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AGRICULTURAL ADJUSTMENT IN FLOOD-PRONE AREA: A CASE OF COMILLA DISTRICT IN BANGLADESH

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Abstract

The focus of the paper is to understand the agricultural adjustment process in flood-prone areas of Comilla district in Bangladesh. The study was mainly based on primary data; data was collected from June 2011- May 2012 at the household level. Field observation indicates that river flooding; flash flooding and flood due to rainfall are very common in the study area. But the farmers of the study area cope with flood by using their indigenous knowledge, traditional beliefs and their perception of the environment. By using their perception and traditional beliefs, their choice of crop in a particular land is determined. Still today, farmers, apply indigenous techniques to face flood- keeping their eyes open on how monsoon winds change with the change of seasons for flood.

Keywords: Adjustment process, Crop diversification and perception

Introduction

Comilla is one of the most agricultural potential areas of the country. But river flooding and flash flooding is very common in the region. Comilla occupies an area of 3085.17 km^2. km with a population of 48381 (BBS, 2008). More than 85% people are farmer. The total cultivable land is 10750km^2. Seasonal flooding is mainly deep, but it is shallow in the southeast. Some basin centers stay wet throughout the dry season. Flooding is mainly by rainwater, but occasionally by flash floods from adjoining hilly areas when the land is flooded with silty water. Moderate and low -river flooding is very common but severe flash flooding occurs in eastern part of the district along the Indian border and the Dakatia River. River flood occurs by Meghna, Gomuti and Dakatia River during rainy season. Gomuti River is a basin for Comilla as bank erosion occurs along the Gomuti River during the rainy season (Islam, 1998).

This study looked into the farmer's perceptions and adjustment processes at all the different stages of the flood viz. pre, during and post flood times. The study was based on the hypothesis that the low land areas are more vulnerable than the high lands of the area. The study also tried to find out the answers of some questions: what mechanism do the

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farmers apply for the lands vacant for six months? or what type of crops are suitable for low lands of the area? The study was specifically conducted- to identify the coping process of the farmers through adjustment in terms of social, occupational and economic status during and after flood and to study the grass root initiatives which have led to various practices adjustments in times of floods.

Materials and Methods

Study Area

The district of Comilla was selected as the study area because it is located in the south-east region of Bangladesh which is flood-prone and most intensively cropped area in the country (Fig. 1). All types of flood occur in the district such as river flooding, flash flooding and flood due to rainfall.

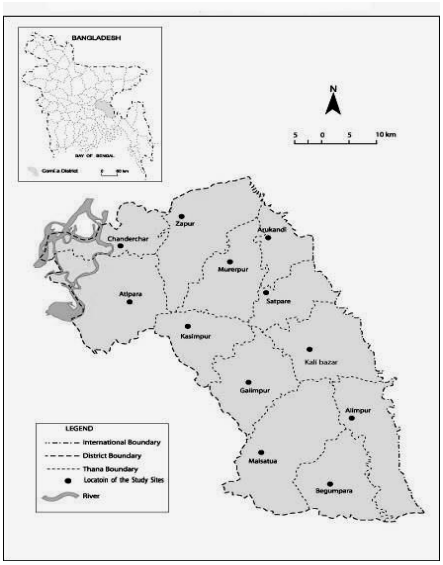


Fig. 1. Location of the Study Sites in Comilla District.

