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A Socioeconomic Study on Farming Practices and Livelihood Status of *Haor* Farmers in Kishoreganj District: Natural Calamities Perspective

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Abstract

The study was conducted to assess the farming practices and livelihood status considering natural calamities in *haor* areas of Kishoreganj district. A total of 120 farmers were selected from Mithamoin upazila on the basis of farm size category following stratified random sampling technique. Data were analyzed with a combination of descriptive statistics, mathematical and statistical techniques. Descriptive statistics showed that average farm size of the farmers was 0.73 hectare, where 73.9% was small farmers. Majority of the farmers were engaged in C-L-F farming system (39.2 percent) which was followed by C-P-F, C-L-P and C-L-P-F farming systems (30.0, 18.3 and 12.5 percent, respectively). Profitability analysis and average productivity index revealed that crop production was profitable and productivity was high in the study areas. Estimates of transcendental production model indicated that human labour cost, chemical fertilizers cost, organic fertilizers cost and irrigation cost had significant impact on profitability of rice crop production. Cropping intensity was found as 132.4% from crop intensification index. Livelihood component framework divulged that *haor* people's asset possession, activities and strategies, well being, and external policies and institutions was improved by their production practices. Applying severity ranking model (SRM), early flood, drought and hailstorm were found most severe natural calamities causing damage to farmers' cultivable land, crop, physical assets and basic necessities. Lower price of output, and less availability and high price of inputs were the major problems faced by the farmers. The study recommended that input subsidy and output price support programmes should be properly implemented and sufficient work opportunities should be created by government and non- government organizations to support the *haor* dwellers in crisis period and for moving away from a single cropping pattern to a double or triple cropping pattern.

Keywords: *haor*, production practices, natural calamities, livelihood, socioeconomic study

Introduction

Bangladesh has witnessed respectable improvements in its economic, social and health conditions with annual GDP growth of 6.6% (WB, 2016). The percent of households living below the poverty line has declined consistently. Health and nutrition outcomes have improved significantly. While the overall conditions of the country are promising, the people residing in the *haor* areas are relatively poor and cannot even meet their basic needs in compare to that of the people in the mainland.

Haor is basically very low lying river basin area below the level of flood plain, which is also similar to swamp land covered by

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water almost six months of a year starting from the monsoon (Sharma, 2010). The *haor* areas of north-eastern region in Bangladesh cover about 2.0 million ha of area and accommodate about 19.4 million people. There are about 373 haors located in the districts of Sunamganj, Sylhet, Kishoreganj, Habiganj, Netrakona, Maulvibazar and Brahmanbaria. These 373 *haors* cover an area of about 858 thousand ha which is around 43% of the total area of the *haor* region (MoWR, 2012). *Haor* areas, i.e., the north-eastern part of Bangladesh has a unique landscape, where natural pattern of flooding has created very productive fisheries resources in the wet season, and allowed rice to grow in the dry season. The productivity of this wetland has contributed to the food security and there is a potentiality for further increases of land for agriculture. The *haor* is a single cropped area where flashflood causes crop damage which is considered as a big threat to the people. Many people in *haor* areas are involved in fish capturing (Rahman and Salam, 2008).

Farming is the major economic activity of the *haor* region. Almost 80% of this area is covered by *Boro* rice (Huda, 2004). This single crop remains under the threat of damage from the early flash floods. Although the economic development of Bangladesh is moving steadily at a moderate pace, the *haor* region is still under-developed. It is difficult to foresee the country's overall progress without the development of the *haor* region as it covers a significant part of the country and population which deserves special development initiatives. Improvements in these regions can lead to increase in production, employment and poverty reduction.

The livelihood patterns of *haor* farmers are much more harsh and full of uncertainties, which is totally different from that of main land. There are very limited and seasonal farm and non-farm work opportunities in the *haor* areas. People living in these areas endure very insecure livelihood because of natural calamities which cause great vulnerability. Since the cropped land area is being continuously shrinking over time leading to challenge towards increasing productivity, it has indeed become imperative to exploit the crop production potentiality of the *haor* areas; it is because those areas usually remain under-utilized with quite low cropping intensity (Jabber and Alam, 1996).

