Available online at www.pelagiaresearchlibrary.com

Pelagia Research Library

Asian Journal of Plant Science and Research, 2018, 8(2):1-7

ISSN : 2249-7412
CODEN (USA): AJPSKY

Riverbank Erosion Impact on Changing of Cropping Pattern: A Study on the Padma Charland

Muhammad Muzibur Rahman[1]* and M. Nazrul Islam[2]

[1]*Department of Geography and Environment, National University, Gazipur, Bangladesh*
[2]*Department of Geography and Environment, Jahangirnagar University, Savar, Bangladesh*

ABSTRACT

Massive bank erosion of the Padma River has devoured 35625.20 acres landmass at Harirampur upazila in Manikganj district in Bangladesh. A major part of the eroded landmass has been emerged as charland on the riverbed with radical changes of the topography and soil properties. This study has explored the changing of cropping pattern in two char unions of the Padma River where most of the mainland agricultural varieties have been extincted only by introducing the few new varieties. The char peasants cultivate local aus, aman, bhutta, teel, kaon, groundnut and tobacco instead of High Yielding Varieties (HYVs) of boro, jute, wheat and sugarcane. The char dwellers are unable to practice the spice varieties like mustard, linseed, soyabean, sunflower, onion, ginger, garlic, turmeric, coriander seed and black cumin in the charland due to changing of the agro-environment. Mashkalai, mung and masur are grown in a wide range of char areas while the char people grow limited number of vegetable varieties substituting most of the vegetables items of the mainland. Bank erosion occurs sand carpeting and localized drought conditions reduce soil moisture, increase water stress and shrink cropping systems eventually decreasing yields that bring about food deficit and changes of food habit among the char people. The study has conducted interviews with the char farmers and performed field observation technique, and has crosschecked agricultural BBS (Bangladesh Bureau of Statistics) data to identify the lost or introduced varieties.

Keywords: Charland, Grow/practice, Varieties, Lost, Introduced

INTRODUCTION

The mighty Padma River has caused its extreme bank line migration to the northeast along the left bank at Harirampur upazila in Bangladesh [1]. The river devoured 35625.20 acres landmass that has been estimated at 59 percent area of the upazila and about 60,000 people have been displaced in the study area [1,2]. This implies that bank erosion was one of the most destructive natural hazards, which caused widespread loss to human settlements and agricultural land. The Padma has correspondingly formed charland on the riverbed where the displacees have been enforced to resettle and induce the agricultural practices for their survival.

The charland is the most affected part due to climate change induced natural hazards that brought about poverty level 50 to 60% in the char areas [3]. Bank erosion is related to climate change which is a multidimensional and complex issue involving varied interactions between the environment, natural resources (land, crops, animals and water) and people [4]. These interactions are key factors to change the ecological and agricultural landscape, and therefore, change agricultural practices and production. The changing of physical properties of environment ultimately changes the agro-ecological environment in the Padma floodplain and in the chars on the riverbed resulting in the loss of crops varieties [5,6]. Bank erosion causes topographic changes such as local landform, soil properties, drainage and surface conditions, slope intensity and slope aspects more significantly influence the status of agricultural practices [3].

The farmers of different regions have been trying to adapt climate variability by altering cultivation and sowing time, crop cultivars and species [7]. At micro level, the climate variability has been supplemented with change of weather and the weather pattern is being changed frequently [8,9]. Farmers take their cropping decisions based on

traditional predominant factor; firstly, related to climatic characteristics and secondly, topography of the farmlands [10,11]. Simulation models have been used for decades to analyze crop responses to environmental stresses and to test alternate management practices [12,13]. The previously used simulation models were complex and required a large number of input parameters [4]. This study has performed the field observation technique and justified the farmers' agricultural practices without compromising the accuracy. Both the mainland and char peasants express their opinions that they always face the changes of physical environment and changing of cropping pattern by the river.

