Project ID: 432

Competitive Research Grant (CRG)

Sub-Project Completion Report

on

"Adaptation to Climate Change and Sustainable Livelihood through Moringa Based Agroforestry Practice in Bangladesh"

Project Duration:

July 2017 to September 2018

Submitted By:
Department of Agroforestry and Environmental Science
Sher-e-Bangla Agricultural University, Dhaka

Submitted to
Project Implementation Unit (PIU)-BARC
National Agricultural Technology Program: Phase II
Bangladesh Agricultural Research Council
Farmgate, Dhaka 1215

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Acronyms

BARC : Bangladesh Agricultural Research Council

SAU : Sher-e-Bangla Agricultural University

NATP : National Agricultural Technology Program

CRG : Competitive Research Grant

PIU : Project Implementation Unit

PCR : Project Completion Report

USAID : United States Agency for International Development

GoB : Government of Bangladesh

MAP : Moringa based Agroforestry Practice

BCR : Benefit-Cost Ratio

AGB : Above-ground biomass

BGB : Below-ground biomass

DW : Dry weight

FW : Fresh weight

CM : Centimeter

M^2 : Square meter

T : Ton

AEZ : Agro-Ecological Zone

IAA : Indole-3-Acetic Acid

LSD : Least Significant Difference

CV : Coefficient of Variation

RCBD : Randomized Complete Block Design

NS : Non Significant

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Executive Summary

Data were collected using questionnaire from 10 selected farmers with Moringa farmers from each of the districts namely Gazipur, Manikgonj, Dhaka, Pabna, Mymensingh and Rajshahi of Bangladesh to identify major constraints of Moringa production technology and marketing system. For this purpose questionnaires were prepared and validated in the survey areas. Moringa is grown mainly in homesteads, along road sides, embankments, land borders and school premises. According to the farmers, Moringa is a promising cash crop, but it was not expanded steadily due to lack of stable marketing system that help to sustain the price of Moringa products as well as lack of free inputs, consultations, and technical supports. A total of 91% surveyed farmers planted the trees for own consumption whereas only 9% farmers planted the Moringa trees for commercial use. Farmers use their 25% pods for their own consumption, and the remaining pods were used for sale. Almost all farmers sold their product to local traders who sold their product to nearby markets where only 11% of the farmers sold their product to middleman who supplied the product to Dhaka. For collection of germplasms, screening and selection of potential Moringa cultivars for sustainable agroforestry farming system we have collected 220 Moringa planting materials from Gazipur, Savar, Manikgonj, Dhaka, Pabna, Mymensingh and Rajshahi Districts. Three field experiments have been completed to fulfill the objectives of the project. Experiments were conducted at agroforestry experimental field, SAU, during February to July 2018. Four treatments were used in Randomized Complete Block Design (RCBD) with four replications. Yield contributing characteristics of the crops such as plant height, no. of leaves, fresh weight, dry weight, yield and growth parameters of drum stick as influenced by the management practice were also determined. Vegetables namely Red Amaranth, Amaranth, Brinjal, Mungbean, Chilli, and Okra were grown in association of Moringa planting materials and found all the crops can successfully be grown up to 6 months in association with Moringa without significant yield loss which ranges from 2 to 6 % only. So, farmer can easily cultivate Moringa tree in association with Amaranth, Red Amaranth, Brinjal, Mungbean, Chilli, and Okra maintaining 18 inches distance from base of the tree without much loss.