A few studies related to production practices and livelihood status of *haor* people have been conducted by different researchers which are: Nowreen *et al.* (2013) evaluated the change of future climate extremes for the *haor* basin area of Bangladesh and experienced the highest variability in both rainfall and temperature during the pre-monsoon season when flash floods normally occurred; Parvin (2013) performed an economic analysis of farm and non-farm activities with their income lingkages in Dingaputa *haor* of Netrokona district, and found that project participants' farm and non-farm income was higher as compared to the non-project participants' income; Khan *et al.* (2012) identified the impacts of flood on crop production in *haor* areas of Kishoreganj district and revealed that *Boro* rice in *Rabi* season was damaged by flash flood due to unavailability of controlling measures; Alam *et al*. (2011) conducted a study on crop production in the *haor* areas of Bangladesh and reported that Rabi-Fallow-T. *Aman*, Vegetable-Aus-T. *Aman* and Rabi-B. *Aman* patterns were the potential cropping patterns; and Sharma (2010) explored the scenario of *haor* vulnerabilities and other obstacles for sustainable livelihood development in

Kishoreganj district and showed that 71% *haor* households were effectively landless where 78.9% households suffered from food insecurity.

The above mentioned literatures clearly indicate that a number of studies have been conducted on economic and environmental prospect of *haor* areas but there is lack of specific study on existing farming practices, crop intensification and livelihood status considering natural calamities of the *haor* farmers. Therefore, to minimize the research gap and add valuable information on the existing notions, the study will be very helpful to the researchers as well as policy makers to recommend policy guidelines regarding the stated aspects in *haor* areas. The specific objectives of the study were: i) to identify *haor* farmers' socioeconomic status and address their farming practices; ii) to examine the status of crop intensification in terms of profitability, productivity and cropping intensity; iii) to address the impact of natural calamities on production practices and livelihood of *haor* dwellers; and iv) to investigate major constraints faced by the farmers and recommend policy options.

Methodology

Study areas and sample size

The study was conducted at four villages namely, Islampur, Sarker Haty, Paschim Kholapara and Dhubajhora of Mithamoin upazila in Kishoregonj district. The villages were selected on the basis of high vulnerability to natural calamities. A total of 120 farmers (i.e., 30 from each village) were selected for primary data collection on the basis of farm size category (i.e., small, medium and large) following stratified random sampling technique. Primary data were collected from the respondents by using a structured questionnaire during November 2017 to February 2018. Key informant interviews (KII) and focus group discussions (FGD) were also conducted for data collection.

Analytical Techniques

Descriptive statistics: Descriptive statistics like sum, averages, percentages, etc. were calculated to identify the farmers' socioeconomic status and address their farming practices.

Profitability analysis: Profitability of crop production per hectare, from the view point of individual farmers was measured in terms of gross return, gross margin, net return and benefit cost ratio (undiscounted). The formula needs for the calculation of profitability are discussed below:

$GR = P \times Q$; $GM = GR - TVC$;

$NR = GR - (TFC + TVC)$;

$BCR = GR \div (TFC + TVC)$

Where,

GR = Gross return; P = Sales price of the product (Tk.); Q = Yield per hectare (unit); GM = Gross margin; TVC = Total variable cost; NR = Net return; TFC = Total fixed cost (Tk.); and BCR = Benefit cost ratio.

Transcendental production model

In order to investigate the extent of influence of the determinants on profitability of crop production, transcendental production model was used (Gujarati, 2003). In the present study, the following transcendental production model was used to identify the level of influence of the factors influencing profitability of crop production in the *haor* areas:

$$Y_i = \beta_0 X_1^{\beta_1} X_2^{\beta_2} X_3^{\beta_3} X_4^{\beta_4} X_5^{\beta_5} X_6^{\beta_6} X_7^{\beta_7} e^{\beta_8 X_1 + \beta_9 X_2 + \beta_{10} X_3 + \beta_{11} X_4 + \beta_{12} X_5 + \beta_{13} X_6 + \beta_{14} X_7}$$

The model was made linear in the following form:

$$\ln Y_i = \ln\beta_0 + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + \beta_4 \ln X_4 + \beta_5 \ln X_5 + \beta_6 \ln X_6 + \beta_7 \ln X_7 + \beta_8 X_1 + \beta_9 X_2 + \beta_{10} X_3 + \beta_{11} X_4 + \beta_{12} X_5 + \beta_{13} X_6 + \beta_{14} X_7$$

Where,

Y_i = Net return (Tk./ha); X_1 = Human labour cost (Tk./ha); X_2 = Power tiller cost (Tk./ha); X_3 = Seed/seedlings cost (Tk./ha); X_4 = Chemical fertilizers cost (Tk./ha); X_5 = Organic fertilizers cost (Tk./ha); X_6 = Insecticides cost (Tk./ha); X_7 = Irrigation cost (Tk./ha); β_0 = Intercept; β_1 to β_7 = Exogenous coefficients; β_8 to β_{14} = Stochastic coefficients; and ln = Natural logarithm.