Data Collection and Analysis

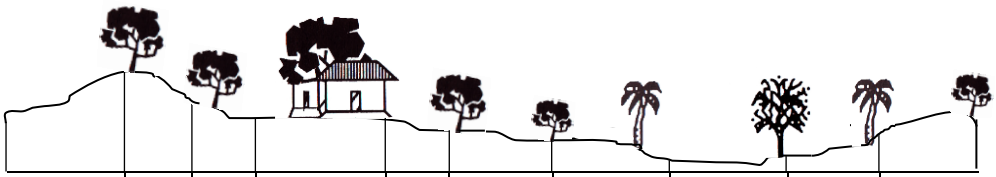
The study was based on primary data, collected through a questionnaire survey of farmer households. The field data were collected from June 2011 to May 2012. Secondary data were used to understand the background of the study area and to evaluate the adjustment process in terms of agriculture. The emphasis of the study was on analyzing the current level of adjustments and the perceptions of the farmer in terms of causes, extent and intensity of flood related to agriculture. Enumeration was undertaken in 200 agricultural households chosen randomly from among households irrespective of those being affected by flood in ten Upazilas. Data processing and analysis was completed by using relevant statistical method. From one-way frequency table, percentages, ratios were calculated.

These were used to analyze the data and also to prepare graphs and diagrams using the MS word and Excel programme.

Results and Discussion

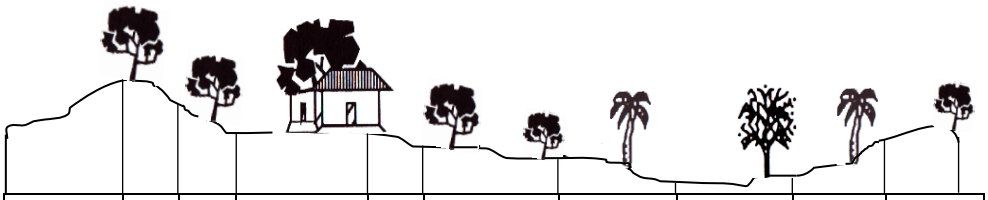
Land use Pattern

Land use of Comilla district mainly based on agricultural activities. A total of 243596.93 hectares land are cultivable; among them single crop land is 18.05%, double crop land is 63.99% and treble crop land is 17.96%. The proportion of highland and medium highland of Murerpur village are higher than Atipara village. But the amount of low land of Murerpur village is less than Atipara village. This is interesting to note that soil types of the two villages are nearly same but cropping patterns vary from one to another. The following figures (Fig. 2-3) show the comparative land use pattern of the two villages.



Land type and area coverage		Road Side	Highland (*bhita*) 10%	Mud Road	Medium highland (danga) 20 %	Medium lowland 30 %	Lowland 40 %	Medium lowland	Medium highland
Enterprise	Metal road		Homesteads, roads		Crop fields 100 %	Crop fields 100 %	Crop fields 100 %		
Soil type			Sandy loam		Loam	Silty loam	Silty loam		
Crops / Cropping pattern and trees			Kitchen garden, seedbed of *boro* Mango, guava, bamboo		*Boro*- Deep water *Aus* 100 %	*Boro* 100 %	*Boro* 100 %		
Livestock			Cattle, buffalo, goat, chicken, duck, pigeon						
Problems			Insufficiency of animal power at peak time of on-farm activities		Need regular irrigation during winter season	Flood water submerged the land during rainy season	Flood water submerged the land during rainy season		
Adjustment Process					*Boro cultivate during Rabi* season and Aus cultivate on highland.	Only cultivate *Boro* during *Rabi* season and left the land fallow during rainy season	Only cultivate *Boro* during *Rabi* season and left the land fallow during rainy season		

Fig. 2. Land use Pattern of Atipara village (Daudkandi Upazila).



