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Exploring Role of Local NGOs in Agriculture: a GIS Based study along the Jamuna River, Bangladesh

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Abstract : Agriculture is the primary source of income for Bangladesh's rural population. Non-government organizations (NGOs) are actively engaged in the improvement of Bangladesh's agriculture sector alongside government organizations (GOs). This study will provide an insight into the agricultural services provided by NGOs at the district level along the Jamuna River. Data was obtained from 533 individuals affiliated to 30 NGOs in 126 Unions using the home survey (HHS) technique and 50 Focused Group Discussions (FGD). Using GIS technology, the study also determined the optimum suited site for agricultural crops in the study region. The research's findings show that local NGOs in the study region assist farmers by providing agricultural supplies (seed, fertilizer, pesticide), agricultural tools, financial loans, agricultural training, irrigation facilities, and help for women in kitchen gardening, among other things. People in remote rural regions largely participated in farming, whilst those near Bangladesh's capital (Dhaka) or other developed areas primarily worked in industry or the service sector. According to correlation research, the number of farmers trained, access to agricultural inputs, presence of domestic animals in the family, and access to agricultural loans all enhance the income of farmers in the study region. The findings also reveal that not all of the study area's land is suited for farming. Identifying the best suited areas for agriculture might help increase agricultural production. According to the study, both the government and non-governmental organizations (NGOs) should create awareness among farmers and assist them in identifying the best suited production locations for crops in order to increase land productivity.

Keywords: Agriculture, NGOs, GIS, Rural area, Bangladesh

1.0 Introduction

Agriculture is a primary source of livelihood for people in Bangladesh (Mahjabeen, 2008; Ali et al., 1998). Like other parts of the world, rural economic activities in

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Bangladesh are largely dependent on agriculture (Bala et al., 2010; BBS, 2016; BIDS, 1981; BIDS, 2011). In Bangladesh, approximately 90% of rural workers are directly employed in the agriculture field, which employs 48% of the nation's employed population and provides for 19.3% of national GDP (Gross Domestic Product) (Bala et al., 2013; BBS, 2011; Alauddin and Biswas,2014). In Bangladesh agriculture is mainly performed through conventional outdated methods; especially in rural remote areas (Borggaard et al., 2003; Bayes and Patwary, 2012; Begum et al., 2004). Furthermore, there are several restrictions that impede the growth of Bangladesh's agriculture industry, such as the political environment, natural disasters, people's choices, modernization and globalization, and so on (Khan and Khisa 2000; Alam et al., 2009; Anonymous, 2003).

One of the major drawbacks of the agricultural activities along the river side of Jamuna is lack of capital and to some extent the environmental threats (Islam et al., 2010). The natural calamities occurred during the rainy season and miles along the river sides swept away due to extreme rise of water level (Haggblade et al., 1986; Grogan, 2012;Holloway and Richard, 1995). Crops and crop field had destroyed by the river bank erosion (Birkhaeuser et al., 1991; Christoplos and Kidd, 2000; Davis et al., 2012). Thus, rural poor people lose their crops, money, food and capital as well. Therefore, they failed to raise capital for the next year’s agricultural practice (ISPAN, 1993; Khan and Khisa, 2000). So, to practice agricultural activity they need help from different mediums (Mahjabeen, 2008; Knudsen and Khan 2002). The mediums can be Government or non-government agencies, commonly known as NGOs in Bangladesh (Khan and Khisa, 2000).

NGOs run different kind of activities to encourage and implement the government orders for the economic improvement of the poor people of the country (Mahmud, 2012; Ministry of Finance, 2015). Some NGOs are lending monetary value to the rural poor people and some are helping them by providing the seed and fertilizer, which has flourished the agricultural sector mostly (Rahman and Islam, 2014; Rahman and Islam, 2011). The NGOs run development activities on agricultural sectors along the river side of Jamuna like easy access to credit, diversified loan and savings products, client friendly door step services, right financing at the right time and quick service & response (Quazi and Rahim, 2000). As of later, some local NGOs are attracting local poor people to horticultures and timber plantations (Rahman and Sousa, 2010; Rahman et al., 2012). The NGO's major areas of interest include home-based income-generating enterprises such as cattle and poultry husbandry, food processing, apiculture, and rural handicrafts, as well as microcredit terms (Rasul et al., 2004; Robbani et al., 2007). Nearly 80% of Bangladesh's villages are projected to be housed by non-governmental organizations (NGOs), but not all of the destitute who require assistance (Roy, 2002; Saleque, 2004). Approximately 13000 non-governmental organizations (NGOs) are involved in agricultural microcredit operations (Haque, 2002; BBS, 2016; Holloway and Richard, 1995).

Farmers along the river side of Jamuna are mostly illiterate, thus they do not know how to take loans from the formal institutions or banks where proper documentation process will be needed (World Bank, 2005; Roy, 2002). Therefore, rural poor people had got the micro-credit facilities with higher interest form the local non-government institutions without major documentation processes (Robbani et al., 2007; World Bank, 1996). This easy process is making them enable to get small amount loans as they need it during their

production time (Saleque, 2004; World Bank, 2005). Agricultural extension and counseling services in rural areas are an important part of acknowledging poverty levels because such organizations are able to train farmers in agricultural practices, supporting farmers in drawback, distributing technology, as well as allowing farmers to be more actively engaged in the agricultural knowledge and information system(Christoplos and Kidd, 2000: 11 ; Davis et al., 2012).

2.0 Aim and Objectives

The broad aim of this research is to know and evaluate local NGOs agricultural services at district level along the river side of Jamuna, Bangladesh. To fulfill the aim, specific objectives are being set for this study includes; 1) to explore socioeconomic situation of the inhabitants along the river side of Jamuna; 2) to investigate agricultural facilities provided by local NGOs in the study area; 3) to analyze correlation between profit from agriculture and six dependent variables at union level along the river side of Jamuna, Bangladesh; 4) and finally, to identify agricultural cropping season and discuss the suitability of land for different crops in the study area.

3.0 Case study and methods

3.1 Study area

According to the research, there are 126 unions in 5 districts along the Jamuna River, as well as 30 non-governmental organizations (NGOs) with 175 sub branches. The districts of Sirajganj, Bogura, Jamalpur, Gaibandha, and Kurigram make up the research region. The Jamuna River is the second largest of Bangladesh's three main rivers (Figure 1). It is a notable distributary flow of the Brahmaputra River, which runs from India to Bangladesh (Rahman et al., 2012; BBS, 2011). As a result, chars play a vital role in Bangladesh in terms of supplying land for human habitation. Chars are particularly prone to erosion and floods. According to a recent study of time series satellite photos, more than 75% of the chars were removed within one and nine years, with just around 10% surviving 18 years or longer (Bayes and Patwary, 2012). Furthermore, Chars have taken up 40% of the active river floodplain, accounting for about 6% of Bangladesh's total land area (Bayes and Patwary, 2012; Bulletin of Institute of Vocational and Technical Education, 2008). Connected chars are said to be inundated more heavily than unconnected chars (Grogan et al., 2012). Every year, a large number of chars are flooded. If the flood occurs too soon, it will harm crops and people's livelihoods (Bayes and Patwary, 2012).