Average productivity index (API): Crop productivity was measured using average productivity index (API). The following formula was used for calculation (Uddin and Dhar, 2018):

$$\text{API} = \sum_{i=1}^{n} \left(\frac{X_i - \bar{X}_i}{\text{SD }(X_i)} \right)^2 \sum_{i=1}^{n} \left(\frac{Y_i - \bar{Y}_i}{\text{SD }(Y_i)} \right)^2$$

Where,

X_i = Average crop yield in the cropped area (metric ton/ha); $\bar{X}_i$ = Average crop yield in the entire region (metric ton/ha); SD (X_i) = Standard deviation of crop yield in the cropped area (metric ton/ha); Y_i = Average harvested extent in the cropped area (metric ton/ha); $\bar{Y}_i$ = Average harvested extent in the entire region (metric ton/ha); and SD (Y_i) = Standard deviation of harvested extent in the cropped area (metric ton/ha).

The productivity grade was determined from the productivity range which is represented in Table 1 as follows:

Table 1 Range and grade of productivity

Range of productivity	Grade of productivity
87.5% and above	Very high
62.5% to 87.5%	High
37.5% to 62.5%	Medium
12.5% to 37.5%	Low
Below 12.5%	Very low

Source: Uddin and Dhar (2018).

Cropping intensity index (CII) : Cropping intensity index was constructed to measure the cropping intensity in a given cropland per year (Uddin and Dhar, 2018). The following formula was used for calculation:

$$\text{Cropping intensity} = (\text{Area}_{GC} \div \text{Area}_{NC}) \times 100$$

Where,

Area_{GC} = Gross cropped area (ha); and
Area_{NC} = Net cropped area (ha).

Livelihood component framework (LCF): Livelihood component framework was constructed to measure the impact of production practices on *haor* farmers' asset possession, activities and strategies, well being, and external policies and institutions (Uddin and Dhar, 2017).

Severity ranking model (SRM) : The severity of damage in *haor* farmers' agricultural and livelihood activities due to the occurrences of different natural disasters was quantified and represented using severity ranking model (SRM) (Uddin and Dhar, 2017). The major components of the model were identified as agriculture, assets and livelihood items. The sub-components of agriculture, assets and livelihood items were crop, livestock, poultry, and homestead and agroforestry; cultivable land, household area and physical assets; and drinking water, sanitation, education and employment; respectively. The damage of the natural calamities (i.e., early flood, drought and hailstorm) were characterized as extreme (severity point = 4), high (severity point = 3), medium (severity point = 2) and low (severity point = 1). The component severity score (CSS) of each sub-component of the model was estimated using the following formula:

$$CSS_N = (N_E \times SP_E) + (N_H \times SP_H) + (N_M \times SP_M) + (N_L \times SP_L)$$

Where,

CSS_N = Component severity score in case of early flood, drought and hailstorm; N_E = Number of farmers in extreme damage level; SP_E = Severity point of extreme damage level; N_H = Number of farmers in high damage level; SP_H = Severity point of high damage level; N_M = Number of farmers in medium damage level; SP_M = Severity point of medium damage level; N_L = Number of farmers in low damage level; and SP_L = Severity point of low damage level.

The CSS of each sub-component could range from 120 to 480. The model severity score (MSS) of each sub-component was computed using the following formula:

$$MSS = CSS_F + CSS_D + CSS_H$$

Where,

CSS_F = Component severity score in case of early flood; CSS_D = Component severity score in case of drought; and CSS_H = Component severity score in case of hailstorm.

The MSS of each sub-component could range from 360 to 1440. The severity of destruction due to natural calamities was ranked on the basis of MSS of each sub-component.