Land type and area coverage	Metal road	Road Side	Highland (*bhita*) 15%	Mud Road	Medium highland *(danga*) 25%	Medium lowland 30%	Lowland 30%	Medium lowland	Medium highland
Enterprise			Homesteads, roads		Crop fields 100 %	Crop fields 100 %	Crop fields 100 %		
Soil type			Sandy loam		Loam	Silty loam	Silty loam		
Crops / Cropping pattern and trees.			Fruits tree, kitchen garden, seedbed of Aus, *Aman* & *Boro* Mango, jackfruit, bamboo, nut, coconut		*Rabi* vegetable-*Aus*- T. *Aman* 30 %*Boro*-*Aus*- T. *Aman 30 %Boro*- T. *Aman* 40 %	*Boro*- T. *Aman* 20 % *Boro*- Deep water *Aman 20% Boro 60 %*	*Boro 60 %*		
Livestock			Cattle, buffalo, goat, chicken, duck, pigeon						
Problems			Insufficiency of animal power at peak time of on-farm activities		Low water holding capacity, Need regular irrigation, Lack of sufficient drainage facilities resulting flood in late *Boro* rice	Flood water submerged the land during the rainy season	Flood water submerged the land during the rainy season		
Adjustment Process					Give regular irrigation. Early harvest mature Boro.	Only cultivate *Boro* during *Rabi* season and left the land fallow during rainy season	Only cultivate *Boro* during *Rabi* season and left the land fallow during rainy season		

Fig. 3. Land use Pattern of Murerpur village (Debidwar Upazila)

Adjustment Processes

In the flood vulnerable areas, farmers cultivate various crops by using their indigenous knowledge, traditional practices, and perception about the environment. People's perceptions, their coping strategies and their interaction with the environment to undertake appropriate measures before, during and after the devastating flood situation was very important.

Two scales of adjustment processes by the farmers of the district were observed in course of the study:

Adjustment processes-Temporary

Adjustment process in a small scale largely involved the activities of flood-affected farmers. Farmers were very active and they were preparing themselves to adjust with the flood situation from June to September. They knew that they cannot prevent the hazard but can prepare themselves to adjust with the situation. Farmers took some initiatives, measures and techniques to save crops from damage and other measures during and after floods. There were some fundamental adjustments that they resorted to adjust with flood (AIS 2007).

Precaution Prior-flood

Usually farmers make seedbed or seedlings of broadcast *Aman*, vegetables and other crops in highlands which are flood-free. In severe flood vulnerable area farmer cultivate short duration *boro*, deepwater rice, jute in lowland area. For the proper growth of deep water *Aus* and *Aman*, they weed out, control pest, and apply urea from the beginning of sowing. They cultivate sapling of long stem paddy where paddy land is submerged by water. In flash flood area to resist the power of flood waters they cultivate hard straw paddy like IRRI-8, *Chandina* (BR1), *Biplab* (BR3). To Protect the transplanted *Aman* field from flood water or floating weeds, debris, rats, and stem borers by making natural fence or enclose the land with *dainchya.* When flood water submerge the paddy field they harvest 80% ripen paddy (*Aus* or *boro*).

Precaution during flood

During the flood they usually prepare seedlings in flood-free highland or floating seedlings in raft or fence covered with soil in flood-free land. In September, sow the BR-22/BR-23/ BINASHAO/ NAGIRSHAO/ Local *Aman* seed. After recession of flood water, transplant the saplings onto the land. For the *Robi* crop they prepare the seedlings of cauliflower, cabbage, tomato, brinjal, chilli, gourd etc. in front of house, wood-box, drum, old tin, poly-bag, plastic container or raft. After the recession of flood water they transplant them onto the land. Usually they harvest 60-80% of mature crop when they are submerged by flood water.

Precaution Post-flood

For the rapid growth of partly damaged crop farmers wash the silt attached to the plant and apply light Urea. Partly damaged cultivated land is filled up by healthy bunch of saplings. In December or mid *Aswin* farmers transplant 7-8 saplings which are 50-60 days old saplings in every bunch in the land. Vegetables lentils and herbs like coriander, potato, maize, mustard, *mashkalai*, *khesari*, etc. are cultivated without ploughing the land after the recession of flood water. To reduce the moisture content of partly damaged vegetables or crop land the soil is loosened and mixed with ash, little Urea; Potash is also added into the soil. Farmers maintain the drainage system of land by removing water

which remains stagnant at the root of plants especially of the medicinal or fruit trees. If necessary they pile fresh soil on the root and steady the saplings or trees with bamboo stakes.

