -

13. Data to be recorded : The physic-chemical properties of biochar will be examined spectroscopic and wet chemical techniques. Chemical compatibility of nutrient will be examined. Nutrient release rate will be examined Plant performance data will be collected while nutrient use efficiency will be determined using nutrient balance method. The collected data will be analyzed using JMP software.

14. Investigator(s) : M. M. Masud, A. Barman, Shamim Mia

15. Season : -

16. Date of initiation : September 2022

17. Date of completion : June, 2023

18. Expt. output/ benefit : Based on the performance, three biochar enriched composite fertilizers will be selected for the field trial.

19. Location : PSTU and SSD, BARI

20. Status : New

21. Estimated Cost : Tk. 60,000/-

22. Source of fund : KGF

23. Priority : 1st

01. Program : Soil Management

02. Project : Chemical Aspects of Soil Management

03. **Experiment 40 : Integrated nutrient management and plant density for bitter gourd in Jashore region**

04. Objective (s) : i. To determine the effects of organic manure with inorganic fertilizers on soil properties and crop productivity, and
ii. To find out a profitable and efficient nutrient package with proper plant density for bitter gourd on trellis at Jashore region.

05. Rationale : Bitter gourd (Momordicacharantia) known as korola, is one of the most popular vegetables in Bangladesh for its nutritive and medicinal values (Nadkarni, 1982). The yield of bitter gourd is low which can be attributed to lack of improved varieties, imbalanced use of fertilizers, disease, insect infestation, and inadequate irrigation. Integrated Nutrient Management (INM) is one of the most important components to obtain sustainable crop production. Proper fertilizer management and use of proper plant density can improve its production and quality greatly (Tindall, 1983). In addition, plant density is also an important factor that will influence the

plant population and affect the nutrient uptake of plants by creating competition between plants for nutrients, water and availability of light to the plants for synthesizing the food. In greater Jashore area, farmers grow bitter gourd on the trellis. But they do not follow proper nutrient management and appropriate plant density for more economic return. Sometimes they cultivate local cultivars and use only chemical fertilizers, which lead to low fruit yield. However, information on proper plant density and appropriate nutrients requirement of bittergourd is scarce for the popular trellis growing at Jashore region. Considering the above point of view, the present investigation will be carried out.

06. Materials and methods

07. Crop/Variety : Bitter gourd (BARI Hybrid Korala-2)

08. Design : RCB

i) Treatments : Factor A: Nutrient levels

F_1: 100% RDCF ($N_{35}P_{12}K_{37}S_{18}Zn_4B_{3.5}$ g/pit)

F_2:125% RDCF

F_3: 100% RDCF + Vermicompost @ 3 t ha^{-1}

F_4: FP (Farmers' practice)

Factor B: Plant densities

D_1: 1.2 m × 1.0 m (high plant density: 5682 plants/ha)

D_2: 1.2 m × 1.5 m (low plant density: 3788 plants/ha)

Note: Drain between the bed/row: 60 & 30 cm alternatively

ii) Replications : Three (03

09 Bed size : 1.2 m × 9.0 m

10. Planting system/ spacing : Transplanting (Seedling grown: polybag, Seedling age 12-15 days)

D_1: 1.2 m × 1.0 m

D_2: 1.2 m × 1.5 m

11. Fertilizer dose and methods of application : As source of nutrients, nitrogen and phosphorus will be applied in the forms of urea and TSP; potassium as muriate of potash, sulphur as gypsum Zn as zinc sulphate and boron as the form of boric acid. N fertilizer was applied in three equal installments as 20-60-90 DAS after pit preparation. The whole amount of all other plant nutrients (P-K-S-Zn-B) will be applied as final land preparation. as final land preparations.

12. Irrigated/ rain fed : Irrigated

13. Data to be recorded : Physical: Soil Texture, Bulk density, Soil moisture content.
Chemical: pH, SOM, TN, Available P, K, Ca, Mg, S, Zn, B contents
Plant data: Main vine length (m), number of branches per plant, days to 1st female flowering, node order of 1st female flowering, days to 1st fruit harvest, fruit length (cm), fruit diameter (cm), individual fruit weight (g), fruits per plant, % fruit fly infestation, incidence of virus and powdery mildew disease, yield per plant (kg), total yield (t ha^{-1}).

14. Investigator(s) : N. Salahin, N. U. Mahmud and K. U. Ahammad

15. Season : Kharif-1 (mid March to mid April) &
Kharif- 2 (mid July to mid August

16. Initiation of the experiment : April, 2023
17. Date of completion : -
18. Expected output/benefit : Improvement of soil health with farmers' economic benefit by cultivating bitter gourd on popular trellis system at Jashore region.

19 Location : RARS, Jashore
20. Status : New
21. Estimated cost : 60,000/=

22. Source of fund : BARI

23. Priority : 1st

01. Programme : Soil Management

02. Project : Chemical Aspects of Soil Management

03. **Experiment 41 : Effect of growth media on yield and storability of summer onion**

04. Objectives :
i. Development of sustainable organic plant growth media
ii. Improvement of physicochemical properties of plant growth media
iii. Maximization of crop growth and yield

05. Rationale : Growing media is one of the most widely used materials for growing greenhouse crops. With many different formulations available for growers, it can be a challenge to choose which the best blend to use is. Growing media provide a reservoir for water holding, a nutrient holding and exchange system, a zone for gaseous exchange for the plant root system and anchorage for plant roots. These physical characteristics of a growing medium are determined by the components used and the proportions in which they are blended together. Biochar and vermicompost are the potential processed and pyrolized organic matter for the formulation of a sustainable plant growth media.
The organopony is a form of cultivation in which environmentally friendly materials are used to carry out the agricultural process. This is usually used as an option for sites where the land is not very fertile. With this cultivation system it is possible to produce food in a controlled way. This method can be used at small, medium or large scale depending on the requirements of the farmer. That is, they can be large farms or they can be done in a small space of a garden or on the roof of a building. Considering the above consequences, a study would be undertaken to develop a sustainable healthy growth media for yield of summer onions.

06. Materials and methods :

07.	Crop/Variety	:	BARI piaz-4
08.	Design	:	RCBD
	i)Treatment	:	8 T_1 = Farmsoil (Native fertility) T_2 =Farmsoil with blanked dose of CF T_3 = Biochar:Soil (4:1) v/v T_4 = VC: Soil (4:1) v/v T_5 = Biochar:VC: Soil (2:2:1) v/v T_6 =Biochar:VC: Soil (4:5:1) v/v T_7 = Biochar:VC: Soil (5:4:1) v/v T_8 =Biochar:VC: (1:1) v/v Note. percent arranged by volume
	ii)Replication	:	3
09	Plot size	:	2 m x 1 m (raised bed system)
10.	Planting system /spacing	:	15 cm x 10 cm
11.	Fertilizer dose and methods of application	:	N_{20} $P_{10}K_{20}S_5$ g m^{-2} (Blanked dose), Half N and full dose of PKS should be mixed at the time of final substrate preparation and rest N to be top dressed at 25 day after planting.
12.	Irrigated/Rainfed	:	Irrigated
13.	Data to be recorded	:	1.Yield and yield components 3. Storage duration at ambient temperature 2. Disease and insect infestations 3. Nutrient status of initial and post harvest substrate. 4. Substrate pH and moisture recording at 15 days interval.
14.	Investigators	:	MA Rahman SSO,FS Shikha SO, MYasmin SO and MM Masud SSO
15.	Season	:	Kharif
16.	Date of initiation	:	1st week of February, 2023
17.	Date of completion	:	1stweek of April, 2025
18.	Expected output /benefit	:	Sustainable healthy growth media for small, medium or large scale depending on the requirements of the farmer. This technology will best fit for rooftop cultivation.
19	Location	:	RARS, Jamalpur

20. Status : 1st year

21. Estimated cost : 50,000/-

22. Source of fund : BARI

23. Priority : 1st

01. Programme : Soil Management
02. Project : Chemical Aspects of Soil Management
03. **Experiment 42 : Parallel and vertical comparison of biochar for groundnut cultivation in charland**
04. Objectives : i. To reduce the chemical fertilizer use for groundnut production in charland
ii. To increase soil organic matter status
iii. To increase crop growth and yield

05. Rationale : Charland soil is mainly a major concern in Bangladesh for crop production because of its sandy type soil texture, low water holding capacity, and low nutrient status. Farmers were using organic manures such as poultry manure (PM), compost (OF), cowdung (CD), and others for their beneficial effects on soil health by improving soil physical and chemical properties since ancient times. Several authors reported that Biochar application decreased soil BD, whereas increased porosity, available soil water content, organic carbon (OC) and plant nutrient supply. Application of chemical fertilizers severely undermines the quality of farming lands and depleting organic matters. Biochar is a carbon-rich solid material enhances the slow-release effect of nutrients, providing an attractive strategy for reducing the economic and environmental burden of excessive conventional fertilizers. Hence proposed research program has been design to reduce the chemical fertilizers use by increasing fertilizers use efficiency.

06. Materials and methods :

07. Crop/Variety : BARI chinabadam-11

08. Design : RCBD

i)Treatment : Treatment: Five (5)
T_1 = Soil test based fertilizer dose
T_2 = Biochar @ 4 t ha^{-1}+ IPNS CF
T_3 = Biochar @ 8 t ha^{-1}+ IPNS CF
T_4 = Biochar @ 4 t ha^{-1}
T_5 = Biochar @ 8 t ha^{-1}

ii)Replication : 3

09 Plot size : 3 m x 4 m

10.	Planting system /spacing	:	30 cm x 15 cm
11.	Fertilizer dose and methods of application	:	Soil test based
12.	Irrigated/Rainfed	:	Irrigated
13.	Data to be recorded	:	1.Yield and yield components 2. Nutrient status of initial and post harvest soil 3.Water holding capacity of soil
14.	Investigators	:	M A Rahman, M Yasmin and F S Shikha
15.	Season	:	Robi
16.	Date of initiation	:	1st week of November, 2022
17.	Date of completion	:	1stweek of December, 2024
18.	Expected output /benefit	:	Integrated package of reduced chemical fertilizer and biochar will be formulated along with sustainable soil health improvement.
19	Location	:	RARS, Jamalpur
20.	Status	:	1st year
21.	Estimated cost	:	20,000/-
22.	Source of fund	:	BARI
23.	Priority	:	1st

01.	Programme	:	Soil Management
02.	Project	:	Chemical Aspects of Soil Management
03.	**Experiment 43**	**:**	**Integrated nutrient management for yield and quality of potato in Jamalpur region**
04.	Objectives	:	i. To reduce the use of chemical fertilizer for potato production by organicmanuring. ii. To improve carbon stock in soil.
05.	Rationale	:	The use of chemical fertilizers can increase tubers but it has negative effects on tuber quality, environmental pollution, public health and economic losses; starch and sugar contents are reduced in tubers. A comprehensive nutrient management program is essential for maintaining a healthy potato crop, optimizing tuber yield and quality, and minimizing undesirable impacts on the environment. So, an alternative method must be developed. Integrating compost with

chemical fertilizer is essential for sustainable potato production and improves soil fertility, soil structure and furthermore helps plant in combating pests and diseases. It also reduces the cost of production. So, the present study aimed to compare the performance of different compost in potato production.

06.	Materials and methods	:	
07.	Crop/Variety	:	BARI Alu-25 (Asterix)
08.	Design	:	RCBD
	i)Treatment	:	Treatment: Five (5) T_1 = 100% Soil Test Based (STB) Fertilizer dose, (FRG 2018) T_2 = Compost @ 2.5 t ha^{-1}+ IPNS CF T_3 = Kitchen Waste Compost @ 2.5 t ha^{-1}+ IPNS CF T_4 = Vermicmpost @ 2.5 t ha^{-1} + IPNS CF T_5 = Trichocompost@ 2.5 t ha^{-1} Note: Nutrients of the Treatments will be formulated through IPNS system
	i)Replication	:	3
09	Plot size	:	4 m x 2 cm
10.	Planting system /spacing	:	60 cm x 25 cm
11.	Fertilizer dose and methods of application	:	N_{158} P_{25} K_{113} S_{12} Zn_3 B_1 Kg ha^{-1} (FRG-2018)
12.	Irrigated/Rainfed	:	Irrigated
13.	Data to be recorded	:	1.Yield and yield components 2. Soil organic carbon content in post soil 3. Nutrient status of initial and post harvest soil. 4.Nutrient uptake 5.Disease and insect infestations 6.Cost and return analysis 7. Storability of potato 8. Quality of Potato
14.	Investigators	:	M Yasmin, F S Shikha and M A Rahman
15.	Season	:	Rabi
16.	Date of initiation	:	2nd week of November, 2022
17.	Date of completion	:	3rd week of February, 2024
18.	Expected output /benefit	:	Suitable combination of chemical fertilizer and compost will be find out and improved soil carbon stock.
19	Location	:	RARS, Jamalpur
20.	Status	:	1st year
21.	Estimated cost	:	50,000/-
22.	Source of fund	:	BARI
23.	Priority	:	1st

01. Programme : Soil Management

02. Project : Chemical Aspect of Soil Management

03. **Experiment 44 : Fertilizer Recommendation of Winter Stem Amaranth in Cumilla Region**

04. Objective(s) : To find out the optimum and economic fertilizer dose for maximizing the yield of winter stem amaranth.

05. Rationale : Stem amaranth (Amaranthus tricolor) is a quick-growing and cheap summer vegetable in Bangladesh. Amaranth is a rich source of iron, calcium, sodium, magnesium, and zinc as well as vitamin riboflavin, ascorbic acid, niacin, and thiamine. Thus, amaranth plays a predominant role both in nutrition and food security. Fertilizer management is one of the important factors that contribute to the production and yield of stem amaranth. Among the nutrients, nitrogen, phosphorus, potassium, and sulfur play the most important role in the vegetative growth of the crop, which ultimately helps in increasing the yield and quality of stem amaranth. BARI has developed a new amaranth variety for the winter season named BARI danta-3 in 2022. However, there is still no recommended fertilizer dose for winter amaranth. To get the maximum return fertilizer management is the most logical way. That's why the present study was undertaken.

06. Materials and method :

07. Crop/variety : BARI danta-3

08. Design : RCB

Treatment (14) :

Treatments	:	Nutrients (kg ha^{-1})			
		N	P	K	S
T_1	=	0	20	60	10
T_2	=	40	20	60	10
T_3	=	80	20	60	10
T_4	=	120	20	60	10
T_5	=	80	0	60	10
T_6	=	80	10	60	10
T_7	=	80	30	60	10
T_8	=	80	20	0	10
T_9	=	80	20	30	10
T_{10}	=	80	20	90	10
T_{11}	=	80	20	60	0
T_{12}	=	80	20	60	20
T_{13}	=	80	20	60	30
T_{14}	=	80	0	0	0

Replications : 3 (Three)

09 Plot size : 3m ×3m

10. Planting system /spacing : Broadcasting

11. Fertilizer dose and methods of application : All organic and chemical fertilizers except nitrogenous fertilizer will be applied as a blanket dose following FRG'2018. Four split applications of nitrogenous fertilizer will be applied as per recommendation. Urea, TSP, MoP, Gypsum, Boric acid, and Zinc Sulfate monohydrate will be used as a source of N, P, K, S, B, and Zn.

12.	Irrigated/rainfed	:	Irrigated
13.	Data to be recorded	:	Date of seed sowing, date of harvest, date of fertilizer application, date of all intercultural operations, initial soil N content, initial soil N, P, K, and S content, working hours of labor, the market value of growing amaranth variety, etc.
14.	Season	:	Winter
15.	Investigator(s)	:	M. M. H. Bhuiyan, M A H Khan, M M Masud, H M Naser, and M O Kaisar
16.	Date of initiation	:	October 2022
17.	Date of completion	:	June 2025
18.	Expected output/benefit	:	Fertilizer recommendations for winter stem amaranth with high yield and economic return will be found out.
19	Location	:	RARS, Cumilla
20.	Status (1st year/2nd year/New)	:	New
21.	Estimated cost	:	50,000/-
22.	Source of fund	:	BARI
23.	Priority	:	1st

01.	Programme	:	Soil Management
02.	Project	:	Chemical Aspects of Soil Management
03.	**Experiment 45**	**:**	**Evaluation of physical, chemical and microbiological soil properties of six unfavorable ecosystem of Bangladesh**
04.	Objective (s)	:	i. To assess the physical properties of unfavorable ecosystem; ii. To evaluate the essential nutrient status of unfavorable ecosystem; iii. To determine the status of microbial population in unfavorable ecosystem; and iv. To find out the heavy metal status of unfavorable ecosystem.
05.	Rationale	:	Unfavorable ecosystem is an adverse ecosystem which is difference from normal ecosystem for crop growth, development and for animal's habitant due to soil, topography and climatic nature. Soil is a natural medium of plant growth. Its physical, chemical and microbiological characteristics influence crop growth and development in many ways. Crops generally perform better in favourable condition and or normal soil condition but it is difficult to grow crop successfully in unfavourable condition like drought prone area, charland, saline belt, haor, waterlogged soil and hill soil area owing to weather, climate and nutrient availability condition. Recently, in these areas researchers and extension personnel take different programme for increasing crop production. Soil management is very crucial for successful crop production through judicial use of balance fertilization and crop establishment practices. For application of balance fertilizer

judiciously, it need to be known soil physical and microbial environment along with nutrient status but there is no such kind of specific database in Bangladesh. Hence, the present study was under taken to know the soil physical, chemical and microbiological properties of different unfavorable ecosystem and to create of different unfavourable ecosystem.

06.	Materials and Methods	:	Collection of soil sample: Soil sample will be collected from six different unfavorable ecosystem and analyze following standard procedure
07.	Crop/Variety	:	-
08.	Design	:	
	ii) Replications		
09.	Plot size	:	
10.	Planting system/spacing	:	
11.	Fertilizer dose and methods of application	:	
12.	Irrigated /rainfed		
13.	Data to be recorded	:	i) Physical properties : Soil Texture, Field capacity and bulk density ii) Chemical properties : pH, organic matter content, cation exchange capacity, All macro and micronutrients in addition to heavy metals. iii) Biological properties : Microbial population counts Section head will take responsibility for data recording.
14.	Investigator(s)	:	H. M. Naser, CSO ATM Anwarul Islam Mondal, PSO M. E. Ali, SSO M. M. Masud, SSO
15.	Season	:	Before starting rabi season (October)
16.	Date of initiation	:	October, 2022
17.	Date of completion	:	March, 2023
18.	Expt. output/ benefit	:	Physical properties, fertility status and microbial population and heavy metal status of soil will be evaluated
19.	Location	:	Rajshahi (drought prone area), Kishoregonj (haor), Kurigram (charland), Potuakhali (waterlogged soil), Satkhira (saline belt) and Khagrachori (Hill soil)

20. Status : New

21. Estimated Cost : 120000/-

22. Source of fund : BARI

23. Priority : 1st

PROJECT-III

MICRONUTRIENT ASPECTS OF SOIL MANAGEMENT

Project Leader: Dr. Habib Mohammad Naser

01.	Programme	:	Soil Management
02.	Project	:	Micronutrient Aspects of Soil Management
03.	**Experiment 01**	**:**	**Determination of heavy metal status of different vegetables from industrially polluted and non-polluted areas**
04.	Objective(s)	:	1. To study the accumulation of heavy metals in vegetables; 2. To correlate the heavy metals uptake with essential plant nutrients; and 3. To compare the heavy metal status of vegetables grown in polluted and non-polluted areas.
05.	Rationale	:	The accumulation of heavy metals (arsenic, lead and cadmium) by plants depends on plant species and soil properties. These heavy metals are not abundant in soil but there may be an accumulation of these heavy metals through urban wastes and industrial effluents. Soil and water bodies of cities are contaminated with heavy metal. The uptake of heavy metals in cereals and vegetables is likely to be higher and accumulation of these toxic metals in human body created growing concern in the recent days. Information regarding the accumulation of heavy metals in cereals and vegetables in industrially polluted areas in Bangladesh is limited/scarce. For this reason this study is undertaken.
06.	Materials and Methods	:	Field survey-based laboratory studies will be carried out to investigate the heavy metal contents in vegetables and soils collected from industrially polluted and non-polluted areas.
07.	Crop/variety	:	Depends on farmers choice
08.	Design	:	N/A
	i) Treatment	:	N/A
	ii) Replications	:	N/A
09.	Plot size	:	N/A
10.	Planting system/spacing	:	N/A
11.	Fertilizer dose and methods of application	:	N/A
12.	Irrigated /rainfed	:	N/A

13.	Data to be recorded	:	Survey based laboratory experiment. Vegetable samples will be collected from contaminated and non-contaminated sites. And all heavy metal concentration will be estimated from collected vegetables and the rizosphere soils.
14.	Investigator(s)	:	H. M. Naser, (CSO); S. Sultana, (SSO); M. Akter (SO); S. Most. Bilkis Banu (SSO), SSD, BARI
15.	Season	:	Rabi season
16.	Date of initiation	:	December, 2009
17.	Date of completion	:	Continuous monitoring
18.	Expt. output/ benefit	:	Information regarding the accumulation of heavy metals in cereals and vegetables in industrially polluted areas in Bangladesh is limited. So information will be generated in this regard.
19.	Location	:	Vegetables and soil samples will be collected from industrial polluted and non-polluted areas
20.	Status	:	Continuous monitoring.
21.	Estimated Cost	:	Tk. 50,000/-
22.	Source of fund	:	BARI
23.	Priority	:	1st

01.	Programme	:	Soil Management
02.	Project	:	Micronutrient Aspects of Soil Management
03.	**Experiment 02**	**:**	**Effect of boron on yield and quality of bitter gourd**
04.	Objective(s)	:	i. To study the effect of boron on number of flower setting and yield of bitter gourd; and ii. To find out the optimum level of boron for maximizing the yield and quality of bitter gourd
05.	Rationale	:	Bitter gourd (Momordicacharantia) belongs to the most prevalent cucurbitaceous vegetable. It is grown extensively throughout the world. Bitter gourd is very nutritional which carries 17 calories 100 g^{-1} and is very rich in phytonutrients like anti-oxidants, minerals, vitamins and dietary fiber. The fresh bitter gourd is an exceptional source of α-carotene, ß-carotene, lutein, zeaxanthin, vitamin-A and vitamin-C. It is also a good source of B-complex vitamins and minerals as zinc, iron, manganese, potassium and

magnesium. During the plant growth period, micronutrients play various roles in physiological and biochemical processes and among those nutrients, boron (B) is a vital element involves in flowering and fruiting of the plant so its deficiency causes floral deformities inducing male bareness (Nonnecke, 1989). Boron deficiency also results in stunted growth because it is a part of structure (Sharma, 2006). Boron deficiency affects the growing points of roots and youngest leaves and its involves in the growth of cells in newly emerging shoots and roots while in some plants it is crucial for boll formation, flowering, pollination, seed development and sugar transport (Takano et al., 2008 and Miwa et al., 2008). Boron plays a supportive role in cell wall synthesis, lignification (Loomis and Durst, 1992) and cell wall structure (Flescher et al., 1998). Boron deficiency plays a significant role in yield reduction of many vegetables, including bitter gourd due to premature flower, square or boll shedding. Bitter gourd is a very popular vegetable in Bangladesh and its yield maximization is a major concern of local farmers. Information regarding boron effect on major crops is although available in Bangladesh, but the vegetables response to boron is not available. So keeping in view the importance of boron and bitter gourd, this study was planned to find the effect of B on the flower, yield and quality of bitter gourd.