Findings and Discussion

Socioeconomic Status of the Respondents

The socioeconomic status of the respondents is represented in Table 1. It is seen that average family size of the respondents was 6.0, which was higher than national average of 4.1 (HIES, 2016) whereas 66.7% member of the household were male and 33.3% were female. In terms of respondents surveyed, 98.3% were male where only 1.7% were female. Majority of them (49.1%) were under the age group of 15.01 to 55.00 years (lower than national average of 54.8%) that are considered as active and working group (HIES, 2016). Most of the respondents were illiterate (43.3%) whereas 35.9% completed primary level of education. In terms of occupation, 65.2% and 34.8% respondents were involved with agriculture only, and agriculture and other income generating activities, respectively (Table 2).

Table 2 Socioeconomic characteristics of the respondents

Particulars about the respondents		Percentages (%) of respondents
Family size (no.)		6.0 (Male: 66.7%; Female: 33.3%)
Sex	Male	98.3
	Female	1.7
Age	0.00 to 15.00 years	21.9
	15.01 to 55.00 years	49.1
	Above 55.00 years	29.0
Educational level attained	Illiterate	43.3
	Primary	35.9
	Secondary	15.0
	Higher secondary and above	5.8
Occupational status	Agriculture only	65.2
	Agriculture and others	34.8

Source: Field survey, 2018.

Land Tenancy Arrangements of the Farmers

Table 3 reveals the land tenancy status of two categories of farmers (i.e., small and medium). Most of the farmers were small farmers (73.9% which is lower than the national average of 76.7%) (HIES, 2016). Average farm size of small and medium farmers was 0.33 and 1.12 ha, respectively. The major share of the farmers' cultivable land was own land (57.6% and 82.1% for small and medium farmers, respectively). Though a small portion of land (7.1%) was rented/leased-out by the medium farmers, no small farmer rented/leased-out any cultivable land.

Table 3 Farmers' land tenancy arrangements

Farmers' categories	% of farmers	Average farm size (ha)	Land leasing arrangements (ha)		
			Own land	Rented/ leased-in land	Rented/ leased-out land
Small farmers (less than 1.00 ha)	73.9	0.33	0.19 (57.6)	0.14 (42.4)	-
Medium farmers (1.01 to 3.00 ha)	26.1	1.12	0.92 (82.1)	0.12 (10.8)	0.08 (7.1)

Source: Field survey, 2018.
Note: Figures in the parentheses indicate percentages of average farm size.

Area under Crop Production

It is evident from Table 4 that total cropped area of the farmers was 0.73 ha. About 76.0 percent of total cropped area of the respondents was under rice cultivation where 7.0% and 6.0% were under spices and wheat cultivation, respectively. A very negligible amount of area was under homestead forestry (0.4 and 0.1 percent for vegetables and fruits cultivation, respectively).

Table 4 Area under crop production

Enterprises		Cultivated area (ha)	% of total cropped area
Crop	Rice	0.553	75.8
	Wheat	0.044	6.0
	Pulses	0.030	4.1
	Oilseeds	0.031	4.3
	Spices	0.051	7.0
	Jute	0.017	2.3
Homestead forestry	Vegetables	0.003	0.4
	Fruits	0.001	0.1
Total cropped area		0.730	100.0

Source: Field survey, 2018.

Major Farming Practices

The major farming practices identified in the study areas were crop-livestock-poultry (C-L-P), crop-livestock-fish capture (C-L-F), crop-poultry-fish capture (C-P-F) and crop-livestock-poultry-fish capture (C-L-P-F), which were followed by 18.3%, 39.2%, 30.0% and 12.5% respondents, respectively (Table 5).

Table 5 Major farming practices in the study areas

Farming systems	No. of farmers (n = 120)	Percentages (%) of farmers
Crop-Livestock-Poultry (C-L-P)	22	18.3
Crop-Livestock-Fish capture (C-L-F)	47	39.2
Crop-Poultry-Fish capture (C-P-F)	36	30.0
Crop-Livestock-Poultry-Fish capture (C-L-P-F)	15	12.5

Source: Field survey, 2018.

Profitability of Crop Production

Boro rice is the only crop in the *haor* region, and almost all the farmers produce this crop. Profitability of *Boro* rice production in the study areas is represented in Table 6. It is observed that total cost of crop production was Tk. 104,182 per hectare. Gross return and net return from crop production was Tk. 132,485 and Tk. 28,303 per ha, respectively. The BCR was found as 1.27 which implied that farmers could earn Tk. 127 by investing Tk. 100 in crop production. So, it can be said that crop farming is profitable in the study areas. The study is supported by Islam *et al.* (2011) where the authors found that all of the farming systems were profitable.