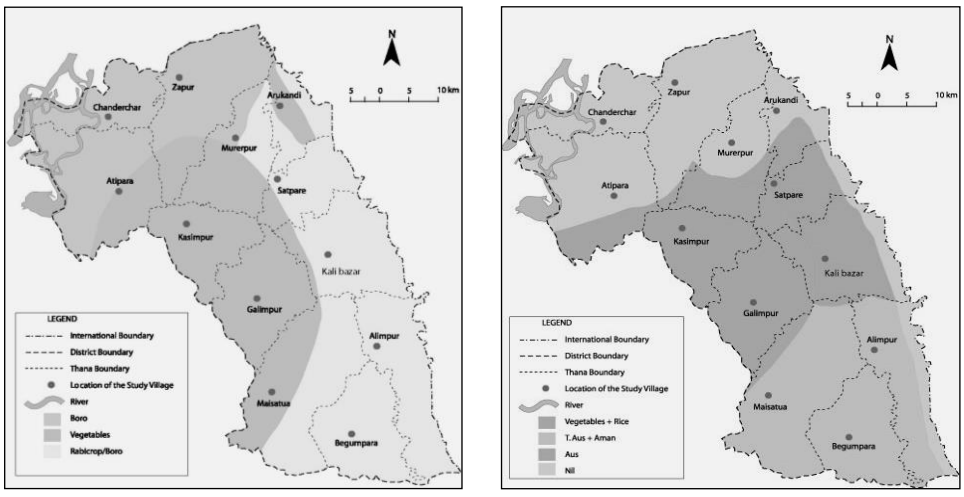
Adjustment Process - Long Term

In the study area traditional cropping pattern is very common. This pattern was mainly determined by the natural agro-ecological conditions of the area. Farmers grow crops and are guided by their perception and indigenous knowledge about the environment. For long term adjustment they did the following:

Cropping Pattern

On the basis of seasonality of rainfall three distinct but partly overlapping cropping seasons are recognized: a) *Rabi* season (dry winter month, mid October-early March), when about two inches of rainfall occurs. b) During k*harif I* season (end of March-May), about fifteen inches of rainfall occurs before the "bursting" of monsoon in June. *Aus* rice and jute are the major crops of this season. c) *Kharif 11* season (May-September), sees the cultivation of the most important crop of this season i.e. *Aman* both broadcast and transplanted varieties (Islam, 2006).

In general, double or triple rice cropping is practiced in high land areas. In Kasimpur, Satpura, Begumpara, Arukandi, Mererpur villages, maximum land is medium to highland. Flood is infrequent here. Farmers grow *Rabi* vegetables, *boro*. T. *Aus* and *Aman* rice. Recently triple to four crops grow in Kasimpur village because the land is very fertile and water availability is sufficient.



Source: SRDI and Field Survey 2012

Fig. 4. Cropping Pattern in the Study Area during *Rabi* and *Kharif* Seasons Respectively.

It was observed that the traditional deepwater *Aman* rice was the major crop in the flood-prone ecosystem in the study villages (Kasimpur, Atipara, Zapur, Arukandi, Murerpur, Satpara, Begumpara and Alimpur) in 1987-1988, occupying nearly two-thirds of the rice land, followed by traditional Aus rice, which used to grow as a mixed crop with B. *Aman.* (BADC, 1992). The *boro* rice grown in the dry season with MVs yielded almost 2.5 times that of the B. *Aman,* but its cultivation was limited to areas with access to irrigation. With the rapid expansion of irrigation facilities, mainly through private-sector irrigation with power pumps and shallow tube-wells, farmers' landuse option shifted from the low-yielding mixed *Aus to Aman, rabi* crops to *boro* rice (Table 1).