STUDY SITE

This study has explored the changing of agricultural practices and cropping pattern of Lesraganj and Sutalari char unions on the Padma riverbed (located 23°38'-23°44'N latitudes and 89°50'-90°00'E longitudes) at Harirampur upazila in Manikganj district in Bangladesh (Figure 1). The hot summer, the long rainy season and the pleasant spring-cum winter are the main noticeable seasons prevailing in the locality [14]. The highest and the lowest average monthly temperature vary from 35.1°C to 14.2°C [15]. The mean July temperature in the area is between 28°C to 29°C [15,16]. The level of humidity varies from 56% to 83%. Monsoonal rains from June to September accounts for 60 to 70 percent of the annual rainfall [14,15]. The annual average rainfall is 250.8 cm. The agricultural practice of the study area is greatly influenced by the tropical monsoon climatic conditions. The area belongs to the active Ganges floodplain which includes river, chars and young floodplain land adjoining the rivers [15-17]. The relief is slightly irregular [6,16]. The eroded part is very unstable which has been emerging as either sandy charland or being carpeted with sand (Field Survey, 2017). The soils are seasonally flooded, have loamy to silty and silty to silty textures and low soil moisture contents. The sand deposition changes local landform, soil properties, drainage and surface conditions ultimately decrease the soil moisture which cause the localized drought conditions are the barriers of normal crops production in the char agro-environment.

Figure 1: Study area and river systems of Harirampur upazila

MATERIALS AND METHODS

Individual interviews with the char farmers have been conducted for which sample size was selected at 100. From

each union 50 farmers were chosen for interviews by applying random sampling technique. Since the study is at micro level and the study area is the two char unions, hence the sample size was considered appropriate for the research purpose. The study has extensively performed field observation technique for attaining the better understanding about the crops loss issue. The Bangladesh Bureau of Statistics (BBS) agriculture data helped to identify the agricultural changes between mainland and charland. Agriculture Sample Survey, Districts Series Manikganj [18] provided the previously practicing crops and pulses, vegetables and spice varieties of the mainland. The listed varieties by BBS were cross-checked and verified among the char peasants during the field survey on the charland. The agricultural practitioners (char peasants) accompanied the study team performing the field observation technique.

RESULTS AND DISCUSSION

Changing of crops varieties

The Aus (*Oryza sativa*) and Aman (*Oryza sativa*) are the principal food crops in the char areas (Table 1). Whenever the land only shallowly flooded or water can be kept on the land by small bounds, farmers grow *aus* followed by transplanted *aman*. This sort of rice practice is confined in particular small areas. When flooding becomes too deep for transplanted *aman* or where rapid rise of the flood-level may cause loss of crops in most years; broadcast *aman*, sometimes mixed with *aus* is grown. On highland where water cannot be kept on the land only *aus* paddy is grown followed by the dry land crop Sweet potatoes (*Ipomoea batatas*) at the end of the rainy season (Field Survey, 2017).

Table 1: Changing of crop varieties in study area

Local or English Name	Scientific Name	Pre-erosion	Post-erosion	Present Status of Varieties	
		Mainland	Charland	Lost	Introduced
Aus	*Oryza sativa*	Practiced	Practiced	-	-
Aman	*Oryza sativa*	Practiced	Practiced	-	-
Boro	*Pisodonophis boro*	Practiced	Not practiced	Lost	-
Jute	*Corchorus capsularis*	Practiced	Not practiced	Lost	-
Wheat	*Triticum aestivum*	Practiced	Not practiced	Lost	-
Sugarcane	*Saccharum officinarum*	Practiced	Not practiced	Lost	-
Maize	*Zea mays*	Practiced	Practiced	-	-
Potato	*Solanum tuberosum*	Practiced	Not practiced	Lost	-
Jowar	*Sorghum vulgare*	Not practiced	Practiced	-	Introduced
Groundnut	*Arachis hypogaea*	Not practiced	Practiced	-	Introduced
Sweet potato	*Ipomoea batatas*	Not practiced	Practiced	-	Introduced
Teel	*Sesamum indicum*	Not practiced	Practiced	-	Introduced
Kaon	*Setaria italica*	Not practiced	Practiced	-	Introduced
Cheena	*Panicum miliaceum*	Not practiced	Practiced	-	Introduced
Tobacco	*Nicotiana tabacum*	Practiced	Practiced	-	-

Source: Field Survey, 2017; Agriculture Sample Survey, District Series Manikganj, BBS, 2016

The char dwellers have not been growing the traditional crops like *boro*, jute or sugarcane rather they have been practicing the non-traditional crops like Teel (*Sesamum indicum*) and Kaon (*Setaria italica*). The most important feature of changing the cropping pattern is that the char community on the charland is extensively practicing Groundnut (*Arachis hypogaea*). Wheat (*Triticum aestivum*) and Potato (*Solanum tuberosum*) would extensively practice by the farmers on the mainland which are not being absolutely practiced on the charland (Table 1). The Maize (*Zea mays*) bhutta and Tobacco (*Nicotiana tabacum*) are being cultivated on the charland, which would also been cultivated on the mainland, but Jowar (*Sorghum vulgare*) is being cultivated only on the char land (Table 1). Most of the study area is used for a single crop of *aus, aman* and *teel*.

