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Char people's production practices and livelihood status: An economic study in Mymensingh district

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Abstract

The study was conducted to explore the production practices followed by the farmers in *char* areas of two Upazilas of Mymensingh district, and determine their livelihood status considering natural calamities. A total of 120 farmers were selected randomly for data collection. Data were analyzed with a combination of descriptive statistics, mathematical and statistical techniques. The results of the descriptive statistics showed that majority of the farmers were engaged in C-L-HA farming system (52.5 percent) which was followed by C-L-P and C-P-HA farming systems (32.0 and 15.5 percent, respectively). Profitability analysis reveals that crop, livestock and poultry were found profitable under C-L-P farming system, where homestead and agroforestry was found profitable under C-L-HA farming system. The differences in productivity of agricultural enterprises between char land and main land were found significant in most of the cases. About 65.0 percent of farmers' average annual income was earned from farming activities and 35.0 percent was from non-farming activities. Food security indices indicated that average per capita daily calorie intake of the households (2068.9 kcal for food secure households and 1482.4 kcal for food insecure households) was still below the national average level of 2122 kcal. Livelihood status of the char dwellers incorporating farmers' asset possession, activities and strategies, well being, and external policies and institutions was improved by their production practices. Applying severity ranking model (SRM) and agreement index (AI), river erosion, flood, cyclone and drought were found most frequent in the study areas that caused severe damage to respondents' cultivable land, assets, agricultural enterprises and basic necessities. The study recommended that input subsidy and output price support, and social safety net programmes should be properly implemented by the government to protect the *char* dwellers in crisis period and enhance their livelihood condition.

Keywords: Char, Production, Livelihood, Economic study

Introduction

Generally, *char* areas have been created along the bed or basin of the big rivers. *Char* lands are the sandbars that emerge as islands within the river channel or as attached land to the river banks. Simply, the riverine sand and silt landmasses known as *char* in Bengali. On an average, 5% of Bangladeshi population as well as 6.5 million people live on the chars covering almost 5% of the total land area of the country and miserably it is narrowed as 7200 square kilometer (EGIS, 2000). Most of the *char* dwellers are involved in various kinds of farming systems that represent production of crops, livestock, poultry, fisheries, etc. Their production practices are different from the main land. The *char* dwellers invest their available resource base to enhance farm productivity. *Char* lands can provide high value crops that can be harvested before the first flood occurrence. In addition to the major physical risk associated with the river, *char* dwellers, in particular, are marginalized from the benefits of the main land. Regardless of facing different natural hazards and calamities due to climate change, movement of the *char* dwellers to safer areas is not feasible because of scarcity of land.

The livelihood patterns of the people in *char* areas are much more harsh and full of uncertainties. There are very limited and seasonal work opportunities in the *char* areas. People living in *char* lands endure insecured livelihoods. Geographical, social, immoral and political instability and insecurity pushed the *char* dwellers to a vicious cycle of poverty. Regular loss of lands and natural disasters often lead to migration. The major issues that the *char* dwellers face are inability to resist physical hazards, poor access to essential services, inadequate saving and credit options, poor access to income enhancing opportunities and services, and so on (Saifullah, 2010). However, the *char* dwellers always fight with the hunger, poverty, illiteracy, less farm productivity, climatic disaster, etc.

The production and livelihood scenarios of *char* dwellers have been picturized in a number of literatures which are: Islam *et al.* (2014) explored indigenous survival techniques and variation in peoples' ability to adopt with flood and river erosion in *char* areas of Tangail district and showed that the people in the *char* lands with high flood proneness and low socioeconomic circumstances were more likely to fail to adopt with the conditions compared to the people in areas with high and sudden flooding; Ibrahim (2011) conducted a study on impact of agroforestry practices on livelihood improvement of the farmers of *Char* Kalibari area of Mymensingh district and found that, by the proper implementation of agroforestry practices with proper tree-crop combination, the people could improve their livelihood and socioeconomic status; Saifullah (2010) identified the perception of *char* dwellers under Kazipur upazila in Sirajganj district regarding their livelihood option and their capacity to cope with climate change and prioritize the adaptation option for reducing their vulnerability and found that the people changed cropping patterns with seasons and selected time of cultivation after prediction of natural disaster to overcome the impact of natural disasters.