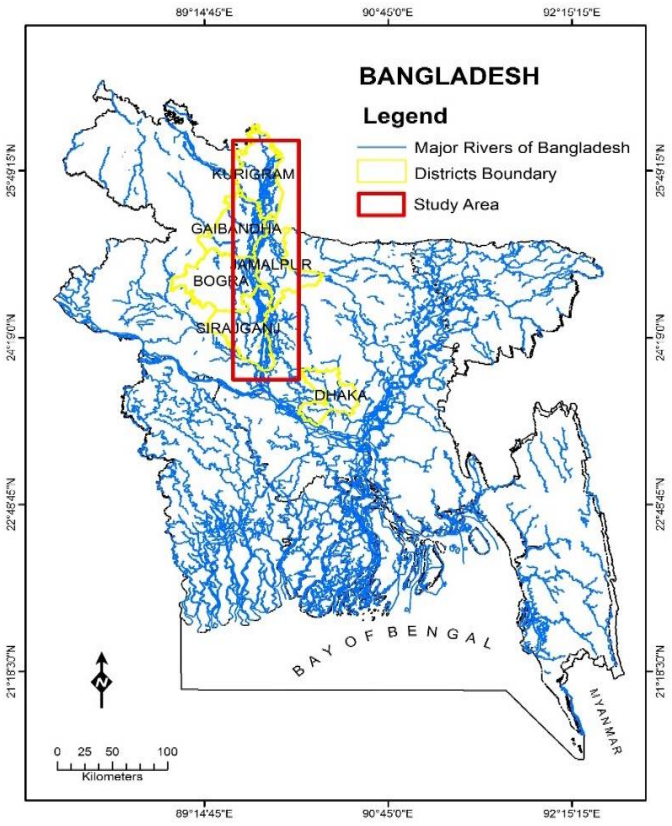


Figure 1: Study area along the river side of Jamuna, Bangladesh
Source: Made by author, 2020

3.2 Data sources and methods

Primary and secondary data were gathered from a variety of respondents as well as a few selected NGOs. Using GPS, absolute information on the locations of 30 NGOs with 175 sub-branches was gathered (Global Positioning System). A total of 533 people were interviewed using the household survey technique, and 50 focus group talks were held at the district and union council levels (comprising a few villages) along the Jamuna River in Bangladesh. The data on the respondents' age, sex, number of family members, occupation, monthly income (before and after joining the local NGOs credit program), distance from the NGOs to the respondents, distance from the growth centers/hat, bazar to the respondents, and facilities provided by the local NGOs in the agricultural sector along the river side of the Jamuna, Bangladesh, 2020 were collected through a questionnaire and analyzed by SPSS 16.0.

Secondary data were acquired from Bangladesh Bureau of Statistics (BBS),Center for Environmental and Geographic Information Services (CEGIS), Bangladesh Institute of Development Studies (BIDS) and different NGOs that supported for developing proper planning on agricultural systems. The study interviewed these following groups:

a. Local community (total 533 respondents and 50 FGDs, information gathered includes; age of the respondents, sex, number of family members, occupation, monthly income before and after joining to local NGOs credit program, distance from the NGOs to the respondents, distance from the growth centers/ hat, bazar to the respondents and facilities had provided by local NGOs).

b. Local NGOs employees who are involved in agricultural services of 126 unions (focused group discussions and interviews with 175 branches of 30 NGOs and provided services to rural poor people namely agricultural training, fertilizer, domestic animals, seeds traditional agricultural tools and agricultural loan).

Finally, Data needed for land and crop suitability along the Jamuna river was borrowed from Bangladesh Bureau of Statistics (BBS, 2011), Bangladesh Agricultural Census (2011 to 2016) and Center for Environmental and Geographic Information Services (CEGIS) and analyzed using ArcGIS 10.1.

3.3 Data analysis

ArcGIS 10.2 has been used for detailed mapping and analysis of productive area of agricultural crops in the sample sites, where the productive area has been extracted with the help of satellite images. 10 major crops were identified regarding on farmers demand. Using ArcGIS 10.2, this paper had identified the production area of each crop in different categories, i.e., very high productive, high productive, medium productive, low productive and finally very low productive based on soil nutrient data. Besides that, the rural poor people who engaged in different economic activities, i.e., agricultural, industrial, services and others were also analyzed in ArcGIS 10.2.

Statistical Package for the Social Sciences (SPSS 16.0) software was also used for Socio-economic characteristics analysis, i.e., age, sex, number of family members, occupation, monthly income, distance from the NGOs office to the respondent's home, distance from the growth centers/ hat, bazar to the respondents and facilities provided by the local NGOs in agricultural sectors of the study site. Besides that, correlation between trained farmers and their profit were also analyzed using SPSS. This paper has tried to show the relation between six dependent variables with income by the following correlation equation:

$$r = [\Sigma xy-\{(\Sigma x)\ (\Sigma y)/n\}]/[\{\Sigma x^2-(\Sigma x)^2/n\}\{\Sigma y^2-(\Sigma y)^2/n\}]^{1/2} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (I)$$

WHILE, X = dependent variables, y = income, n = number of unions and results, r is between 1 and +1. The value close to 0 means that there is no correlation and about 1 and +1 means that it has lower or strong correlations between the variables with income.

4.0 Results and Discussion

4.1 Socio-economic characteristics of households

Socio-economic attributes of the households interviewed during household survey are presented in this section. The data presented here is collected through 533 household survey (HHS) questionnaire and 50 focused group discussions (FGD) in 2020. Socio-economic attributes include; age, sex, number of family members, occupation, monthly income, distance from the NGOs office to the respondent's home, distance from the

growth centers/ hat, bazar to the respondents and facilities provided by the local NGOs in agricultural sectors along the river side of Jamuna, Bangladesh.

Results reveal that most of the respondents (56.1%) were below or equal to 25 years old followed by 42.8%, in the age group of 26 to 35 years old. 36.4% of the respondents were women, while 63.6% of the male respondents were all employed in agriculture. Most of the rural poor people in the study area (90.3%) have 7 to 9 persons whilerest of the 7.7% people have more than 9 members in the household. Among the respondents most of them (36.8%) are housewife involved with kitchen gardening. There are majority respondents which is 37.1% are involved in agricultural activities and rest of the 12.4%, 7.5% and 6.2% are involved in business, daily labor and industrial services respectively.

Before joining the Micro Credit program started by NGO, most respondents (89.9%) were in a low-income group (less or equal to 63 USD), 7.7% of average income (USD 126) And the rest of 2.4% in high-income groups. (Above 126 USD). Subsequently, by combining the microcredit program, the low-income group decreased intensely from 89.9% to 41.3%, the average income group increased significantly to 55.0% benefiting from the micro-credit program. People living near NGO offices receive more benefits and vice versa. Our results show that 46.5% of the sampled respondents were living within 5 kilometers distance from the NGO office. Approximately, 74% of the respondents live near growth center where most of the facilities offered by NGOs can be accessed easily.

4.2 List of NGOs and their contribution in agricultural development at the study area

In the research region, there were several non-governmental groups functioning in nearly every field. With the sort of project for which they get money, the purpose and scope of their activity changes. NGOs such as ASA, BRAC, Grameen Bank, and RDRS Bangladesh are national NGOs that work only in Bangladesh. Table 1 contains a comprehensive list of all NGOs currently functioning in our research region, as determined by household surveys, focus group discussions (FGD), and previous government publications.