Changing of pulse varieties

Riverbank erosion has great impact on production of the pulses varieties. Most of the respondents expressed their opinion that they could grow Mashkalai (*Vigna mungo*), Masur (*Lens culinaris*), Kheshari (*Lathyrus sativus*), Motor (*Pisum sativum*), Mung (*Vigna radiata*), Arhar (*Cajanus cajan*) and Chick pea (*Cicer arietinum*) in the mainland (Table 2). After erosion, the peasants of the charland have been practicing Mashkalai (*Vigna mungo*), Mung (*Vigna*

radiata) and Masur (*Lens culinaris*) in a wide range of area because silt is deposited in every flooding season on the charland. The pulses of *kheshari, motor, arhar* and chick pea are not being practiced by the farmers in the charland.

Table 2: Changes of pulse varieties in study area

Local Name	Scientific Name	Pre-erosion	Post-erosion	Present Status of Varieties	
		Mainland	Charland	Lost	Introduced
Mashkalai	*Vigna mungo*	Practiced	Practiced	-	-
Mung	*Vigna radiata*	Practiced	Practiced	-	-
Masur (Lentil)	*Lens culinaris*	Practiced	Practiced	-	-
Kheshari	*Lathyrus sativus*	Practiced	Not practiced	Lost	-
Motor (Field pea)	*Pisum sativum*	Practiced	Not practiced	Lost	-
Chick pea (Chola)	*Cicer arietinum*	Practiced	Not practiced	Lost	-
Arhar (Pigeon pea)	*Cajanus cajan*	Practiced	Not practiced	Lost	-

Source: Field Survey, 2017; Agriculture Sample Survey, District Series Manikganj, BBS, 2016

Loss of spice varieties

Bank erosion has tremendous adverse impact on the growing of spice varieties. The farmers might have cultivated the spice varieties in the mainland with commercial view but the displaced char community cannot grow the same spice varieties in the charland (Table 3). Before erosion, the farmers of Harirampur upazila could grow the Mustard (*Brassica napus*), Linseed (*Linum usitatissinum*), Soyabean (*Glycine max*), Sunflower (*Helianthus annuus*), Onion (*Allium cepa*) and Chilies (*Capsicum frutescens*) extensively in the fertile mainland introducing proper irrigation, fertilizer and care. The people of mainland would have grown Ginger (*Zingiber officinale*), Garlic (*Allium sativum*) and Turmeric (*Curcuma longa*), Coriander seed (*Coriandrum sativum*) and Black cumin (*Nigella sativa*) in farm and in homestead land.

Table 3: Loss of spice varieties in study area

English Name	Scientific Name	Pre-erosion	Post-erosion	Present Status of Varieties	
		Mainland	Charland	Lost	Introduced
Mustard	*Brassica napus*	Practiced	Not Practiced	Lost	-
Linseed	*Linum usitatissinum*	Practiced	Not Practiced	Lost	-
Soyabean	*Glycine max*	Practiced	Not Practiced	Lost	-
Sunflower	*Helianthus annuus*	Practiced	Not practiced	Lost	-
Onion	*Allium cepa*	Practiced	Not practiced	Lost	-
Garlic	*Allium sativum*	Practiced	Not practiced	Lost	-
Ginger	*Zingiber officinale*	Practiced	Not practiced	Lost	-
Turmeric	*Curcuma longa*	Practiced	Not practiced	Lost	-
Chilies	*Capsicum frutescens*	Practiced	Not practiced	Lost	-
Coriander seed	*Coriandrum sativum*	Practiced	Not practiced	Lost	-
Black cumin	*Nigella sativa*	Practiced	Not practiced	Lost	-

Source: Field Survey, 2017; Agriculture Sample Survey, District Series Manikganj, BBS, 2016

The soil properties have been changed especially by sand deposition therefore, the char peasants have not been able to grow mustard, linseed, soyabean, sunflower, onion, ginger, garlic, turmeric, coriander seed and black cumin in the charland (Table 3). The cultivation of all the spice varieties has been dismissed and has lost their identity to the char community.