The above mentioned literatures clearly indicate that most of the studies dealt with either the socioeconomic condition of the farmers in *char* areas or their adoption options to reduce vulnerability due to natural disasters. To minimize the research gap, the present study explores the production practices, estimates the productivity and profitability, and determines the livelihood status as a consequence of natural disasters of the *char* dwellers. The specific objectives of the study are: i) to estimate the profitability and productivity of different farming systems in *char* areas; ii) to analyze the livelihood status of the *char* people; and iii) to address the impact of natural calamities on *char* dwellers.

Materials and Methods

The study was conducted at different villages of two upazilas (Mymensingh Sadar and Gauripur) of Mymensingh district. These regions were selected for the study because they are very close to the Brahmaputra River, dependent on rich natural resources, bounty of diversified farming systems and vulnerable to natural hazards. A total of 120 (60 from each upazila) farmers were selected following purposive random sampling technique. Both primary and secondary data and information were collected. Field survey method and focus group discussions (FGD) were followed to collect the primary data. Secondary data and information from different reports, publications, notifications, etc. relevant to this study were also collected and analyzed.

Analytical techniques

Profitability analysis: Profitability of different agricultural enterprises under most common farming systems was measured in terms of gross return, gross margin, net return and benefit cost ratio (undiscounted). The formula needed for the calculation of profitability is:

Gross return (GR): Gross return was calculated by multiplying the total volume of output of an enterprise by the average price in the harvesting period (Dillon and Hardaker, 1993). The equation was as follows:

$$GR = X_{mp}P_{mp} + X_{bp}P_{bp}$$

Where,

X_{mp} = Yield of main product per unit area;

P_{mp} = Price of main product;

X_{bp} = Yield of by-product per unit area; and

P_{bp} = Price of by-product.

Gross margin (GM): Gross margin was calculated by the difference between gross return and total variable cost. The following equation was used to calculate GM:

$$GM = GR - \Sigma C_v$$

Where,

GR = Gross return; and

ΣC_v = Total variable cost.

Net return (NR): Net return was calculated by deducting all costs (variable and fixed) from the gross return. The following algebraic form of NR was used for estimation:

$NR = GR - \Sigma C_v - \Sigma C_f$

Where,

GR = Gross return;

ΣC_v = Total variable cost per unit area; and

ΣC_f = Total fixed cost per unit area.

Benefit cost ratio (BCR): Benefit cost ratio (BCR) is a relative measure which is used to compare the return per unit of cost. BCR was estimated as a ratio of gross return to gross cost. The formula used for calculating BCR (undiscounted) was as follows:

$BCR = GR \div GC$

Where,

GR = Gross return; and

GC = Gross cost (i.e., $\Sigma C_v + \Sigma C_f$).

Productivity measurement: Productivity of different agricultural enterprises under most common farming systems was measured using descriptive statistics (i.e., sum, average, percentage, etc.).

Measurement of food security: To identify the food security status of the *char* households, two stages of analyses were done. At first a food security index (Z) was constructed and food security status of each household was determined based on the food security line using the recommended daily calorie intake (Babatunde *et al.,* 2007). Households whose daily per capita calorie intake amounted up to 2122 kcal were regarded as food secure and those below 2122 kcal were regarded as food insecure. The mathematical representations were as follows:

$Z_i = Y_i \div R$

Where,

Z_i = Food security index for i^{th} households

(1 = food secure households and 0 = food insecure households, i.e.,

$Z_i = 1$ for $Y_i \geq R$; and $Z_i = 0$ for $Y_i \geq R$);

Y_i = Daily per capita calorie intake of i^{th} households;

R = Daily per capita calorie required for i^{th} households; and

i = 1, 2, 3, ……., 200.

Based on the household food security index (Z), food shortfall/surplus index (P) and the head count ratio (H) were calculated. Food shortfall/surplus index was calculated as:

$$P = \frac{1}{M} \sum_{j=1}^{m} G_i$$

Where,

P = Food shortfall/surplus index;

M = Number of food secure households (for food surplus index) or food insecure households (for food shortfall index); and G_i = Per capita calorie intake deficiency (or surplus) faced by i^{th} households where, $G_i = [(Y_i - R) \div R]$.

The head count ratio (H) measures the percentages of the households that are food secure or insecure which was defined as: $H = M \div N$

Where,

H = Head count ratio;

M = Number of households that are food secure (for food surplus index) or food insecure (for food shortfall index); and N = Number of sample households.