Table 1. List of NGOs in the study area

No	Branch Name	Frequency	No	Branch Name	Frequency
1	AKOTA	2	16	PRODIPON	1
2	ARBAN	1	17	PROGRESS	1
3	ARCHES	3	18	RDRS Bangladesh	22
4	ASA	35	19	RSDA	1
5	AttoMohilaUnnaionSomity	1	20	Sajida Foundation	1
6	BhomukhiMohilaUnnaionSomity	1	21	SAP	1
7	BRAC	31	22	SATU	1
8	DORP	1	23	SKS	7
9	GKS	1	24	SSS	6

No	Branch Name	Frequency	No	Branch Name	Frequency
10	Grameen Bank	31	25	Thangara Mara MohilaSabujSongo	1
11	GUK	9	26	TMSS (ThakurganMohilaSobuj Sango)	4
12	MMS	2	27	UDDIPAN	1
13	NDP	3	28	Uddog	1
14	PDBF	1	29	UDPS	2
15	Porosh	1	30	US	2
				Total	175

Source: Bangladesh Bureau of Statistics (BBS), The Center for Environmental and Geographic Information Services(CEGIS) and field survey, 2020

Local NGOs along the river side of Jamuna provided various agricultural facilities to the poor people. These facilities include; agricultural inputs (seed, fertilizer, pesticide), agricultural tools, cash loans, agricultural trainings, irrigation facility, providing helps to women in kitchen gardening etc. (Figure 2). All these facilities are given to people selected by NGO based on their socioeconomic situation, i.e., poorest people get it first. The aid included in the analysis of this paper was given in 2020. Among the 533 respondents, majority of the local respondents receive agricultural loan (63.60%), agricultural tools (64%), fertilizer (69%), seeds (77.70%), agricultural training (74.30%), livestock (74.30%) and pesticides (68.30%). Among sampled respondents', majority (71.30%) did not have access to receive handicraft training, as shown in figure below.

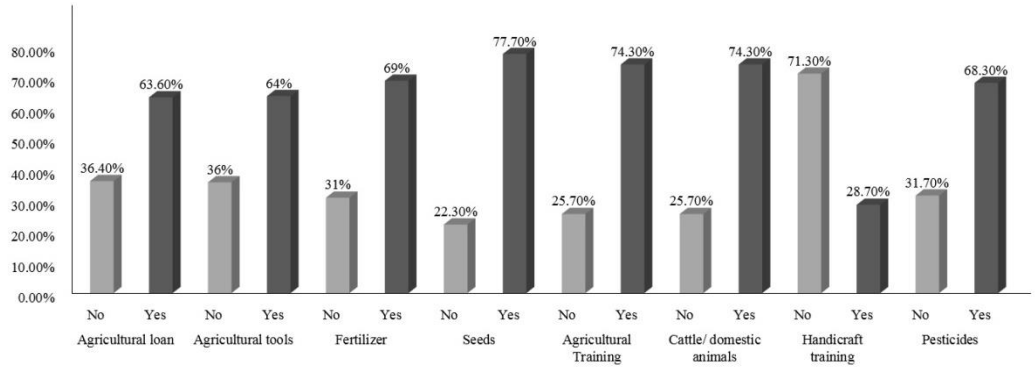


Figure 2: Facilities provided by the local NGOs in agricultural sectors along the river side of Jamuna, Bangladesh, 2020

4.3 Population engaged in agriculture, industry and services sector in the study site

In this section, we provide gender based (male/female) union council wise results on population engaged in three different sectors (agriculture, industry and services) to support to their livelihood (Figure 3a-f). The result presented in this section borrows data from Bangladesh Institute of Development Studies (BIDS), Center for Environmental and

Geographic Information Services (CEGIS) and Bangladesh Bureau of Statistics (BBS) and also includes field data in 2020.

As discussed earlier and shown in figure 3(a, b), majority of male and female respondents were involved in agriculture. Figure 3(a) shows that, upper and middle stream of Jamuna has a very high rate of male participating in agricultural activities. In some areas there are around 5,180-8,630 farmers participating in agricultural activities in some unions. In least cases, there are no less than 798 people participating in agricultural practice. The lower part of Jamuna stream has a less density of male working in agricultural sectors. The highest density found in the Jamalpur district, where most of the male take part in cultivation. The figure 3(b) indicates nearly the same proportion of women's participation in agriculture as men. Some area in Jamalpur district in the upper stream and in the middle stream which crosses the district of Bogura are mostly agriculture dominated. In some unions nearly 296-488 female participate in agricultural activities ranked very high among all the unions (Figure 3b). Kurigram and Jamalpur have the highest portion where females mostly take part in this kind of activities. Some unions in the southern part of Sirajganj are also agriculture dominant by females.

Figure 3(c, d) show that in the lower stream of Jamuna river, most of the population are engaged in industry as this area is the closest to most developed part of the country, i.e., Dhaka, the capital of Bangladesh. Both male and female were almost equally involved in industry sector. People live in Sirajganj has a high ratio of participating in industrial work than any other areas of the people living across the stream. At most over 4,000 thousand people in some unions work in industry for their livelihood and in rest of the areas have very minimum number of people who works in industry (Figure 3c). In the 3(d) figure of the series shows the females' participation in industrial sector along the Jamuna river bank. The number of female participants in industrial sector is very much limited like males. In the downstream, females of Sirajganj mostly participate in industrial work. Some other areas in Kurigram and the southern part of Bogura have some workers who choose industrial labor as their priority for livelihood. It clearly indicates that, people of these areas are not industry dominated and their economic activities are driven by other mediums.

Figure 3(e, f) shows male and female involvement in services sector. Uneven distribution of both male and female can be seen across the study area indicating that not many of the inhabitants of the region are involved in services sector compared to agriculture and industry. Compare to other parts of the study area, lower stream area has relatively more people involved in service sector. This may be due to its close proximity to the most developed part of the country, i.e., Dhaka, the capital of Bangladesh. If we look into the comparison between those three medium of livelihood; agriculture clearly lead the way. But the other two sources have also some roles to play in the livelihood pattern and economic activities alongside Jamuna riverbank districts.