Changing of vegetables practice

The people of mainland would cultivate the vegetables from commercial point of view as well as for their own consumption. The people of mainland would practice the Cauliflower (*Brassica oleracea*), Cabbage (*Brassica oleracea*), Radish (*Raphanus sativus*), Tomato (*Lycopersicon lycopersicum*) and Carrot (*Daucus carota*) in mainland but after erosion, the char community practices only the cauliflower bearing the same views (Table 4). Patal (*Trichosanthes dioica*) and Brinjal (*Solanum melongena*) were practiced in mainland and the char community practice the same vegetables on the charland. The char peasants stated that they grow *patal* extensively in the char land that has great demand in the markets of mainland. The char dwellers do not practice Cucumber (*Cucumis sativus*), Beans

(*Lablab purpureus*), Chichinga (*Trichosanthes anguina*) and Jhinga (*Luffa acutangula*) in the farmland and even in the homesteads land.

Table 4: Changing of vegetables practices in study area

English or Local Name	Scientific Name	Pre-erosion	Post-erosion	Present Status of Species	
		Mainland	Charland	Lost	Introduced
Cauliflower	*Brassica oleracea*	Practiced	Practiced	-	-
Cabbage	*Brassica oleracea*	Practiced	Not practiced	Lost	
Radish	*Raphanus sativus*	Practiced	Not Practiced	Lost	-
Tomato	*Lycopersicon lycopersicum*	Practiced	Not practiced	Lost	-
Carrot	*Daucus carota*	Practiced	Not practiced	Lost	-
Brinjal	*Solanum melongena*	Practiced	Practiced	-	-
Patal	*Trichosanthes dioica*	Practiced	Practiced	-	-
Cucumber	*Cucumis sativus*	Practiced	Not practiced	Lost	-
Beans	*Lablab purpureus*	Practiced	Not practiced	Lost	-
Chichinga	*Trichosanthes anguina*	Practiced	Not practiced	Lost	-
Jhinga	*Luffa acutangula*	Practiced	Not practiced	Lost	-
Chal kumra	*Benincasa hispida*	Practiced	Practiced	-	-
Water gourd	*Lagenaria vulgaris*	Practiced	Practiced	-	-
Sweet gourd	*Cucurbita maxima*	Practiced	Practiced	-	-
Palong sak	*Spinacea aleracea*	Practiced	Not practiced	Lost	-
Lal sak	*Anaranthus oleraceus*	Practiced	Not practiced	Lost	-
Pui sak	*Basella alba*	Practiced	Practiced	-	-
Uchcheya	*Momordica charantia*	Practiced	Practiced	-	-
Lady's finger	*Abelmoscus esculentus*	Practiced	Practiced	-	-

Sources: Field Survey, 2017; Agriculture Sample Survey, District Series Manikganj, BBS, 2016

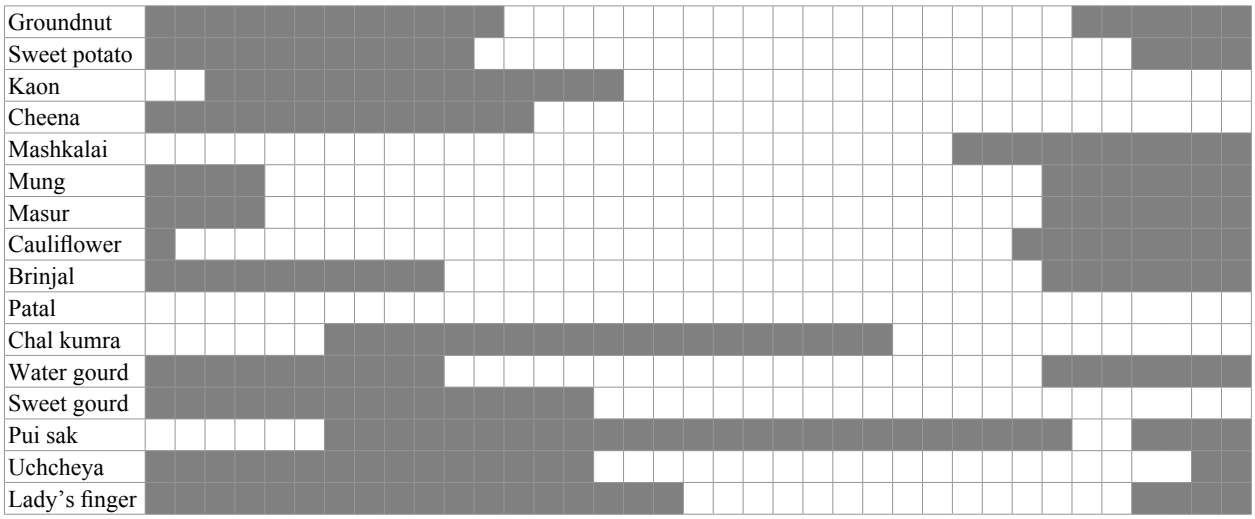
The mainlanders would have grown Chal kumra (*Benincasa hispida*), Water gourd (*Lagenaria vulgaris*) and Sweet gourd (*Cucurbita maxima*) which are also grown in the char areas and have reconstructed their identity to the char community. The peasants of charland grow Puisak (*Basella alba*) throughout the year but not grow Palong sak (*Spinacea aleracea*) or Lalsak (*Anaranthus oleraceus*) in the char areas (Table 4). Both the mainlanders and char dwellers grow Uchcheya (*Momordica charantia*) and Lady's finger (*Abelmoscus esculentus*).