Livelihood component framework (LCF): Livelihood component framework was constructed to measure the impact of production practices on farmers' asset possession, activities and strategies, well being, and external policies and institutions (adopted from Ashley and Hussein, 2000).

Severity ranking model (SRM): The severity of damage in farmers' agricultural and livelihood activities due to the occurrences of different natural disasters was quantified and represented in severity ranking model (SRM) (adopted from Caldera *et al.,* 2016). 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 severity level of the natural calamities (i.e., river erosion, flood, cyclone and drought) 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 river erosion, flood, cyclone and drought;
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 200 to 800. The model severity score (MSS) of each sub-component was computed using the following formula:

$MSS = CSS_R + CSS_F + CSS_C + CSS_D$

Where,

CSS_R = Component severity score in case of river erosion;
CSS_F = Component severity score in case of flood;
CSS_C = Component severity score in case of cyclone; and
CSS_D = Component severity score in case of drought.

The MSS of each sub-component could range from 800 to 3200. The severity of destruction due to natural calamities was ranked on the basis of MSS of each sub-component.

Agreement index (AI): Agreement index (AI) was used to quantify farmers' perceptions about the impacts of natural calamities on environment and their livelihood (adopted from Barnhart *et al.,* 2007). The index was composed of two divisions: i) positive impacts of natural calamities; and ii) negative impacts of natural calamities. Each division of the index included 10 statements. Farmers' agreement or disagreement with the statements were quantified with the following formula:

Depth of agreement = $\sum \partial\omega \times 100$

Where,

∂ = Farmers agreed or disagreed with the statements; and
ω = Weighted score of the statements.

Results and Discussion

Socioeconomic profile of the sample farmers

The basic information of the selected farmers in the study areas are represented in Table 1. It is seen that average household size and farm size of the farmers were 5.0 and 0.26 ha, respectively. Average dependency ratio was estimated at 1.3. Among the farmers surveyed for the study, 67.0 and 33.0 percent were male and female respondents, respectively.

Table 1. Basic information about the farmers

Particulars		Percentages of farmers
Average household size (no.)		5.0
Average farm size (ha)		0.26
Average dependency ratio (no.)		1.3
Average sex distribution	Male	67.0
	Female	33.0
Average age	0.00 to below 5.00 years	6.0
	5.01 to 15.00 years	11.0
	15.01 to 55.00 years	46.0
	Above 55.00 years	37.0
Literacy rate	Illiterate	22.0
	Sign only	23.0
	Primary and above	55.0
Occupational status	Agriculture only	24.0
	Agriculture and others	76.0

Source: Field survey, 2015–16.

Majority of the farmers were in the age category of 15.01 to 55.0 years (46.0 percent) which is considered as the most active and working group. Most of the farmers completed primary and above level of education (55.0 percent) in the study areas. It is also found that major portion of the sample farmers were engaged in agriculture as well as other income generating activities like labour selling, service, small business, etc (76.0 percent) whereas others were engaged with agriculture only (24.0 percent).

Production practices in the study areas

A number of production practices were found in the study areas that involved agricultural enterprises like crop, livestock, poultry, homestead and agroforestry. The most common farming practices were crop-livestock-poultry (C-L-P), crop-poultry-homestead and agroforestry (C-P-HA) and crop-livestock-homestead and agroforestry (C-L-HA). It is evident from Table 2 that majority of the farmers were engaged in C-L-HA farming system (52.5 percent) which was followed by C-L-P and C-P-HA farming systems (31.7 and 15.8 percent, respectively).

Table 2. Farming systems in the study areas

Farming practices	No. of farmers	Percentages of farmers
Crop-livestock-poultry (C-L-P)	38	31.7
Crop-poultry-homestead and agroforestry (C-P-HA)	19	15.8
Crop-livestock-homestead and agroforestry (C-L-HA)	63	52.5
Total	120	100.0

Source: Field survey, 2015–16.

Area under agricultural production

It is evident from Table 3 that 73.1 percent of total cropped area of the farmers was under crop production (i.e., cereal crops, pulses, oilseeds, spices) and 26.9 percent were under homestead and agroforestry enterprises (i.e., vegetables and fruits). On an average, each household belonged 13 poultry birds (i.e., hen, duck, pigeon, etc.), and 8 small (i.e., goat) and large (i.e., dairy cow, bullock, ox, calve, etc.) livestock animals.