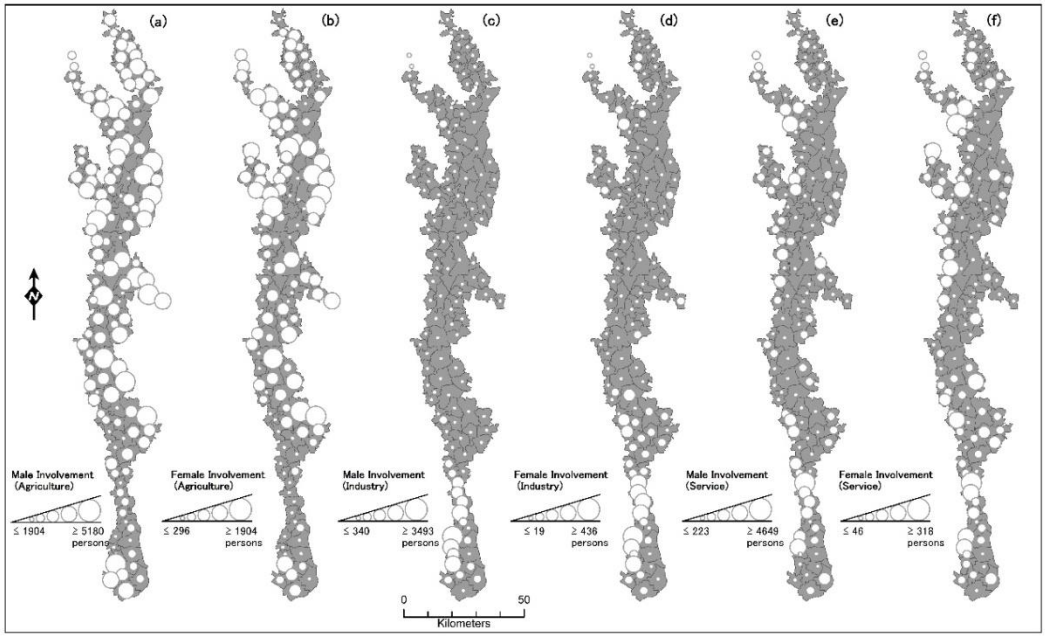


Figure 3 (a-f): Population engaged in agricultural sectors in union wise and linked to the BBS data sets along the river side of Jamuna, Bangladesh, 2020

4.4 Correlation results of profit and selected dependent variables

In this section we present a correlation analysis performed for six dependent variables, i.e., agricultural training, fertilizer, domestic animals, seeds and agricultural loan; to show how they correlate with profit farmers receive annually. Results show that, out of the total number of farmers (432,550), 3,737 were trained, selected from 126 union councils in 2020. Here union council refers to lowest administrative boundary and consist of few villages.The correlation analysis presented in Table 2 show that the correlation of coefficient for training (r) equals to 0.952, indicating a significant relationship between trained farmers and their profit per Bigha ($r = 0.952$, $p < 0.001$). This might be due to the fact that during the practical training, NGOs also advise farmers to share knowledge and resources and encourage them to cultivate same type of crops on adjacent lands so that the farmers can utilize the experiences from the trainings with each other. In total, 4,590 farmers received fertilizer. The correlation analysis between numbers of people who had received fertilizer was able to increase profit from farming. The correlation coefficient (r) equals to .250, indicating a significant relationship between increase in annual profit and access to fertilizer. This had happened because; local NGOs had provided fertilizer facility to the rural poor in proper way and time. Besides that, there were also positive correlation among the number of farmers who had gotten domestic animal, agricultural seeds and agricultural loan with an increment in annual income and their correlation of coefficient (r) equals to .270, .085 and .527 respectively as shown in Table 2. Access to agricultural training workshops, provision of livestock and agricultural loans made farmers able to improve profit from farming. Domestic animals given by NGOs are used for ploughing instead of using expensive modern technologies resulting in saving money. One of the major facilities that was provided by local NGOs is agricultural loan. In

proper time and proper way of distribution of agricultural loan to the rural poor people had made them economically self-sufficient. Traditional agricultural tools namely plough, spade, ladder were only used for producing agricultural crops. A negative correlation (r = -.046) was found between profit from farming and availability of traditional agricultural tools.

Table 2. Descriptive statistics of the selected indicators along the river side of Jamuna, Bangladesh, 2020

	TNP	PP	APY (USD)	p-value	df	Coefficient (r)
TFA and PPB						
Pearson Correlation	3,406,272	3,737	94.09	0.000	1	.952**
Sig. (2-tailed)						
FL and PPB						
Pearson Correlation	3,406,272	4,590	59.30	0.005	1	.250**
Sig. (2-tailed)						
DA and YINC						
Pearson Correlation	3,406,272	3,519	87.25	0.002	1	.270**
Sig. (2-tailed)						
TAT and PPB						
Pearson Correlation	3,406,272	3,237	18.45	0.606	1	-.046**
Sig. (2-tailed)						
AS and PPB						
Pearson Correlation	3,406,272	3,264	9.54	.346	1	.085**
Sig. (2-tailed)						
AL and PPB						
Pearson Correlation	3,406,272	2,865	69.78	0.000	1	.527**
Sig. (2-tailed)						

Source: Interview with local NGOs employee of 126 unions (focused group discussions and interviews with 175 branches of 30 NGOs

** Correlation is significant at the 0.01 level (2-tailed).

* 1 Bigha = 0.16055846 hectare

* TFA= Trained farmers in agriculture, PPB= Profit per Bigha, FL= Fertilizer, DA= Domestic animals, YINC= Yearly income, TAT= Traditional agricultural tools, AS= Agricultural seeds, AL= Agricultural loan, NU= Number of unions, TNP= Total number of populations, PP= Privileged population and APY= Average profit in yearly.

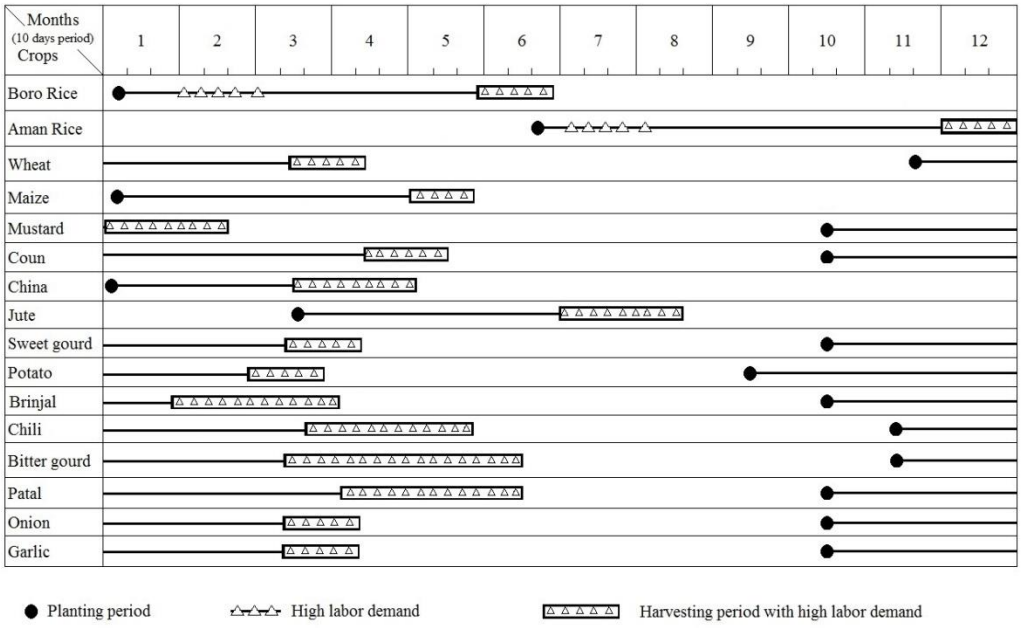
4.5 NGOs Role on Exploring Land and Crop Suitability of along the Jamuna River

NGOs are making a big contribution to agricultural development along the Jamuna River in Bangladesh. Agricultural training for the poor, agriculture services such as distribution of equipment, fertilizer, pesticides, and seeds, poverty alleviation, environment, health and population, education, and other activities are among the major activities carried out by local NGOs in an unstructured manner though at present they are trying to develop crop suitability map to find out which specific crop is appropriate for a region. At present

BARK is engaged in complying crop suitability app based on soil nutrient data and crop calendar by which farmers can get information about cropping season, suitable crop for specific areas which will help them to produce more than before.