CRG Sub-Project Completion Report (PCR)

A. Sub-project Description

1. Title of the CRG sub-project: **Adaptation to climate change and sustainable livelihood through Moringa based agroforestry practice in Bangladesh**

2. Implementing organization: Dept. of Agroforestry and Environmental Science
Faculty of Agriculture
Sher-e- Bangla Agricultural University, Dhaka-1207

3. Name and full address with phone, cell and E-mail of PI/Co-PI (s):

Principal Investigator	**Co-principal investigator**
Prof. Dr. Md. Kausar Hossain Dept. of Agroforestry and Environmental Science Sher-e-Bangla Agricultural University, Dhaka Tel: 02-9134125, Fax: +88-02-8155800 Email: kausarsau@gmail.com Mobile: 01701-777941	Prof. Dr. Ferzana Islam Dept. of Agroforestry and Environmental Science Sher-e- Bangla Agricultural University,Dhaka Tel: 02-9134125, Fax: +88-02-8155800 Email: ferzanaislam@yahoo.com Mobile: 01715-013998

4. Sub-project budget (Tk):
4.1 Total: 25, 99,100.00 Tk
4.2 Revised (if any):

5. Duration of the sub-project:
5.1 Start date (based on LoA signed) : 13 July 2017
5.2 End date : 30 September 2018

6. Justification of undertaking the sub-project:

Bangladesh is one of the most densely populated country in the world with limited natural resources. The country has only 7.6 million ha of arable land which is used to feed 156.5 million people. The natural resources are depleting rapidly due to constant pressure by the ballooning population (Rahman et al., 2010). To meet the food and nutritional demand of the ever-increasing population multilayered agroforestry system is essential to maximize production within limited natural resources. Agroforestry provides food, fuel wood and timber for construction, medicinal plants and other important non-timber products. Tree plays a crucial role in diminishing the impacts of natural disasters, improve soil fertility and enhance local climate conditions (Albrecht et al., 2003; Capoor and Ambrosi, 2007). Moringa is one such multipurpose tree of global interest and grown in combination with agricultural crops by smallholder

growers and give growers a wide range of benefits (Palada and Hang, 2003; Radovich, 20013).

Moringa Oleifera belonging to the family of Moringaceae is an effective remedy for malnutrition. It is considered one of the most useful trees in the world because every part of the Moringa tree can be used for food, medication and industrial purposes (Moyo et al., 2011). In particular, the leaves can be eaten fresh in salad, cooked, or stored as dried powder for many months without loss of nutritional value. Apart from treating malnutrition, in rural areas of Africa, its leaves are used to treat a wide range of medical conditions such as HIV/AIDS-related symptoms, bronchitis, ulcers, malaria and fever (Kasolo et al., 2010). In this regard, leaf extracts of *M. oleifera* have been reported to exhibit antioxidant activity both *in vitro* and *in vivo* due to their abundance of phenolic acids and flavonoids (Vongsak et al., 2013; Al Khateeb et al., 2013).

Moringa is known as the tree of life. Previous phytochemical analysis of *M. oleifera* from different countries have shown that the leaves are particularly rich in potassium, calcium, phosphorus, iron, vitamin D, essential amino acids, as well as known antioxidants such as carotene, vitamin C, and flavonoids (Mbikay, 2012). Moringa is said to provide 7 times more vitamin C than oranges, 10 times more vitamin A than carrots, 17 times more calcium than milk, 9 times more protein than yoghurt, 15 times more potassium than bananas and 25 times more iron than spinach (Fahey, 2005; Rockwood et al., 2013; Animashaun et al., 2013; Lakshmipriya et al., 2016). The fact that moringa is easily cultivable makes it a sustainable remedy for malnutrition (Omotesho et al., 2013; Musa et al., 2015). Both Moringa species *M. oleifera* (locally known as Sajna, fruiting in one season) and *M. stenopetala* (locally known as Lajna, fruiting year round) are widely cultivated in Bangladesh. It is considered as a minor vegetable in Bangladesh but its market price is higher compared to many other vegetables. So, demand of Moringa is increasing day by day.