Table 6 Profitability of crop production

Particulars			Tk./ha
Variable costs	Human labour		21,254
	Power tiller		10,295
	Seed/seedlings		8,563
	Fertilizers	Chemical	7,581
		Organic	3,667
		Total	11,248
	Insecticides		590
	Irrigation		43,258
i. Total variable cost			95,208
Fixed costs	Land lease value		7,416
	Interest on operating capital		1,558
ii. Total fixed cost			8,974
iii. Total cost (i + ii)			104,182
iv. Gross return			132,485
v. Gross margin (iv - i)			37,277
vi. Net return (iv - iii)			28,303
vii. BCR (iv ÷ iii)			1.27

Source: Authors' estimation, 2018.

Factors Affecting Profitability of Crop Production

A transcendental production model was used conveying the determinants influencing profitability of crop production in the study areas. Seven explanatory variables were identified as major factors for this study. The estimated equation was as follows:

$$\ln Y_i = 0.044 + 0.001\ln X_1 + 0.133\ln X_2 + 0.073\ln X_3 + 0.070\ln X_4 + 0.020\ln X_5 + 0.012\ln X_6 + 0.102\ln X_7 + 0.131X_1 + 0.030X_2 + 0.077X_3 + 0.038X_4 + 0.142X_5 + 0.108X_6 + 0.069X_7$$

Table 7 Estimates of transcendental production model

Variables	Exogenous coefficients	p-value	Stochastic coefficients	p-value	Value of R^2	F-value
Constant	0.044	0.306	-	-	0.613	42.719
Human labour cost (X_1)	-0.001**	0.049	-0.131	0.239		
Power tiller cost (X_2)	0.133	0.122	0.030	0.130		
Seed/seedlings cost (X_3)	0.073	0.309	-0.077	0.117		
Chemical fertilizers cost (X_4)	-0.070***	0.001	0.038	0.853		
Organic fertilizers cost (X_5)	0.020*	0.075	0.142**	0.049		
Insecticides cost (X_6)	-0.012	0.148	0.108	0.700		
Irrigation cost (X_7)	0.102**	0.026	-0.069	0.306		

Source: Authors' estimation, 2018.

Note: ***, ** and * indicate significant at 1%, 5% and 10% percent probability level, respectively.

The exogenous estimates of transcendental production model indicates that power tiller cost, seed/seedlings cost, organic fertilizers cost and irrigation cost had positive impacts; while human labour cost, chemical fertilizers cost and insecticides cost had negative impacts on profitability of crop production. Again, the stochastic estimates indicates that power tiller cost, chemical fertilizers cost, organic fertilizers cost and insecticides cost had positive impacts; and human labour cost, seed/seedlings cost and irrigation cost had negative impacts on profitability of crop farming. The significant exogenous coefficients demonstrated that 1 percent increase in organic fertilizers cost and irrigation cost will lead to increase in crop profitability by 0.020 and 0.102 percent, respectively, whereas 1 percent increase in human labour cost and chemical fertilizers cost will lead to decrease in crop profitability by 0.001 and 0.070 percent, respectively. The significant stochastic coefficient represented that 1 unit increase in organic fertilizers cost will result in increase in crop profitability by 0.142 percent (Table 7).

The value of coefficient of determination (R^2) was found as 0.613 which implied that 61.3 percent variation of dependent variable has been explained jointly by the independent variables, i.e., the model is well fitted. The F-value of 42.719 meant that all of the explanatory variables included in the model were important to explain the variation in the dependent variable (Table 7). The findings can be compared with Ahmad *et al.* (2005) where the authors found from Cobb-Douglas production model that seed, fertilizer and sowing of carrot in September and October were yield enhancing variables while the yield limiting factors were high prices of inputs, limited financial resource and inadequate availability of labour during peak load period.

Measurement of crop productivity

Crop productivity is defined in agricultural geography as well as in economics as “output per unit of input” or “output per unit of land area” (Dharmasiri, 2009). In this study, crop productivity was estimated using average productivity index which can identify the spatial distribution pattern of crop productivity of a specific region (Table 8). It is seen that average yield in the cropped area was 2.12 metric ton per ha, whereas average yield in the entire region was 1.85 metric ton per ha (Upazila Agriculture Office, 2018). On the other hand, average harvested extent of the farmers was 2.10 metric ton per ha, whereas average harvested extent in the entire region was 1.90 metric ton per ha (Upazila Agriculture Office, 2018). Average crop productivity of the farmers in *haor* areas was estimated at 86.4%. The result is relatively similar with Uddin and Dhar (2018) where the authors observed that productivity of *Aus* rice in plain areas was 138.0 and 100.0 percent in stare of government input supported and non-supported farmers, respectively.