4.5.1 Cropping season in the study area

Crop-oriented agriculture is practiced in the study communities. In different agricultural seasons and under varied physical conditions, a variety of crops are cultivated (especially rainfall and elevation of land in relation to the flood level). This article creates a crop calendar with a growth period and a high labor demand for rural farmers to pick plants and seeds at the right time to produce based on local people's opinions and information from local NGOs. The following is the crop calendar:



Note: *Aman* rice, *Boro* rice, *Coun,China are local variety of crops*

Figure 4: Suitable crop calendar along the river Jamuna, Bangladesh, 2020
Source: Field survey, 2020

As a flood plain, several types of crops have been growing along the river side of Jamuna (Nye and Greenland, 1960). Main crops are *aman* rice, *boro* rice, wheat, maize, mustard, *coun,china*, jute, sweet gourd, potato, brinjal, chili, bitter gourd, onion and garlic. *Boro* rice is planted in the month of January and harvesting and threshing is done in the month of June. It is very high labor period for harvesting *boro* rice. February is the peak time for irrigation and pesticides. There are three types of rice namely *Aus, Aman and Boro* are called major cereal crops in Bangladesh. *Aman* rice is harvested in the month of November and December. Wheat is grown under a wide range of climatic conditions and requires dry weather and bright sunlight. Depending on variety and weather conditions, it takes 100-120 days for sowing to harvest. Wheat is planted in the month of November and harvesting and threshing happens in the month of March or mid-April. Maize is

cultivated to a limited extent in Kharif and Rabi seasons along the river side of Jamuna, Bangladesh. The cultivation of maize and food prepared from it is not very familiar and extensive. Wheat is planted in the month of January and harvested and threshed in the month of mid-April or May. The large quantity of oil comes from mustard seeds. It is more expensive than soybean. Mustard seeds are sowed in the month of October and harvested and threshed in the month of February.

Jute is grown in the rainy season. Jute is known as the golden fiber of Bangladesh. It is the main source of income in the country. Jute fibers are mainly made from two major commercial types, namely white jute and tossa jute. On the banks of the Jamuna River, sowing usually begins at the end of February or March, depending on the variety, and lasts until the end of June. The best fertility clay to sandy loam is suitable for jute, and the pH of the soil is 5.08.6 (Nye et al., 1960).

Potato is the major crop in Bangladesh (Lal, 1987). Potato is needed to be cultivated in well-fertilized, sunny land along the river side of Jamuna during winter. Potato plantation is required sufficient moisture in soil. The first October is appropriate for potato plantation and March and April for harvesting. Potatoes in this country are planted manually. Generally row spacing is from 45cm. to 60 cm. The optimum depth of planting depends on moisture of the soil and temperature. Chili is cultivated in both the summer and winter seasons. Chili is widely cultivated along the river side of Jamuna during summer and winter seasons. There are various local varieties of chili like *balijuri, bona, bain, saita, suryamukhi, paba, halda, dhani, shikarpuri and patnai*(Yearbook of Agricultural Statistics of Bangladesh, 2015).

As we all know, our rural life encompasses a wide range of natural and man-made elements and components, such as population, environment, religion, culture, health, education, agriculture, economy, etc. Non-governmental organizations are committed to eliminating economic crises a well-functioning agricultural system. You have been particularly committed to the agricultural system and tried to minimize the cracking rate (Bangladesh Agricultural Statistical Yearbook, 2015; Ramesh et al., 1971).

4.5.2 Analysis of land and crop suitability along the Jamuna River

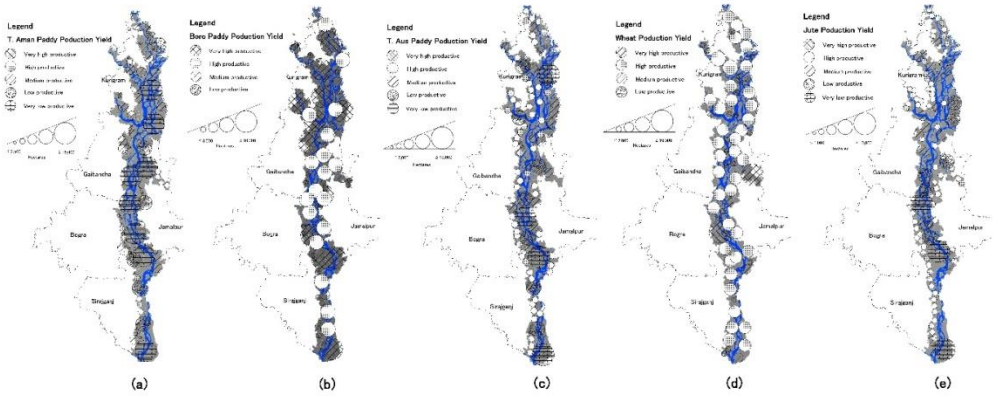
This section provides results from household surveys (533 respondents) and 50 focus group discussions (5 to 6 participants in each discussion) and reports on agricultural land suitability from Bangladesh Bureau of Statistics (BBS), Bangladesh Agricultural Census and CEGIS on the appropriateness of land for agricultural crops in our sample sites. Total area included in the analysis was 340,659.49 hectares. Results are analyzed using a five-point Likert scale, i.e., very high, high, medium, low and very low; which is summarized in Table 3. Crops being included in the analysis are; rice, wheat, Jute potato, chili, ginger and turmeric, onion and garlic, mustard and sugarcane. Results show that three varieties of rice namely; *T. Aman, Boro and T. Aus* are grown in the study area whereas *Boro* rice is the best suites for farmers of the study site. The land for jute and potato cultivation is moderately suitable. Furthermore, the production of chili, ginger and turmeric is perceived very low among sampled respondents due to unavailability of suitable land.

Table 3. Suitability of crop type and land along the river side of Jamuna River, Bangladesh

Crop Type	Very High (ha)/%	High (ha)/%	Medium (ha)/%	Low (ha)/%	Very Low (ha)/%	Comments
1. T. Aman	19,009.97 (5.58)	13,529.14 (3.97)	75,536.43 (22.17)	34,800.15 (10.22)	1,977,83.80 (58.06)	Not enough suitable for *T. Aman* rice
2. *Boro*	124,605.49 (36.58)	136,328.78 (40.02)	36,302.69 (10.66)	43,422.55 (12.75)	--	Suitable for *Boro* rice
3. *T. Aus*	3,726.54 (1.09)	73,155.10 (21.47)	68,642.28 (20.15)	66,750.88 (19.59)	128,384.70 (37.67)	Not Suitable for *T. Aus* rice
4. Wheat	24,143.73 (7.09)	250,645.53 (73.58)	11,888.80 (3.49)	53,981.43 (15.85)	--	High productive area for wheat
5. Jute	527.4 (0.15)	65,372.29 (19.19)	82,171.64 (24.12)	67,700.35 (19.87)	124,887.81 (36.66)	Moderate suitable for Jute cultivation
6. Potato	--	7,401.37 (2.17)	215,457.19 (63.25)	107,900.47 (31.67)	9,900.47 (2.91)	Moderate suitable for potato cultivation
7. Chili	18,195.51 (5.34)	61,255.73 (17.98)	8,372.28 (2.46)	252,835.99 (74.22)	--	Low productive chili yield
8. Ginger and Turmeric	--	6405.27 (1.88)	19273.3 (5.66)	6690.66 (1.96)	308290.26 (90.50)	Not Suitable for ginger and turmeric
9. Onion and Garlic	25,227.03 (7.41)	220,773.15 (64.81)	77,047.59 (22.62)	9,239.45 (2.71)	8,372.28 (2.46)	Suitable for onion and garlic cultivation
0. Mustard	243,789.45 (71.56)	65,919.89 (19.35)	22,395.15 (6.57)	182.72 (0.05)	8,372.28 (2.46)	Highly suitable for mustard cultivation

Note: T. Aman, Boro and T. Aus are the local variety of rice along the river Jamuna, Bangladesh.