Crop calendar on the charland

The climate induced natural hazards river erosion and floods have been constantly changing the char agro-environment of the Padma River [19]. The changing of topography and soil properties along with changing of weather pattern has caused the changes of crops cycle. Sand carpeting, erratic rainfall and localized drought conditions, and early or uncontrolled flooding situations greatly hamper to follow the previous crop cycle on the charland. Many varieties have been extinct while the present existing and newly introduced varieties are facing the difficulties in the char agro-environment. Having the fact, the farmers are trying to adjust their agricultural practices with the changed agro-environment following the crops cycle (Table 5). The local farmers have been trying in attaining the capability of practicing crops in the new char agro-environmental conditions.

Table 5: Crop calendar on the cahrland

	Jan.			Feb.			Mar.			Apr.			May			Jun.			Jul.			Aug.			Sep.			Oct.			Nov.			Dec.		
	e.	m	l.	e	m	l.	e.	m	l.	e	m	l.	e.	m	l.	e.	m	l.	e.	m	l.	e.	m	l.	e.	m	l.	e.	m	l.	e.	m	l.	e.	m	l.
Aus (B.C.)																																				
Aus (T.P.)																																				
Aman (B.C.)																																				
Aman (T.P.)																																				
Maize (Rabi)																																				
Tobacco																																				
Teel (Kharif)																																				
Jowar																																				



Source: Field survey, 2017

Explanatory key: B.C.=Broadcast, T.P.=Transplant, e.=early, m.=mid, l.=late, shade indicates the showing/planting to harvesting period

Less cropping intensity

Intensity of cropping represents the ratio of the gross cropped area to the net temporary cropped area expressed in terms of percentage. It indicates the extent to which the same area is used for cropping. Thus, the intensity of cropping is determined by BBS [19] as:

$$\text{Intensity of cropping} = \frac{Gross\ cropped\ area}{Net\ temporary\ cropped\ area} \times 100 \quad (1)$$

By using the equation (1) the cropping intensity of study char unions is calculated as

$$\text{Cropping intensity of the study area} = \frac{8556}{7460} \times 100 = 115$$

The cropping intensity of Bangladesh has been estimated at 180 percent while it is 173 percent in Manikganj district and 115 in the char land [18]. This implies that cropping intensity of the mainland has been radically declined in the charland because the fertile cultivable land has become unsuitable for crops production by sand deposition. The sand carpeting in most of the cases has turned the cultivable land into barren and fallow land, or has reduced the fertility for agricultural practices (Field Survey, 2017). Besides, the peasants of weak economic base are not eager to introduce irrigation, fertilizer, and modern tools in sandy soil hence; the high cropping intensity has not been occurred in the char agro-environment.

CONCLUSION

The effects of bank erosion on land use and agricultural practices are serious and wide ranging. The erosion has degraded the physical environment disturbing the agro-ecosystem particularly crops biodiversity loss in the study area. Bank erosion has changed the topography and soil properties of the eroded landmass by two ways firstly; eroded land has emerged either as sandy charland, secondly, the land has developed with unexpected grass, weed and catkin reed *shon*, which are great hindrance to growing crops. Sand carpeting, localized drought conditions reduce soil moisture, increased water stress and reduced yields from cropping systems. Bank erosion has shrinked cropping pattern, only a few varieties of local *aus* and *aman* are practiced replacing the High Yielding Varieties (HYVs) *boro*. All the spice varieties have lost in the charland due to the changing of agro-environment. Actually, most of the crops, pulse and vegetables varieties of the mainland have not been practiced in the charland and these non-practiced varieties have lost their identity to the char community. The lack of agricultural land and limited crops items has decreased production-causing food deficit and changing of food habit in the study area. The loss of agricultural land and natural resources, and the degradation of the services of the ecosystem by the erosion hazard have exacerbated the poverty conditions in the study charland. The shrinked agricultural land should be increased through charland management, i.e., planting