Table 3. Area under agricultural enterprises

Enterprises		Cultivated area (ha)	% of total cropped area	No./household
Crop		0.19	73.1	-
Homestead and agroforestry		0.07	26.9	-
Total cropped area		0.26	100.0	-
Livestock	Poultry	-	-	13
	Small and large animal	-	-	8

Source: Field survey, 2015–16.

Profitability and productivity of agricultural enterprises in most common farming systems

One of the most important aspects of this study was to evaluate the profitability and productivity of agricultural enterprises (i.e., crop, livestock, poultry, homestead and agroforestry) under most common production practices. For calculating total production cost, variable and fixed costs were taken into consideration. The components of variable cost were: i) human labour; ii) power tiller; iii) seeds/seedlings; iv) feed; v) fertilizers; vi) insecticides; vii) artificial insemination; viii) vitamin and medicine; ix) irrigation; and x) maintenance. Fixed cost items for different agricultural enterprises were as follows: i) lease value of land; ii) housing cost; and iii) interest on operating capital. The cost items differed in accordance with each farming practice.

Profitability of crop production

Profitability of crop production under C-L-P, C-P-HA and C-L-HA farming systems are represented in Table 4. It is observed that total cost of crop production was Tk. 45441, Tk. 40233 and Tk. 52809 per hectare in C-L-P, C-P-HA and C-L-HA farming systems, respectively. Net return from crop production was higher in C-L-P farming system (Tk. 4544 per ha) compared to C-P-HA and C-L-HA farming systems (Tk. 805 and Tk. 3169 per ha, respectively). The BCR was higher in C-L-P farming system (i.e., 1.10) which was followed by C-L-HA and C-P-HA farming systems (i.e., 1.06 and 1.02, respectively).

Table 4. Crop profitability under common farming systems (Tk./ha)

Cost items		Farming systems		
		C-L-P	C-P-HA	C-L-HA
Cost of crop production				
Variable costs	Human labour	13652	11235	18647
	Power tiller	3458	4940	4940
	Seed/seedlings	1258	1245	3520
	Fertilizers	6754	2159	4529
	Insecticides	2015	1986	2560
	Irrigation	9880	9880	9880
i. Total variable cost		37017	31445	44076
Fixed costs	Rental charge	4586	4475	5120
	Depreciation cost	1247	1874	1582
	Interest on operating capital	2591	2439	2031
ii. Total fixed cost		8424	8788	8733
iii. Total cost (i + ii)		45441	40233	52809
Return from crop production				
iv. Gross return		49985	41038	55978
v. Gross margin (iv - i)		12968	9593	11902
vi. Net return (iv - iii)		4544	805	3169
vii. BCR (iv ÷ iii)		1.10	1.02	1.06

Source: Authors' estimation based on field survey, 2016–17.

Profitability of livestock rearing

Table 5 represents profitability of livestock rearing under C-L-P and C-L-HA farming systems. It is seen that total cost of livestock rearing per animal per year was Tk. 6096 and Tk. 5741 under C-L-P and C-L-HA farming systems, respectively. Net return from livestock rearing in C-L-P farming system was much higher than in C-L-HA farming system (Tk. 6828 and Tk. 5626 per animal per year in C-L-P and C-L-HA farming systems, respectively). The BCR was found as 2.12 and 1.98 under C-L-P and C-L-HA farming systems, respectively indicating C-L-P farming system more profitable compared to C-L-HA farming system.

Table 5. Profitability of livestock rearing under most common farming systems (Tk./animal/year)

Cost items		Farming systems	
		C-L-P	C-L-HA
Cost of livestock rearing			
Variable costs	Human labour	1250	1158
	Feed	365	401
	Artificial insemination	256	269
	Vitamin and medicine	495	365
	Maintenance	1200	1069
i. Total variable cost		3566	3262
Fixed costs	Rental charge	1254	1248
	Housing cost	569	589
	Depreciation cost	457	414
	Interest on operating capital	250	228
ii. Total fixed cost		2530	2479
iii. Total cost (i + ii)		6096	5741
Return from livestock rearing			
iv. Gross return		12924	11367
v. Gross margin (iv - i)		9358	8105
vi. Net return (iv - iii)		6828	5626
vii. BCR (iv ÷ iii)		2.12	1.98

Source: Authors' estimation based on field survey, 2016–17.