Source: Bangladesh Bureau of Statistics (BBS), Bangladesh Agricultural Census, 2011, CEGIS and field survey, 2020



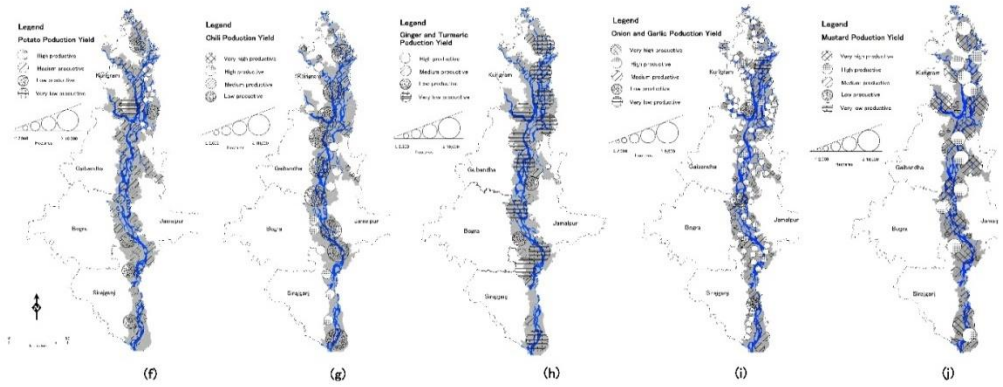


Figure 5 (a-j): Analysis of land and crop suitability along the Jamuna River, 2020

Source: Bangladesh Bureau of Statistics (BBS), Bangladesh Agricultural Census, 2011, CEGIS and field survey, 2020

(a) Production area of *T. Aman* rice (5a)

The results show that the northeastern part of Kurigram district, the western part of Jamalpur along with the river bank and the eastern part of Bogra district have very high production areas, i.e. 5.58% of the total land. The upper stream of Jamuna river, i.e., districts of Kurigram and Gaibandha have medium productive zones of *T. Aman* rice which accounts for nearly 22.17% of the total area. Low production of *T. Aman* rice was mostly noticed in the lower middle stream of Jamalpur and Sirajganj district which is almost 10.22 % of the total land. Around 58.06% of the reaming land is classified as very low productive area (Table 3). The lower part is prone to erosion causing low production of *T. Aman* rice.

(b) Production area of *Boro* rice (5b)

Boro rice production is more suitable than any other rice species along the river side of Jamuna River. Almost all the districts are very highly productive for *Boro* rice. The upper part of Jamuna is highly productive in comparison to the middle and lower part of Jamuna stream. The total area of *Boro* with very high effectiveness is almost 36.58% of the total *Boro* production area (Table 3). The eastern part of Kurigram and Jamalpur districts are highly suitable for *Boro* rice cultivation. Relatively the southern side of Jamalpur and eastern side of Sirajganj lack in very high productivity zones of *Boro* rice cultivation (Figure 5b). The middle stream of Jamuna was completely dominated with *Boro* production. The total area of high *Boro* production is around 136,328.78 hectares which is highest ratio among all types of productivity with 40.02% production area. Low productive zones (12.75%) of *Boro* rice were found to be very minimal alongside districts of Jamuna River. The effective cultivation of *Boro* rice will lead the farmer to more interest in cultivation of this species in the bank of river Jamuna.

(c) Production area of *T. Aus* rice (5c)

T. Aus rice is the one of the major cereal food grains in Bangladesh. The western side of the river is dominated mostly by very high production zones (1.09%) whereas in eastern

side of the river, some scattered distribution of *T. Aus* rice was found (Figure 3). Kurigram and Gaibandha districts are dominantly covered with high productive zones of *T. Aus* rice. In Jamalpur district, close to the main channel of Jamuna has a huge land of high productive zone which counts to nearly 21.47% of total area of *T. Aus* cultivation (Table 3). Around 20.15% of the total area in upper to middle stream is covered by medium production covering the districts of Kurigram, Gaibandha and the northern part of Jamalpur (Table 3). Around 37.67% areas of total cultivable land for the *T. Aus* rice are very low productive zones.

(d) Production area of Wheat (5d)

The second most important grain crop after rice is wheat which is most vital winter crop in Bangladesh. The northern part of Kurigram district in the upper stream, the eastern part of Jamalpur district in the middle stream and Bogra and Sirajganj in the lower middle; have the equal distribution of very high production. The total land coverage of very high production area for wheat is 7.09% of all types of land coverage. The high productive zones of wheat production area are spread all over the Jamuna channel in all districts. Approximately 73.58% of the total cultivable land is highly suitable for the cultivation of wheat. Kurigram, Gaibandha and Jamalpur districts are not suitable for wheat crop. Mostly the southeastern part of Kurigram has very limited land suitability for wheat yields, covering around 15.85% of the total wheat production in the study area (Table 3).

(e) Production area of Jute (5e)

A small portion of land in the upper stream in Kurigram district has a very high productive zone for jute production which was only 527.4 hectares covering less than 0.15% of the total jute production area. From upper to lower stream, in all districts, some areas have high Jute production (Figure 5e). The total high productive jute land is around 65,372.29 hectares (19.19% of the total productive area). Mostly Gaibandha district has the highest amount of land piece of medium production of jute which was around 82,171.64 hectares covering nearly 24.12% of the total land. The eastern most part of Kurigram in the upper stream and the western part of Jamalpur in the middle stream of Jamuna river has the highest density of low jute production area which was around 67,700.35 hectares and covering 19.87% of the total area. The southernmost part of the district and the northernmost part of Bogra has very low production areas of jute cultivation. A huge portion of around 36.66% (124,887.81 hectares) of the total area is very low productive zone for jute production.

(f) Production area of Potato (5f)

Almost 215,457.19 hectares (63.25%) of all the land along the river bank of Jamuna is medium productive zone of potato (Table 3). Only small land (7,401 hectares or 2.17% of the total land) in Kurigram district has high productive zone of potato. The total area of very low production was 9,900 hectares which is covering 2.91% of the total land of potato production. The northern and southernmost part of Kurigram, Gaibandha in the middle stream and eastern side of Bogra and Sirajganj have the highest land forms of low production of potato that are occupying 107,900.47 (31.67%) of the total productive land.

(g) Production area of Chili (5g)

Majority of the land (74.22%) is also not suitable for growing chili along the river side of Jamuna. Results show that, small portions of Jamalpur and Kurigram district in the north are highly suitable for the production of chili. Total area of very high production is only 18,195 hectares which covers only 5.34% of the total cultivable land (Table 3). The northern and western part of Kurigram in the upper stream, the northern most part of Jamalpur, parts of Bogra and Sirajganj, were highly suitable for chili production which covered 61,255.73 hectares (17.98%). A negligible portion of land in the northern most part of Kurigram to southern part along the river bank and a small part of southern Jamalpur has a medium productive zone (2.46%) for chili (Figure 5g). The cultivable land for chili with low production is very high in amount.