06. Materials and Methods : The experiment will be conduct in a randomized complete block design with five treatment and three replications.

07. Crop/variety : Bitter gourd/ BARI Karola-4

08. Design : RCBD

i) Treatment : T_1: Control – NPKSZn (STB)
T_2: Recommended dose of chemical fertilizers (HYG) (FRG, 2018)
T_3: 1.0 kg B ha^{-1} + NPKSZn (STB)
T_4: 1.5 kg B ha^{-1} + NPKSZn (STB)
T_5: 2.0 kg B ha^{-1} + NPKSZn (STB)

ii) Replications : 3

09. Plot size : 1m × 2m

10. Planting system/spacing : 1.0 m wide beds at 45 cm plant-plant distance

11. Fertilizer dose and methods of application : NPKS and Zn will be applied as basal in all treatments as per STB following FRG- 2018, except T_2. Urea, Triple Super phosphate, Muriate of Potash, Gypsum, Zinc Sulphate Monohydrate ($ZnSO_4$. H_2O) and Boric acid (H_3BO_3) were used as the sources of N, P, K, S, Zn, and B respectively. All P, K, S, Zn and B were applied at the time of sowing as basal dose while N was applied in two splits (half at sowing and half with first irrigation). Bitter gourd seeds were sown on 1.0 m wide beds at

45 cm plant-plant distance. All the cultural practices during the growth period were carried out when and where necessary.

12.	Irrigated /rainfed	:	Irrigated
13.	Data to be recorded	:	Initial and post-harvest soil status, date of fertilizer application, time of planting, nutrient uptake by bitter gourd at harvesting stages, number of flower sheds, fruit length (cm), weight (g), grith (cm), and yield (t ha^{-1}), and vit. C, TSS, iron, calcium and protein.
14.	Investigator(s)	:	Most. Bilkis Banu (SSO); M. Akter (SO); S. Sultana (SSO) and H. M. Naser (CSO); SSD, BARI
15.	Season	:	Rabi season
16.	Date of initiation	:	November, 2020
17.	Date of completion	:	March, 2023
18.	Expt. output/ benefit	:	Information regarding the impact of B on the flower sheds, fruit settings, yield and bitter gourd quality will be collected. Production cost will be reduced.
19.	Location	:	Micronutrient experimental field, SSD, BARI, Joydebpur, Gazipur
20.	Status	:	3rd year
21.	Estimated Cost	:	Tk. 45,000/-
22.	Source of fund	:	BARI
23.	Priority	:	1st

01.	Programme	:	Soil Management
02.	Project	:	Micronutrient Aspects of Soil Management
03.	**Experiment 03**	**:**	**Foliar application of boron on reproductive growth of sunflower**
04.	Objective(s)	:	i. To determine the effect of foliar spray of boron on yield contributing characters of sunflower. ii. To find out the optimum rate of boron for maximizing the yield and quality of sunflower.

05. Rationale : Sunflower is the most important oilseed crop. It is cultivated in different countries of the world. Sunflower pollination is best performed by insects and in commercial fields honeybees are reported to be the most suitable pollinating vectors (Dag et al., 2002). Even under optimal honeybee activity in sunflower crops relatively large proportions (15–50%) of seeds can remain empty. Empty seeds are primarily located in the proximal (central) and distal (peripheral) regions of the capitulum (Vakninet al., 2008). It has been suggested that the empty seeds result from several unrelated factors including boron deficiency. It has been reported that boron is required for pollen germination and pollen tube growth (Dugger, 1983), and boron deficiency at flowering can affect pollen viability and abortion of stamens and pistils (Chitralekha and Nirmala, 2000; Dell and Longbin, 1997; Xu et. al., 1993 and Zang et al., 1994) which contributes to low seed set. The boron requirement of many plants during reproductive growth is reputedly much higher than during vegetative growth (Bamery et al., 1987 and Oyinlola, 2007; Asad et al., 20020). Sunflower, has been found to be particularly sensitive to boron deficiency and is sometimes used as an indicator for assessing available boron in soils (Oyinlola, 2007). Although boron is essential for crop growth and can be applied to meet crop demands, harmful effects can be induced by excessive applications during early phases of growth (Oyinlola, 2007 and Shorrocks, 1997). Yield and the component vegetative and reproductive stages of sunflower may both be affected both positively and negatively by boron depending upon the dose used as a fertilizer. So keeping in view the importance of boron and sunflower, this study was planned to find the effect of B foliar application on reproductive growth of sunflower.

06. Materials and Methods : To study the effect of B as foliar spray on reproductive (beginning of flowering) growth stage of sunflower, B at different combinations in the form of boric acid (H_3BO_3) having 17 % boron at the rate of 50, 100 and 150 mg L^{-1} will be applied as foliar spray at 20-25 and 40-45 days after sowing (DAS).

07. Crop/variety : Sunflower/ BARI Surjamukhi-3

08. Design : RCBD

i) Treatment : T_1: control (spray with distilled water)
T_2: 50 mg L^{-1}
T_3: 100 mg L^{-1}
T_4: 150 mg L^{-1}

ii) Replications : 3

09. Plot size : 1m × 2m

10. Planting system/spacing : Line sowing

11.	Fertilizer dose and methods of application	:	NPKS and Zn will be applied as basal in all treatments as per STB following FRG- 2018. Urea, Triple Super phosphate, Muriate of Potash, Gypsum, and Zinc Sulphate Monohydrate ($ZnSO_4$. H_2O) were used as the sources of N, P, K, S, Zn, and B respectively. All P, K, S, and Zn were applied at the time of sowing as basal dose, while N was applied in two splits (half at sowing and half with first irrigation). Sunflower seeds were sown at 25 cm plant-plant distance. All the cultural practices during the growth period were carried out when and where necessary.
12.	Irrigated /rainfed	:	Irrigated
13.	Data to be recorded	:	Initial and post-harvest soil status, date of fertilizer application, time of planting, nutrient uptake by sunflower at harvesting stages, length of green leaf, dry matter, head area, no. of seed, seed weight, % empty seed, seed yield (t ha^{-1}) and oil content.
14.	Investigator(s)	:	Most. Bilkis Banu (SSO); M. Akter (SO); S. Sultana (SSO) and H. M. Naser (CSO); SSD, BARI
15.	Season	:	Rabi season
16.	Date of initiation	:	November, 2021
17.	Date of Completion	:	Early March, 2023
18.	Expt. output/ benefit	:	B will be affect positively reproductive growth of sunflower. Production cost will be reduced.
19.	Location	:	Micronutrient experimental field, SSD, BARI, Joydebpur, Gazipur
20.	Status	:	3rd year
21.	Estimated Cost	:	Tk. 45,000/-
22.	Source of fund		BARI
23.	Priority		1st

01.	Programme	:	Soil Management
02.	Project	:	Micronutrient Aspects of Soil Management
03.	**Experiment 04**	**:**	**Foliar application of manganese on yield and nutrient uptake of groundnut**

04.	Objective(s)	:	i. To investigate the effect of manganese on yield and quality of groundnut. ii. To find out the optimum dose of manganese to maximizing the yield of groundnut.
05.	Rationale	:	Groundnut (Arachishypogaea L.) is one of the world's fundamental sources of vegetable oil. Micronutrients are essential for healthy growth and reproduction of plants i.e. boron, manganese, molybdenum, chlorine, copper, iron, nickel and zinc. Manganese plays an important function in many biological processes i.e., oxidation reactions, reduction, carboxylation, carbohydrates metabolism, phosphorus reactions and citric acid cycle as well as electron transport in photosynthesis, also, it acts as an activator for many enzymes i.e., protein-manganese in Photosystem II and superoxide dismutase. Manganese (Mn) also is a heavy metal micronutrient, the functions of which are fairly known. It is involved in the oxygen-evolving step of photosynthesis and membrane function, as well as serving as an important activator of numerous enzymes in the cell (Wiedenhoeft, 2006). Soil application of Mn is problematic, since its efficiency depends on many soil factors, including soil pH. A suitable method for the correction and /or prevention of Mn deficiency in plants is the foliar application of ionic or chelated solution forms of this nutrient (Papadakis et al., 2007). Keeping in view the key role played by manganese in plant growth, this study is designed to find out the suitable dose and method of manganese application of groundnut production.
06.	Materials and Methods	:	To study the effect of Mn as foliar spray on growth stages of groundnut, Mn at a different combination in the form of manganese sulphate ($MnSO_4$, H_2O) having 36% Mn at the rate of 0.02%, 0.04% will be applied at 20-25 days after sowing (DAS) and 35-40 DAS.
07.	Crop/variety	:	Groundnut /BARI Chinabadam-9
08.	Design	:	RCBD
	i) Treatment	:	T_1:Control (spray with distilled water) T_2: Foliar spray of 0.02% Mn T_3: Foliar spray of 0.04% Mn T_4: Soil application of Mn0.5 kg ha^{-1} T_5: Soil application of Mn1.0 kg ha^{-1}
	ii) Replications	:	3
09.	Plot size	:	1.5 m × 2 m
10.	Planting system/spacing	:	Line sowing /spacing L-L 30 cm × P-P 15 cm
11.	Fertilizer dose and methods of application	:	NPKS and Zn will be applied during lad preparation as basal in all treatments as per STB following FRG- 2018.

12.	Irrigated /rainfed	:	Irrigated
13.	Data to be recorded	:	Analysis of initial soil for all parameters including Mn, date of fertilizer application, time of transplanting, Nutrient content at harvesting stages, nutrient content of soil at harvest time, Plant height (cm), number of branches plant^{-1}, fresh weight plant^{-1} (g) and dry weight plant^{-1} (g),number of pods plant^{-1}, number of seeds pod^{-1}, pod weight plant^{-1} (g), seeds weight plant^{-1} (g), 100 seed weight (g). Oil and protein content of groundnut will be estimated.
14.	Investigator(s)	:	S. Sultana (SSO), H. M. Naser (CSO), M. Akhter (SO), Most. Bilkis Banu (SSO) and Priyanka Ray (SO, ORC), SSD, BARI.
15.	Season	:	Rabi season
16.	Date of initiation	:	November, 2020
17.	Date of Completion	:	March, 2023
18.	Expt. output/ benefit	:	Manganese application will influence positively the growth and yield of groundnut. Production cost will be reduced.
19.	Location	:	Micronutrient Experimental Field, SSD, BARI, Joydebpur, Gazipur.
20.	Status	:	3rd year
21.	Estimated Cost	:	Tk. 45,000/-
22.	Source of fund	:	BARI
23.	Priority	:	1st
01.	Programme	:	Soil Management
02.	Project	:	Micronutrient Aspects of Soil Management
03.	**Experiment 05**	**:**	**Bioremediation of arsenic in contaminated soils using microbes and biochar**
04.	Objective(s)	:	To evaluate the role of microbes and biochar in arsenic availability 2. To find out the suitable microbes and biochar for soils in reducing arsenic contamination 3. To mitigate arsenic contamination and to improve crop quality

05. Rationale : Other heavy metals such as Pb, Cd, Hg, and As (a metalloid but generally referred to as a heavy metal) do not have any beneficial effect on organisms and are thus regarded as the "main threats" since they are very harmful to both plants and animals. Bioremediation process esentail natural attenuation, bio-augmentation, and bio-transformation (Dua et al., 2002). Microorganisms play an important role in the environmental fate of As with a multiplicity of mechanisms affecting transformation between soluble and insoluble forms (Karn et al., 2017). Many studies have reported that biochar has been effectively used to immobilize the metal(loid)s in contaminated soils and influence the bioavailability and bioaccessibility of metal(loid)s. Bioremediation, especially phytoremediation of metal(loid)s, has been extensively studied. Biochar, the carbon-rich product, is perceived to play significant roles on the bioaccessibility and bioavailability, hence biotransformation and bioremediation of heavy metal (loid) contaminated soil (Sun et al., 2018). Arsenic (As) has long identified as a carcinogen. Elevated concentrations in the ecosystem is of great concern for public health and the environment (Hingston et al., 2001). There is renewed interest in using bioremediation to treat and remove complex metals from soil and waste streams. Therefore, it is important to focus on the effect of microbes and biochar to As-contaminated soils and the consequences on As uptake and biomass production of common crop plants.

06. Materials and Methods : Arsenic will be added 20000 and 40000µg kg^{-1} soil as As_2O_3 in solutions and all fertilizers will be added as solutions and thoroughly mixed with the soil. After added fertilizer, soil will be treated with three types of microbes and three types of biochar. Amaranth will be used as a test crop and will be grown up to maturity. Arsenic content and uptake will be determined.

07. Crop/variety : Amaranth

08. Design : CRD

i) Treatment : Soil Contamination level:
Arsenic will be added 20000 and 40000µg kg^{-1} soil as As_2O_3

The possible treatment combinations as below:

Treatment 1: Contaminated soil 20000µg As kg^{-1} soil- Control;
Treatment 2: Contaminated soil 40000µg As kg^{-1} soil- Control;

Microbes group:
Treatment 3: Rhizobium sp + 20000 µg $Askg^{-1}$ soil.
Treatment 4: Rhizobium sp + 40000 µg $Askg^{-1}$ soil.
Treatment 5: Phosphorus solubilizing bacteria+ 20000 µg $Askg^{-1}$ soil.
Treatment 6: Phosphorus solubilizing bacteria+ 40000 µg $Askg^{-1}$ soil.

			Biochar group: Treatment 7: Water hyacinth biochar+ 20000 µg Askg^{-1} soil; Treatment 8: Water hyacinth biochar+ 40000 µg Askg^{-1} soil. Treatment 9:Fern plant biochar+ 20000 µg Askg^{-1} soil; Treatment 10: Fern plant biochar+ 40000 µg Askg^{-1} soil.
	ii) Replications	:	3
09.	Plot size	:	Pot culture Pot size: 14 inch × 12 inch (height ×diameter)
10.	Planting system/spacing	:	Planting
11.	Fertilizer dose and methods of application	:	Fertilizers (N, P. K, S, Zn, B) will be applied at the time of soil preparation for potting.
12.	Irrigated /rainfed	:	Irrigated
13.	Data to be recorded	:	Arsenic uptake by plant and the status of As in soil will be estimated. Arsenic status in biochar will be determined.
14.	Investigator(s)	:	H. M. Naser, (CSO); S. Sultana, (SSO); M Akter, (SO); Most. BilkisBanu (SSO); F. Alam (SSO) and MM Masud (SSO); SSD, BARI
15.	Season	:	Rabi season
16.	Date of initiation	:	January, 2021
17.	Date of completion	:	March, 2023
18.	Expt. output/ benefit	:	It is important to focus on the effect of microbes and biochar to As-contaminated soils and the consequences on As uptake and biomass production of common crop plants. So information will be generated in this regard.
19.	Location	:	Shade house, SSD, BARI, Joydebpur, Gazipur
20.	Status	:	3rd year
21.	Estimated Cost	:	Tk. 45,000/-
22.	Source of fund		BARI
23.	Priority		1st
01.	Programme	:	Soil Management

02. Project : Micronutrient Aspects of Soil Management

04. **Experiment 06** **: Assessment of heavy metal pollution and health risks in the soil-plant-human systems**

04. Objective(s) :
1. Determine the contamination levels of chromium (Cr), lead (Pb), cadmium (Cd), nickel (Ni), and arsenic (As) in soil and plants;
2. Evaluate the potential health risks caused by heavy metals and metalloids in different age groups via different pathways; and
3. Analyze the bioaccumulation factor of heavy metals and metalloids in soil-plant systems.

05. Rationale : Heavy metal contamination and accumulation is a serious problem around the world due to the potential threat to food safety and its detrimental effects on human and animal health (Schneider et al., 2016). It has also become one of the major environmental problems in developing country due to continuous industrialization and urbanization (Niu et al., 2013 and Hu et al., 2017). Many researchers have found that heavy metals are easily accumulated in various edible vegetables and fruits through contaminated soil (Atafar et al., 2010; Xiong et al., 2013; Wang et al., 2006; Sun et al., 2017; Naser et al., 2017). Naser et al. (2011-2017) reported that Pb, Cd, Ni and Cr accumulated in spinach, red amaranth, amaranth, bottle gourd, sweet guard, cauliflower, cabbage, potato, turnip, radish, kankon, indian spinach, taro, garlic, onion and chili. Heavy metals in soil can threaten human health through vegetable consumption, and the chronic low-level intake of soil metals through ingestion or inhalation has a seriously negative effect on human health (Qu et al., 2012; Tsai et al., 2012; Huang et al., 2014). When heavy metals are transferred into food chains and accumulate in vital organs, such as the liver, kidneys, and bones, there is a direct threat to human health (Jolly et al., 2013) that can result in numerous serious health disorders (Duruibe et al., 2007). The pollution degree of soil heavy metals contamination in the Turag River Delta is remarkably high (Naser et al., 2017). The selected study area is an important industrial and most developed economic area. There are more than one million people living in the Turag River Delta. Therefore, it is very necessary to explore the state of heavy metal pollution in soil and agricultural food and to assess the potential health risk caused by metal pollution.

06. Materials and Methods : Field survey based laboratory studies will be carried out to investigate the heavy metal and metalloid contents in crops and soils collected from different areas of Bangladesh. The methodology used for the health risk assessment was based on the guidelines and Exposure Factors Handbook released by the U.S. Environmental Protection Agency (USEPA, 1989; 1997; 2001).

07. Crop/variety : Depends on farmers choice

08.	Design	:	N/A
	i) Treatment	:	
	ii) Replications	:	3
09.	Plot size	:	N/A
10.	Planting system/spacing	:	N/A
11.	Fertilizer dose and methods of application	:	N/A
12.	Irrigated /rainfed	:	N/A
13.	Data to be recorded	:	Survey based laboratory experiment. Crops and soil samples will be collected from contaminated sites. And all heavy metal and metalloid concentration will be estimated from collected crops and the rizosphere soils. Health risk assessment will be carried out based on the guidelines by the U.S. Environmental Protection Agency.
14.	Investigator(s)	:	H. M. Naser, (CSO); S. Sultana, (SSO); M. Akter (SO) and; Most. Bilkis Banu (SSO), SSD, BARI
15.	Season	:	Round the year
16.	Date of initiation	:	January, 2021
17.	Date of completion	:	March, 2023
18.	Expt. output/ benefit	:	Information regarding the accumulation of heavy metals and metalloids in crops and soils in different areas in Bangladesh is limited. So information will be generated in this regard. Health risk assessment of heavy metals and metalloids will be calculated.
19.	Location	:	Crops and soil samples will be collected from selected different locations. Data collection of food intake by the peoples will be performed.
20.	Status	:	3rd year
21.	Estimated Cost	:	Tk. 150,000/-
22.	Source of fund	:	BARI
23.	Priority	:	1st

01. Programme : Soil Management

02. Project : Micronutrient Aspects of Soil Management

03. **Experiment 07** **: Bioremediation of heavy metals polluted soil from industrial effluents polluted areas using microbes and biochar**

04. Objective(s) : . To evaluate the efficiency of microbes and biochar as a bioaccumulator for heavy metal in contaminated soil;
2. To determine the uptake pattern of heavy metal in the root, shoot and grain/fruit system of tested crop as influenced by microbes and biochar; and
3. To quantify the heavy metal status of polluted soils.

05. Rationale : Various methods of remediating metal polluted soils exist; they range from physical and chemical methods to biological methods. Most physical and chemical methods are expensive and do not make the soil suitable for plant growth (Marques et al., 20097). Biological approach (bioremediation) on the other hand encourages the establishment or reestablishment of plants on polluted soils. It is an environmentally friendly approach because it is achieved via natural processes. Bioremediation of heavy metals can be achieved via the use of microorganisms, plants, or the combination of both organisms. Several microorganisms especially bacteria (Bacillus subtilis, Pseudomonas putida, and Enterobacter cloacae) have been successfully used for the reduction of Cr (VI) to the less toxic Cr (III) (G. U. Chibuike and Obiora, 2014). Biochar is one organic material that is currently being exploited for its potential in the management of heavy metal polluted soils. Namgay et al. (2010) recorded a reduction in the availability of heavy metals when the polluted soil was amended with biochar; this in turn reduced plant absorption of the metals. The ability of biochar to increase soil pH unlike most other organic amendments (Novak, 2009) may have increased sorption of these metals, thus reducing their bioavailability for plant uptake. The role of organic matter on the metal absorption, transportation and assimilation is known from literature but a little is known about accumulation of heavy metal through organic amendments. For this reason this study is undertaken.