Profitability of poultry rearing

Profitability of poultry rearing under C-L-P and C-P-HA farming systems is depicted in Table 6. It is found that net return from poultry rearing in C-L-P farming system was comparatively higher than C-P-HA farming system (Tk. 277 and Tk. 159 per bird per year, respectively) where the total cost was Tk. 243 and Tk. 249 per bird per year, respectively. The BCR of poultry rearing was higher in C-L-P farming system (i.e., 2.13) in respect of C-P-HA farming system (i.e., 2.03).

Profitability of homestead and agroforestry enterprises

Table 7 shows profitability of homestead and agroforestry enterprises in C-L-HA and C-P-HA farming systems. It is apparent that total cost of homestead and agroforestry enterprises was Tk. 51640 and Tk. 47874 per ha under C-L-HA and C-P-HA farming systems, respectively. Net return under C-L-HA farming system (Tk. 4131) was relatively higher with regard to C-P-HA farming system (Tk. 1915). The BCR of homestead and agroforestry enterprises under C-L-HA and C-HA-P farming systems was 1.08 and 1.04, respectively.

Table 6. Profitability of poultry rearing under most common farming systems (Tk./bird/year)

Cost items		Farming systems	
		C-L-P	C-P-HA
Cost of poultry rearing			
Variable costs	Human labour	42	40
	Feed	110	122
	Vitamin and medicine	30	28
	Maintenance	10	11
i. Total variable cost		192	201
Fixed costs	Rental charge	8	8
	Housing cost	12	11
	Depreciation cost	15	12
	Interest on operating capital	16	17
ii. Total fixed cost		51	48
iii. Total cost (i + ii)		243	249
Return from poultry rearing			
iv. Gross return		520	408
v. Gross margin (iv - i)		328	207
vi. Net return (iv - iii)		277	159
vii. BCR (iv ÷ iii)		2.13	2.03

Source: Authors' estimation based on field survey, 2016–17.

Table 7. Profitability of homestead and agroforestry enterprises (Tk./ha)

Cost items		Farming systems	
		C-L-HA	C-P-HA
Cost of homestead and agroforestry enterprises			
Variable costs	Human labour	14578	12457
	Seed/seedlings	4852	4820
	Fertilizers	6485	5861
	Insecticides	1254	1342
	Irrigation	4940	4940
	Maintenance	8475	7425
i. Total variable cost		40584	36845
Fixed costs	Lease value	8215	8450
	Interest on operating capital	2841	2579
ii. Total fixed cost		11056	11029
iii. Total cost (i + ii)		51640	47874
Return from homestead and agroforestry enterprises			
iv. Gross return		55771	49789
v. Gross margin (iv - i)		15187	12944
vi. Net return (iv - iii)		4131	1915
vii. BCR (iv ÷ iii)		1.08	1.04

Source: Authors' estimation based on field survey, 2016–17.

Productivity of agricultural enterprises

Average productivity of agricultural enterprises (i.e., crop, livestock, poultry, homestead and agroforestry) is represented in Table 8. Based on FGD and experts' opinion, it is seen that there were noteworthy differences in productivity of these enterprises between *char* land and main land. Also, the differences among most of them were found statistically significant. The results of profitability and productivity analyses are faintly similar with Uddin *et al.* (2014) where the authors found significantly increased financial profitability as well as enterprise productivity in six districts of Bangladesh.

Table 8. Average productivity of agricultural enterprises

Enterprises		Productivity			
		Char land	Main land	Difference	p-value
Crop (kg/ha)		8591	8042	549**	0.039
Livestock	Milk (litre/animal)	252	189	63	0.194
	Meat (kg/animal)	92	83	9*	0.088
Poultry	Egg (no./bird)	26	30	–4***	0.009
	Meat (kg/bird)	1.8	1.2	0.6**	0.041
Homestead and agroforestry (kg/ha)		802	658	144	0.336

Source: Authors' estimation based on field survey, 2016–17.
Note: ***, ** and * indicate significant at 1%, 5% and 10% probability level, respectively.