(h) Production area of Ginger and Turmeric (5h)

Approximately 308,290.26 hectares (90.50%) of total land is not suitable for ginger and turmeric production (Figure 5h). Only a small portion of land i.e. 6,405.27 hectares (1.88%) is highly productive and nearly 5.66% is moderately productive for ginger and turmeric cultivation (Table 3). Some areas in Kurigram and Jamalpur have highly productive zones for turmeric and ginger (Figure 5h). Throughout the whole river bank of Jamuna the production of ginger and turmeric suitable land in medium context is scattered available. In the middle stream of Jamuna there are some areas where the production of ginger and turmeric were low and it covered 6,690.66 hectares (1.96%) of the total land.

(i) Production area of Onion and Garlic (5i)

In the upper stream, northern part of Kurigram has a very high production zone for onion and garlic. Along with this in the middle part of Jamuna, Jamalpur and Bogra has a very high productivity of onion and garlic cultivation (Figure 5i). In the lower stream, i.e., Sirajganj has high productive zones. There are total of 25,227.03 hectares of land is very high productive which is almost 7.41% of the entire cultivation area. The high production area for onion and garlic is 220,773.15 hectares which is almost 64.81% of the total cultivable land (Table 3). In the lower bank of Jamuna in Sirajganj district is cultivated for medium production of garlic and onion. Total of 77,047.59 hectares of land is causing medium production of the entire land which is almost 22.62 % of the total land. Low and very low production lands are mostly situated very close to the main channel of Jamuna which is covering respectively 2.71% and 2.46% of total land (Table 3).

(j) Production area of Mustard (5j)

The river bank of Jamuna is highly suitable for mustard production. The total high productive land covered nearly 243,789.45 hectares which is nearly 71.56 % of the total cultivable land. From the upper to downstream of land are equally fertile for mustard production. In the upper stream, the district of Kurigram and the northern part of Gaibandha are very high productive zones for mustard cultivation. In the middle stream, the northern part of Jamalpur and Bogra has a very high density of mustard production (Figure 5j). In lower part of the middle stream in Bogra district, some areas have high mustard production, i.e., 65,919.89 hectares or 19.35 % of the total cultivable land. There is hardly any area found of very low mustard productive zones in the middle stream

which includes the district of Gaibandha, Jamalpur and Bogra which was 8,372.28 hectares covering nearly 2.46% of the total land for mustard production. In the lower stream, the southernmost part of Sirajganj district nearly 22,395.15 hectares which is 6.57% of the total available land, is moderately suitable for mustard. Only 82.72 hectares (0.05%) in southern Jamalpur, far away from the main river course is low productive zone for mustard cultivation (Table 3).

5.0 Conclusion

A large number of non-governmental organizations (NGOs) work in nearly every sector in the studied region. The sort of project for which they get funding determines the objective and extent of their employment.According to the findings, local NGOs in the research region have aided farmers by providing agricultural supplies (seed, fertilizer, pesticides), agricultural tools, financial loans, agricultural trainings, irrigation facilities, and kitchen gardening, among other things. Farmers are selected for aids based on their socio-economic condition, i.e., poorest people are given priority.The study shows that three varieties of rice named as; *T. Aman, Boro* and *T. Aus* are grown in the study area. *Boro* rice suites best in the soil of study site while the land for jute and potato is moderately suitable. Furthermore, the production of chili, ginger and turmeric is perceived very low among sampled respondents due to unavailability of suitable land. The research concludes that most of the farmers in the study area are from the poorest of the poor communities of the country. Regardless of the fact that NGOs are providing agricultural support to those poor farmers, it is advised that government agricultural extension institutions should also train farmers on how to improve agricultural production as well as raise awareness among the farmers to identify suitable location for crops beforehand. Besides that, setting the clear policy goals on improving farming, improving the use of advanced technology for farming, improving market access and other technical assistance will help farmers to improve crop yield.

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References

Alam, G.M., Hoque, K.E., Khalifa, T.B., Siraj, S.B., and Gani, M.F.B.A., 2009: The role of agriculture education and training on agriculture economics and national development of Bangladesh. African Journal of Agricultural Research Vol. 4 (12), pp. 1334-1350, December Academic Journals.

Alauddin, M., and Biswas, J., 2014: Agricultural Credit in Bangladesh: Present Trend, Problems and Recommendations. Journal of Economics and Sustainable Development, Vol.5, No.27, 2014. ISSN 2222-1700 (Paper) ISSN 2222-2855 (Online), www.iiste.org.

Ali, M.S. et al., 1998: Agricultural Sector: Policies and Performances in Bangladesh. The University Press Limited (http://salekseraj.com/TP8.pdf).

Anonymous, 2003: Existing Extension System: Strengths, Weaknesses and Proposed Reforms in Bangladesh. Country Paper: Paper Presented in Regional Workshop on Operationalizing Reforms in Agricultural Extension in South Asia, held on 6-8 February, 2003 at New Delhi, India.

Bala, B. K., Hossain, S. M. A., Haque, M. A., Majumder, S., & Hossain, M. A., 2010: Management of agricultural systems of the uplands of Chittagong hill tracts for sustainable food security, final technical report (PR-1). Dhaka: FAO Office.

Bala, B.K., Majumder, S., Altaf Hossain, S.M. et al., 2013: Exploring development strategies of agricultural systems of Hill Tracts of Chittagong in Bangladesh, Journal of Environment, Development and Sustainability , August 2013, Volume 15, Issue 4, pp 949–966 doi:10.1007/s10668-012-9420-2.

BBS, 2011: Statistical Year Book of Bangladesh. Bangladesh Bureau of Statistics, Statistics Division, Ministry of Planning, Government of the People's Republic of Bangladesh, Dhaka. Available at:

(http://203.112.218.65:8008/WebTestApplication/userfiles/Image/SubjectMatterDataIndex/YB-2012.pdf)

BBS, 2016: Estimates of Potato. (2016, September 14). Retrieved from Bangladesh Bureau of Statistics.

(http://www.bbs.gov.bd/WebTestApplication/userfiles/Image/Agriculture/potato2013-14.pdf).

Bangladesh Institute of Development Studies (BIDS), 1981: 'Rural Industries Study Project — Final Report,' (Dacca, Bangladesh: BIDS).

Bangladesh Institute of Development Studies (BIDS), 2011: 'Rural Industries Study Project — Final Report,' (Dhaka, Bangladesh: BIDS).

Bayes, A., and Patwary, F.K., 2012: An Empirical Analysis of the Impact of Agricultural Credit from Banks andMicrofinance Institutions (MFIs) in GDP Growth: Bangladesh Perspective, Bangladesh Bank Working Paper.

(www.bangladesh-bank.org/pub/research/.../wp1204_draft.pdf).

Begum, S. F., Zaman, S. H., and Khan, M.S., 2004: Role of NGOs in the rural poverty eradication- A Bangladesh observation, BRAC University journal, vol. I, no. I, 2004, pp. 13-22.