Vegetables are grown in Bangladesh throughout the year but the production is not sufficient. The demand of vegetables is increasing but the area under vegetables production is decreasing. Average vegetable consumption of the people of Bangladesh is about 120 g/person/day, which are far below from the standard

requirement of 200 g/person/day (Karim et al., 2017). Hence malnutrition is a serious public health problem in Bangladesh. Tomato, brinjal, coriander and Okra, amaranthus and Indian spinach are the high valued popular rabi and kharif vegetables in our country which are rich in vitamins and minerals specially vitamin A, B_1, B_2, B_9, iron, calcium (Anwar et al., 2007). Moringa is sporadically cultivated in and around the homestead in Bangladesh (Rahim et al., 2013). So far to our knowledge, Moringa cultivation in association with vegetables crops is rare across the country. In our country, Moringa are part of the landscape but not widely cultivated in the field. We could grow Moringa in association of agricultural crops as it is deciduous, so understorey crop will not be hampered and get sufficient sunlight, water and nutrients. If we can select compatible Moringa–vegetable cropping pattern, we can up-scale it to the farmers by further research activities. In such way farmer can get higher benefits which will increase their livelihood. Therefore, it is essential to conduct an experiment during the early period of Moringa tree plantation in association with vegetables at different spacing in term of their growth and yield performance for identifying the best tree-vegetables combinations.

7. **Sub-project goal**: Improving the livelihood of poor farmers as well as bring back the ecological congenial environment through Moringa based agroforestry practice.

8. Sub-project objective (s):

8.1 To identify major constraints of Moringa cultivation related to planting materials, production technology and marketing approaches

8.2 To collect, conserve, screen, and identify potential Moringa cultivars for sustainable agroforestry farming system

8.3 Benefit-cost ratio (BCR) and evaluation of potential Moringa based agroforestry practice (MAP) for ensuring sustainable livelihood of the poor farmers

9. **Implementing location (s):** Agrofoestry Farm. Sher-e-Bangla Agricultural University (SAU), Dhaka- 1207

10. **Methodology in brief:**

10.1 Identifying major constraints of Moringa in Bangladesh:

A reconnaissance field survey was carried out for data collection on moringa at six districts namely Gazipur, Dhaka, Pabna, Rajshai, Mymensingh, and Manikgonj by personal interviews. Data were collected from moringa growers, traders and research organizations regarding current cultivation practice, constraints of cultivation, planting materials, marketing system etc. A number of personal interviews were conducted at different areas during data collection.

10.2 Screening of potential moringa mother plants for multipurpose uses

Farmer's opinion was given preference to select mother plants for planting materials collection. Fruit size and shape, fruit yield, fruiting per year, biomass productions etc. were considered for mother plant selection. Once a plant was selected it was tagged by suitable code number with address of the respective farmer. The branch cuttings were collected from the selected mother plants few days before planting. Necessary precautionary measure was taken to retain optimum moisture into the cuttings and keep the cuttings non-scratch. All the collected planting materials were selected through two-stage of screening procedure.

10.2.1 *In vitro* screening for adaptability to local climatic condition and biomass production. In first stage of screening, all the collected planting materials were tested for adaptability to local climatic condition.

10.2.2 Screening of Moringa mother plants in association with crops:

After first stage of screening, the best adapted Moringa saplings were tested in association with amaranth, red amaranth, brinjal, okra and chilli following the methods developed by Khatun et al. (2010). All vegetable seeds/seedlings were collected from the nearest Horticulture Centre of SAU, Dhaka.

Tree establishment

A 40 cm deep square size pit was dug at 5 feet distance in the experimental field. Then each pit was filled with surrounding soils. All the cuttings were 3.8 feet in length which was placed separately at the center of each pit. After planting, the above ground length of each sapling was 2.6 feet which was similar for all used as tree planting materials. Irrigation was done as necessary by using watering cane.

Experimental design and treatment combination

All vegetables in association of 15 days old Moringa saplings were sown and/or planted following the Randomized Complete Block Design (RCBD). The total plot size was 30 feet × 15 feet. Individual block size was 11 feet × 5 feet. Each of the four treatments was replicated four times. Four treatments which were used in this study are as follows:

T_0= Open field referred to as control

T_1= 6 inch distance from the tree base

T_2= 12 inch distance from the tree base

T_3= 18 inch distance from the tree base.

All vegetables grown at particular distance from the tree base will be considered as agroforestry treatment and control condition will be sole agricultural practice.