06. Materials and Methods : Soil samples will be collected from industrial effluents polluted areas. Initial status of heavy metal in the polluted soil will be estimated. Soil will be treated with three types of microbes and three types of biochar. Amaranth will be used as a test crop and will be grown up to maturity. Heavy metals content and uptake in plant will be determined. Heavy metal status of post-harvest soil will be determined.

07. Crop/variety : Amaranth

08. Design : CRD

	i) Treatment	:	The possible treatment combinations as below: Treatment 1: Contaminated soil - Control; Microbes group: Treatment 2: Rhizobium sp; Treatment 3:Azotobactersp; Treatment 4: Phosphorus solubilizing bacteria; Biochar group: Treatment 5: water hyacinth biochar; Treatment 6: barnyard grass biochar; Treatment 7: Fern plant biochar.
	ii) Replications	:	3
09.	Plot size	:	14 inch × 12 inch (height × diameter)
10.	Planting system/spacing	:	Sowing/ N/A
11.	Fertilizer dose and methods of application	:	Recommended doses for Amaranth cultivation. Fertilizer will be applied at the time of soil preparation for potting.
12.	Irrigated /rainfed	:	Irrigated
13.	Data to be recorded	:	Heavy metal uptake by plant and the status of heavy metal in soil will be estimated. Heavy metal status in biochar will be determined.
14.	Investigator(s)	:	S. Sultana, (SSO); H. M. Naser, (CSO); M Akter, (SO); Most. Bilkis Banu (SSO); F. Alam (SSO) and MM Masud (SSO); SSD, BARI
15.	Season	:	Rabi season
16.	Date of initiation	:	January, 2022
17.	Date of completion	:	March, 2024
18.	Expt. output/ benefit	:	Information regarding the remediation of heavy metals polluted soil from industrial effluents polluted areas is limited. So information will be generated in this regard.
19.	Location	:	Heavy metal polluted soil will be collected from industrial effluents polluted areas and pot experiment will be conducted at Shade house, SSD, BARI, Joydebpur, Gazipur
20.	Status	:	2nd year
21.	Estimated Cost	:	Tk. 45000/-
22.	Source of fund		BARI

23. Priority 1st

01. Programme : Soil Management

02. Project : Micronutrient Aspects of Soil Management

03. **Experiment 08** : **Nanoscale zinc oxide particles for improving yield and quality of tomato**

04. Objective(s) : i. To study the effects of ZnOnano particles on the yield and quality of tomato.
ii. To calculate zinc content and uptake of tomato; and
iii. To evaluate the efficiency of $ZnSO_4$ and ZnO nanoparticles.

05. Rationale : Zinc (Zn) is an essential nutrient required by all living organisms and represents the 23rd most abundant element on earth (Broadleyet al., 2007) and the 2nd most abundant transition metal, subsequent to iron (Jain et al., 2010). It is the required in six different classes of enzyme, which include oxidoreductases, transferases, hydrolases, lyases, isomerases and ligases (Auld, 2001). Zinc has been considered as an essential micronutrient for metabolic activities in plants and animals including humans. Nanoparticles (NPs) with small size and large surface area are expected to be the ideal material for use as a Zn fertilizer in plants. Currently use of nanomaterials has been expanded in every fields of science including agriculture. It has been stated that application of micronutrient fertilizers in the form of NPs is an important route to release required nutrients gradually and in a controlled way, which is essential to mitigate the problems of fertilizer pollutions (Naderi and Abedi, 2012). It is well known that bulk zinc oxide (bZnO) is highly insoluble; moreover, by decreasing the size of the particle at the nanoscale level, the surface/volume ratio increases substantially, making it more soluble and bioavailable (Juan Estrada-Urbina et al., 2018). However, the use of zinc oxide nanoparticles (ZnO NPs) to improve the yield and quality of tomato has not yet been reported.

06. Materials and Methods : ZnO nanoparticles: <100 ŋm particle size of ZnO (78 % Zn) will be purchased.
Zinc sulfate heptahydrate ($ZnSO_4$. $7H_2O$) containing 21 % Zn will be used.

07. Crop/variety : BARI tomato-15

08. Design : CRD

i) Treatment : Foliar application frequency:
(i) before flower initiation; and (ii) after fruit set when it becomes approximately marble sized.

Foliar application rate:

1. ZnOnano particles @ 10 and 15 ppm.
2. $ZnSO_4$. $7H_2O$ @ 100 and 150 ppm.

Soil application before transplanting:
1. ZnO nano particles @ 0.2 kg Zn ha^{-1}
2. Soil application @ 6 kg Zn ha^{-1}

Treatment combination:

T_1 = Control
T_2 = ZnO nano particles @ 10 ppm
T_3 = ZnO nano particles @ 15 ppm
T_4 = $ZnSO_4$. $7H_2O$ @ 100 ppm
T_5 = $ZnSO_4$. $7H_2O$ @ 150 ppm
T_6 = ZnO nano particles @ 0.2 kg Zn ha^{-1}
T_7 = Soil application @ 6 kg Zn ha^{-1} ($ZnSO_4$. $7H_2O$)

ii) Replications : 3

09. Plot size : 1.5 m × 2 m

10. Planting system/spacing : Transplant at 60 cm × 50 cm spacing

11. Fertilizer dose and methods of application : Blanket dose: As per STB, following FRG 2018.

12. Irrigated /rainfed : Irrigated

13. Data to be recorded : Initial and post-harvest soil physical and chemical analysis. Zinc concentration in initial and post-harvest soil (treatment wise). Zinc content and uptake by tomato plants. Date of all management (sowing, fertilization, irrigation, weeding, harvesting). Yield attributes and yield etc. Climate data (daily maximum and minimum temp., rainfall and sunshine hour).

14. Investigator(s) : H.M. Naser, (CSO); S. Sultana, (SSO); M. Akter, (SO) and Most. Bilkis Banu (SSO); SSD, BARI.

15. Season : Rabi season

16. Date of initiation : November, 2021

17. Date of completion : March, 2023

18. Expt. output/ benefit : ZnO nanoparticles crystals will be used to improve the yield and quality of tomato. And evaluate the efficiency of ZnO nanoparticles there by mitigate the problems of fertilizer pollutions.

19. Location : Micronutrient experimental field, SSD, BARI, Joydebpur,

			Gazipur.
20.	Status	:	2nd year
21.	Estimated Cost	:	Tk. 90,000/-
22.	Source of fund		BARI
23.	Priority		1st

01.	Programme	:	Soil Management
02.	Project	:	Micronutrient Aspects of Soil Management
03.	**Experiment 09**	**:**	**Determination of critical limit of zinc for chickpea**
04.	Objective(s)	:	1. To evaluate the available Zn status of Calcareous and Non-Calcareous soils using DTPA extraction reagents and to correlate extractable Zn with soil properties, dry matter yield and Zn content by chickpea; and 2. To determine and update of critical limit of zinc in different soils for chickpea.
05.	Rationale	:	There is a wide range of variation and complexity in different soils of Bangladesh, which governs nutrient availability including zinc. Critical limit (CL) of a nutrient in soils refers to a level below which the crops readily respond to its application. Thus CL varies with crops, soil and reagents used for extraction. However, there is a general perception that CL is definite for all soils and crops. Following of such CL value for all soils and crops resulted in inappropriate interpretation and improper use of fertilizer, which affect the crop yield and soil fertility. In order to maintain soil fertility and sustain crop yield, it necessary to replenish the soil with appropriate amount of nutrient. chickpea is one of the most important and demandable pulse crop .The present study was therefore, is undertaken to achieve the above objective.
06.	Materials and Methods	:	Twenty composite soil samples will be collected based on soil series, pH, texture and types. These soils will be brought under laboratory studies for physical and chemical properties. After characterization, pot trial will be conducted using chickpea as a test crop. Crop harvest at100% flowering stage . Zinc treatments 0 and 5 ppm.
07.	Crop/variety	:	chickpea /BARI chola- 9
08.	Design	:	CRD (Factorial)
	i) Treatment	:	Treatment : 40 Level of added zinc: 0 and 5 mg kg^{-1}

Soil: 20

ii) Replications : 3

09. Plot size :

10. Planting system/spacing : Pot culture

11. Fertilizer dose and methods of application : N_{22} P_{16} K_{20} S_{10} B_1 $Mo_{0.6}$ mg kg^{-1} will be applied as per STB following FRG- 2018.

12. Irrigated /rainfed : Irrigated

13. Data to be recorded : Texture, pH, organic carbon, total N, available P, K, S, Zn, B, Content and uptake of Zn by the plants

14. Investigator(s) : Mousumi Akter (SO), Sarmin Sultana, M.B. Banu and H. M. Naser, SSD, BARI, Gazipur,

15. Season : Rabi season

16. Date of initiation : Second week of November, 2021

17. Date of completion : At 100% flowering stage

18. Expt. output/ benefit : Critical limit of Zn for chickpea in different soils will be determined which helped in the reduction of fertilizer wastage

19. Location : Shade house, SSD, BARI, Joydebpur

20. Status : 2nd year

21. Estimated Cost : Tk. 75,000/-

22. Source of fund : BARI

23. Priority : 1st

01. Programme : Soil Management

02. Project : Micronutrient Aspects of Soil Management

03. **Experiment 10 : Effect of foliar application of zinc in sweet orange**

04. Objective(s) :
i. To determine the efficiency of Zn sources in providing the plants with sufficient micronutrients.
ii. To compare new doses of sweet orange orchards with traditionally used sources.

05.	Rationale	:	Oranges are very much important commercial crop in Bangladesh. Appropriate fertilizer management influences on yield and quality of sweet orange. Proper soil fertility management is the most important endeavor to increase crop productivity. The sweet orange is mainly acid soil loving plants but can be cultivated in acid to neutral pH soils. It requires regular supply of Zn, otherwise fruit production become poor. Leaf application has been an effective and preferred management practice followed by growers for micronutrient fertilization in the field. It also considers the nearness of distribution of small amounts of products and mixture with defensives. Soluble salts such as sulfate, chloride and nitrate micronutrient signify the main fertilizer sources for spraying on leaf in citrus. Sparingly soluble sources of Zn fertilizer, such as oxides and carbonates, has been required by sustainable production systems. Efficacy of traditional foliar fertilizers depends on water solubility, while sparingly soluble sources rely upon the size of particles. It facilitates constant supply of nutrient for longer periods and reduced the risk of leaf tissue injury. Considering the necessity to confirm the efficiency of new Zn sources, the present research study was undertaken.
06.	Materials and Methods	:	
07.	Crop/variety	:	Sweet orange BARI Malta 1
08.	Design	:	RCBD
	i) Treatment	:	Doses: T_0 : Control (without Zn fertilizer) T_1 : 500 mg of Zn L^{-1} T_2 : 1000 mg of Zn L^{-1} T_3 : 1500 mg of Zn L^{-1}
	ii) Replications	:	3
09.	Plot size	:	
10.	Planting system/spacing	:	
11.	Fertilizer dose and methods of application	:	All chemical fertilizers except Zn fertilizer will be applied following FRG-2018.Zinc fertilizer will be applied as per treatment. As a source of nutrients, N will be applied in the forms of prilled urea, Pas TSP; K as MoP, S as gypsum, Zn as zinc oxide and zinc sulphate monohydrate and B as boric acid. The whole amount of plant nutrients (N-P-K-S-B) will be applied attwo split doses following the recommendation of HRC, BARI.
12.	Irrigated /rainfed	:	Irrigated
13.	Data to be recorded	:	Date of plant transplanting, plant height, plant dimension, date of

flowering, Zn in leaves, Zn in woody parts, Dry matter in leaves, Dry matter in woody parts, Dry matter of canopy, Enzymatic activity, toxicity symptoms, date of fruit harvest and yield.

14. Investigator(s) : M.M.H. Bhuiyan, M.H. Rahman, RARS, Cumilla and H.M. Naser, SSD, BARI, Gazipur

15. Season : Year-round

16. Date of initiation : May, 2022

17. Date of completion : April, 2025

18. Expt. output/ benefit : Efficiency of Zn fertilizer for sweet orange will be standardized and use of Zn fertilizer will be reduced.

19. Location : RARS, Cumilla

20. Status : 2nd year

21. Estimated Cost : Tk. 80,000/-

22. Source of fund : BARI

23. Priority : 1st

01. Programme : Soil Management

02. Project : Micronutrient Aspects of Soil Management

03. **Experiment 11** : **Estimation of greenhouse gas emission and carbon sequestration from crop fields**

04. Objective(s) :
1. To obtain quantitative estimates of greenhouse gases (CO_2, CH_4 and N_2O) and the carbon sequestration for dominant cropping patterns; and
2. To determine the impact of management practices for carbon sequestration under different cropping patterns.

05. Rationale : Soil carbon sequestration is the process of transferring carbon dioxide from the atmosphere into the soil through crop residues and other organic solids, and in a form that is not immediately reemitted. In keeping with definitions suggested by the Intergovernmental Panel on Climatic Change (IPCC) (Watson et al., 2007), sequestration is an increase in the carbon stock of a pool other than the atmosphere. This transfer or sequestering of carbon helps off-set emissions, combustion and other carbon-emitting activities and, in turn, enhancing soil quality and long-term agronomic productivity. It is a matter to observe whether the existing traditional management practices or developed and modified management practices are judicious. Also, organic

matter and the associated soil biological population will increase in vigor and numbers with more diverse crop rotations. Though many crop rotations are practiced all over all the Agro Ecological Zones (AEZs) - rice based crop rotations dominate others. Strategies to sequester soil carbon are urgently needed so that degraded land can be restored and further land degradation can be avoided. There is a growing concern that increasing levels of carbon dioxide in the atmosphere will change the climate, making Earth warmer and increasing the frequency of extreme weather events. It is believed that the declining productivity of this country's soils is the result of depletion of organic matter due to increasing cropping intensity, higher rates of decomposition of organic matter under the prevailing hot and humid climate, use of lesser quantities of organic manure, little or no use of green manure practices etc. Regarding soil carbon sequestration is taken in order to determine and also emission of greenhouse gases remain un touched or be short of in our country.

06. Materials and Methods : Collection of greenhouse gas (CO_2, CH_4 and N_2O) samples from the fields will be carried out using a closed-chamber technique (Yagi et al. 1991). Soil carbon sequestration will be estimated subtracting C loss through C based emission and crop C harvest from net primary production (NPP) including leaching loss and others. For this purpose relevant data considering the factor influencing carbon sequestration will be collected. Apart from this data on meteorological information, organic matter chain i.e., either the organic matter incorporates in or exclude from the field, the cultivation and management practices, and cropping history of that locality will be collected. Finally the carbon budget of the respective ecosystem will be performed.

07. Crop/variety : Existing cropping pattern

08. Design : N/A

i) Treatment :

ii) Replications :

09. Plot size : N/A

10. Planting system/spacing : As required for respective crops

11. Fertilizer dose and methods of application : As required for respective crops and cropping patterns

12. Irrigated /rainfed : All water regime

13. Data to be recorded : Collection of greenhouse gas (CO_2, CH_4 and N_2O) samples from the studied fields. C based emission and crop C harvest from net primary production (NPP) including leaching loss and others.

Meteorological information, organic matter incorporates in or exclude from the field, the cultivation and management practices, and cropping history of that locality will be collected.

14. Investigator(s) : H. M. Naser, (CSO); S. Sultana, (SSO); M. Akter, (SO) and Most. Bilkis Banu (SSO), SSD, BARI.

15. Season : Round the year

16. Date of initiation : December, 2022

17. Date of completion : Continuous up to 2025

18. Expt. output/ benefit : Carbon sequestration is very much important in the context of Bangladesh. To cope with the alarming rate of organic matte depletion from the soils due to increase of atmospheric temperature there is no alternative but increasing carbon storage or sequestration.

19. Location : Experimental Field, SSD, and other suitable cropping pattern from other Davison, BARI, Joydebpur, Gazipur.

20. Status : New

21. Estimated Cost : Tk. 400000/-

22. Source of fund : BARI

23. Priority : 1st

01. Programme : Soil Management

02. Project : Micronutrient Aspects of Soil Management

03. **Experiment 12** : **Estimation of CO_2 and N_2O emission from organic manures and amenders in maize field**

04. Objective(s) :
i) To evaluate the CO_2 and N_2O emission from terrace soils due to application of biochar, cowdung, poultry manure and vermicompost
ii) To observe the maize yield and nutrient uptake,
iii) To enhances soil physicochemical properties.

05. Rationale : Soil organic matter plays a crucial role in maintaining soil health and its productivity potential. However, most of the world's agricultural soils have become depleted in organic matter and therefore soil health over the years, compared with their place under natural vegetation. When soils in a natural state are converted to agricultural land, there is an important loss of soil organic carbon (SOC) mainly in form of CO_2 (Vanden Bygaart et

al., 2003). Global agricultural production will need to increase by 70 percent (and by practically 100 percent in developing countries) to meet the needs of an estimated world population of approximately 9.2 billion in 2050 (FAO, 2006), but the environmental impact of changing land use to agriculture varies significantly under different management systems. As a result, SOM decrease chronologically by emission of the concentration of CO_2 in the atmosphere has increased from 280 ppmv at beginning of the industrial revolution to the present day value of 391 ppmv (WMO, 2012). The application of organic with inorganic fertilizers, aiming to maximize agronomic use efficiency of the applied nutrients (Vanlauwe et al., 2010), but naturally rapid mineralization of soil organic matter is a limitation on the practical application of organic fertilizers. Thus, in addition to repeated application at high dose and cost of application of organic materials, their rapid decomposition and mineralization may make a significant contribution to global warming (Kaur et al., 2008; Srivastava et al., 2014; Zech et al., 1997). Realizing such environmental and soil degradation problems, biochar has now been widely studied and promoted as a soil amendment that can increase soil C sequestration, improve soil fertility, and thus help mitigate climate change (Lehmann, 2007; Zhang et al., 2010; Jeffery et al., 2011; Nelissen et al., 2014; Partey et al., 2016; Wang et al., 2016; Subedi et al., 2016; Zhang et al., 2016; Subedi et al., 2017).

06. Materials and Methods :

07. Crop/variety : Maize / BARI Hybrid Maize-9

08. Design : RCBD

i) Treatment : Treatment: 6 (Six)
T_1 = STB fertilizer dose (FRG-2018)
T_2 = T_1 through IPNS with 5 t ha^{-1}cowdung
T_3 = T_1 through IPNS with 5 t ha^{-1} poultry manure
T_4 = T_1 through IPNS with 5 t ha^{-1}vermicompost
T_5 = T_1 through IPNS with 5 t ha^{-1} crop straw
T_6 = T_1 through IPNS with 5 t ha^{-1} rice husk biochar

ii) Replications : 3

09. Plot size : 4m × 5m

10. Planting system/spacing : Line sowing / spacing60 cm x 20 cm

11. Fertilizer dose and methods of application : All organic fertilizer and amender and 1/3rd of nitrogen will be applied during final land preparation. Remaining 2/3rd nitrogen will be applied in two installments; one at 40 days after sowing another at 75 days at sowing.

12. Irrigated /rainfed : Irrigated

13.	Data to be recorded	:	1.CO_2 and N_2O emission from each plot 2. Yield and yield attributes 3. Nutrient status of initial and post-harvest soil. 4. Cost and return analysis
14.	Investigator(s)	:	M.M. Masud, SSO, SSD, BARI Mst.R.Khatun, SSO, SSD, BARI H.M. Naser, CSO, BARI
15.	Season	:	Rabi season
16.	Date of initiation	:	November, 2022
17.	Date of completion	:	May, 2025
18.	Expt. output/ benefit	:	Efficient organic manure and amender emitting less quantity of CO_2 and N_2O will be find out.
19.	Location	:	BARI Central Farm, Gazipur
20.	Status	:	New
21.	Estimated Cost	:	Tk. 1,00,000/-
22.	Source of fund	:	BARI
23.	Priority	:	1st

01.	Programme	:	Soil Management
02.	Project	:	Micronutrient Aspects of Soil Management
03.	**Experiment 13**	**:**	**Effect of zinc and biochar on the yield and nutrient content of squash**
04.	Objective(s)	:	• To assess the effect of Zn and biochar on the yield of squash • To find out the Zn concentation and uptake of squash • To identify a suitable combination of Zn application with biochar.
05.	Rationale	:	Squash is one of the important vegetable crops which belong to the Cucurbitaceae Family. Zinc is one of the important micronutrient required for plant growth of squash. Zinc deficiency is not only the cause of low productivity of the crops, but it also results in low Zn concentration in seeds, which leads to poor dietary Zn intake when consumed (Pathak et al.,2012). Zinc also tends to reduce the severity of trace metals in soil (Turan et al., 2017).The combined application of biochar with Zn could be a viable option to minimize the adverse effects of trace metals on

plants, reducing their bioavailability, and also improve antioxidant activities and biomass of plant as compared to sole application of biochar or Zn (Farooq et al., 2020). Biochar is a stable form of organic carbon that improves soil condition and sequestrates carbon. Biochar adds organic matter, N, K, P, Mg, Ca, and other micronutrients which enhance the soil enzymes and microbial activity (Zulfiqar et al., 2019). Previously, several biochar studies were conducted with and without chemical fertilizers but information regarding effect of zinc and biochar in squash plant are not much available.That's why, the study was undertaken.