Average annual income of the *char* farmers

Mainly, there were two sources of money income in the study areas which are: farm income and non-farm income. Farm income included income from crop, livestock, poultry, homestead and agroforestry. Non-farm income included income from small business, wage labour, shop keeping, van/rickshaw pulling and other sources. The money income earned by the *char* farmers from different sources is embodied in Table 9.

Table 9. Average annual income of the *char* farmers

Sources of income		Tk./year	Percentage of total income
Farm income	Crop	31250 (56.0)[a]	59.6
	Livestock	13059 (23.4)[a]	
	Poultry	2454 (4.4)[a]	
	Homestead and agroforestry	7500 (13.4)[a]	
	Others	1500 (2.8)[a]	
Total farm income		55763 (100.0)[a]	
Non-farm income	Small business	11468 (30.5)[b]	30.4
	Wage labour	8457 (22.5)[b]	
	Shopkeeping	9567 (25.4)[b]	
	Van/rickshaw pulling	5615 (14.9)[b]	
	Others	2500 (6.7)[b]	
Total non-farm income		37607 (100.0)[b]	
Total income		93460	100.0

Source: Field survey, 2015–16.
Note: a. Figures in the parentheses indicate percentages of total farm income; and
b. Figures in the parentheses indicate percentages of total non-farm income.

It is found that average annual income of the farmers was Tk. 93460 of which 59.6 percent income (Tk. 55763) was from farming activities and 60.4 percent (Tk. 37607) was from non-farming activities. The result is supported by Jannat and Uddin (2016) where the authors found that crop farming was the largest source of farm income for all the farming systems and other income sources were livestock and poultry rearing, fish farming, homestead vegetables and forestry.

Households' food security status of the *char* farmers

Food security was glimpsed from the viewpoint of three perspectives, such as, availability of safe and nutritious food, access to food and utilization of food. It is evident from Table 10 that food security index value for food secure households was 1.05 and for food insecure households, it was 0.51. Based on the recommended daily calorie intake of 2122 kcal, it is observed that 68.0 percent households were food secure and remaining 32.0 households were food insecure. Average calorie intake of food secure households was 2268.9 kcal per day which was 1882.4 kcal in case of food insecure households but it was still lower than the national average level (i.e., 2122 kcal) for both food secure and insecure households.

Table 10. Food security indices

Food security indices	Index values	
	Food secure households	Food insecure households
Food security index (Z)	1.05	0.51
Head count index (H)	68.0	32.0
Per capita daily calorie availability	2268.9	1882.4
Food shortfall/surplus index (P)	0.01	–0.33

Source: Authors' estimation based on field survey, 2016–17.

The value of food surplus index in stare of food secure households was 0.01 which means that households had superfluous food for crisis period, where the value of food shortfall index for food insecure households was -0.33 indicating a situation of food shortage and no surplus food at the dilemma period (Table 10). The result is quite similar with Mohiuddin *et al.* (2016) where the authors observed that on an average, the rural households were more or less secured in relation to availability of food round the year.

Impact of production practices on *char* farmers' livelihood

Farmers' engagement with different production practices had a great impact on their livelihood which was represented by livelihood component framework (LCF) in Table 11. The positive and negative impacts of the farming practices were overviewed on the basis of farmers' asset possession, activities and strategies, well being, and external policies and institutions. In terms of farmers' asset possession, it is observed that land use efficiency was increased in case of 25.0 percent *char* farmers, and income for purchasing assets and agricultural inputs was increased for 42.5 percent farmers. Financial solvency of the *char* dwellers also increased. On the other hand, 55.0 percent farmers experienced increasing ecological imbalance and decreasing environmental condition.

Char farmers' livelihood activities and strategies were greatly influenced by their farming practices. It is seen that 56.0 percent farmers stated about increased cropping intensity in the study areas which allowed them to grow more crops in a year. Additional income from farming activities had been increased accordingly. Production risk was decreased according to 32.5 percent farmers. But 20.0 percent *char* dwellers opined that their involvement with other income generating activities was decreased to some extent. Most of the farmers discoursed about improved food security condition (62.5 percent farmers) and sustainable livelihood provision (62.0 percent farmers). Risk and uncertainties associated with production practices caused limited and unpredictable cash earnings which was experienced by 77.5 percent farmers. Also, market access of the people was increased in the study areas (Table 11).