Land Preparation

The experimental field preparation was started on 1 January 2018 and all operations were done by spades. Then the land was left fellow for one month. During this time all crop residues and weeds were removed from the land, broken stones and bricks were sorted out and finally 20 cm raised bed was leveled properly for Moringa plantation.

Crop establishment and management

Vegetables were transplanted/seeded in the experimental plot by maintaining proper spacing. Thinning out of plants and fertilization were done accordingly. The plots were irrigated at regular interval to supply sufficient soil moisture for the vegetable.

Data collection and cost benefit analysis

Sample of vegetables were collected randomly from all rows of the respective plots. Ten to twenty plants were selected from each plot for data collection, plant height, number of fruits per plant, no of fruits cluster, fruit diameter, weight of fruit, and yield will be measured when fruit attained to edible size.

10.3 Cost-benefit analysis and evaluation of potential germplasms through on farm demonstration incorporating agroforestry practice

Fruit quality, yield performance, seasonality of fruiting, vegetative growth, soil organic matter content will be determined in this study. Cost-benefit ratio will be analyzed by comparing with controlled plot (farmer's practice). This experimental work will be performed by PI, MS students and local farmers.

It is noted that we will create an opportunity of research on Moringa-crop at SAU campus, Dhaka. Up-scaling of Moringa will take extra time and cost beyond the proposed project which may be continued by the funding of PI, Co-PI and SAU authority.

10.4 Design, statistical analysis and reporting

All the experiments were conducted by following appropriate statistical design with necessary replications. Data were collected using data collection formats. The collected data were coded, categorized and fed in computer and analyzed using scientific statistical computer software packages. The data were subjected to analysis of variance (ANOVA) and tested for significance using Least Significant Difference (LSD) using PC-SAS software (SAS Institute, Cary, NC, 2001).