06.	Materials and Methods	:	The experiment will be conducted at research field of Soil Science Division, BARI, Gazipur. Eight (8) treatments will be used in this study.
07.	Crop/variety	:	Squash (BARI squash 1)
08.	Design	:	RCBD
	i) Treatment	:	Treatment:8 T_1: Control (native fertility) T_2:Soil application of Zn 2kg ha^{-1} T_3: Soil application of Zn 4 kg ha^{-1} T_4: Soil application of Zn 6 kg ha^{-1} T_5:Biochar (3 t ha^{-1}) T_6: Soil application of Zn (2kg ha^{-1})+ Biochar (3 t ha^{-1}) T_7: Soil application of Zn (4kg ha^{-1})+ Biochar (3 t ha^{-1}) T_8: Soil application of Zn (6 kg ha^{-1})+ Biochar (3 t ha^{-1})
	ii) Replications	:	3
09.	Plot size	:	2. 5 m × 2.5 m
10.	Planting system/spacing	:	P- 80 L-80 cm
11.	Fertilizer dose and methods of application	:	STB based
12.	Irrigated /rainfed	:	Irrigated
13.	Data to be recorded	:	Initial and post-harvest soil physical and chemical analysis. Zinc content and uptake by plants. Physiological data etc
14.	Investigator(s)	:	M. Akter (SO), S. Sultana(SSO), M.B. Banu (SSO) and H. M. Naser (CSO), Soil Science Division, BARI, Gazipur,

15.	Season	:	Rabi season
16.	Date of initiation	:	November, 2022
17.	Date of completion	:	March, 2025
18.	Expt. output/ benefit	:	A suitable combination of zinc and biochar will be find out for squash production which will contribute to the soil enrichment with better yield.
19.	Location	:	Micronutrient Experimental Field, SSD, BARI, Joydebpur, Gazipur.
20.	Status	:	New
21.	Estimated Cost	:	Tk. 60,000/-
22.	Source of fund		BARI
23.	Priority		1st

1.	Program	:	Soil management
2.	Project	:	Micronutrient Aspects of Soil Management
3.	**Experiment 14**	**:**	**Effect of soil and water quality on Arsenic uptake by irrigated winter upland crops in southwest Bangladesh**
4.	Objective (s)	:	1. To observe the effect of soil and water salinity on As mobility in vegetables 2. To find out the relationship (synergetic/antagonistic) between salinity and As in plant growth
5.	Rationale	:	The vulnerability of southwest region to increased salinity, arsenic contamination, and fresh water scarcity are the result of a complex interrelationship among biophysical, social, economic, and technological characteristics of the country. Moreover, in the current and foreseeable future, the country is likely to be affected by the biggest, most long-lasting and global scale but silent disaster: increased salinity, natural arsenic contamination, and drought. In addition, climate change could result in increased soil surface salinity due to long periods of drought in winter season. To date, the issue of arsenic in Bangladesh has concentrated on the direct adverse effects of drinking arsenic-contaminated water on human health. But enough attention has not yet been paid to the indirect route of exposure to arsenic. The use of high arsenic-content groundwater for irrigation has led to the

accumulation of arsenic in crops and vegetable plants. Sporadic research provides disparate information on the adverse effect of arsenic in agri- culture. Continuous use of arsenic-contaminated groundwater to irrigate crops, especially paddy rice (Oryza sativa), has resulted in elevated soil arsenic levels in Bangladesh. Abedin, Cotter-Howells, and Meharg (2002) revealed that the use of arsenic-contaminated irrigation water decreased seed germination and rice yield, reduced plant height, and affected the development of root growth. In addition, Huq, Ara, Islam, Zaher, and Naidu (2001) noted that high concentrations of arsenic in vegetables and rice in affected areas indicate that dietary habits are also responsible for arsenic problems for the people of Bangladesh. During the dry season ground water moves upward by capillary action and leaves arsenic in the soil. In addition, dry season aggravate salinity condition too. Moreover, it is found that As acts as soluble salts (Rabbi et al. 2007) which increase the possibility of being absorbed by plants instead of local soluble salts. Thus, a possible interaction between salinity and arsenic on winter crops grown on saline soil may exist. With this view in mind the present work was done to observe the effect of soil and water salinity on As mobility in saline soils of Bangladesh.

6.	Materials and Method	:	
7.	Crop/variety	:	Brinjal and Tomato Variety: BARI Begun-12 and BARI Tomato-17
8.	Design	:	RCBD factorial
	i) Treatments	:	Factor A: Soil Salinity: <8 dS/m, >8 dS/m Factor B: Arsenic contaminated Irrigation water: As_0, $As_{0.05}$ Factor C: Crop: Brinjal, Tomato
	ii)Replication	:	02 (dispersed location)
9.	Plot size	:	$4m^2$
10.	Planting system/Spacing	:	Line sowing
11.	Fertilizer doses and application methods	:	As per FRG-2018
12.	Irrigated/rainfed	:	Irrigated
13.	Data to be recorded	:	pH, EC (dS/m), Available N (%), Available P (mg/kg), Available K (meq/100g soil), Available S (mg/kg), Soluble Na, Total As
14.	Investigator (s)	:	O.A. Fakir, ARS, Satkhira H. M. Naser, SSD, BARI, Gazipur
15.	Season	:	Rabi

16. Date of initiation : October, 2022

17. Date of completion : April, 2023

18. Expected output/benefit : Arsenic sensitivity in terms of saline soil and water for BARI released Brinjal and tomato varieties can be evaluated.

19. Location : ARS, Satkhira

20. Status : New

21 Estimated cost : 60,000/-

22. Source of fund : BARI

23. Priority : 1st

1. Programme : Soil Management
2. Project : Micronutrients Aspects of Soil Management
3. **Experiment 15** : **Effect of zinc and boron on the yield of BARI Sarisha 18 (canola type)**
4. Objectives :
   1. To estimate optimum dose of Zinc and Boron on yield and yield components of BARI Sarisha-18.
   2. To study the effect of Zinc and Boron on yield and yield components of BARI Sarisha-18.
   3. To find out Zinc and Boron use efficiency of BARI sarisha-18
5. Rationale : Mustard has become the dominant field crop in the Bangladesh, about 80% of the total oilseed area and contributing to more than 60% of the total oilseed production. The only one canola type variety of mustard is BARI sharisha 18. Canola is a high-value crop of healthy oil and animal meal protein as well as a viable renewable feedstock for biofuel production (Blackshaw et al., 2011; Ma and Zheng, 2016). Urecic acid content about 1.06% in BARI sharisha 18 where 35%-40% in other mustard.

   The grain yield can be improved by addition of Zn fertilization (Maqsood et al., 2009). Bora and Hazarika, (1997) reported highest stover yield (2770 kg ha-1) with Zn and almost the same trend of seed yield.
   Brassica crops also have relatively high B requirements and are among the most susceptible to B deficiency (Jones Jr., 1997). As a key element in cell wall structure and cell division, carbon metabolism, sugar transport, flowering and pollination, B deficiency affects apical growth and seed formation (Subedi and Ma, 2009). Therefore, this study was conducted to find out the effect of Zinc and Boron on yield and yield components of BARI sarisha 18 in Jamalpur.

6. Materials and methods :

7. Variety/Line(s) : BARI Sarisha 18 (canola)

8. Design : RCBD

i). Treatments : Rate of fertilizers: 16 (sixteen)
4 level of Zn : (0, 2.5, 3.5, 4.5 kg ha.$^{-1}$)
4 level of Boron : (0, 1.5, 2.0, 2.5 kg ha.$^{-1}$)

Treatment combination
Zn_0B_0
$Zn_0 B_{1.5}$
$Zn_0 B_{2.0}$
$Zn_0 B_{2.5}$
$Zn_{2.5} B_0$
$Zn_{2.5} B_{1.5}$
$Zn_{2.5} B_{2.0}$
$Zn_{2.5} B_{2.5}$
$Zn_{3.5} B_0$
$Zn_{3.5} B_{1.5}$
$Zn_{3.5} B_{2.0}$
$Zn_{3.5} B_{2.5}$
$Zn_{4.5} B_0$
$Zn_{4.5} B_{1.5}$
$Zn_{4.5} B_{2.0}$
$Zn_{4.5} B_{2.5}$

ii). Replication 03

9. Plot size 4 m x 3 m

10. Planting system /spacing : 30 cm x continuous in line

11. Fertilizer dose and methods of application : Fertilizer dose: N_{150} P_{40} K_{90} Zn_3 kg ha^{-1} (FRG-2018) and Sand B as per treatment.
Half of N and all of P, K, S, Zn, B, OF should be applied as basal during final land preparation. Remaining half N should be applied as top dress at the time of flower initiation stage (25 DAS).

12. Irrigated/Rainfed : Irrigated

13. Data to be recorded : 1.Yield and yield components
2. Disease and insect infestations
3. Nutrient status of initial and post-harvest soil.
4.Cost and return analysis

14. Investigator (s) : F. S. Shikha, SO, RARS, Jamalpur

M. Yasmin, SO, RARS, Jamalpur
M. A. Rahman, SSO, RARS, Jamalpur
H. M. Naser, CSO, SSD, BARI, Gazipur

15. Season : Rabi

16. Date of initiation : 1st week of November, 2022

17. Date of completion : 1stweek of February, 2024

18. Expected output / benefit : Zinc and boron dose would be formulated for the successful production of BARI sarisha18.

19. Location : RARS, Jamalpur

20. Status : 1st

21. Estimated cost : 50,000/-

22. Source of fund : BARI

23. Priority : 1st

1. Programme : Soil Management

2. Project : Micronutrients Aspects of Soil Management

3. **Experiment 16 : Effect of foliar application of boron trioxide and zinc oxide nanoparticles on the yield and fruit quality of Sweet Orange**

4. Objective(s) : To determine the appropriate concentration of nano-zinc and nano-boron to reach the best fruits yield of sweet orange and improve its chemical and morphological traits.

5. Rationale : Sweet orange is widely distributed and one of the most important commercial crops in Bangladesh. The production of sweet orange is generally low due to poor soil fertility. Appropriate fertilizer management influences on yield and quality of sweet oranges. Proper soil fertility management is the most important endeavor to increase crop productivity. The sweet orange is mainly an acid soil-loving plant but can be cultivated in acid to neutral pH soils. Zinc is one of the essential micronutrients for plants, and its deficiency is common in many crops. Boron deficiency is also a common micronutrient problem in agriculture, which results in reducing in yield and quality. Nanotechnology has emerged as one of the most innovative scientific fields in agriculture. Leaf application has

been an effective and preferred management practice followed by growers for micronutrient fertilization in the field. It also considers the nearness of distribution of small amounts of products and mixture with defensives.

6.	Materials and methods	:	
7.	Crop/variety	:	BARI Malta-1
8.	Design	:	RCB
	i) Treatment (4)	:	T_1 = Nano-boron @ 10 ppm + Nano-zinc @ 100 ppm T_2 = Nano-boron @ 10 ppm + Nano-zinc @ 200 ppm T_3 = Nano-boron @ 20 ppm + Nano-zinc @ 100 ppm T_4 = Nano-boron @ 20 ppm + Nano-zinc @ 200 ppm
	ii) Replication	:	3
9.	Plot size	:	-
10.	Planting system/ spacing	:	-
11.	Fertilizer dose and method of application	:	All chemical fertilizers except nano-Zn and nano-B fertilizer will be applied following FRG-2018. Nano-Zn and nano-B will be applied as per treatment. As a source of nutrients, N will be applied in the forms of prilled urea, P as TSP; K as MoP, S as gypsum, Zn as Zinc oxide nanoparticles, and B as boron trioxide. The whole amount of plant nutrients (N-P-K-S-B) will be applied at four splits of the total amounts following the recommendation of HRC, BARI.
12.	Irrigated/rainfed	:	Irrigated
13.	Data to be recorded	:	Date of sapling transplanting, plant height, plant dimension, leaf pigments, leaf mineral contents, date of flowering, fruit set, fruit drop, physical properties of fruits, fruit chemical properties, date of the fruit harvest, and fruit yield.
14.	Investigator(s)	:	M M H Bhuiyan, S Sultana, M O Kaisar and H M Naser
15.	Season	:	Kharif-II
16.	Date of initiation	:	March-2023
17.	Date of completion	:	December 2026
18.	Expected output/benefit	:	The appropriate concentration of nano-zinc and nano-boron for higher and quality sweet orange fruit yield will find out.
19.	Location	:	RARS, Cumilla
20.	Status	:	New
21.	Estimated cost	:	Tk. 80,000
22.	Source of fund	:	Upgrading RHRS, Cumilla to RARS Cumilla Project
23.	Priority	:	1st

PROJECT-IV

MICROBIOLOGICAL ASPECTS OF SOIL MANAGEMENT
Project Leader: Dr. Mohammad Eyakub Ali

01. Programme	:	Soil Management
02. Project	:	Microbiological Aspects of Soil Management
03. **Expriment 01**	**:**	**Study on collection, isolation and screening of indigenous *Rhizobium* strains, arbuscular mycorrhizal fungi, *Azotobacter*, phosphate solubilizing bacteria and *Azospirillium* strain(s) for different crops from different AEZs of Bangladesh**
04. Objective(s)	:	1. To select the best indigenous *Rhizobium* strain(s), arbuscular mycorrhizal fungi, *Azotobacter*, phosphate solubilizing bacteria and *Azospirillium* strain(s) from different AEZs of Bangladesh 2. To prepare biofertilizer for different legume and other crops
05. Rationale	:	The role of legumes in enriching the fertility of soil was known through the centuries. Nitrogen is an essential element for crop growth which is very costly in the country. Legumninous crop can use nitrogen in the air, if infected with proper bacteria, called *Rhizobium*. Bangladesh soil is more or less deficient in nitrogen as well as lack in sufficient, effective and resisstant *Rhizobium* strains. Bacteria involved are specific as to crop. An extensive programme of strain selection and inoculant response is needed. Degration of *Rhizobium* occurs regularly. Arbuscular mycorrhiza (AM) fungi are beneficial fungi forming symbiotic association with roots of the most plant species and help them in uptake of nutrients and moisture from the soil. They improve P uptake from less soluble sources. Collection on free living bacteria like *Azotobacter* is also needed to reduduce the requiremwent of N fertilizers. Study on PSB and *Azospirillum* are also needed. So, collection and selection of *Rhizobium* strains, AM, PSB and other micoorganisms are needed from different agro-ecological zones of Bangladesh for biofertilizer production.
06. Materials and methods	:	Standard microbiological methods will be followed
07. Crop/variety	:	Grasspea, lentil, chickpea, blackgram, mungbean, cowpea, gardenpea, bushbean, bean, groundnut, soybean, pigeonpea, different fruit plants, cereals, spice crops etc.
08. Design:	:	N/A
09. Plot size	:	N/A
10. Planting system/spacing	:	N/A

11. Fertilizer dose and methods of application : N/A

12. Irrigated/rainfed : N/A

13. Data to be recorded : -

14. Investigator(s) : M. E. Ali, SSO,SSD, Joydebpur
M. Rahman, SO, SSD, Joydebpur
M.F.A. Anik, SO, SSD, Joydebpur
H.M. Naser, CSO, SSD, Joydebpur

15. Season : Rabi, Kharif-I and Kharif-II

16. Date of initiation : October, 2002

17. Date of completion : -

18. Expected output/benefit : *Rhizobium* biofertilizer, arbuscular mychrrorhizal inoculum, *Azotobacter*, phosphate solubilizing bacterial biofertilizer and *Azospirillium* will be developed.

19. Location : Rahmatpur, Jessore, Joydebpur, Hathazari, Rajshahi, Dinajpur, Rangpur, Ishurdi, Khagrachari, Raikhali, Patuakhali, Sathkhira, Noakhali, Cox's Bazar, Sylhet, etc.

20. Status : On going

21. Estimated Cost : Tk. 2,50,000/-

22. Source of fund : BARI

23. Priority : 1st

01. Programme : Soil Management

02. Project : Microbiological Aspects of Soil Management

03. **Expriment 02** : **Assessment of Arbuscular mycorrhizal association in diffirent plants and crops**

04. Objective(s) : 1. To study the percent root colonization and AM fungal spore population in the rhizosphere soil
2. To produce suitable AM inoculum for future use in different plants and crops

05. Rationale : Mycorrhizae are symbiotic association between beneficial soil fungi and plant roots. They have an important role in increasing plant uptake of P and other poorly mobile micronutrients particularly Zn and Cu. Out of the different types of mycorrhizae, the AM fungi are the most widely occurring mycorrhizae and are

			very important in relation to the improvement of agricultural and horticultural crops and forest trees in hilly areas. They form three-way associations involving plants, fungi and soils. Arbuscular mycorrhizal fungi have an important role in nutrient availability in fruit plants. So, this present work was taken to know the percent root colonization of different plants and crops as well as the number of AM spores in the rhizosphere soils for producing suitable inoculum for future use in different crops.
06.	Materials and methods	:	Standard microbiological methods will be followed
07.	Crop/variety	:	Different plants and crops available in Bangladesh
08.	Design	:	- i) Treatment ii) Replication
09.	Plot size	:	N/A
10.	Planting system/spacing	:	N/A
11.	Fertilizer dose and methods of application	:	N/A
12.	Irrigated/rainfed	:	N/A
13	Data to be recorded	:	1. Per cent root colonization 2. Spore population 3. AM structure
14.	Investigator(s)	:	M. E. Ali, SSO, SSD, Joydebpur M. Rahman, SO, SSD, Joydebpur M.F.A. Anik, SO, SSD, Joydebpur H.M. Naser, CSO, SSD, Joydebpur
15.	Season	:	Rabi and Kharif
16.	Date of initiation	:	October, 2008
17.	Date of completion	:	-
18.	Expected output/benefit	:	Arbuscular mychrrorhizal inoculum will be developed.
19.	Location	:	Khagrachori, Jamalpur, Gopalgonj, Rangpur, Jashore
20.	Status	:	On going
21.	Estimated Cost	:	Tk. 80,000/- (Tk. 20,000/- for each location)
22.	Source of fund	:	BARI
23.	Priority	:	1st

01. Programme : Soil Management

02. Project : Microbiological Aspects of Soil Management

03. **Expriment 03** **: Effect of *Azotobacter* on the growth and yield of Chilli**

04. Objective(s) : 1. To study the role of *Azotobacter* on the growth and yield of chilli
2. To find out the nutrient uptake as influenced by *Azotobacter*

05. Rationale : *Azotobacter chroococcum*, the most abundant species of genus *Azotobacter* is commonly found in arable soils. Its number in Indian soil never exceeds 1×10^5/g soil due to poor organic matter content and presence of antagonistic microorganisms in soil. It also produces antifungal antibiotic, which inhibits growth of several plant pathogenic fungi. Inoculation with efficient strain of *Azotobacter* is known to improve the yield of brinjal, tomato, cabbage and chilli by 2-40% and in sorghum, maize and cotton in the range of 9-71%.

06. Materials and methods :

07. Crop/variety : Chilli/BARI Morich-2

08. Design : RCBD
Treatment : 6 (Six)
T_1 : 100% N of RD (Recommended Dose)
T_2 : 90% N + *Azotobacter inoculum*
T_3 : 80% N + *Azotobacter inoculum*
T_4 : 70% N + *Azotobacter inoculum*
T_5 : *Azotobacter inoculum*
T_6 : Control

Replication : 04 (Four)

09. Plot size : 3m x 4m

10. Planting system/spacing : -

11. Fertilizer dose and methods of application : Blanket dose: $P_{55}K_{75}S_{22}Zn_5$ kg ha^{-1}
Recommended dose of N: 100 kg ha^{-1}
All PKSZn will be applied at the time of final land preparation.

12. Irrigated/rainfed : Irrigated

13. Data to be recorded : 1. Yield and yield component
2. Uptake of different nutrient

14. Investigator(s) : M.E. Ali, SSO, SSD, Joydebpur
M. Rahman, SO, SSD, Joydebpur
M.F.A. Anik, SO, SSD, Joydebpur

H.M. Naser, CSO, SSD, Joydebpur

15. Season : Rabi

16. Date of initiation : 2017-2018

17. Date of completion : 2023

18. Expected output/benefit : Effect of *Azotobacter* on chilli and reduction of application of urea-N will be find out.

19. Location : Net House of SSD, Gazipur

20. Status : 2nd year

21. Estimated Cost : Tk. 25,000/-

22. Source of fund : BARI

23. Priority : 1st

01. Programme : Soil Management

02. Project : Microbiological Aspects of Soil Management

03. **Expriment 04** : **Effect of Arbuscular mycorrhizal fungi and phosphorus on vegetables, spices and legume crops**

04. Objective(s) : 1. To study the effect of combined use of arbuscular mycorrhiza and phosphorus on the performing of vegetables spices and fruit crops under field condition
2. To reduce to use of P-fertilizer for vegetables, spices and legume crops

05. Rationale : Arbuscular mycorrhizal fungi (AMF) are known to improve plant growth mainly by improving plant uptake of nutrient, particularly the immobile nutrient. Under low soil P concentrations, most plant species are developed on a symbiotic association with arbuscular mycorrhizal fungi for the acquisition of P. AMF can increase plant growth by enhancing uptake of mineral nutrients from soil, particularly diffusion limited ions such as phosphorus. Availability of phosphorus to plant roots is limited both acidic and alkaline soils, mainly due to formation of sparingly soluble phosphate compounds with AI and Fe in acidic and Ca in alkaline soils. Every year, large amounts of phosphorus fertilizers are applied to soils for crop production globally, and only 10 to 20 per cent of the applied phosphorus fertilizers can be absorbed by plant. As such seedlings of vegetables, spices and legumes crops might be grown better with mycorrhiza studied under pot culture which reduced the dose of P fertilizer. The study therefore, might be undertaken in the field.