Table 8 Average productivity index (API)

Particulars	Index values	Productivity grade
Average yield in the cropped area (metric ton/ha)	2.12	High
Average yield in the entire region (metric ton/ha)	1.85	
Standard deviation of yield in the cropped area (metric ton/ha)	0.25	
Average harvested extent in the cropped area (metric ton/ha)	2.10	
Average harvested extent in the entire region (metric ton/ha)	1.90	
Standard deviation of harvested extent in the cropped area (metric ton/ha)	0.20	
Average productivity (%)	86.4	

Source: Authors’ estimation, 2018 and Upazila Agriculture Office, 2018.

Cropping Intensity Analysis

Cropping intensity is explained as the number of crops grown in a given cropland per year. It measures the productivity of per unit gross cropped area in a year (Bhaskar, 2009). The whole process is named as crop intensification. Intensification of crop production in the study areas is represented in Table 9. It is seen that gross and net cropped area of the farmers in the study areas were 0.73 and 0.55 ha, respectively. Cropping intensity was found as 132.4%. The study considered homestead gardening beside *Boro* rice production, which was the reason of cropping intensity being more than 100.0%. The results implied that farmers of the *haor* areas could grow crops for nearly 1.3 times per year in a particular cropland. The result is quite similar with Islam and Uddin (2014) where the author found variability in crop intensity from one farming household to the next was higher among high intensity households than those of low intensity households.

Table 9 Cropping intensity index (CII)

Particulars	Index values
Gross cropped area (ha)	0.73
Net cropped area (ha)	0.55
Cropping intensity (%)	132.4

Source: Authors' estimation, 2018.

Impact of production practices on *haor* farmers' livelihood

Livelihood component framework (LCF) depicted farmers' engagement with different production practices (Table 10). In terms of farmers' asset possession, it is observed that 43.5 percent *haor* farmers' savings and cash at hand were increased, income for purchasing assets and equipments was increased for 39.0 percent farmers, and land use efficiency and optimized uses of open water resources were increased for 27.2 percent farmers. On the other hand, 60.0 percent farmers experienced increasing ecological imbalance and decreasing environmental condition.

It is seen that 51.2 percent farmers stated about increased crop productivity as well as cropping intensity in the study areas which allowed them to grow more crops in a year. Additional income from farming activities had been increased according to 40.0 percent farmers. Risks and uncertainties involved in income generation from farming activities were decreased accordingly. But 23.0 percent farmers opined that their involvement in other income generating activities was decreased to some extent. Most of the farmers' food security condition was improved which helped to enhance sustainable livelihood provision. Limited and unpredictable cash earnings due to natural calamities were experienced by 70.2 percent farmers. Also, market access and control of the people was increased in the study areas. Overall, it can be depicted from Table 10 that farmers' livelihood was positively influenced through their production practices. The findings are supported by Uddin and Dhar (2017) where the authors declared that livelihood status of the *char* dwellers was improved by their production practices.