Consequently, the area under *boro* rice increased of the cultivated land. The intensity of cropping patterns has almost disappeared in favor of single-cropped *boro* rice, thereby reducing the cropping intensity substantially. Farmers safely grow short-duration modern *boro* and *T. Aman* varieties and keeps the land fallow during the months of heavy flooding. The dry-season crops, particularly the pulses and oilseeds, declined substantially in the flood-prone villages (Chanderchar, Atipara).

The study finds that (Fig. 4) in *Rabi* season, flood affected area farmer grow short duration HYV *boro* rice and in *Kharif* season they keep the fallow the land. In less flood affected area farmer grow double to triple crop in a year.

Table 1. Changes in Cropping System and Yield Rate

Crop	Percent of Land Under Crop		Yield (kg per hector)		Percent Change of Crop Land
	1987- 1988	1999-2000	1987- 1988	1999-2000	
Rice	127.7	110.0	2,164	3,589	66
Aus TV	30.9	7.3	1,220	1,416	16
B. *Aman* TV	67.6	45.4	1,618	1,842	14
T. *Aman*	1.7	5.3	2,605	3,914	50
Boro	27.5	52.0	4,541	5,386	19
Other crops	45.9	32.5			
Jute	7.1	4.3	1,801	1,891	5
Wheat	6.4	4.8	1,734	2,121	22
Pulses	15.0	9.4	892	852	-4
Oilseeds	6.8	2.3	992	862	-13
Potato	4.3	2.9	10,578	26,741	153
Vegetables	0.9	2.6	6,352	11,621	83
Others	5.4	6.2	-	-	-
Cropping Intensity	173.6	142.5	-	-	-

Source: SRDI (Thana Instruction Guide) 1999 and Field Survey, 2012

In some cases, farmers reduced the risk of flood damage by choosing suitable varieties. They use early-maturing *boro* varieties (HYV or local) on land subject to early floods and quick-maturing *Aus* varieties (HYV or local) on land subject to early floods. They also

use long seedlings of *boro, Aus* or *Aman* on land where there is a risk that water within fields might be too deep for short seedlings at the time of transplanting. Quick-maturing wheat varieties also use where late recession of floodwater or wet soil conditions normally delay sowing until December; also in areas where early rains might damage wheat in March-April, or where *Aus,* deepwater *Aman* and jute need to be sown early in order to reduce the risk of subsequent food damage. Recently maize is practiced in some areas. Late-maturing *Aman* varieties are in sites where the water-level might be too deep for transplanting *Aman* at the normal time (in August).

Crop Diversification

Country bean and bottle gourd with under-planted chilli were also grown as muli-storey crops. On high land, after harvesting ginger, onion, garlic, tomato and cucumber were planted as mixed crops. Short duration vegetables incorporated into the gap between the HYV, T. *Aman* harvest and b*oro* planting on medium high land.

Coping Strategies

Adjustment processes of farmer in different disasters are more innovative than the government or non-government agencies. Their patterns of choice of adjustments are very effective and very dynamic in nature. Farmers developed these adjustments for successful adaptation by themselves (Hafiza *et al.*, 2004). They participate in sharing their own activities to ensure the protection of the crops damaged by flood.

Farmers harvest their mature crop with the help of neighbors and relatives during early flash flood or extreme flood situation. With the help of neighbor farmers, they protect the B. *Aman* field from flood wave or floating weeds, debris, rats, and stem borers .

Farmers face shortage of seeds after flood especially the small and marginal farmers. Big farmers hold adequate reserve stocks of seed to re-sow or replant their own land. Farmers sometime borrow seeds from neighbors or often travel together long distances to obtain seed or seedlings re-sowing or replanting in an emergency situation. When farmers lose their cattle due to extreme flood, they borrow cattle from neighbors for sloughing the land.

The flood effect on occupation is serious on small farmers or marginal farmers than big farmers. Small farmers or marginal farmers are occasionally wage laborers. During the flood they do not have any agricultural work. During this time they engage themselves as boatman (10%), rickshaw puller (35%t), and day laborer (10%) etc. But the effect of flood on big farmers is very significant on their livelihood.