06. Materials and methods :

07. Crop/variety : Broccoli/Premium

08. Design :

Factorial RCB

Treatment : 06 (Six)
In seed bed: 02 (With mycorrhiza and Without mycorrhiza)
In field: 06 (AM level: 2, P level: 3)
T_1P_1U: 0% P × Without AM
T_2P_2U: 50% P × Without AM
T_3P_3U: 100% P × Without AM
T_4P_1AM: 0% P × With AM
T_5P_2AM: 50% P × With AM
T_6P_3AM: 100% P × With AM
Recommended fertilizer doses for different crops will be used in seedbed and field.

Replication: 04 (Four)

09. Plot size : 3m × 2m

10. Planting system/spacing : Row to row-50 cm
Plant to plant-40 cm

11. Fertilizer dose and methods of application : 90-30-50-15-2-1 kg ha^{-1} N-P-K-S-Zn-B

All PKSZn will be applied at sowing and N will be applied in three equal splits.

12. Irrigated/rainfed :

13. Data to be recorded : Date of sowing, seedling height, no. of leaves/plant, collar diameter, biomass yield. AM root colonization, spore population in rhizosphere soil, yield contributing characters and yield, uptake of nutrients.

14. Investigator(s) : M.E. Ali, SSO, SSD, Joydebpur
M. Rahman, SO, SSD, Joydebpur
M.F.A. Anik, SO, SSD, Joydebpur
H.M. Naser, CSO, SSD, Joydebpur

15. Season : Rabi

16. Date of initiation : 2009-2010

17. Date of completion :

18. Expected output/benefit : Reduction of uses of P-fertilizer for vegetables, spices and legume crops will be find out.

19. Location : Joydebpur

20. Status : On going

21. Estimated Cost : Tk. 30,000/-

22. Source of fund : BARI

23. Priority : 1st

01. Programme : Soil Management

02. Project : Microbiological Aspects of Soil Management

03. **Experiment 05** : **Effect of biofertilizer, vermicompost and chemical fertilizers on cowpea**

04. Objective(s) : 1. To study the effect of bio-fertilizer and vermicompost on yield of cowpea
2. To find out nutrient uptake as influence by bio-fertilizer and vermicompost
3. To reduce the chemical fertilizer in cowpea cultivation

05. Rationale : Vermicompost is basically decomposition of organic matter with the use of earthworm and the method is called vermicomposting. Vermicompost improves physical, chemical and biological properties of soil in the long run on repeated application. Huge quantities of domestic agricultural and rural industrial organic wastes can be recycled for various usages which reduces pollution. It is effective biofertilizers containing beneficial soil micro flora and earthworm cocoon. It has potential to reduce dependence on non-renewable input like chemical fertilizers and effective environmental protection. Now-a-days gradual deficiencies in soil organic matter and reduced yield of crop are alarming problem in Bangladesh. The cost of inorganic fertilizers is very high and sometimes it is not available in the market for which the farmers fail to apply the inorganic fertilizers to the crop field in optimum time. Vermicompost is a good source of different macro and micronutrients particularly NPKS. Use of vermicompost for vegetable production in large scale can solve the problem of the lack of organic matter. Earthworms consume large quantities of organic matter excrete soil as cast and this cast have several enzymes and rich in plant nutrients. It was also noted that vermocimpost is an excellent base for the establishment of beneficial non-symbiotic and symbiotic microbes. Application of vermicompost increases the total microbial population of N-fixing bacteria and actinomycetes. The increased microbial activity improves the availability of soil phosphorous and nitrogen. There is no research information about the effect of vermicompost and bio-fertilizer on cowpea production. So, the present investigation would be undertaken.

06. Materials and methods :

07. Crop/variety : Cowpea/ BARI Felon -1

08. Design : RCB

Treatment : 09 (Nine)

T_1: Control
T_2: Vermicompost (VC) @ 2.5 t ha^{-1}
T_3: VC @ 5 t ha^{-1}
T_4: VC @ 2.5 t ha^{-1} + IPNS based NPKS
T_5: VC @ 5.0 t ha^{-1} + IPNS based NPKS
T_6: VC @ 2.5 t ha^{-1} + *Rhizobium* + IPNS based PKS
T_7: VC @ 5.0 t ha^{-1} + *Rhizobium* + IPNS based PKS
T_8: 100% NPKS
T_9: 100% PKS + *Rhizobium*

Replication: 04 (Four)

09. Plot size : 3m × 4m

10. Planting system/spacing : Row to row 30 cm, plant to plant 10 cm

11. Fertilizer dose and methods of application : As per recomended dose

12. Irrigated/rainfed : Irrigated

13. Data to be recorded : Date of sowing, nodule no., nodule weight, root weight, shoot weight, no. of leaves, no. of pod $plant^{-1}$, plant height, 1000-seed weight, stover yield, seed yield, pod yield, plant population, nutrient content in seed and stover.

14. Investigator(s) : M.E. Ali, SSO, SSD, Joydebpur
M. Rahman, SO, SSD, Joydebpur
M.F.A. Anik, SO, SSD, Joydebpur
M. M. Alam, SSO, RARS, Hathazari
H.M. Naser, CSO, SSD, Joydebpur

15. Season : Rabi

16. Date of initiation : 2009-2010

17. Date of completion : -

18. Expected output/benefit : Reduction of chemical fertilizers by using biofertilizer and vermicompost for cowpea production will be found out.

19. Location : Joydebpur, Jamalpur

20. Status : 2nd year

21. Estimated Cost : Tk. 30,000/-

22. Source of fund : BARI

23. Priority : 1st

01. Programme : Soil Management

02. Project : Microbiological Aspects of Soil Management

03. **Experiment 06** : **Study on the rhizobial population and other soil microorganism status of different soils (AEZs) of Bangladesh**

04. Objective(s) : 1. To study the native rhizobial and other soil microorganism population of different soils of Bangladesh
2. To know the effect of climate change on the rhizobial population and other soil microorganisms

05. Rationale : The role of legumes in enriching the fertility of soil was known through the centuries. Nitrogen is an essential element for crop growth which is very costly in the country. Legumninous crop can use nitrogen in the air, if infected with proper bacteria, called *Rhizobium*. Bangladesh soil is more or less deficient in nitrogen as well as lack in sufficient, effective and resisstant *Rhizobium* strains. Degration of *Rhizobium* occurs regularly. Crops grown under greenhouse/nethouse condition need large number of rhizobia (10^6-10^8 cells seed^{-1}) for maximum nodulation and N_2 fixation. With a background, rhizobial popupalaytion of 10^2-10^3 cells g^{-1} soil higher rates of inoculum may be required for field inoculants. A minimum number of 10^6 cells seeds^{-1} is required for legume crops. *Rhizobium* inoculation may give better results than fertilizer–N application. In some soils, other factors such as soil pH, mineral toxicities, or nutrient deficiencies, can influence N_2-fixation without directly affecting plant growth. Moreover, climate change may affect on soil microogrganisms in the soil especially in Bangladesh soil. So, soil microognasism population study is requireed.

06. Materials and methods : Standard microbiological methods will be followed.

07. Crop/variety : N/A

08. Design : N/A

09. Plot size : N/A

10. Planting system/spacing : N/A

11. Fertilizer dose and methods of application : N/A

12. Irrigated/rainfed : N/A

13. Data to be recorded : *Rhizobium*, PSB and *Azotobacter* population g^{-1} soil.

14. Investigator(s) : M.E. Ali, SSO, SSD, Joydebpur
M. Rahman, SO, SSD, Joydebpur
M.F.A. Anik, SO, SSD, Joydebpur
H.M. Naser, CSO, SSD, Joydebpur

15. Season : Rabi and Kharif

16. Date of initiation : 2015-2016

17. Date of completion : -

18. Expected output/benefit : Native rhizobial and other soil microorganism population of different soils of Bangladesh will be findout.

19. Location : Different AEZs of Bangladesh.

20. Status : On going

21. Estimated Cost : Tk. 1,60,000/-

22. Source fund : BARI

23. Priority : 1st

01. Programme : Soil Management

02. Project : Microbiological Aspects of Soil Management

03. **Experiment 07** **: Response of lentil varieties to elite strains of *Rhizobium***

04. Objective(s) : 1. To study the response of *Rhizobium* inoculation with different varieties of lentil
2. To study the effect of *Rhizobium* inoculation and varieties at different locations
3. To popularize the use of *Rhizobium* inoculant instead of applying urea-N for lentil production

05. Rationale : Lentil is a popular vegetable belonging to the family leguminoceae. It is rich in protein, calcium, iron and vitamins which can be exported in European countries. Immature and tender pods are used as vegetable. Lentil can be easily grown in the field or in the homestead garden. Nitrogen requirement in bushbean is very high than other legumes. Recently, BARI has isolated *Rhizobium* bacteria and developed *Rhizobium* biofertilizer for bushbean. Moreover, a good number of strains have been collected from abroad for producing rhizobial inoculum. The microbiological study on lentil is going on at Soil Microbiology Laboratory, BARI. In Bangladesh, there is a good

number of bushbean varieties and have a greater scope to find out the best varieties which have the ability to response higher with *Rhizobium.* Using high yielding variety/ advance lines of lentil in combination with effective rhizobial strains along with management practices including manures and fertilizers can enhance the yield. The present investigation was under taken to find out the best variety which performs better with *Rhizobium* in case of lentil varieties.

06. Materials and methods : -

07. Crop/variety : Lentil variety: BARI Masur -6, BARI Masur -7, BARI Masur -8 and BARI Masur -9

08. Design : Factorial RCB
Treatment : 08 (Eight)
Treatment combination: 6 (six)
T_1: BARI BARI Masur -6 + Uninoculated
T_2: BARI BARI Masur -6 + Inoculated with *Rhizobium*
T_3: BARI BARI Masur -7 + Uninoculated
T_4: BARI BARI Masur -7 + Inoculated with *Rhizobium*
T_5: BARI BARI Masur -8 + Uninoculated
T_6: BARI BARI Masur -8 + Inoculated with *Rhizobium*
T_7: BARI BARI Masur -9 + Uninoculated
T_8: BARI BARI Masur -9 + Inoculated with *Rhizobium*
Replication : 04 (Four)
Rhizobium starin: BARI RLs-103

09. Plot size : 4m × 5m

10. Planting system/spacing : Row to row 30 cm, Plant to plant 5 cm

11. Fertilizer dose and methods of application : 22-42-20-5-2 kg ha^{-1} of P-K-S-Zn and boron from TSP, MoP, gypsum, zinc sulphate and boric acid All PKSZn will be applied at the time of final land preparation. Zinc will not be applied at Joydebpur, B and Mo will be applied as basal dose if needed after soil analysis.

12. Irrigated/rainfed : Irrigated

13. Data to be recorded : Date of sowing, nodule no., nodule wt., root wt., shoot weight, plant height, plant population, pod yield (green pod), no. of pod per plant, no. of seeds per pod, pod wt. per plant, pod length, pod breadth, 1000-seed wt., date of flowering, date of harvesting, nutrient content in seed and stover, nutrient status and rhizobial population of initial and post harvest soil

14. Investigator(s) : M.E. Ali, SSO, SSD, Joydebpur
M. Rahman, SO, SSD, Joydebpur
M.F.A. Anik, SO, SSD, Joydebpur
N. Salahin. SSO, RARS, Jashore and
Concern Scientists of the location

15. Season : Robi

16. Date of initiation : 2018-19

17. Date of completion : 2023

18. Expected output/benefit : Responses of *Rhizobium* inoculation with different varieties will be find out and popularize the use of *Rhizobium* inoculant instead of applying urea-N for lentil production.

19. Location : Joydebpur, Ishurdi, Jamalpur and Jashore

20. Status : 2nd year

21. Estimated Cost : Tk. 80,000/- (Tk. 20,000/- for each location)

22. Source fund : BARI

23. Priority : 1st

01. Programme : Soil Management

02. Project : Microbiological Aspects of Soil Management

03. **Experiment 08** **: Validation of biofertilizer on different legumes (Mungbean, lentil, chickpea, groundnut, soybean etc.)**

04. Objective(s) : To popularize the rhizobium biofertilizer technology for producing pulse and oilseed legumes in the farmer's level.

05. Rationale : -

06. Materials and methods :

07. Crop/variety : Variety:
Mungbean: BARI Mung-6
Lentil: BARI Masur-6
Chickpea:BARI Chola-5
Groundnut: BARI Chinabadam-7
Soybean: BARI Soybean-6
Rhizobium strains:
Mungbean: BARI RVr-403
Lentil: BARI RLc-104
Chickpea :BARI RCa-203
Groundnut:BARI RAh-801
Soybean: BARI RGm-901

08. Design : Treatment : 03 (three)
1. Without *Rhizobium* inoculant + PKSZn
2. With *Rhizobium* inoculant + PKSZn
3. NPKSZn

Replication : 4 (Dispersed)

09. Plot size : 10 m × 15 m

10. Planting system/spacing : -

11. Fertilizer dose and methods of application : Mungbean: $P_{22}K_{42}S_{20}Zn_5$ kg ha^{-1}
Lentil: $P_{22}K_{42}S_{20}Zn_5$ kg ha^{-1}
Chickpea: $P_{22}K_{42}S_{20}Zn_5$ kg ha^{-1}
Groundnut: $P_{22}K_{42}S_{40}Zn_5$ kg ha^{-1}
Soybean: $P_{22}K_{42}S_{40}Zn_5$ kg ha^{-1}
Rhizobium biofertilizer: 1.5 kg ha^{-1}
Nitrogen: 50 kg N kg ha^{-1} for mungbean, lentil, chickpea and 100 kg N kg ha^{-1} for groundnut and soybean

12. Irrigated/rainfed :

13. Data to be recorded :

14. Investigator(s) : M.E. Ali, SSO, SSD, Joydebpur
M. Rahman, SO, SSD, Joydebpur
M.F.A. Anik, SO, SSD, Joydebpur
H.M. Naser, CSO, SSD, Joydebpur
M.M. Anwar, CSO, OFRD, Joydebpur and
Concerned Scientists of OFRD, BARI

15. Season : Mungbean: First week of March 2022 at Kustia, Satkhira, Sylhet & Faridpur; Mid January to Mid February 2022 at Patuakhali, Bhola and Cox's Bazar.
Lentil : November 2022
Chickpea : November 2022
Groundnut : November 2022
Soybean : December 2022

16. Date of initiation : -

17. Date of completion : -

18. Expected output/benefit : Application of biofertilizer will reduce the dependence of nitrogenous fertilizers. Farmers will be benefited through use of low cost biofertilizer. Woman income generation will be increased by picking mungbean pod and harvesting of crops.

19. Location : i) For mungbean: Kustia, Faridpur, Patuakhali, Bhola, Satkhira, Sylhet, Cox's Bazar
ii) For lentil: Meherpur, Faridpur, Jessore, Sylhet, Jamalpur
iii) For chickpea: Kustia, Faridpur, Rajshahi, Pabna, Sylhet
iv) For groundnut: Rangpur, Jamalpur, Kishoregonj, Cox's Bazar.
v) For soybean: Noakhali, Lakhmipur, Bhola, Rangpur

20. Status : On going

21. Estimated Cost : Tk. 2,00,000/- (Tk. 8,000/- for each location & for each crop)

22. Source fund : BARI

23. Priority : 2nd year

01. Programme : Soil Management

02. Project : Microbiological Aspects of Soil Management

03. **Expriment 09** **: Bio-control of *fusarium* wilt disease of cowpea by dual inoculation with Rhizobium and arbuscular mycorrhiza**

04. Objective(s) : 1. To observe the effect of pre-inoculation of AM and Rhizobium leguminosarum on the disease resistance of cowpea crops infected by pathogen
2. To produce healthy and vigorous seedlings of cowpea crops

05. Rationale : Fusarium wilt is a major disease of cowpea crops. Seedling mortality seriously affected by fungal pathogen is a major problem in Bangladesh. Dual inoculation with arbuscular mycorrhizal fungi (AMF) and Rhizobium leguminousarum might help the cowpea crops to obtain the required phosphorus and other nutrient for nodulation. The root system of cowpea crops can be infected by arbuscular endomycorrhizal fungi and nitrogen fixing rhizobactria. These microorganisms are beneficial to the plant and the possibility of a direct interaction between the fungus and bacterium was considered. AM fungi play an important role in the life of plant by reducing the susceptibility or increasing the tolerance of plant, especially the roots, to plant pathogen. Modifications in plant physiology following mycorrhizal infection may explain the decrease in susceptibility to pathogen. These effects may arise through changes in pectin and lignin formation, sugar levels, phenol synthesis, amino acid concentrations, oxidative enzyme activities or ethylene production following VA mycorhizal infection. Different studies revealed that simultaneous inoculation with AM and Rhizobium leguminosarum increased plant tolerance to a variety of pathogens causes seedling disease. As such the fungi and Rhizobium might be helpful in controlling fungal seedling disease of cowpea crops. The study therefore might be undertaken.

06. Materials and methods :

07. Crop/variety : BARI Felon -1

08. Design : RCB
Treatment : 08 (Eight)
1. Arbuscular mycorrhiza (AM)
2. Rhizobium (R)
3. AM + Rhizobium

4. Pathogen
5. Pathogen + AM
6. Pathogen + Rhizobium
7. Pathogen + AM + Rhizobium
8. Control

Replication : 04 (Four)

09.	Plot size	:	Pot study
10.	Planting system/spacing	:	
11.	Fertilizer dose and methods of application	:	Recommended dose needed in pot culture
12.	Irrigated/rainfed	:	Irrigated
13.	Data to be recorded	:	1. Seed germination 2. Seedling mortality 3. AM root colonization and spores 4. Nodule no., nodule weight, root fresh weight, shoot fresh weight, plant height, root dry weight, shoot dry weight, shoot length, 100-seed weight, yield, plant nutrient content.
14.	Investigator(s)	:	M. Rahman, SO, Joydebpur M.E. Ali, SSO, Joydebpur M.F.A. Anik, SO, Joydebpur M.N. Islam, SO, Plant Pathology Division, Joydebpur H.M. Naser, CSO, SSD, Joydebpur
15.	Season	:	Rabi
16.	Date of initiation	:	2021-2022
17.	Date of completion	:	2024
18.	Expected output/benefit	:	1. Mortality of different cowpea crop seedlings will be contrilled by a biological mean using AM fungi and Rhizobium. 2. Healthy and vigorus seedlings of cowpea crops will be produced.
19.	Location	:	Net House, SSD, Joydebpur, Gazipur
20.	Status	:	On going
21.	Estimated Cost	:	Tk. 30,000/-
22.	Source of fund	:	BARI
23.	Priority	:	1st

01. Programme : Soil Management

02. Project : Microbiological Aspects of Soil Management

03. **Experiment 10** **: Study on symbiotic, biochemical and molecular characterization of Rhizobial strains isolated from different AEZs and their PGPR activity and N_2 fixation properties in pulse and oil seed legume**

04. Objective(s) : 1. To isolate and identify effective rhizobial strains from acidic, drought, saline and hilly areas of Bangladesh.
2. To measure nodulation test of collected strains in respective crops.
3. To measure plant growth promoting activity and N fixation capacity in respective crops.
4. Genomic DNA isolation, PCR amplifications and sequencing to know family, genus and species of effective rhizobial strains.

05. Rationale : Rhizobia are soil bacteria capable of forming nodules and establishing symbiosis with the roots of legumes plants. During the process of symbiotic association, rhizobia reduce free N_2 to nitrogen compound ammonia that is a usable nitrogen resource for the plants. The capability of rhizobia to fix nitrogen has significantly reduced the dependence of agriculture on nitrogen fertilizers. The populations and variety of rhizobia represent a valuable bio-resource for the exploitation of bacterial selection in attempts to find bacterial strains with desirable traits that maximize legume crop productivity. Therefore, investigations of the diversity, dynamics, and characteristics of rhizobia residing in acidic, drought, saline and hilly soils of different AEZs have practical importance in both ecology and agriculture. Such studies not only facilitate the discovery of unknown rhizobia but also support research efforts aimed at selecting effective combinations of *Rhizobium*-legume genotypes to exploit the enormous potential of increased nitrogen fixation. Owing to the ecological and economic importance of these microorganisms, their diversity and taxonomy have been needed to extensively investigation. Moreover, many rhizobial bacteria strains were collected before from different locations which have no genetic information about the strains belongs to which genus and species. So, it is very important to need genetic information of BARI collected rhizobial strains and their further research for large scale biofertilizer production for BARI mandates pulse and oil seed legume.

06. Materials and methods : Isolation and identification, preservation, characterization and PGPR activity will be done following in standard laboratory protocol. Genomic DNA isolation, PCR amplification, Gel extraction, Cloning and Sequencing and Phylogenetic analysis will be performed following respective molecular protocol.

07. Crop/variety : Pulses and oil seed legume

08.	Design	:	- Treatment Replication
09.	Plot size	:	-
10.	Planting system/spacing	:	-
11.	Fertilizer dose and methods of application	:	-
12.	Irrigated/rainfed	:	-
13.	Data to be recorded	:	Data will be recorded according to respective bacterial characters and respective plant growth properties.
14.	Investigator(s)	:	M.E. Ali, SSO, Joydebpur M. A. Yousuf Akhond, CSO, Biotechnology Division, Joydebpur Mainul Islam, SSO, Plant Pathology Division M.F.A. Anik, SO, Joydebpur M. Rahman, SO, Joydebpur
15.	Season	:	All year round
16.	Date of initiation	:	2018
17.	Date of completion	:	2025
18.	Expected output/benefit	:	Preserve effective Rhizobial strains as genetic materials for biofertilizer production and future research. Rhizobial strain genome sequencing to know family, genus and species of effective Rhizobial strains and get accession number from NCBI and store in BLAST database.
19.	Location	:	Rahmatpur, Jessore, Joydebpur, Hathazari, Rajshahi, Dinajpur, Rangpur, Ishurdi, Khagrachari, Raikhali, Patuakhali, Sathkhira, Noakhali, Cox's Bazar, Sylhet and different AEZs.
20.	Status	:	On-going
21.	Estimated Cost	:	Tk.150,000/-
22.	Source fund	:	BARI
23.	Priority	:	1st
01.	Programme	:	Soil Management
02.	Project	:	Microbiological Aspects of Soil Management
03.	**Experiment 11**	**:**	**Effect of Arbuscular mycorrhizal inoculation on maize at different salinity levels**

04. Objective(s) : 1. To evaluate the role of AMF and the percentage of AM colonization on growth and nutrient uptake of maize under salinity stress condition.
2. To observe the effect of AM under salinity stress condition.
3. In order to further understand salt tolerance mechanisms in inoculated plants.