Birkhaeuser, D., R. E. Evenson, and G. Feder, 1991: The economic impact of agricultural extension: a review." Economic Development and Cultural Change, Vol.39, pp. 610-650.

Borggaard, O. K., Gafur, A., & Petersen, L., 2003: Sustainability appraisal of shifting cultivation in the Chittagong Hill Tracts of Bangladesh. AMBIO: A Journal of the Human Environment,32(2):118-123. 2003 doi: http://dx.doi.org/10.1579/0044-7447-32.2.118.

Bulletin of Institute of Vocational and Technical Education No.5 October 2008: Agricultural Extension Services In Bangladesh: A Review Study Mohammed Nasir Uddin, pp: 119-130).

Christoplos and Kidd, 2000: Guide for monitoring, evaluation and joint analyses of pluralistic extension support, Neuchâtel Group, Lindau (2000).

Davis, K., Nkonya, E. , Kato, E., Mekonnen, D.A., Odendo, M., and Miiro, R. , 2012: Impact of Farmer Field Schools on Agricultural Productivity and Poverty in East Africa. The journal of World Development, Volume 40, Issue 2, February 2012, Pages 402–413 (http://dx.doi.org/10.1016/j.worlddev.2011.05.019).

Grogan, P., Lalnunmawia, F., & Tripathi, S. K., 2012: Shifting cultivation in steeply slopped regions: A review of management options and research priorities for Mizoram state, Northeast India. Journal of Agroforestry Systems, February 2012, Volume 84, Issue 2, pp 163–177, DOI: 10.1007/s10457-011-9469-1.

Haggblade, S., Liedholm C. and Mead, D., 1986: The Effect of Policy and Policy Reforms on Non-Agricultural Enterprises and Employment in Developing Countries: A Review of Past Experiences. Employment and Enterprise Policy Analysis Discussion Paper, no. 1 (Cambridge, Mass.: Harvard Institute of International Development).

Haque, M.S., 2002: The Changing Balance of Power between the Government and NGOs in Bangladesh," International Political Science Review, Vol. 23:4, 2002, pp. 411-435.

Holloway, Richard J. V., 1995: Civil Society - the Non-Profit Private Sector: trying to categorize it in Bangladesh, UNICF, Dhaka.

ISPAN, 1993: Char land Study Overview: Summary Report, FAP 16 & 19. FPCO, Dhaka.

Khan NA, Khisa SK, 2000: Sustainable land management with rubber-based agroforestry: a Bangladeshi example of upland community development. Journal of Sustainable Development, Volume 8, Issue 1, February 2000, Pages 1–10, DOI: 10.1002/(SICI)1099-1719(200002)8:1<1::AID-SD126>3.0.CO;2-C.

Knudsen, J. L., & Khan, N. A., 2002: An exploration of the problems and prospects of integrated watershed development in the CHT. Bangladesh. In N. A. Khan, M. K. Alam, S. K. Alam, & M. Millat-e-Mustafa (Eds.), Farming practices and sustainable development in the Chittagong hill tracts (pp. 165–180). Chittagong: CHTDB and VFFP- IC.

Lal, R., 1987: Effect of soil erosion on crop productivity. Journal of Critical Review Plant Science, Volume 5, 1987 - Issue 4, Pp 303–367, (http://dx.doi.org/10.1080/07352688709382244).

Mahjabeen, R., 2008: Micro financing in Bangladesh: Impacts on household consumption and welfare. Journal of Policy modeling.

Volume 30, Issue 6, November–December 2008, Pages 1083–1092.http://dx.doi.org/10.1016/j.jpolmod.2007.12.007.

Ministry of Finance, 2015: Bangladesh Economic Review, 2015. Dhaka, Bangladesh: Finance Division, Ministry of Finance, Government of Bangladesh.

Nye, P. H, & Greenland, D.J., 1960: The soil under shifting cultivation. Harpenden, UK: Commonwealth bureau of soils, Technical communication. No. 51.

Quazi and Rahim, 2000: Macroeconomic Effects of Foreign Aid in Bangladesh Revisited. Journal of Bangladesh Studies, Vol. 2:2, 2000, pp. 7-15.

Rahman, K.M.M. and Islam, M.A, 2014: Nutrition-sensitive agriculture in Bangladesh: a review, Food Security, October 2014, Volume 6, Issue 5, pp 671–683, DOI: 10.1007/s12571-014-0380-2.

Rahman, K. M. M., & Islam, M. S., 2011: Nutritional status and food security of farm households in Bangladesh: a study on major land use patterns. Farming and Rural Systems Economics, 127, 203–220.

Rahman, K. M. M., and Sousa-Poza, A., 2010: Food Consumption and Nutritional Status of Vulnerable People Rearing Livestock in Bangladesh. Bangladesh Journal of Agricultural Economics, 33(1 & 2), 41–56.

Rahman, S., Rahman, M., & Sunderland, T., 2012: Causes and consequences of shifting cultivation and its alternatives in the hill tracts of eastern Bangladesh. Journal of Agroforestry Systems, February 2012, Volume 84, Issue 2, pp 141–155 doi:10.1007/s10457-011-9422-3.

Ramesh, K.S. et al., 1971: Planning Rural Growth Centers for Integrated Area Development: A Study in Miryalguda Taluka, Hyderabad, National Institute of Community Development.

Rasul, G., Thapa, G. B., & Zoebisch, M., 2004: Determinants of land-use changes in the Chittagong Hill Tracts of Bangladesh. The journal of Applied Geography, Volume 24, Issue 3, July 2004, Pages 217–240. (http://dx.doi.org/10.1016/j.apgeog.2004.03.004).

Robbani, M., S. U. Siddiquee, S. Zaman, and H. Nakamura, 2007: Agriculture in Bangladesh: Recent Trend and Agro environment toward Sustainability. Journal of the Faculty of Agriculture Shinshu University, Vol.43, No.2, pp. 17-25.

Roy, R. D., 2002: Sustainable and equitable resource management in the Chittagong Hill Tracts. Bangladesh. In N. A. Khan, M. K. Alam, S. K. Khisa, & M. Millat-e-Mustafa (Eds.), Farming practices and sustainable development in the Chittagong Hill Tracts (pp. 135–154). Chittagong: CHTDB and VFFP- IC.

Saleque, M. A., 2004: Scaling-up: Critical Factors in Leadership, Management, Human Resource Development and Institution Building in Going from Pilot Project to Large Scale Implementation: The BRAC Poultry Model in Bangladesh. BRAC Center, 75 Mohakhali C.A. 1212 Dhaka, Bangladesh.

World Bank, 2005: "Revitalizing the Agricultural Technology System in Bangladesh." Bangladesh Development Series, Paper No.7. The World Bank Office, Dhaka.

(http://documents.worldbank.org/curated/en/774421468013249065/pdf/354820BD0Revit10also03454301PUBLIC1.pdf).

Yearbook of Agricultural Statistics of Bangladesh, 2015 and Bangladesh Bureau of Statistics (BBS), 2011: Ministry of Planning, Dhaka. Bangladesh. (http://www.bbs.gov.bd/Page WebMenuContent.aspx?MenuKey=234).

World Bank, 1996: Bangladesh: Rural Infrastructure Strategy Study, Dhaka. The University Press Limited (http://salekseraj.com/TP8.pdf).