The economic status of flood affected farmers are low compared to flood-free farmers. Flood has bad effect on the economy of small and marginal farmers. To recover their loss due to the flood damage (20%) and also to buy agricultural inputs (60%), grow

rehabilitation crops (30%) or purchase cattle (10%), farmers take loan from NGOs, *Samitti* or *mohajons* (money lender) with high interest. They try to increase production of their normal *Kharif* or *rabi* crops in the following season. But if the flood again destroys their crops, they fail to return the money and are thus compelled to sell their small land or other assets and become a wage laborer or any other job that comes their way.

Coping Mechanism of Women

The coping mechanism of men and women are different in the study area. Women usually do the pre plantation and post harvesting activities including every day home based activities involving poultry, livestock and homestead gardening (Bashar *et al.*, 2005). They dry the seed and preserve the seed for field crops as well as home-based vegetables gardens. For the survival in post flood situation they prepare seedling on a piece of land or even in a pot which is planted after the flood. They collect and preserve straw and *bhushee* (dry food) for the livestock as grass is not available during flood (Miah *et al.*, 2006).

Vulnerability to Climate Change

Depending on climatic factors such as temperature, rainfall and humidity the farmer of the study area practice their cultivation. Since the elements of global climate are changing the climatic factors of the study are also changing which has bad impact on cultivation. Robi crops like potato, wheat, vegetables etc need specific temperature and humidity. But the duration of winter season become narrow and very cool which is not suitable for better production. On the other hand, extreme hot and rainfall destroy the *Kharif* crops. Due to climate change the intensity of flash floods and river floods are increased in the study area which destroy crops and fishery. So the food security of the study area is unpredictable. In the flood prone area people catch fish during *Barsha* season. Recently people can not get enough fish because the availability of fish is very low.

Recommendations

The study may be concluded with some recommendations. After disastrous losses of *Aus*, jute, deep water *Aman* or *T. Aman* occur, farmers need additional amounts of seed or planting material of *rabi* crops (especially HYV seed of wheat and vegetables). For overcoming the loss of crop farmers need training for suitable cultivation. Suitable crop rotation helps farmers to increase production by using additional amounts of seed (including HYV seed, where appropriate), fertilizer and other inputs. It needs to supply the additional amount of credits (or rehabilitation grants) so that flood affected farmers can grow rehabilitation crops, purchase cattle or in some cases, fodder), or increase production of their normal *kharif* or *rabi* crops in the following season. It also needs to reschedule the agricultural loans of flood-affected farmers. Provision of long forecasting of the seasonal flooding is essential before the beginning of the season. The information

should be accessible to farmers. It is essential that the Ministry of Agriculture and its component Directorates, Boards and Institutes should be prepared at all times to deal with an emergency caused by flood affecting agricultural production.

Conclusion

Comilla is one of the most intensive cropped areas in the country. Agriculture is the main occupation of the people of Comilla. The present study focused on the perception of farmers like cropping pattern, land level and land use, change of cropping pattern, length of growing period, cultivating flood-prone crops, growing *rabi* crops, and crop diversification etc. in flood-prone areas liable to flooding. Farmers depend upon several factors such as land characteristics, its rainfall, seasonal rhythm of flood including past experience with respect to different types of flood, initial resources, social and kin networks, knowledge and training. The selected hypothesis and research questions of the study justify that farmers of the area cultivate their crops using their perception and indigenous knowledge about the environment especially the duration and magnitude of flood. Flood affected farmers grow single or double crops in a year and leave the land fallow for 5-6 months during the rainy season. The flood-free farmers grow triple to four crops in a year but sudden heavy rain may damage their crops. Farmers cultivate fruit trees in *bhiti* or highland, vegetables on high to medium highland, T. Aman and Aus in medium lowland to lowland and Deep Water Aman in very lowland. In flood affected areas, farmers cultivate short length growing period (LGP) crop to reduce the risk of crop damage.

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