05. Rationale : Bangladesh is probably the biggest delta in the world with total area of 147,570 km^2 formed by the three great river systems of Ganges, Brahmaputra and Meghna. About 80% of the country area of 1.45.000 sq-km is featured with 310 rivers and their floodplains, which support life, livelihoods, economy and ecology of the whole delta. The coastal region covers almost 29,000 km^2 or about 20% of the country. Again, the coastal areas of Bangladesh cover more than 30% of the cultivable lands of the country. About 53% of the coastal areas are affected by salinity. Agricultural land use in these areas is very poor, which is much lower than country's average cropping intensity. Moreover, climate change is an important issue now a day. Various anthropogenic impacts on the environment making the world hot to hotter. The ultimate result is global warming, *ie.* Climate change. Rising temperature in the atmosphere causes sea level rise and affects low lying coastal areas and deltas of the world. In 1990, Intergovernmental Panel on Climate Change estimates that with a business-as-usual scenario of greenhouse gas emission, the world would be 3.3^0C warmer by the end of the next century, with a range of uncertainty of 2.2 to 4.9^0C (Warrick *et al*., 1993). With rise in temperature, sea level will rise because of thermal expansion and ice melt. Salinity causes unfavorable environment and hydrological situation that restrict the normal crop production throughout the year. The factors which contribute significantly to the development of saline soil are, tidal flooding during wet season (June-October), direct inundation by saline water, and upward or lateral movement of saline ground water during dry season (November-May). The severity of salinity problem in Bangladesh increases with the desiccation of the soil. It affects crops depending on degree of salinity at the critical stages of growth, which reduces yield and in severe cases total yield is lost. Increasing rate of saline water in agricultural fields leads to a major threat to plant production and hence retards the growth and development of plants (Rabie and Almadini, 2005; Pascal *et al*., 2005; Shokri and Maadi, 2009) by affecting various metabolic processes.

Bhatisak found more tolerant (8-12 ds/m) in saline condition compared to radish, red amaranth which resulted higher yield and income. Bottle gourd, been and sweet gourd are more remunerative than other root (radish, carrot) and fruit type vegetables (Lady's finger, bitter gourd). Other salt tolerant non-rice-e.g. Chilli, carrot, sugar beet, barley etc. grows well in these areas. We must try to be introduced other crops in these salinity

areas.

Scientists have put an effort to minimize the crop loss due to salt stress by providing salt-tolerant crop plants (Gallagher, 1985; Evelin *et al.,* 2009) and also established salt-tolerant crops through breeding (Cuartero and Fernandez-Munoz, 1999; Evelin *et al*., 2009). In addition, different genes have also been employed to enhance the salt tolerance in different plants (Wei-Feng *et al*., 2008; Tang *et al.,* 2005; Evelin *et al*., 2009). Leaching of excess accumulated salts in groundwater also provides an alternative means to alleviate the salt stress. But these techniques are very costly and unaffordable to underdeveloped countries. Among the environmental stress, soil salinity globally results in the greater loss in agricultural productivity and therefore affecting the lives of humans and animals (Aggarwal *et al*., 2012). Plants grown in fields are surrounded by various microorganisms such as bacteria and fungi that help and improve the plant growth and yield under various stress conditions (Creus *et al*., 1998). To cope with this stress, AM fungi play a key role in alleviating the toxicity induced by salt stress, thus normalizing the uptake mechanism in plants by supplying the essential nutrients. In this way, the plant recovers the water balance machinery, enhancing their tolerance capacity and thereby enduring the salt stress (Carretero *et al.*, 2008; Porcel *et al*., 2012). AM fungi form symbiotic associations with most of the plants and enhance the tolerance capacity to withstand the abiotic stresses including salinity besides increasing the uptake of inorganic nutrients (Hajbagheri and Enteshari, 2011; Rabie and Almadani, 2005). AM fungi supply mineral nutrients to plants, especially phosphorus, which is precipitated by the ions such as Ca, Mg, Zn (Al-Karaki *et al.,* 2001).

Salinity problem received very little attention in the past. It has become imperative to explore the possibilities of increasing potential of these (saline) lands for increased production of crops. Thus is necessary to have an appraisal or summing-up of the present state of land areas affected by salinity.

06. Materials and methods : -

07. Crop/variety : Maize/BARI Hybrid Maize-9

08. Design :

Factorial RCB

Treatment : 10 (Ten)
Factor A (concentration of salt)
0, 2, 4, 6 and 8 dsm^{-1}
Factor B (AM inoculation)
With AM
Without AM

Replication : 04

09.	Plot size	:	Pot study
10.	Planting system/spacing	:	
11.	Fertilizer dose and methods of application	:	As per recommended in pot culture.
12.	Irrigated/rainfed	:	
13.	Data to be recorded	:	Plant height, no. of cob plant^{-1}, no. of filled and unfilled grain panicle^{-1}, weight of thousand grains, grain and straw yield pot^{-1}, nutrient content.
14.	Investigator(s)	:	M. Rahman, SO, SSD, Joydebpur M.E. Ali, SSO, SSD, Joydebpur M.F.A. Anik, SO, SSD, Joydebpur H.M. Naser, CSO, SSD, Joydebpur
15.	Season	:	Kharif
16.	Date of initiation	:	2021-2022
17.	Date of completion	:	2024
18.	Expected output/benefit	:	The role of AMF and the percentage of AM colonization on growth and nutrient uptake of respective crop under salinity stress as well as the effect of AM under salinity stress condition will be find out.
19.	Location	:	Joydebpur
20.	Status	:	2nd year
21.	Estimated Cost	:	Tk. 30,000/-
22.	Source of fund	:	BARI
23.	Priority	:	1st
01.	Programme	:	Soil Management
02.	Project	:	Microbiological Aspects of Soil Management
03.	**Experiment 12**	**:**	**Effect of bio-fertilizer and chemical fertilizers on nodulation pattern, nodule initiation date and yield of pulse crop varieties**
04.	Objective(s)	:	1. To know the microbial population status, nodulation pattern and nodule initiation date of chickpea varieties. 2. To increase the yield of chickpea by using bio-fertilizer with low input cost

05. Rationale : Today, global agriculture is at crossroads as a consequence of climatic change, increased population pressure and detrimental environmental impacts. Increased population needs more food to live on the earth. Bangladesh is a developing country. Most of the people are closely related to the cultivation of land. They only produce rice to feed the family members as well as to feed the nation. Pulse crops are a cheapest source of protein for the poor people. They are not interested to produce pulse crops because of their low yield potential. If we want to increase the yield of pulse crops then we have to use bio-fertilizer besides chemical fertilizer to save the environment as well as to improve the soil fertility. Bio-fertilizers have attracted greater attention particularly in developing countries like Bangladesh as a substitute for costly chemical fertilizers. They can be applied to seed, root or in order to soil mobilize the availability of nutrients by their biological activity and turn the soil health in general. Bio-fertilizers provide eco-friendly organic agro input and are more cost effective then chemical fertilizers (Amutha *et al*., 2014). Bio-fertilizers are living cells of different types of microorganism (bacteria, algae, fungi), which have an ability to mobilize nutritionally important elements from non-usable form. These microorganisms require organic matter for their growth and activity in soil and provide valuable nutrients to the plant (Saini *et al.*, 2004). Biofertilizers are ecofriendly fertilizer, which improve soil quality and provide yield increments. It greatly benefit farmer with only very small input cost (Kumudha, 2005; Kumudha and Gomathinayagam, 2007).Use of bio-fertilizer and organic manure in agriculture is becoming popular nowadays not only in order to minimize the cost of chemical fertilizers but also to reduce the adverse effects of chemical fertilizers on soil and plant environment and to ensure more crop productivity (Viyas, 1988).

06. Materials and methods : -

07. Crop/variety : Grasspea
Varieties-
1. BARI Khesari-3
2. BARI Khesari-4
3. BARI Khesari-6

08. Design : RCBD (Factorial)
Factor I: Fertilizer combinations
T_1: 100% PKSZnB
T_2: *Rhizobium* + 100% PKSZnB
T_3: 100%NPKSZnB

Factor II: Variety
V_1: BARI Khesari-3
V_2: BARI Khesari-4
V_3: BARI Khesari-6

Replication : 04 (Four)

09.	Plot size	:	3 m × 2 m
10.	Planting system/spacing	:	-
11.	Fertilizer dose and methods of application	:	50-22-42-20-5-1 kg N-P-K-S-Zn-B ha^{-1}. All the fertilizers except N will be applied as basal at final land preparation. N will be applied in three equal splits at 10, 20 and 30 days after sowing.
12.	Irrigated/rainfed	:	Irrigated
13.	Data to be recorded	:	Date of sowing, nodule number, nodule weight, nodule initiation date, root weight, shoot weight, root length, shoot length, plant height, no. of branch per plant, plant population/m^2, no. of pods per plant, no. of seeds per pod, 1000-seed weight, date of flowering, date of harvesting, nutrient content of seed and stover, soil physical, chemical and microbiological status of initial and post-harvest soil. For nodule initiation date plant samples with roots will be uprooted at alternate days starting from 7 DAS. Nodulation pattern data will be taken from 7 days interval up to harvesting.
14.	Investigator(s)	:	M.F.A. Anik, SO, SSD, BARI, Gazipur M. E. Ali, SSO, SSD, BARI, Gazipur M. Rahman, SO, SSD, BARI, Gazipur H.M. Naser, CSO, Joydebpur D. Sarkar, SO, RARS, Ishurdi M. J. Alam, SSO, RARS, Ishurdi F.S. Shikha, SO, RARS, Jamalpur M.A. Salam, SSO, RARS, Ishurdi
15.	Season	:	Rabi
16.	Date of initiation	:	2017-2018
17.	Date of completion	:	2024
18.	Expected output/benefit	:	Nodulation pattern, nodule initiation date, nutrient uptake and microbial population status of different pulse crops will be find out
19.	Location	:	BARI, Gazipur, RARS, Jamalpur and RARS Ishurdi, Pabna.
20.	Status	:	2nd year
21.	Estimated Cost	:	Tk. 40,000/- per location
22.	Source fund	:	BARI
23.	Priority	:	1st

01. Programme : Soil Management

02. Project : Microbiological Aspects of Soil Management

03. **Experiment 13** : **Effect of Arbuscular mycorrhizal fungi, biochar and vermicompost on maize in saline soil**

04. Objective(s) : 1. To evaluate the effect of indigenous Arbuscular Mycorrhizal Fungi (AMF), biochar and vermicompost on nodulation, colonization and yield character of maize in 8 dS m^{-1} saline soil.

05. Rationale : As a resolution of our salinity problem in Bangladesh we underscore the use of biological soil amendments such as arbuscular mycorrhizal fungi, biochar and vermicompost in different rates. Arbuscular mycorrhizal fungi are pervasive and they are found in 80% of vascular plant families in existence today and fungi belonging to the order glomeromycota. Plants inoculated with mycorrhiza have been reported to improve plant growth and yield under salinity or NaCl stress conditions such as *Ocimum basilicum* (Ashoori *et al*., 2015) and *Lens culinaris* (Rahman *et al.*, 2017). Biochar is a porous, fine grained substance with a similar appearance to charcoal and are decomposed much more slowly than other organic matter in the soil. Although biochar has little plant nutrient content, its high surface area and porous structure increase the soil surface area, provide a habitat for beneficial soil microorganisms, aids in water retention and reduces leaching out of nutrients. All of these functions increase availability of nutrients to plants (Schahczenski, 2010). Vermicompost is a humus-like substance formed when organic matter is broken down by the joint action of earthworms and microorganisms (Lazcano *et al*., 2008). Vermicompostare highly porous, well aerated, well drained and have good water holding capacity. They also contain important nutrients like nitrogen, phosphorous and potassium. Increased biomass and plant height has been attributed to these properties of vermicomposts (Darzi *et al*., 2012).

However, maize is an important cereal crop of Bangladesh and we can't deny the usefulness of horizontal expansion of this important crop. There is no evidence of combined use of AM fungi, biochar and vermicompost in reclamation of saline soil using test crop maize. So, we hypothesize that the combined use of AM fungi, biochar and vermicompost can improve maize yield in saline conditions. Keeping in view the above information, present investigation was carried out to evaluate the effect of indigenous Arbuscular Mycorrhizal Fungi (AMF), biochar and vermicompost on nodulation, colonization and yield character of maize in 8 dS m^{-1} saline soil.

06. Materials and methods :

07. Crop/variety : Maize/BARI Hybrid Maize-9

08.	Design:	:	RCB i) Treatment : 10 (Ten) T_1: Control T_2: AM T_3:Biochar @ 10 t ha^{-1} T_4:Vemicompost @ 3 t ha^{-1} T_5: AM + Biochar @ 5 t ha^{-1} T_6: AM + Biochar @ 10 t ha^{-1} T_7: AM + Vemicopmost @ 3 t ha^{-1} T_8: AM + Vemicompost @ 6 t ha^{-1} T_9: Biochar @ 5 t ha^{-1}+ Vemicompost @ 3 t ha^{-1} T_{10}: AM + Biochar @ 5 t ha^{-1}+ Vemicompost @ 3 t ha^{-1} ii) Replication : 04 (Four)
		:	
09.	Plot size	:	Pot study
10.	Planting system/spacing	:	
11.	Fertilizer dose and methods of application	:	As per recommended in pot culture.
12.	Irrigated/rainfed	:	Irrigated
13.	Data to be recorded	:	1. Seedling emergence 2. Yield and yield components 3. Uptake of salt 4. Uptake of other nutrients 5. Root colonization and spore population
14.	Investigator(s)	:	M. Rahman, SO, SSD, Joydebpur M.E. Ali, SSO, SSD, Joydebpur M.F.A. Anik, SO, SSD, Joydebpur H.M. Naser, CSO, SSD, Joydebpur
15.	Season	:	Rabi
		:	
16.	Date of initiation	:	2021-2022
		:	
17.	Date of completion	:	2024
		:	
18.	Expected output/benefit	:	The role of AMF and the percentage of AM colonization on growth and nutrient uptake of respective crop under salinity stress as well as the effect of AM, Biochar and Vermicompost under salinity stress condition will be find out.
19.	Location	:	Net house, Soil Science Division, BARI, Joydebpur, Gazipur.
		:	
20.	Status	:	2nd year

21. Estimated Cost : Tk. 30,000/-
:
22. Source of fund : BARI
:
23. Priority : 1st

01. Programme : Soil Management

02. Project : Microbiological Aspects of Soil Management

03. **Expeerimet 1**4 **: Isolation of salt tolerant *Rhizobium* and their characterization, plant growth promoting and symbiotic performance on pulse and oilseed legume**

04. Objective(s) : 1. To isolate and identify effective rhizobial strains from coastal saline areas of Bangladesh.
2. To characterize morphological, biochemical and PGPR of effective rhizobial strains
3. To measure nodulation test of collected strains in respective crops.

05. Rationale : Saline soils cover about 380-995 million hectares of the earth's land surface. The ground water in salt affected areas is also saline and thus unfit for crop production. Therefore, the agriculture sectors face a big challenge to meet the requirements of food and raw materials for ever increasing population of the world. In case of Bangladesh, the coastal area covers about 20% of the total area and 30% of the net cultivable area (Ahmed *et al.,* 2013). Due to the climate change and decreased flow rate freshwater from the north, about 1 (one) million hectare of land in the southern region is adversely affected by salinity (Ahmed *et al.,* 2013). Rhizobia are soil bacteria capable of forming nodules and establishing symbiosis with the roots of legumes plants. During the process of symbiotic association, rhizobia reduce free N_2 to nitrogen compound ammonia that is a usable nitrogen resource for the plants. The capability of rhizobia to fix nitrogen has significantly reduced the dependence of agriculture on nitrogen fertilizers. The populations and variety of rhizobia represent a valuable bio-resource for the exploitation of bacterial selection in attempts to find bacterial strains with desirable traits that maximize legume crop productivity. Therefore, investigations of the diversity, dynamics, and characteristics of rhizobia residing in acidic, drought, saline and hilly soils of different AEZs have practical importance in both ecology and agriculture. Such studies not only facilitate the discovery of unknown rhizobia but also support research efforts aimed at selecting effective combinations of *Rhizobium*-legume genotypes to exploit the enormous potential of increased nitrogen fixation. Owing to the ecological and economic importance of these microorganisms, their diversity and taxonomy have been needed to extensively investigation. Moreover, many rhizobial bacteria strains were collected before from different locations which have no genetic information about the strains belongs to which genus and species. So, it is very important to need genetic information of BARI collected rhizobial strains and their further research for large scale biofertilizer

production for BARI mandates pulse and oil seed legume.

06.	Materials and methods	:	Isolation and identification, preservation, salt tolerance assay, biochemical characterization and PGPR activity will be done following in standard laboratory protocol.
07.	Crop/variety	:	Pulses and oilseed legume
08.	Design	:	- i) Treatment ii) Replication
09.	Plot size	:	
10.	Planting system/spacing	:	
11.	Fertilizer dose and methods of application	:	
12.	Irrigated/rainfed	:	
13.	Data to be recorded	:	Data will be recorded according to respective bacterial characters and respective plant growth properties.
14.	Investigator(s)	:	M.E. Ali, SSO, Joydebpur M. A. YousufAkhond, PSO, Biotechnology Division, Joydebpur M. SalimUddin, SSO, PGR Center, Joydebpur M MotiarRahman, SSO, Plant Breeding Division, Joydebpur M Mainul Islam, SSO, Plant Pathology Division, Joydebpur M.F.A. Anik, SO, SSD, Joydebpur M. Rahman, SO, SSD, Joydebpur
15.	Season	:	All the year round
16.	Date of initiation	:	2018-2019
17.	Date of completion	:	
18.	Expected output/benefit	:	Preserve effective salt tolerant rhizobial strains as genetic materials for biofertilizer production and future research. Rhizobial strains genome sequencing will be done to know family, genus and species of effective Rhizobial strains and get accession number from NCBI and store in BLAST database.
19.	Location	:	Noakhali, Lakhmipur, Cox's Bazar, Chittagong, Satkhira, Bhola, Borguna, Patuakhali, Satkhira and different coastal AEZs of Bangladesh.
20.	Status	:	On going

21. Estimated Cost : Tk.150,000/-

22. Source of fund : BARI

23. Priority : 1st

01. Programme : Soil Management

02. Project Microbiological Aspects of Soil Management

03. **Experment 15** **: Effects of biofertilizer, biochar and chemical fertilizers on yield and qualitative properties of Groundnut-Dhaincha-T.aman rice cropping pattern**

04. Objective(s) : 1. To study the effects of bio-fertilizer and biochar on yield and qualitative properties of groundnut
2. To reduce the use of chemical fertilizer in groundnut and rice cultivation
3. To estimate the nutrient uptake by crops and recording other quality of the soil

05. Rationale : In recent decades, the excess application of chemical fertilizers has given rise to serious environmental problems. The cost of inorganic fertilizers is very high and sometimes it is not available to the farmers causes fail to apply the inorganic fertilizers to the crop field in optimum time. On the other hand, bio-fertilizers are considered an important source of nutrients in sustainable agriculture. Nowadays, it is crucial to apply various types of biofertilizers and soil amendments to maintain the balance of soil fertility (Mariya Dainya and Ushab 2016).

Biofertilizers contain beneficial soil microorganisms that have the potential to not only reduce dependence on non-renewable input like chemical fertilizers but are also be effective in environmental protection. On the other hand, biochar has been widely studied. Biochar as a stable, highly porous, fine-grained carbon compound is produced from pyrolysis of biomass under conditions of limited oxygen (Sohi *et al*. 2010; Abbas *et al*. 2018). With a greater effectiveness than manure, biochar can reduce the soil bulk density and enhance the water holding capacity in soils (Malik *et al*. 2018). Besides this, it has other beneficial effects on both soil and crop.

Dhaincha is another cover crop that is beneficial for soil fertility and augmenting quality crop production. If we incorporate dhancha in the pattern, it will add a considerable amount of organic matter and improved the physical, chemical, and biological properties of soil. The subsequent crops highly benefited from dhaibcha incorporation. We choose T Aman because rice is our staple food. On the other hand, groundnut is an oil crop that has adequate nutritional value and health issues concerns.

Reduction of chemical fertilizers, as well as improved soil health and sustained agricultural productivity in respected pattern production, will be our target. Therefore, this study will be explored for the above-mentioned objectives.

06. Materials and methods :

07. Crop/variety : Groundnut/BARI Chinabadam-8
Dhaincha
T.Aman rice/BRRI dhan-71

08. Design : RCB
Treatment : 09 (Nine)
For groundnut :
T_1: Control/Native fertility
T_2: Biochar @ 5 t ha^{-1}
T_3: Biochar @ 10 t ha^{-1}
T_4: Biochar @ 5 t ha^{-1} + IPNS based NPKS
T_5: Biochar @ 10 t ha^{-1} + IPNS based NPKS
T_6: Biochar @ 5 t ha^{-1} + *Rhizobium* + IPNS based PKS
T_7: Biochar @ 10 t ha^{-1} + *Rhizobium* + IPNS based PKS
T_8: 100% NPKS
T_9: 100% PKS + *Rhizobium*

For Dhaincha :
Recommended fertilizer will be applied in all treatments except T_1 control and T_1 control treatment will be devoid of any dhaincha plantation.