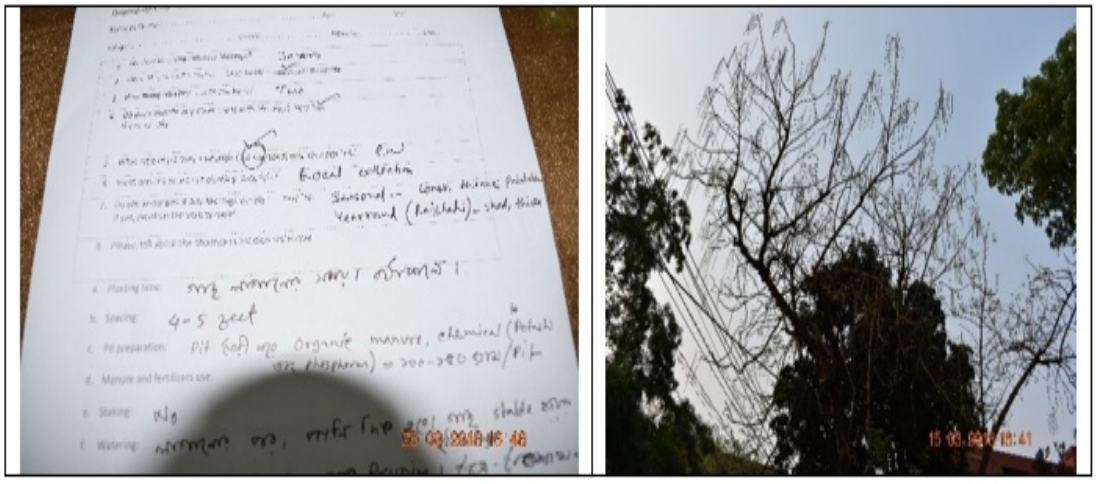

Fig 1. Questionnaire and Moringa Mother Plant

Fig 2. Collection of Moringa Planting Materials

Fig 3. Preparation of Moringa Planting Materials

Fig 4. Preparation of Moringa Planting Materials

Fig 5. Plantation of Moringa Planting Materials in association with crops

Fig 6. Field Preparation

Fig 7. Field Preparation

Fig 8. Irrigation and intercultural operations

Fig 9. Seedling Transplanting & Irrigation

Fig 10. Reproductive stages of chilli grown as inter-crop

Fig 11. Reproductive stages of tomato

11. Results and discussion:

Experiment:1. Identifying major constraints of Moringa in Bangladesh

A survey was conducted in December 2017 to April 2018 to determine the constraints of Moringa related to planting materials, production technology and marketing approaches in Bangladesh. Field survey was conducted on 60 farmers in six districts namely Gazipur, Dhaka, Manikgonj, Pabna, Mymensingh and Rajshahi. Data were collected from Moringa growers, traders and research organizations. So far, Moringais not a crop of commercial interest in our country. The tree is grown in most areas of Bangladesh mainly in homesteads, along road sides, embankments and land borders. The highest diversity of Moringa was found in Rajshahi i.e., four types, seasonal, year round, pinkish coloured, and thin (Figures 12-15) followed by Pabna, Bogura and Mymensingh. Consumption of the pods is popular, the leaves is less popular and the flowers is rare. The market value of pods is around 80-120 BDT per kg in peak season and 250-300 BDT per kg in off season. The leaves, root barks are mashed and eaten. A total of 91 % farmers under present survey planted the trees for own consumption not with commercial purposes. Only 9 % farmers mentioned they planted the Moringa trees for commercial use. The pods were used by 100 % farmers, the leaves by 85 % farmers and the flowers only by 15 % farmers. Of the total amount of pods produced by the famers about one fourth (25%) were being used for own consumption. The remaining of the produced pods (75%) were used for sales. All surveyed farmers sold their Moringa product to local traders who sold the products to the local rural markets. Only 11% of the surveyed farmers sold Moringa products to a middleman, who did not sell the products at local market.

Barriers for expanding the cultivation of Moringa

1. Quality planting materials
2. Water logging condition
3. Lack of stable marketing system that help to sustain the price of Moringa products
4. Farmers need to be provided free inputs, consultations, and technical supports
5. Lack of extension service, etc.

Fig 12. Seasonal -Early

Fig 13. Seasonal -Late

Fig 14. Year-round- Early

Fig 15: Year-round Late

Figures. Moringa planting materials

Experiment 2. Screening and identification of potential Moringa cultivars for sustainable agroforestry farming system

Treatments consists of
Tree: Moringa saplings
Crops: Stem amaranth, Red amaranth, Okra, Chilli, and Brinjal.

Stem Amaranth:

Table 1: Performance of stem amaranth at harvest as influenced by distance from tree base

Distance from tree	Plant height (cm)	Leaf number	Fresh weight (kg)	Yield (Kg/ plot)
T0	78.7 a	45.06 a	253.3 a	12.74 a
T1	71.2 b	42.19 b	232.1 b	11.46 b
T2	76.7 a	44.77 a	246.9 a	12.17 ab
T3	77.2 a	44.24 a	248.7 a	12.49 a
LSD $_{(0.05)}$	3.3	2.96	8.75	0.81
CV (%)	5.3	8.55	8.25	8.31

Fig 16. Moringa with red amaranth

Fig 17. Moringa with stem amaranth

In stem amaranth all the studied parameters were found significantly higher in control condition (Table 1). Plant height ranges from 79 cm to 71cm where plants belong to control treatment appeared as tallest followed by T_3 and T_2 treatments and plants belong to T_1 treatment was the shortest in height. In T_0 treatment, the number of leaves per plant was the highest (45) and the lowest no. of leaves (42) were found for T_2 treatment where amaranth was grown at 6 inches distance from tree base. Fresh weight as well as yield per plant of stem amaranth significantly differed among treatments. The highest yield was found in T_0 treatment (control condition), followed by T3 and T2 treatments.