Table 10 Livelihood component framework

Impacts on	Outcomes			
	Positive effects	% of farmers	Negative effects	% of farmers
i) Impact of production practices on farmers' asset possession				
Human capital	Income used for health and educational purposes	38.3	-	-
Physical capital	Income used to buy household assets, food, machineries and equipments, housing construction, etc.	39.0	-	-
Financial capital	Increased savings and cash in hand, GO-NGO aid, and reduced capital borrowing tendency	43.5	-	-
Natural capital	Increased land use efficiency and optimized uses of open water resources	27.2	Reduced environmental quality, increased ecological imbalance, increased use of chemical fertilizer and pesticides, biodiversity disturbance, etc.	60.0
Social capital	Reduced gender inequality, increased training facilities, involvement in social groups, etc.	31.3	Conflicts within community, political unrest, etc.	45.5
ii) Impact of production practices on farmers' activities and strategies				
Farming, schooling and other activities	Increased crop productivity and cropping intensity	51.2	Reduced involvement in other income generating activities	23.0
	Increased child enrollment	45.3		
	Work can be shared within household	27.5		
	Further reducing tradeoff with other works	21.0		
Strategies for selecting activities: - Diversify - Minimize risk - Maintain liquidity	Contributes to diversification	32.0	-	-
	Reduce risk and uncertainty	27.3		
	Increased additional income	40.0		
iii) Impact of production practices on farmers' well being				
Cash	Enhanced monetary income	46.2	Limited and unpredictable	70.2
Food security	Helps to ensure households' food security	62.5	-	-
Sustainability of livelihood	Contributes to livelihood sustainability	57.0	Some earn distrust	20.5
Empowerment	Increased empowerment, especially *haor* women	40.5	Lack of self managerial capability and capacity building of groups	28.3
Reduced vulnerability	Cannot rely on unpredictable earnings	30.0	-	-
iv) Impact of production practices on farmers' external policies and institutions				
Market access	Gain access to market	69.2	-	-
	Control access of members	52.5		

Source: Field survey, 2018.

Natural calamities' impact on *haor* residents' livelihood

The people of the study areas are victim of frequent natural calamities like early flood, drought and hailstorm. It is seen from Table 11 that 73.8 percent farmers were affected by early flood which was followed by drought and hailstorm (32.5 and 21.3 percent farmers, respectively). In monetary term, the amount of loss for early flood, drought and hailstorm were Tk. 43197, Tk. 17950 and Tk. 12430 per household, respectively. Hossain *et al.* (2017) also found that a considerable area of agricultural land had been submerged in Tanguar *haor* basin by flash flood leading to loss of a significant amount of crop which is partly supportive to the findings.

Table 11 Monetary loss of farmers due to natural calamities

Types of natural calamities	Percentages of farmers faced	Average monetary loss (Tk./household)
Early flood	73.8	43197
Drought	32.5	17950
Hailstorm	21.3	12430

Source: Field survey, 2018.

Table 12 Severity ranking model for impact evaluation of natural calamities

Model components		Natural calamities															MSS	SR
		Early flood					Drought					Hailstorm						
		Severity of damage																
		E	H	M	L	CSS	E	H	M	L	CSS	E	H	M	L	CSS		
Agriculture	Crop	54	31	22	13	366	38	52	16	14	354	65	28	15	12	386	1106	2
	Livestock and poultry	40	21	49	10	331	47	33	21	19	348	35	55	10	20	345	1024	9
	Fish	46	35	22	17	350	58	19	22	21	354	39	32	40	9	341	1045	7
	Homestead and agroforestry	62	27	12	19	372	37	26	35	22	318	56	40	13	11	381	1071	4
Assets	Cultivable land	64	35	12	9	394	60	32	17	11	381	58	30	20	12	374	1149	1
	Homestead area	47	27	31	15	346	30	37	35	18	319	36	25	39	20	317	982	10
	Physical assets	54	41	17	8	381	61	13	32	14	361	40	34	30	16	338	1080	3
Livelihood items	Drinking water	62	14	34	10	368	39	25	38	18	325	43	51	14	12	365	1058	6
	Sanitation	40	15	46	19	316	50	29	21	20	349	55	43	8	14	379	1044	8
	Education	52	25	30	4	347	43	15	38	24	317	31	45	22	10	313	977	11
	Employment	43	39	24	14	351	56	42	12	10	384	29	49	22	20	327	1062	5

Source: Authors' estimation, 2018.

Note: E = Extreme, H = High, M = Medium, L = Low, CSS = Component severity score, MSS = Model severity score, and

SR = Severity ranking.

Severity points: Extreme = 4, High = 3, Medium = 2, and Low = 1.

Calculation of CSS (crop) for early flood = $(54 \times 4) + (31 \times 3) + (22 \times 2) + (13 \times 1) = 366$.

Calculation of CSS (crop) for other natural calamities was done accordingly.

Calculation of MSS (crop) = $366 + 386 + 354 = 1106$.

Calculation of CSS and MSS of other model components for all stated natural calamities were done following the same procedure, and ranked consequently.