For BRRI dhan-71:
Recommended dose of chemical fertilizer will be applied in all treatments except T_1 control.

Replication : 04 (Four)
Rhizobium strain: BARI Rah-892 for groundnut

09. Plot size : 3m × 4m

10. Planting system/spacing : For groundnut: Row to row 40 cm and plant to plant 10 cm
For dhaincha: As per recommended
For T. Aman: Row to row 20 cm and plant to plant 20 cm

11. Fertilizer dose and methods of application : For groundnut: All PKSBZn and half of N will be applied at the time of final land preparation and remaining half of N will be applied at flowering stage. Rhizobium inoculum will be applied at the rate of 30 g/kg seed.
For dhaincha: All N will be applied at the time of final land preparation
For T.aman: All PKSZn will be applied at the time of final land preparation and N will be applied in two equal installments i.e. 15-20 days and 40-45 days after transplanting.

12. Irrigated/rainfed : For groundnut: Irrigated
For dhaincha: Rainfed
For T. Aman: Irrigated

13. Data to be recorded : For groundnut: Date of sowing, nodule no., nodule weight, root weight, shoot weight, no. of leaves, no. of pod plant^{-1}, plant height, 1000-seed weight, seed yield, stover yield, pod yield, bulk density, CEC, oil content, protein content. Nutrient uptake and other parameters of soils.
For dhaincha: Plant height and plant population m^{-2}

For T. Aman: Plant height, number of effective tillers plant^{-1}, number of filled and unfilled grains panicle^{-1}, 1000 grain weight, grain and straw yield (t ha^{-1})

14. Investigator(s) : M. Rahman, SO, SSD, Joydebpur
M.M. Masud, SSO, SSD, Joydebpur
M.F.A. Anik, SO, SSD, Joydebpur
M.E. Ali, SSO, SSD, Joydebpur
H.M. Naser, CSO, SSD, Joydebpur.

15. Season : Year round

16. Date of initiation : November, 2021

17. Date of completion : November, 2023

18. Expected output/benefit : Reduction of chemical fertilizers, as well as improved soil health and sustained agricultural productivity in respected pattern production, will be found out. Residual effect of biochar and biofertilizer in subsequent crop will also be found out.

19. Location : Joydebpur, Gazipur

20. Status : 2nd year

21. Estimated Cost : Tk. 120,000/-

22. Source of fund : BARI

23. Priority : 1st

01. Programme : Soil Management

02. Project Microbiological Aspects of Soil Management

03. **Experment 16 : Isolation of phosphate solubilizing bacteria and their efficacy on the growth of barley**

04. Objective(s) : 1. To isolate the phosphate solubilizing bacteria (PSB) from rhizospheric soil from different AEZs of Bangladesh
2. To evaluate the efficacy of PSB on growth of barley

3. To monitor the soil fertility status

05. Rationale : Phosphorous (P) is the second most essential macronutrient after nitrogen for plant growth and development. Conventional farming system relies on heavy application of chemical phosphorous fertilizers to maintain optimum levels of phosphorous in agricultural soils. However, major portions (around 75% in some soils) of these soluble phosphorous are rapidly immobilized in soil which makes it unavailable for plants. Low levels of plant available P in addition to high costs of P fertilizers have warranted the use of soil microorganisms as inoculants to mobilize poorly available phosphorous present in soil. Several bacterial species are able to solubilize insoluble inorganic phosphates in-vitro among which *Bacilli*, *Rhizobia* and *Pseudomonus* are the most studied genera. This ability to dissolve insoluble calcium phosphates present in soil is termed as mineral phosphate solubilization (Mps). The basic mechanism of mineral phosphate solubilization by PSB strains entails the release of low molecular weight organic acids. The hydroxyl and carboxyl groups of organic acids chelate the cations bound to phosphate and hence convert them to plant available forms. However, P-solubilization mechanism is quite complex and depends on factors such as nutritional, physiological and growth conditions of the culture.

Barley (*Hordeum vulgare*), a member of the grass family, is a major cereal grain grown in temperate climates globally. It was one of the first cultivated grains, particularly in Eurasia as early as 10,000 years ago. Barley has been used as animal fodder, as a source of fermentable material for beer and certain distilled beverages, and as a component of various health foods. It is used in soups and stews, and in barley bread of various cultures. Barley grains are commonly made into malt in a traditional and ancient method of preparation. In 2017, barley was ranked fourth among grains in quantity produced (149 million tons) behind maize, rice and wheat. In 2019, barley production for Bangladesh was 71000 tons. Total production area of barley is 330 hectare. Barley production of Bangladesh fell gradually from 251000 tons in 1970 to 71000 tons in 2019.

Grains like oats, wheat, rye and rice play a big part in many of our diets, and with good reasons. Whole grains are packed with nutrients, including protein, fiber, B vitamins and minerals like iron and zinc. Barley is one healthy grain, however, which doesn't get the attention it deserves. Barley can help with weight loss, helps control blood sugar levels and improve insulin response, reducing risk of type 2 diabetes, helps reduce blood pressure, improves lipid profile and reduces cholesterol, which reduces risk of cardiovascular disease, helps reduce inflammation due to levels of antioxidants and phytochemicals, contains moderate protein content (10 percent) and contains a protein complex which forms gluten (although a smaller amount than wheat), high in soluble fiber, specifically beta-glucan, which is beneficial for gut health, has a low glycaemic index (GI) to assist blood glucose control and high in potassium and low in sodium and fat. According to the above discussions, following objectives will be specified to fulfill

the targets of the study.

06. Materials and Methods :

07. Crop/variety : Barley (BARI barley-6)

08. Design : RCB

Treatment
05 (Five)
T_1: Control
T_2: PSB isolates I
T_3: PSB isolates II
T_4: PSB isolates III
T_5: PSB isolates IV

Replication: 04 (Four)

09. Plot size : Pot study

10 Planting system/spacing : -

11. Fertilizer dose and methods of application : Recommended dose needed in pot culture

12. Irrigated/ rainfed : Irrigated

13. Data to be recorded :
1. Seed germination
2. Seedling mortality
3. Yield and yield component
4. Vigor index etc

14. Investigator(s) : M.F.A. Anik, SO, SSD, BARI, Gazipur
M. E. Ali, SSO, SSD, BARI, Gazipur
M. Rahman, SO, SSD, BARI, Gazipur
H.M. Naser, CSO, Joydebpur

15. Season : Rabi

16. Date of initiation : November 2020

17. Date of completion : 2024

18. Expected output/benefit : To find out best suitable PSB strain for crop production

19. Location : BARI, Gazipur

20. Status : 2nd year

21. Estimated cost : Tk. 50,000/-

22. Source of fund : BARI

23. Priority : 1st

01. Programme : Soil Management

02. Project : Microbiological Aspects of Soil Management

03. **Experment 17** **: Effect of Different Biofertilizers on the Growth and Yield of Onion**

04. Objective(s) : To find out the effectiveness of different biofertilizers for minimizing the use of chemical N and P in respect of growth and yield of Onion.

05. Rationale : Onion (*Allium cepa* L.), belonging to the family Alliaceae, is a herbaceous annual for the edible bulb production and biennial for the seed production. Onion is important spices crop of Bangladesh. It is number one spices crop in Bangladesh. It occupies about 426157 acres of land and produces about1802868 metric ton in the year 2018-2019 (BBS 2019). Raw onion has an antiseptic value through the alimentary canal. It promotes bile production and reduces blood sugar. It is rich in minerals like phosphorus and calcium, vitamin C, protein and carbohydrates. Crop production of onion is affected by several fac tors. Biofertilizers have recently gained with momentum for affecting the sustainable increase in crop yield under various agroclimatic conditions. Biofertilizers are live carrier based microbial preparations used in agriculture as low in put resources to enhance the availability of plant nutrients or promote the growth by way of synthesizing growth fac tors (Subba Rao *et al*., 1982). They are low cost effective, inexpensive and ecofriendly sources of nutrient. Role of biofertilizer on the crop growth and yield was documented by Yogita and Ram (2012). Azotobacter fixes atmospheric nitrogen independently near the root zone, thus, enhancing the available nitrogen to the soil, whereas phosphate solubilizing bacteria solubilize the soil phosphorus and make them easily available for the plants. Arbuscular Mycorrhizae (VAM) play a vital role in development of stronger root system, improved growth (Zandavalli *et al*., 2004), nutrient up take, increase tolerance of host roots to soil borne pathogens (Nelson and Achar, 2001). Uses of biofertilizers in onion pro duction, to at least partially supplement its nutrient demand and to improve soil fertility by way of the integration of different sources of plant nutrients is desired. Onion has a good response for biofertilizer inoculation due to real nature of their root morphology. Keeping in view the above facts, present study was under taken on yield parameters of onion applying various biofertilizers and graded level of chemical fertilizers.

06. Materials and methods : -

07.	Crop/variety	:	Onion
08.	Design	:	RCB i) Treatments : 09 (Nine) T_1 : 100% NPKSZn of RD (Recommended Dose) T_2 : 80% N + *Azotobacter inoculum* T_3 : 80% P + *PSB inoculum* T_4 : 50% P + *AM inoculum* T_5 : 80% NP +*Azotobacter* + *PSB* T_6 : 80% N+ 50% P +*Azotobacter* + *AM* T_7 : 50% P + *AM*+*PSB* T_8 : 80% N+ 50% P + Azotobacter +*AM*+*PSB* T_9 : Control ii) Replications : 04 (Four)
09.	Plot size	:	3m × 2m
10	Planting system/spacing	:	20cm × 10cm
11.	Fertilizers dose and methods of application	:	Blanket dose: $K_{75}S_{22}Zn_5$ kg ha^{-1} dose and Cowdung 5 t ha^{-1} Recommended dose of N and P: 100 kg ha^{-1} and 55 kg ha^{-1} All PSZn, 1/3rd K and cowdung will be applied at the time of final land preparation. Urea will be applied in 3 equal installments at 15, 30 and 55 days after transplanting. Rest of the K will be applied with last two split of urea.
12.	Irrigated/rainfed	:	Irrigated
13.	Data to be recorded	:	1. Plant height 2. Number of leaves per plant 3. Root length 4. Collar diameter (cm) 5. Bulb length (cm) 6. Bulb diameter 7. Individual bulb weight (g) 8. Yield/ plot (kg) & hectare (ton)
14.	Investigator(s)	:	M.E. Ali, SSO, SSD, Joydebpur M. Rahman, SO, SSD, Joydebpur M.F.A. Anik, SO, SSD, Joydebpur H.M. Naser, CSO, SSD, Joydebpur
15.	Season	:	Rabi
16.	Date of initiation	:	2nd week of November 2021
17.	Date of completion		1st week of July 2024
18.	Expected output/benefit	:	Effect of different biofertilizer on onion and reduction of application of N and P will be find out.

19. Location : SSD, BARI, Gazipur

20. Status : 2nd year

21. Estimated cost : 50,000 /=

22. Source of fund : BARI

23. Priority : 1st

01. Programme : Soil Management

02. Project : Microbiological Aspects of Soil Management

03. **Experment 18** : **Performance of Kazi Joibosar on growth and yield of different crop and sustainable soil health**

04. Objective(s) : i. To determine nutrient status of soils, plant and and Kazi Joibosar.
ii. To determine the best organic fertilizer application option for better growth of different crops.
iii. To determine the combination of organic and chemical fertilizer management of different crops and sustainable soil health.

05. Rationale : Continuous application of chemical fertilizer has bad impact on soil health and environment. It is an established fact that use of inorganic fertilizer for the crops is not so good for health because of residual effect but in the case of organic fertilizer such problem does not arise. Soil management practices have recently changed dramatically including an increased use in synthetic fertilizers and pesticides to help crop yields. However, some studies have suggested that the excessive use of these agrochemicals may actually increase pest problems in the long run (Altieri and Nicholls 2003). Overall, these results propose a hypothesis that higher synthetic fertilizer inputs may lead to higher levels of herbivore damage to crops (Letourneau 1996). Variety is an important factor successful crop yield. An improved variety represents higher yield than wild one. Generally nutrient requirement is determined by the variety of crops. High yielding variety requires more nutrients than the local or wild variety. Generally, it depends on its vegetative and reproductive characters. And it was also mentioned that vegetable variety and history of fertilizer use are important factors to be considered in the development of a soil nutrient management program (Huang 2006). The requirement of plants nutrients can be provided by applying inorganic fertilizer or organic manure or both. However, farmers are now showing interest in organic farming because of, they are more aware about the residual effect of chemical substances used in the crops field and environmental degradation. Besides, the excess application of inorganic fertilizer causes hazard to public health and to the environment. But the application of both organic and inorganic fertilizer combined, can increase the yield as well as keep the environment sound (Hsieh *et al*. 1996). Considering the above factors,

the present experiment was undertaken to identify the organic fertilizer (KaziJoibosar) dose along with chemical fertilizer that could be suggestive for growth of different crops for the farmers of Bangladesh. In addition, attempt was undertaken to determine the best organic fertilizer option for better growth of different crops and to determine the combination of organic and chemical fertilizer management of different crops.

06. Materials and methods : Standard methods will be followed

07. Crop/variety : Wheat (BARI wheat-30), Potato (BARI Potato -46), Tomato (BARI Tomato-14), Brinjal (BARI Brinjal-9)

08. Design : : RCB

i) Treatment : i) Treatment : 8 (Eight)
T_1: Control
T_2: 100% Recommended fertilizer dose (RFD)
T_3: 80% RFD,
T_4: 80% RFD + 2.5 t ha^{-1} Kazi Joibosar (KJS)
T_5: 80% RFD + 5 t ha^{-1} KJS
T_6: 70% RFD + 5 t ha^{-1} KJS
T_7: 80% RFD + 5 t ha^{-1} CD

ii) Replications : 04 (Four)

09. Plot size : 2m × 3m

10. Planting system /spacing : Standard planting system and spacing will be followed for respective crops

11. Fertilizer dose and methods of application : All PKSZnB will be applied as basal during final land preparation. Nitrogen will be applied as urea in three equal splits, 1^{st} dose will be used 10-15 DAS, 2^{nd} dose will be used 30-35 DAS, and rest at 40-45 DAS (flower initiation stage). Biofertilizer will be applied instead of urea in respective plot.

12. Irrigated/rainfed : Irrigated

13. Data to be recorded : Date of sowing, root weight, shoot weight, plant height, root length, no. of leaves, Time of flowering, Time of maturity; Time of harvest, Fruit diameter; No. of fruit $plant^{-1}$, weight of fruit/plant Yield $plot^{-1}$, Nutrient content and uptake by tomato/brinjal, wheat/ potato.

14. Investigator(s) : M.E. Ali, SSO, SSD, Joydebpur
M.F.A.Anik, SO, SSD, Joydebpur

15. Season : Robi

16. Date of initiation : July 2021

17. Date of completion : June 2023

18. Expected output/benefit : i) Nutrient status of soils, plant and and Kazi Joibosar will be determined.
ii) Methods of combined application of organic and chemical fertilizer will be established for better growth of different crops.
iii) Combination of organic and chemical fertilizer management of different crops and sustainable soil health will be studied.

19. Location : Joydebpur, Gazipur

20. Status (1^{st} year/2^{nd} year/3^{rd} year) : 3^{rd} year

21. Estimated cost : 4,00,000/-

22. Source of fund : Kazi Farms Limited, Dhanmondi, Dhaka

23. Priority : 1^{st}

01. Programme : Soil Management

02. Project : Microbiological Aspects of Soil Management

03. **Experiment 19 : Effect of different fertilizer combination on groundnut in Barishal region**

04. Objective (s) : i. To find out the response of BARI Chinabadam to different fertilizer.
ii. To determine the optimum dose of nutrient to maximizing the yield of BARI Chinabadam-9.

05. Rationale : Groundnut (Arachis hypogaea L.) also known, as peanut, earthnut or monkey-nut is one of the most important legume oil seed crops in Bangladesh (Shahjahanet al., 2004).Groundnut is a versatile crop. In addition to about 45% high quality oil, it contains more than 25% highly assumable proteins, 20% carbohydrates, unsaturated fats and magnesium as well as vitamin E and D. Being a legume it can enrich the soil with N without draining the non-renewable energy and without upsetting the agro ecological balance. Groundnut is a cash crop. It is an excellent edible oil seed crop. In Bangladesh, there were 32 thousand hectares of land were cultivated under groundnut cultivation and the production was 47 thousand metric ton (KPHB, BARI, 2020).Groundnut is well grown in the river bank and medium high land of Bangladesh. Apart from harvesting peanut, the plants can be used as cattle feed and fuel. The yield of groundnut (local variety) per hectare in Bangladesh is very low (1150 kg/ha) (Anon., 2004). There is ample scope for increasing production through proper fertility management with modern developed variety. BARI groundnut varieties are well and

their production ranges in between 1.8-2.8 ton per hectare (KPHB, 2020). After covid-19 situation and the global changing condition, the commodities price is highly increased and edible oil is one of them. So it is very important to increase the production of oil seed crop. In Barishal region most of the farmers cultivated groundnut in Char land areas. The cultivated area of this region was1304 hectare and the production was 2485 m ton (U. Dev and S. Paramanic, 2015). The nutritional needs of groundnut must be satisfied to attain maximum yields. An adequate supply of every essential element is needed throughout the growing season. Farmers of this region interested to cultivate groundnut. Fertilizer management as well as better variety is big factor for crop cultivation. So this experiment is under taken for fertilizer management with better variety in this region.

06. Materials and Methods : The experiment will be conducted at RARS, Rahmatpur, Barishal experimental field. Nut is sowing in November 2022.

07. Crop/Variety : BARI Chinabadam-9

08. Design : RCBD

i) Treatment : 07 (Seven)
T_1: Native fertility
T_2: NPKSZnB
T_3: NPKSZnB + Vermicompost 3t/ha
T_4: PKSZnB + Vermicompost 3t/ha+ Rhizobium
T_5: PKSZnB + Rhizobium
T_6: NPKSZnB + CD 5t/ha
T_7: PKSZnB + CD 5t/ha+ Rhizobium

ii) Replications 4 (Four)

09. Plot size : 4.5 m × 3m

10. Planting system/spacing : 30cm × 15cm

11. Fertilizer dose and methods of application : According to treatments. As source of nutrients, nitrogen and phosphorus will be applied in the forms of urea and TSP; potassium as muriate of potash, sulphur as gypsum. N fertilizer was applied in two equal installments as 25 and 45 DAS. The whole amount of all other plant nutrients (P-K-S-Zn-B) will be applied as final land preparation

12. Irrigated /rainfed Mainly rainfed. Irrigated as and when necessary

13. Data to be recorded : Nodule data, Phenological parameters, yield and yield components, biomass etc.

14.	Investigator(s)	:	M.R. Islam, M.R. Uddin, M.F.A. Anik and M.E. Ali
15.	Season	:	Rabi
16.	Date of initiation	:	November, 2022
17.	Date of completion	:	May, 2025
18.	Expt. output/ benefit	:	Developed rate of nutrient requirement for groundnut in Barishal region.
19.	Location	:	RARS, Rahmatpur, Barishal
20.	Status	:	New
21.	Estimated Cost	:	Tk. 60,000/-
22.	Source of fund	:	BARI
23.	Priority	:	1st

APPENDIX

Cereal Crops:

A. Data Collection

01. Time of fertilizer application
02. Time of sowing/transplanting
03. Population of plant/m^2
04. Height of plant (cm)
05. No. of effective tillers/m^2
06. No. of panicle or cob/m^2
07. No. of filled and unfilled grain panicle^{-1}
08. Weight of 1000 grains
09. Infestation of pest and disease
10. Time of flowering
11. Time of maturity
12. Time of harvesting
13. Grain and straw yield plot^{-1} and t ha^{-1}
14. Moisture content of grain and straw plot^{-1} and t ha^{-1}
15. Nutrient content of soil before sowing and after harvest
16. Nutrient content of grain and leaf straw^{-1}
17. Soil physical parameters before sowing and after harvest

B. Sample collection

1. Soil sample to be collected from each plot before fertilizer application and at harvest.

2. Grain and leaf straw^{-1} to be collected from each plot at harvest.

Pulse Crops:

A. Data Collection

01. Time of fertilizer application
02. Time of sowing/transplanting
03. Population of plant/m^2
04. Height of plant (cm)
05. No. of effective nodules plant^{-1}
06. Weight of nodules plant^{-1}
07. No. of filled and unfilled grain pod^{-1}
08. Weight of 1000 grains
09. Infestation of pest and disease
10. Time of flowering
11. Time of maturity
12. Time of harvesting
13. Grain and straw yield plot^{-1} and t ha^{-1}
14. Moisture content of grain and straw plot^{-1} and t ha^{-1}
15. Nutrient content of soil at sowing and harvest
16. Nutrient content of grain and leaf straw^{-1}
17. Nutrient content of grain and leaf straw^{-1} root^{-1}
18. Soil physical parameters before sowing and after harvest

B. Sample collection

1. Soil sample to be collected from each plot before fertilizer application and at harvest.

2. Root with nodules to be collected from each plot at 50% flowering and at harvest. Grain and leaf/straw to be collected from each plot at harvest for legume crops.