Impact of natural calamities on *char* dwellers' livelihood

A natural calamity is the occurrence of an abnormal or infrequent hazard that has an impact on vulnerable communities or geographical areas, causing substantial damage, disruption and possible casualties, and leaving the affected communities unable to function normally. From an economic perspective, a disaster implies some combination of losses in terms of human, physical and financial capital, and a reduction in economic activities (Benson and Clay, 1998). The people of the study areas are victim of frequent natural calamities like river erosion, flood, cyclone and drought from their birth to death. It is seen from Table 12 that majority of the farmers (75.0 percent) were affected by river erosion which was followed by cyclone (44.5 percent), flood (36.5) and drought (12.5). In monetary term, the amount of loss for river erosion, flood, cyclone and drought were Tk. 72850, Tk. 48500, Tk. 35685 and Tk. 20130 per household, respectively (Table 12).

Table 11. Livelihood component framework

Impacts on	Outcomes			
	Positive effects	% of farmers	Negative effects	% of farmers
Impact of production practices on farmers' asset possession				
Human capital	Income used for educational purposes	36.0	-	-
Physical assets	Income used to buy food, modern agricultural equipments, housing construction, etc.	42.5	-	-
Financial assets	Increased savings and cash at hand, reduced borrowing tendency of capital	39.5	-	-
Natural capital	Increased land use efficiency	25.0	Reduced environmental quality, increased ecological imbalance due to over extraction of underground water, more use of chemical fertilizer and pesticides, etc.	55.0
Social capital	Reduced dowry system, increased training facilities, etc.	34.0	Conflicts within community	47.0
Impact of production practices on farmers' activities and strategies				
Farming, schooling and other activities	Increased cropping intensity	56.0	Reduced involvement in other income generating activities	20.0
	Increased child enrollment	45.3		
	Work can be shared within household	23.5		
	Further reducing tradeoff with other works	21.0		
Strategies for selecting activities: - Diversify - Minimize risk - Maintain liquidity	Contributes to diversification	29.5	-	-
	Less production risk	32.5		
	Additional income	41.0		
Impact of production practices on farmers' well being				
Cash	Earnings can be significant	45.0	Limited and unpredictable	77.5
Food security	Helps to ensure households' food security	62.5	-	-
Sustainability of livelihood	Contributes to livelihood sustainability	62.0	Some earn distrust	17.5
Empowerment	Increased empowerment, especially *char* women	35.0	Lack of capacity building of groups	32.0
Reduced vulnerability	Cannot rely on unpredictable earnings	29.5	-	-
Impact of production practices on farmers' external policies and institutions				
Market access	Gain access to market	78.5	-	-
	Control access of members	46.0		

Source: Field survey, 2015–16.

Table 12. Monetary loss of farmers due to natural calamities

Types of natural calamities	Percentages of farmers faced	Average monetary loss (Tk./household)
River erosion	75.0	42850
Flood	36.5	8500
Cyclone	44.5	5685
Drought	12.5	2130

Source: Field survey, 2015–16.

Note: To picturize the depth of natural calamities' severity, several FGDs were done in different *char* villages at Islampur upazila of Jamalpur district

Severity of damage caused by natural calamities

The severity of damage in farmers' agricultural and livelihood activities attributable to the occurrences of different natural calamities was quantified taking the observations of the respondents into account and represented in severity ranking model (SRM). The model was composed of three components which are: agriculture (sub-components: crop, livestock, poultry, 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 13 shows that the highest MSS in this model was 2235 and the lowest one was 1669. The level of damage was the highest in case of cultivable land which was ranked as 1st (with MSS 2235). It was followed by physical assets (with MSS 2196), crop (with MSS 2193), homestead area (with MSS 2185) and employment (with MSS 2159) receiving rank as 2nd, 3rd, 4th and 5th, respectively (Table 13). 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 in Bangladesh.