the *Hogla* (*Typha angustata*) and *kumli* (*Ipomoea aquatica*) in outer boundary of the agriculture land that reduce the strong water current from high flooding conditions, and make favorable condition to deposit silt in that particular land areas. The char community must extensively practice *Dhanchia* and catkin reed (*Saccharum spontaneum*) to deposit sediment and turn the sandy soil into fertile soil and stabilize the land for cultivation in the following years. The local crop varieties which are capable to grow in the charland should be extensively practiced by the char dwellers. The new varieties of crops should also be regenerated for cultivation in the charland to overcome the limited crop production.

REFERENCES

[1]. CEGIS. Prediction of River, bank erosion and morphological changes along the Jamuna, the Ganges, the Padma and the Lower Meghna Rivers, **2015**.

[2]. Rahman MM, Islam NM, Islam NM. Integrated approach of remote sensing and field survey data in assessment of bank erosion intensity of the Padma River in Bangladesh. *Int J Geomat Geosci*, **2016**, 7(2): 285-297.

[3]. BBS. Year book of Agricultural Statistics of Bangladesh. Bangladesh Bureau of Statistics, Statistics Division, Ministry of Planning, Government of the People's Republic of Bangladesh, **2009**.

[4]. Haque QME, Jannat S. Impact of climate change on agriculture in relation to livestock and food security in Bangladesh. Proceedings of the International Conference on Climate Change in relation to Water and Environment, Department of Civil Engineering, DUET-Gazipur, Bangladesh, **2015**.

[5]. Brammer H. The agroecology of Bangladesh's floodplains. *Asia Pac J Environ Dev*, **1994**, 1(2): 1-2 (BUP).

[6]. Brammer H. Geography of soils of Bangladesh. The University Press Limited, Dhaka, Bangladesh, **1995**.

[7]. IPCC. Climate Change. Impacts, Adaptation and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group Π to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, **2014**.

[8]. Ahmad QK, Warrick RA, Ericksen NJ, Mirza MQ. The implications of climate change for Bangladesh: A synthesis, a national assessment of the implications of climate change for Bangladesh. In: Warrick RA and Ahmad QK, *The implications of climate and sea level change for Bangladesh*. Kluwer Academic Publishers, Dordrecht, **1996**.

[9]. Warrick RA, Bhuiya AH, Mirza MQ. The greenhouse effect and climate change. In Warrick RA and Ahmad QK, *The implications of climate and sea-level change for Bangladesh*. Kluwer Academic Publishers, Dordrecht, **1996**.

[10]. Sillitoe P. Indigenous knowledge development in Bangladesh: Present and future. The University Press Limited Dhaka, Bangladesh, **2000**.

[11]. Schmuck-Widmann H. Facing the Jamuna River: Indigenous and engineering knowledge in Bangladesh. Bangladesh Resource Centre for Indigenous Knowledge (BARCIK), **2001**.

[12]. Boote KJ, Jones JW, Pickering NB. Potential uses and limitations of crop models. *Agronomical Journal*, **1996**, 88: 704-716.

[13]. Sinclair TR, Seligman NG. Crop modeling: From infancy to maturity. *Agronomical Journal*, **1996**, 88: 698-704.

[14]. BMD. Bangladesh Meteorological Department, Dhaka, **2015**.

[15]. BBS. Population census, Dhaka. Bangladesh Bureau of Statistics, Statistics Division, Ministry of Planning, Government of the People's Republic of Bangladesh, **2011**.

[16]. Rashid H. Geography of Bangladesh. The University Press Limited. Dhaka, Bangladesh, **1991**.

[17]. Ahmed N. Geography of East Pakistan. O.U.P. Dhaka, **1968**.

[18]. BBS. Agriculture sample survey of Bangladesh. *Zila Seris Manikganj*, Planning Division, Ministry of Planning, Government of the People's Republic of Bangladesh, Dhaka, Bangladesh, **2016**.

[19]. Khadiza Q. Vegetation diversity in flood plains: A biogeographical approach. M.Sc. Thesis, Unpublished, Department of Geography, Jahangirnagar University, Savar, Dhaka, **1996**.