Oilseed Crops:

A. Data Collection

01. Time of fertilizer application
02. Time of sowing
03. Population of plant/m^2
04. Height of plant (cm)
05. No. of effective pod $plant^{-1}$
06. No. of filled and unfilled grain pod^{-1}
07. Weight of 1000 grains
08. Infestation of pest and disease
09. Time of flowering
10. Time of maturity
11. Time of harvesting
12. Grain and straw yield $plot^{-1}$ and per ha
13. Moisture content of grain and straw $plot^{-1}$ and per ha
14. Nutrient content of soil at sowing and at harvest
15. Nutrient content of grain and leaf $straw^{-1}$
16. Soil physical parameters before sowing and after harvest

B. Sample collection

1. Soil sample to be collected from each plot before fertilizer application and at harvest.

2. Root with nodules to be collected from each plot at 50% flowering and at harvest. Grain and leaf/straw to be collected from each plot at harvest for legume crops.

Tuber Crops:

A. Data Collection

01. Time of fertilizer application
02. Time of sowing/transplanting
03. Population of plant/m^2
04. Height of plant (cm)
05. No. of shoot and tuber $hill^{-1}$ and tuber weight 10 $hills^{-1}$
06. Size of tuber (grading)
07. Weight of tuber
08. Infestation of pest and disease
09. Time of flowering
10. Time of maturity
11. Time of harvesting
12. Tuber and haulm yield $plot^{-1}$ and per ha
14. Moisture content of tuber and leaf $plot^{-1}$ and t ha^{-1}
15. Nutrient content of soil at sowing and harvest
16. Nutrient content of tuber and haulm at harvest
17. Soil physical parameters before sowing and after harvest

B. Sample collection

1. Soil sample to be collected from each plot before fertilizer application and at harvest.

2. Tuber and haulm to be collected from each plot at harvest.

Fruit Crops:

A. Data Collection

1. Time of fertilizer application
2. Time of sowing/transplanting
3. Height of plant (cm) at first flowering and at harvest
4. Weight and size of fruit plant^{-1}
5. Infestation of pest and disease
6. Time of flowering
7. Time of maturity
8. Time of harvesting
9. Fruit and leaf yield t ha^{-1}
10. Moisture content of fruit and leaf t ha^{-1}
11. Nutrient content of soil at sowing and harvest
12. Soil physical parameters before sowing and after harvest
13. Nutrient content of fruit and leaf at harvest
14. Girth of trunk measurement
15. Measurement of Crop Canopy.
16. No. of female spikelet tree^{-1}.
17. No. of male spikelet tree^{-1}
18. No. of female spikelet dropped tree^{-1}
19. No. of Jackfruit tree^{-1}
20. No. of deformed shape Jackfruit
21. No. of well-developed Jackfruit.
22. Size of Jackfruit (Length and Breadth)
23. No. and weight of pulp Jackfruit^{-1}
24. No. of seeds Jackfruit^{-1}
25. Weight of rind (kg).

B. Sample collection

1. Soil sample to be collected from each plot before fertilizer application and at harvest.

2. Fruit and leaf to be collected from each plot at harvest.

Vegetable Crops:

A. Data Collection

01. Time of fertilizer application
02. Time of sowing/transplanting
03. Population of plant/m^2
04. Height of plant (cm) at first flowering and at harvest
05. No. of effective leaves plant^{-1}

06. Weight and size of vegetable fruit or head/plant
07. Infestation of pest and disease
08. Time of flowering
09. Time of maturity
10. Time of harvesting
11. Vegetable fruit head^{-1} and leaf yield plot^{-1} and t ha^{-1}
12. Moisture content of fruit head^{-1} and leaf plot^{-1} and t ha^{-1}
13. Nutrient content of soil at sowing and harvest
14. Nutrient content of vegetable fruit head^{-1} leaf at harvest
15. Soil physical parameters before sowing and after harvest

B. Sample collection

1. Soil sample to be collected from each plot before fertilizer application and at harvest.
2. Vegetable fruit head^{-1} and leaf to be collected from each plot at harvest.

Spice Crops:

A. Data Collection

01. Time of fertilizer application
02. Time of sowing/transplanting
03. Population of plant/m^2
04. Height of plant (cm)
05. No. of effective leaves plant^{-1}
06. Weight and size of spice bulb or rhizome plant^{-1}
07. Infestation of pest and disease
08. Time of flowering
09. Time of maturity
10. Time of harvesting
11. Spice bulb or rhizome and leaf yield plot^{-1} and t ha^{-1}
12. Moisture content of bulb rhizome^{-1} and leaf plot^{-1} and t ha^{-1}
13. Nutrient content of soil at sowing and harvest
14. Nutrient content of spice bulb rhizome^{-1} and leaf at harvest
15. Soil physical parameters before sowing and after harvest

B. Sample collection

1. Soil sample to be collected from each plot before fertilizer application and at harvest.
2. Spice bulb rhizome^{-1} and leaf to be collected from each plot at harvest.

Ornamental Plants:

1. Percent of germination
2. Days for spike emergence
3. No. of leaves
4. Days of first florets blooming
5. Length of spike (cm)
6. Length of rachis (cm)
7. No. of floret rachis^{-1} spike^{-1}
8. Length of florets (cm)
9. Diameter of florets
10. Plant height
11. Disease infestation if any

Green manuring crops:

Data to be recorded :

1. Biomass and Moisture content to be recorded at 40-50 days after sowing from 1 sq. meter area (at least 3 spots) of the plot.
2. Crops to be ploughed down at 40-50 days after sowing.

Soil Physical Properties:

1. Texture
2. Bulk density
3. Porosity
4. Infiltration characteristics
5. Field capacity moisture content
6. Wilting point moisture content
7. Initial and harvest time soil moisture content
8. Moisture content before and after each irrigation for irrigation experiment
9. Soil temperature

Climatic Data:

1. Rainfall
2. Temperature (maximum and minimum)
3. Humidity
4. Pan evaporation
5. Solar radiation
6. Sun shine hours
7. Wind speed

SOIL SCIENCE DIVISION
BANGLADESH AGRICULTURAL RESEARCH INSTITUTE
JOYDEBPUR, GAZIPUR-1701

Recommendations and Suggestions of the Internal Research Review and Program Planning Workshop 2021-2022

Sl. No.	Recommendations and Suggestions	Action Taken
Project I: Physical Aspects of Soil Management		
01.	Booklet should be made for Kc values of different crops done in different years.	Suggestion will be followed
02.	Determination of Kc and ETc values should be done for more vegetables crop	Suggestion already been followed
03.	Field validation of Kc values based on water requirement should be conducted	Suggestion will be followed
04.	For organic based experiments C:N ratio should be measured	Suggestion will be followed
05.	Write red amaranth instead of red amaranthus	Already been written
06.	Crop sequence should be maintained for cropping pattern experiments	Already been maintained
07.	Write available phosphorus instead of total phosphorus in phosphorus experiment	Already been written
08.	Root proliferation data should be counted for tillage experiments	Suggestion will be followed
09.	In organic fertilizer-based experiments, entomologist and pathologist should be included for maintaining GAP protocol.	Suggestion will be followed
10.	Scientist number should be increased to conduct experiments precisely	-
Project II : Chemical Aspects of Soil Management		
01.	When estimating nitrogen use efficiency, placement and earthing up of USG should be considered.	Suggestion will be followed
02.	Nitrous oxide emission data should be included.	Data will be included in the next year
03.	Banana peel fertilizer production should be increased and experiments should be taken in the field condition. Banana peel fertilizer has adverse effect; care should be taken while using Banana peel fertilizer.	Suggestion will be followed
04.	How much nutrient content in Banana fertilizer? Analysis should be determined.	Nutrient content data has been included
05.	Mg fertilizer should be written in elemental form instead of Magnesium sulphate chemical formula.	Followed
06.	When calculating carbon accumulation in soil, soil depth should be considered.	Followed
07.	Fertilizer recommendation should be done on fruit crops especially for mango.	Followed
08.	Fertilizer and irrigation scheduling should be combined during fruit crop cultivation.	will be considered
09.	The use of nano technology should be increased in fruit crops.	Will be taken
10.	Minimum tillage and mulching have not been meaningful. It should be redesigned.	Action taken

Sl. No.	Recommendations and Suggestions	Action Taken
11.	Greenhouse gas emissions measurement should be done in proper way.	Will be taken
12.	pH should be checked in High Gangetic areas experiment.	Followed
13.	How much biomass is added through mungbean, it should be checked.	Followed
14.	Optimum amount of biochar should be used.	Considered
15.	Soil physiochemical properties should be checked annually.	Will be followed
16.	Soil salinity variation changes the soil profile. It should be explained.	Followed
17.	Nano fertilizer with biochar related work should be taken.	Will be done
18.	IPNS based experiment should be taken.	Followed
19.	In case of leguminous crops, it is better to add molybdenum.	Will be considered
20.	In the plant density experiment, they only used high and low density. Medium density should be added.	Followed
21	Recommended dose of fertilizer should be written clearly.	Followed
22	AEZ should be mentioned in abstracts.	Followed
23	In vermicompost related experiment, pH, sulphur, zinc and boron should be checked.	Followed
24	For new fertilizer recommendation, previous recommendation should be required.	Considered
25	It should be checked whether it follows IPNS or not.	Checked
26	It is not needed to find out the doses using compost. One-fold or half fold whether follow IPNS or not. It should be checked.	Suggestion followed
27	Boron should be added in Chia seed experiment in the future.	Considered
28	Fertilizer treatment should be considered follow in oil seed experiment recommendation.	Considered
29	There are four treatment levels in new programme 6 & 7. It will be difficult to manage. So, reshuffling is necessary.	Treatment will be managed properly
30	Pathologists should be included in tricho compost experiment.	Suggestion followed
31	The dose of phosphorus should be increased in lentil experiment. FRG should be used for other nutrients.	Done
32	Vermicompost is not needed to add groundnut seed in Barisal soil. Manure+*Rhizobium*+Chemical fertilizer should be added.	Considered
33	In case of programme 14, consult with CSO, Jessore about vegetable then designed it.	Redesigned as per suggestion
34	The title should be rearranged as follows “Integrated nutrient management using different sources of organic manure in combination with chemical fertilizer.	Followed
35	The name of crop i.e., BARI Piaz-4/Onion should be mentioned in the title.	Followed
36	In GHG emission experiments, CSO, Soil Science should be take necessary action.	Will be considered

Sl. No.	Recommendations and Suggestions	Action Taken
Project III: Micronutrient Aspects of Soil Management		
01.	For groundnut experiment, BARI recommended fertilizer dose should be compared with FRG, 2018 dose.	The recommendations of the FRG, 2018 are based on the recommendation of fertilizers derived from Bangladesh Agricultural Research Institute.
02.	Economic study of nano fertilizer should be included.	Suggestion will be followed
03.	CV (%) value of sunflower, groundnut and critical limit experiments should be checked.	Already checked
04.	$ZnSo_4$ should be used instead of ZnO as a source of Zn for sweet orange experiment.	Suggestion will be followed
05.	Lentil experiment in Barisal region should be done in same field for 2 consecutive years and seed rate should be maintained.	Suggestion will be followed
06.	Unit should be unified for bitter gourd experiments.	Suggestion already been followed
07.	Additional boron dose should be added in sunflower experiment.	Suggestion will be followed
09.	Nutrient balance should be calculated for the future report.	Suggestion already been followed
10.	SDG, APA and GAP should be emphasized in research programme planning.	The program has been designed with priority given to the mentioned subjects
11.	Application rate of Biochar should be validated in pot before going to field experiment.	Initially cumin crop was selected for this experiment later it was changed to squash
12.	Biochar application experiment should be considered as pattern experiment instead of single crops.	Suggestion already been followed
13.	Feasibility study on Nano Zn and Nano B should be studied in Cumilla region	Suggestion already been followed
14.	For nano-fertilizers, major elements should be considered as well as micro elements.	Suggestion already been followed
15.	In black cumin programme, treatment should be rearranged.	Squash crop have already been taken in place of black cumin
16.	A feasibility study should be taken into account before beginning the arsenic experiment in Satkhira.	The experiment was canceled by the Task Force Committee
Project IV: Microbiological Aspects of Soil Management		
01.	According to the current no. of scientists in microbiology section, the no. of research should be reduced and quality should be maintained	Suggestion will be followed
02.	Experiment location name should be written correctly in case of disperse location research	Suggestion will be followed
03.	Growth media name should be mentioned properly	Suggestion already

Sl. No.	Recommendations and Suggestions	Action Taken
		been followed
04.	New experiment should be taken according to molecular basis and current and modern research activities should be reviewed	Suggestion will be followed
05.	During N fixation calculation, nodule mass measurement should be considered	Suggestion will be followed
06.	During counting microorganism colonization, correlation must be performed between number and different types of soil parameters	Suggestion will be followed
07.	Mature technology should be released as a patent	Suggestion will be followed
08.	Phosphatase activity should be observed in PDB experiment	Suggestion will be followed
09.	For inoculum performance, future research should be taken emphasizing on micronutrient rather than macro nutrient	Suggestion will be followed
10.	Biochar dose should be taken considering economic and environmental feasibility	Suggestion will be followed
11.	Salinity dose should be selected very carefully and experiment on salinity should be done with other sources of salt instead of only with sodium chloride	Suggestion will be followed
Plenary and Rapporteurs Report Presentation Session		
Sl. No.	**Recommendations and Suggestions**	**Action Taken**
Comments and Suggestion by DG, BARI		
01.	Physico-chemical properties of six unfavorable ecosystem's (hotspots) should be analyzed. In that context, new programs have to be taken	New programme already been taken
02.	Every presenter should present the source of fund in every single experiment which was approved by the funding authority	Suggestion will be followed
Comments and Suggestion by Director (Support Service), BARI		
01.	Every experiment should be supported by an economic analysis, such as a benefit-cost ratio or a financial cost statement	Suggestion will be followed
02.	The total number of approved experiments and how many will be presented in the review program should be specified	Suggestion will be followed
03.	The approved experiments which were not reported in the Annual Research Report, explanation should be given clearly for those were not able to conduct	Suggestion will be followed
04.	Before developing any technology, the Benefit Cost ratio or economic analysis of that specific technology should be done properly	Suggestion will be followed
Comments and Suggestion by Director (Research), BARI		
01.	The report should be corrected according to the comments or suggestions given by chairman, expert members and all other participants	Correction has been made as per suggestion

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Recommendations and Suggestions of the Task Force committee 2021-2022

Sl. No.	Recommendations and Suggestions	Action Taken
Project I: Physical Aspects of Soil Management		
01.	Experiment titled "Greenhouse gas emission sensitivity and reduction potentiality of Barley as influenced by irrigation and salinity management for southwestern saline areas" should be discarded	Already been discarded
Project II: Chemical Aspects of Soil Management		
02.	The word "with" should not be included in the title "Development of fertilizer recommendation for onion with linseed intercropping"	Already been corrected
03.	The words "enhancing growth" should be dropped from the title "Effect of different levels of sulphur and boron on enhancing growth, yield and nutrient uptake of sesame" should be changed	Already been dropped
04.	"Integrated Nutrient Management for" should be included instead of "organic and inorganic fertilizers on growth" in the experiment entitled "Effect of organic and inorganic fertilizers on growth, yield, quality and nutrient uptake of linseed (*Linum usitatissimuml*)"	Modification done as per suggestion
05.	"Integrated Nutrient Management on" should be included instead of "organic and inorganic fertilizer on soil properties and yield" in the experiment entitled "Effect of organic and inorganic fertilizer on soil properties and yield and yield of safflower)"	Already been included
06.	Experiment entitled "Development of fertilizer recommendation for Chia Seed" should be canceled	Already been canceled
07.	Experiment title "Quality chilli production and sustain soil health through application of tricho compost" should be changed to "Effect of tricho compost on chilli"	The experiment title has been changed
08.	The words "level of and the growth and yield of" ought to be eliminated from the title. "Effect of variety and level of phosphorus fertilizer on the growth and yield of lentil"	Words have already been removed
09.	It was suggested to adopt short and catchy titles in case of the experiment number 10 (Performance of different sesame through nutrient management in Barishal region), experiment number 12 (Integrated nutrient management and proper plant density for the popular trellis growing bitter gourd at jashore region), experiment number 13 (Sustaining a healthy growth media as influenced by organoponic approach for yield maximization and storability of summer onion), experiment number 14 (Biochar to reduce fertilizer use and soil health improvement for groundnut in Brahmaputra river charland) and experiment number 15 (Integrated nutrient management for quality potato under Jamalpur region)	The experiment titles have been changed
10.	It was suggested to add "of" after "development" in the title of the experiment "Development fertilizer recommendation for winter stem amaranthin in Cumilla region"	Already been added

Sl. No.	**Recommendations and Suggestions**	**Action Taken**
	Project III: Micronutrient Aspects of Soil Management	
11.	It was suggested to change the title of the experiment "Effect of soil and water quality on Arsenic uptake for upland irrigated winter crops in southwestern Bangladesh" to a short and catchy title [Effect of soil and water quality on Arsenic uptake by irrigated winter upland crops in southwestern Bangladesh"	The experiment title has been changed
12.	It was suggested to change the title of the experiment "Application of zinc and boron on the growth and yield of BARI Sarisha 18 (canola type)" to a short and catchy title	The experiment title has been changed
Project IV: Microbiological Aspects of Soil Management		
13.	It was suggested to change the title of the experiment "Response of different fertilizer combination on groundnut in Barishal region" to a short and catchy title	The experiment title has been changed

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Recommendations and Suggestions of the BARC Research Review and Programme Planning Workshop 2021-2022

Sl. No.	Recommendations and Suggestions	Action Taken
Project I: Physical Aspects of Soil Management		
01.	Research on soil physical properties improvement under different cropping systems should be strengthened with all NARS institute and universities	Will be followed
02.	Research program should be developed on soil management against physical land degradation	Will be followed
03.	BARI is the pioneer on determining Crop Coefficient values (*Kc*) for different crops in Bangladesh. Determination of the *Kc* values should be continued and with due priority for estimating water requirement and improving water use efficiency in different regional stations	Will be followed
04.	Research should be strengthened in the hilly areas by using diversified crops and soil conservation practices for having higher productivity and improving soil health	Will be followed
05.	Developed technology on hill soil management should be disseminated	Will be followed
06.	Critical tillage depth for different crops in major Agro-Ecological Zones (AEZs) and moisture retention status of soils under upland crops based on rice cropping systems	Will be followed
07.	Studies on improvement of soil organic carbon stock and climate change mitigation through residue recycling, organic manuring and conservation tillage should be strengthened	Will be followed
08.	Research on unfavorable ecosystem like saline (coastal), drought, char land, haor area etc. should be strengthened for successful crop production through improvement of soil physical environment	Will be followed
Project II: Chemical Aspects of Soil Management		
01.	Fertilizers application protocol of farmers should be properly captured by researchers	Will be followed
02.	When appropriate, soil series name followed by soil texture should be mentioned in the report	Will be followed
03.	GPS data should be included in the experiment	Will be followed
04.	Treatments should be designed according to the hypothesis. Treatments should be complete and avoid of compounding	Will be followed
05.	In case of liming experiment, lime requirement should be determined before field experiment.	Will be followed
06.	Standard sampling technique should be mentioned with reference	Will be followed
07.	Extrapolation area of the research findings should be mentioned.	Will be followed
08.	Comparison of treatments like (i) 50% RD, (ii) 100% RD, (iii) 150% or (ii) T1, T2 ----------T10 with different combinations of nutrient doses cannot determine optimum doses of different nutrient	Will be followed

Sl. No.	Recommendations and Suggestions	Action Taken
09.	Site-specific nutrient management (SSNM) technique should be used for optimum doses of fertilizers	Will be followed
10.	Researchers should compare different fertilizer recommendation models	Will be followed
11.	Experimental data of numerical variables should be presented in line graph with regression equations	Will be followed
12.	Research in problem areas like coastal areas, char lands, haor areas etc. should be strengthened	Will be followed
13.	Vermicompost and bio slurry should be studied in depth	Will be followed
14.	Carbon sequestration research should be taken	Will be followed
15.	Climate smart agriculture research should be taken into consideration with nutrient management	Will be followed
16.	Fate of applied fertilizers in crop fields should be studied properly	Will be followed
Sl. No.	**Recommendations and Suggestions**	**Action Taken**
Project III: Micronutrient Aspects of Soil Management		
01.	Updating of micronutrient status (Zn and B) of soils and investigating new micronutrients eg. Mn, Mo and other trace elements deficiencies in different AEZs of Bangladesh	Will be followed
02.	More researches should be conducted on the determination of critical limits of micronutrients for soils and different crops	Will be followed
03.	Pollution reduction and remediation of polluted soils by different heavy metals should be strengthened	Will be followed
04.	Micronutrient bio-fortification research should be strengthened to emphasize on the production of safe and nutritious food	Will be followed
05.	Bio-fortification of zinc (Zn), iron (Fe) and selenium (Se) in food grains, fruits and vegetables by using Nano-fertilizer and conventional fertilizer	Will be followed
06.	Health risk assessment and remediation of different heavy metals in soil-water-plant and food chain	Will be followed
07.	Development of standard protocol for the measurement of micronutrients including essential and non-essential heavy metals using certified reference materials (CRMs)	Will be followed
08.	Micronutrient availability should be considered during liming	Will be followed
Project IV: Microbiological Aspects of Soil Management		
01.	Field trial/multi-location trial using developed biofertilizer/ inoculants for nitrogen (N) fixing (symbiotic, associative), P solubilizing and plant growth promoting rhizobacteria (PGPR) for increasing availability of NPK and other nutrients and yield in major crops should be conducted	Will be followed
02.	Biodiversity and characterization of soil microorganisms in different AEZs of Bangladesh should be continued	Will be followed
03.	Biochemical and molecular characterization of beneficial and efficient microorganisms for increasing crop yield and improvement of soil health should be strengthened	Will be followed
04.	Management of plant diseases using efficient microorganisms should be researched	Will be followed
05.	Development of climate-smart biofertilizer for sustainable crop production under adverse soil conditions	Will be followed
06.	Studies on remediation of environmental pollution through soil microbiological approaches should be conducted	Will be followed