Red amaranth:

Table 2: Performance of red amaranth at harvest as influenced by distance from tree base

Distance from tree	Plant height (cm)	Leaf area (cm^2)	Fresh weight (g)	Yield (Kg/ plot)
T0	42.16 a	50.5 a	21.5 a	4.71 a
T1	37.00 b	44.2 b	17.1 b	3.94 b
T2	38.66 b	48.9 a	19.6 a	4.59 a
T3	43.66 a	49.4 a	20.2 a	4.66 a
$LSD_{(0.05)}$	3.85	2.26	1.3	0.358
CV (%)	7.62	8.38	9.19	9.17

In case of red amaranth, plant height ranged from 44 cm to 37cm where plants belong to T3 treatment appeared as the tallest in stature followed by the plants belong to T_0, whilst T_1 was the shortest in height closely followed by the plants belong to T_2 treatment (Table 2). However, leaf area ranged from 51 to 44 where maximum leaf area were recorded in control treatment (T_0) and minimum leaf area were recorded in T_1 treatment. Treatment T_0 and T_2 and T3 were statistically similar. Fresh weight varied from 22 g to 17 g. The significantly highest shoot weight (22 g) was recorded in control treatment followed by treatment T_3, whilst the lowest shoot weight (17 g) was recorded in treatment T_1 followed by treatment T_2. The highest yield of red amaranth (4.7 t/ha) was obtained in control without any competition and shading effect and the lowest yield (3.94 t/ha) was obtained in T_1 treatment followed by the plants belong to T_2 and T_3 treatments.

Okra

Table 3. Yield and yield contributing characters of okra as influenced by distance from tree base

Treatments	Leaf area (cm^2)	Fruits/plant	Fruit Length (cm)	Yield (g/plant)
T0	167.42	8.55 a	12.43	106.1 a
T1	165.64	7.15 b	12.27	98.3 b
T2	160.57	7.18 b	11.37	103.2 ab
T3	161.32	7.78 b	12.56	104.3 a
$LSD_{(0.05)}$	NS	0.695	NS	5.81
CV (%)	8.83	7.33	9.03	8.05

In okra, leaf area and fruit length were non-significant in between the treatments. Fruit length and yield different significantly among the treatments (Table 3). The highest yield was found in plants belong to the control condition followed by T3 and T2 treatments, respectively.

Chilli

Table 4. Yield and yield contributing characters of chilli as influenced by distance from tree base

Treats	Plant height (cm)	Plant spread (cm)	Branch /plant	Fruit length (cm)	Fruits /plant	Yield (g/plnt)
T0	61.3	58.9	5.8	8.9	53.4 a	60.4 a
T1	62.1	57.1	5.2	8.4	47.8 b	53.6 b
T2	62.3	58.6	5.3	8.7	51.1 a	59.7 a
T3	64.9	59.3	5.6	8.6	51.7 a	58.3 a
LSD $_{(0.05)}$	NS	NS	NS	NS	3.13	4.74
CV (%)	8.3	9.5	8.3	9.5	9.7	10.2

In chilli, all the studied parameters were found non-significant except no. of fruits per plant and yield (Table 4). The significantly highest yield was found in T_0 treatment followed by T_2 and T_3 treatments, whereas it was the least in T1 treatment.

Fig 18. Moringa in association with Brinjal

Fig 19. Moringa in association with chilli

Brinjal

Table 5. Yield and yield contributing characters of brinjal as influenced by distance from tree base

Treatments	Fruit Length (cm)	Fruit Girth (cm)	Fruit/plant	Yield (ton/ ha)
T0	10.5±0.62	3.5 ± 0.20a	26.5 ± 0.53 a	59.56± 2.30 a
T1	11.1± 0.29	3.4 ±0.17 a	23.7 ± 1.42 c	54.73 ±3.82 c
T2	10.7 ± 0.23	4.7± 0.14 a	24.1± 1.17 c	56.68± 2.67 b
T3	10.4± 0.28	3.6± 0.12a	25.8± 1.84 b	56.17 ± 3.06 b
LSD $_{(0.05)}$	NS	NS	0.79	2.03
CV (%)	5.82	6.34	6.19	7.35

Similar trends were also found in case of Brinjal, where the significantly highest yield was found in plants under T_0 treatment followed by T_2 and T_3 treatments, whereas it was the least in T_1 treatment.