Impact evaluation of natural calamities

The severity of damage in *haor* farmers' agricultural and livelihood activities for the occurrences of different natural calamities was quantified through severity ranking model (SRM). The model was composed of three components which are: agriculture (sub-components: crop, livestock and poultry, fish and homestead and agroforestry), assets (sub-components: cultivable land, homestead area and physical assets) and livelihood items (sub-components: drinking water, sanitation, education and employment). The destruction severity in model sub-components was ranked according to their model severity score (MSS). Table 12 shows that the highest MSS in this model was 1149 and the lowest one was 977. The level of damage was the highest in case of cultivable land which was ranked as 1st (with MSS 1149). It was followed by crop (with MSS 1106), physical assets (with MSS 1080), homestead and agroforestry (with MSS 1071) and employment (with MSS 1062) ranking as 2nd, 3rd, 4th and 5th, respectively (Table 12). The result is partially supported by Khan and Nahar (2014) where the authors showed that natural calamities had destructive impacts on human lives, health, education and property damages.

Natural Calamities' Consequences on Production Practices

Major consequences of natural calamities on production practices included reduced farm production, increased cost of production, damaged communication system, deformed land topography, etc. Table 13 reveals that 27.3%, 24.1%, 24.0% and 24.6% respondents stated that the severity of natural calamities were extreme, high, moderate and low, respectively.

Table 13 Consequences of natural calamities in the study areas

Major consequences	Degree/severity of natural calamities (% of respondents)			
	Extreme	High	Moderate	Low
Reduced farm production	24.8	19.8	39.0	16.4
Damaged farm infrastructure	34.0	19.0	15.5	31.5
Disrupted communication system	21.9	32.8	23.4	21.9
Increased cost of production	33.6	27.7	17.7	21.0
Higher market prices of inputs	37.1	16.2	17.9	28.8
Enhanced soil erosion	25.0	22.5	30.0	22.5
Siltation and sedimentation	21.2	33.8	29.5	15.5
Deformed land topography	29.8	23.1	14.0	33.1
Average degree/severity	27.3	24.1	24.0	24.6

Source: Field survey, 2018.

Problems faced by the respondents and probable solutions

Table 14 represents the problems faced by the respondents and their probable solutions. It is seen that 93.3% respondents stated about lower price of output and 88.3% stated about less availability and high price of inputs which pushed them to rank the problems as 1st and 2nd, respectively. In terms of the solution, 75.0% gave opinion for government subsidy on input price, and 68.3% stated to fix the ceiling and floor price of the output in the market. Uddin *et al.* (2017) supported the findings where the authors found high price of inputs, lack of institutional credit, lack of knowledge about conservation agriculture, etc. as major problems of crop production.

Table 14 Problems faced by the respondents and probable solutions

Major problems	Percentages (%) of farmers stated	Rank	Probable solutions to the problems	Percentages (%) of farmers stated
Less availability and high price of inputs	88.3	2	Government subsidy on input price	75.0
Lower price of output	93.3	1	To fix the ceiling and floor price of the output	68.3
Poor transportation and storage facilities	57.5	4	Improvement of road communication and storage facilities by local government	67.5
Frequent occurrence of natural hazards like flood, storm, etc.	71.7	3	Knowledge on pre-disaster and post-disaster management activities	73.3
Weak market management system	50.8	5	Improve market administration and supervision structure	60.0

Source: Field survey, 2018.

Conclusion

The study concludes that though the *haor* people were intermittent victims of natural calamities and had limited scope for crop production, they coped up the circumstances with diversified production practices. Majority of the farmers were found as small farmers having less than one hectare of land. The most common farming practices were C-L-P, C-L-F, C-P-F and C-L-P-F. The study exposed that crop production was profitable and productivity was high in the study areas which resulted in a moderate cropping intensity. Majority of the farmers experienced positive impacts of farming practices in terms of asset possession, activities and strategies, well being, and external policies and institutions. Natural calamities like early flood, drought, hailstorm, etc. caused a immense destruction to the agriculture, non-agriculture and day-to-day activities of the *haor* people. Cultivable land, crop and physical assets were obstinately affected by those natural hazards. Considering the findings of the study, some essential policy recommendations have been arisen which are: moving away from a single cropping pattern of *Boro* rice to a double or triple cropping pattern consisting of pulses, oilseeds, vegetables and *Boro* rice with the help of DAE and other research organizations. Input subsidy and output price support to the farmers as well as essential pre-disaster and post-disaster actions should be properly implemented by government to support them in the crisis period. Moreover, GOs-NGOs should create work opportunities for the *haor* residents so that they can be involved in income generating activities (IGAs) throughout the year.

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