Fig 20. Moringa Germplasm Centre

Fig 21. Agroforestry Field Laboratory

Plants belong to control treatment (T_0) were the fastest growing and performed consistently better in morphological characteristics compared the plants belongs to agroforestry treatments. The higher yield in control treatment may be explained by the fact that plants utilized substantial amount of production inputs particularly light, irrigation water and organic amendments without any challenge from tree components.

Among the agroforestry treatments, the higher yield were found under T_3 treatment which were far away from Moringa saplings compared to other treatments. Reductions in crop growth and corresponding yield losses are known to happen when tree and crops are grown in close proximity. In agroforestry systems, yield reduction had been reported

compared to sole cropping (Zamora et al. 2007; Sanou et al. 2012). Yield reduction in agroforestry system occurs usually due to competition between trees and crops for light, water, and nutrients (Allen et al. 2004; Jose et al. 2004; Zamora et al. 2007). Moringa are known to have limited water requirement which primarily an adaptation strategy is enabling them to grow under harsh environmental conditions (Akhter et al., 2005). Tree species rooting pattern consists of deep and far reaching lateral roots so as to cover a bigger soil volume to capture more resources compared to crops (Akinnifesi et al., 2004). As a results, soil moisture, soil nutrients and solar radiation decreased in agroforestry treatments. Therefore, the competition for soil moisture and nutrients are important in tree-crop systems (Sudmeyer and Hall, 2015; Sudmeyer et al., 2002; Miah et al., 2017).

12. Research highlight/findings (Bullet point – max 10 nos.):

12.1 A total of 220 Moringa planting materials (cutting) have been collected from eight districts

12.2 The highest diversity of Moringa was found in Rajshahi (4 types, seasonal-two, year round- two) followed by Pabna, Bogura and Mymensingh. The lowest diversity was found in Manikgonj

12.3 Major constraints to further widening the plantation of Moringa are stable market, quality planting materials, technical knowledge, and lack of evidence of the benefits of Moringa products

12.4 All the Moringa planting materials were being screened in association with crops. Six vegetables namely red amaranth, stem amaranth, chilli, okra, mung bean and brinjal were grown with Moringa saplings and found all the crops can successfully be grown up to 6 months in association Moringa without significant yield loss.

B. Implementation Position

1. Procurement:

Description of equipment and capital items	PP Target		Achievement		Remarks
	Phy (#)	Fin (Tk)	Phy (#)	Fin (Tk)	
(a) Office equipment	Desktop Computer (1)	60,000	Desktop Computer (1)	60,000	100%
	Laser Printer (1)	20,000	Laser Printer (1)	20,000	100%
	DSLR Camera (1)	50,000	DSLR Camera (1)	50,000	100%
(b) Lab and field equipment	Measuring Balance 60 kg (1)	20,000	Measuring Balance 60 kg (1)	20,000	100%
	Measuring Balance 100 gm (1)	20,000	Measuring Balance 100 gm (1)	20,000	100%
(c) Other capital items	Almira (1)	24,000	Almira (1)	24,000	100%

2. Establishment/renovation facilities:

Description of facilities	Newly established		Upgraded/refurbished		Remarks
	PP Target	Achievement	PP Target	Achievement	
Field Laboratory	Land development	100%	-	-	100%
	Fencing	100%	-	-	100%
Plant Propagation Unit	Structure Development	100%	-	-	100%
	Interior Setting	100%	-	-	100%

3. Training/study tour/ seminar/workshop/conference organized: N/A

Description	Number of participant			Duration (Days/weeks/ months)	Remarks
	Male	Female	Total		
(a) Training					
(b) Workshop					

C. Financial and physical progress

Fig in Tk

Items of expenditure/activities	Total approved budget	Fund received	Actual expenditure	Balance/ unspent	Physical progress (%)	Reasons for deviation
A. Contractual staff salary	21,3400	213,400	213,400	-----	100%	
B. Field research/lab expenses and supplies	18,74,300	18,81,494	18,79,997		100%	
C. Operating expenses	1,31,400	1,31,387	1,31,004		99.7 %	
D. Vehicle hire and fuel, oil & maintenance	40,000	40,000	40,000		100%	
E.Training/workshop/seminar etc.						
F. Publications and printing	96,000	18,000	18,000		18.75%	
G. Miscellaneous	50,000	49,949	49,940		98.88 %	
H. Capital expenses	1,94,000	1,94,000	1,94,000		100%	

D. Achievement of Sub-project by objectives: (Tangible form)

Specific objectives of the sub-project	Major technical activities performed in respect of the set objectives	Output(i.e. product obtained, visible, measurable)	Outcome(short term effect of the research)
Identifying major constraints of Moringa in Bangladesh	Questionnaire, Field Survey	Pre-testing the Questionnaire with Moringa farmers 80 questionnaire have been completed	Moringa cultivation problem identified
To collect, conserve, screen, and identify potential Moringa cultivars for sustainable agroforestry farming system	Effect of phytohormones on initial growth and development of Moringa	Indole-3-Acetic Acid (IAA), Raw honey, Cinnamon powder pest, Honey with cinnamon powder pest, Control (distilled water) were tested on root and shoot	Germplasm center
	Study of Moringa-vegetables interactions	Moringa saplings were cultivated in association with red amaranth, mung bean, brinjal, amaranth okra, and chilli	Moringa based agroforestry system (MAP)
BCR and evaluation of potential MAP for ensuring sustainable livelihood of the poor farmers	–	–	

E. Materials Development/Publication made under the Sub-project:

Publication	Number of publication		Remarks (e.g. paper title, name of journal, conference name, etc.)
	Under preparation	Completed and published	
Technology bulletin/ booklet/leaflet/flyer etc.			
Journal publication	Two	Two MS student have completed their degree.	1. Agroforestry practices with red amaranth during the early establishment period of Moringaplantation, *SAURES Journal* **(under review)** 2. Tree-crop interaction during the early establishment period of Moringa plantation, Science Domain International **(under review)**
Information development			
Other publications, if any	Two	Two	

F. Technology/Knowledge generation/Policy Support (as applied):

i. Generation of technology (Commodity & Non-commodity)

i. Moringa based agroforestry farming system (On –going)

ii. Generation of new knowledge that help in developing more technology in future

iii. Technology transferred that help increased agricultural productivity and farmers' income

iv. Policy Support

G. Information regarding Desk and Field Monitoring

i) Desk Monitoring[description & output of consultation meeting, monitoring workshops/seminars etc.):

Field survey – why not Rangamati?
Survey data are not provided.

Is there any market survey?
Do you suggest Moringa for large scale plantation?
It is better to cultivate in homesteads?

Development of Morianga variety should not be in objectives of this project. Middle and lower storied crops should be identified and should develop the technology.

Variety development in dram stick is needed for higher production and more quality fruits

ii) Field Monitoring (time & No. of visit, Team visit and output):

Fixing signboard

1. Professor Dr. GM Mugibur Rahman
   Comments: Intercropping of crops and Moringa by creating different canopy density Intercropping of crops during leafless period of Moringa

2. Professor Dr. Abiyer Rahman
   Comments: Planting different crops at different planting densities

3. BARC Technical Team
   Comments: Fixing signboard. Regular irrigation and other intercultural operations in the early establishment period

I. Lesson Learned/Challenges (if any)

i) Ensuring stable marketing system of Morina products

ii) Development of improved Moringa variety

iii) Cent percent survival rate was found only in the month of March-April

iv) Delaying of fund release

J. Challenges (if any)

Signature of the Principal Investigator Date ……. Seal	Counter signature of the Head of the organization/authorized representative Date …….. Seal

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