Table 13. Severity ranking model

Model components		Natural calamities																				MSS	SR
		River erosion					Flood					Cyclone					Drought						
		Severity of damage																					
		E	H	M	L	CSS	E	H	M	L	CSS	E	H	M	L	CSS	E	H	M	L	CSS		
Agriculture	Crop	120	26	40	14	652	45	67	23	65	492	76	45	37	42	555	63	29	47	61	494	2193	3
	Livestock	67	47	36	50	531	68	49	47	36	549	37	64	58	41	497	59	29	72	40	507	2084	8
	Poultry	78	44	17	61	539	61	76	43	20	578	39	42	62	57	463	74	34	29	63	519	2099	7
	Homestead and agroforestry	46	18	75	61	449	93	27	60	20	593	35	62	29	74	458	42	34	76	48	470	1970	9
Assets	Cultivable land	102	44	32	22	626	44	29	63	64	453	71	63	28	38	567	91	40	36	33	589	2235	1
	Homestead area	38	120	27	15	581	85	24	56	35	559	45	56	78	21	525	68	34	48	50	520	2185	4
	Physical assets	82	61	36	21	604	36	68	82	14	526	93	27	37	43	570	37	65	55	43	496	2196	2
Livelihood items	Drinking water	82	35	49	34	565	69	83	25	23	598	60	61	39	40	541	32	38	76	54	448	2152	6
	Sanitation	36	71	67	26	517	32	42	69	57	449	64	32	36	68	492	49	28	90	33	493	1951	10
	Education	35	48	25	92	426	26	46	42	86	412	22	35	60	83	396	42	22	65	71	435	1669	11
	Employment	79	72	24	25	605	34	38	67	61	445	70	49	37	44	545	66	57	52	25	564	2159	5

Source: Authors' estimation based on field survey, 2016–17.

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 river erosion = (120 × 4) + (26 × 3) + (40 × 2) + (14 × 1) = 652.
Calculation of CSS (crop) for other natural calamities was done accordingly.
Calculation of MSS (crop) = 652 + 492 + 555 + 494 = 2193.
Calculation of CSS and MSS of other model components for all stated natural calamities were done following the same procedure, and ranked consequently.

Farmers' perceptions about the impact of natural calamities

Farmers' perceptions about the impact of natural calamities on their day-to-day life were evaluated using agreement index (AI). Farmers' observations were recorded on 10 positive and 10 negative statements about the impacts of natural calamities, and their depth of agreements on the selected statements were calculated consequently.

Table 14 shows that 56.0 percent farmers of the study areas were agreed with the statements about positive impacts of natural calamities like increased water supply, improved soil fertility, enlarged water living space, increased soil moisture, reduced air pollution, etc., whereas 44.0 percent farmers were disagreed with the statements. On the other hand, 53.0 percent farmers were agreed with the statements about negative impacts of natural calamities like reduced farm production, damaged farm infrastructure, damaged communication system, hampered biodiversity, increased cost of production, etc., while 47.0 percent farmers were disagreed with the statements (Table 14).

Table 14. Agreement index regarding the impacts of natural calamities

Statements	Farmers' agreement		Weights
	Agreed	Disagreed	
Positive impacts			
Increased water supply	103/200	97/200	1/10
Improved soil fertility	79/200	121/200	1/10
Enlarged water living space	112/200	88/200	1/10
Increased soil moisture	109/200	91/200	1/10
Reduced air pollution	68/200	132/200	1/10
Better nutrient management	127/200	73/200	1/10
Recharged groundwater reserve	120/200	80/200	1/10
Improved pest management	135/200	65/200	1/10
Facilitation of government support	175/200	25/200	1/10
Development of community support	91/200	109/200	1/10
Index score	0.56	0.44	-
Depth of agreement (%)	56.0	44.0	-
Negative impacts			
Reduced farm production	167/200	33/200	1/10
Damaged farm infrastructure	149/200	51/200	1/10
Disrupt communication system	128/200	72/200	1/10
Disturbed biodiversity	93/200	107/200	1/10
Increased cost of production	86/200	114/200	1/10
Higher market prices of inputs	117/200	83/200	1/10
Enhanced soil erosion	124/200	76/200	1/10
Reduced rainfall	72/200	128/200	1/10
Siltation and sedimentation	69/200	131/200	1/10
Deformed land topography	57/200	143/200	1/10
Index score	0.53	0.47	-
Depth of agreement (%)	53.0	47.0	-

Source: Authors' estimation based on field survey, 2016–17.
Note: Calculation of index score for positive impacts (agreed opinions) = (103/200 × 1/10) + (79/200 × 1/10) + (112/200 × 1/10) + (109/200×1/10) + (68/200×1/10) + (127/200×1/10) + (120/200×1/10) + (135/200×1/10) + (175/200 × 1/10) + (91/200×1/10) = 0.56
Calculation of index score for positive impacts (disagreed opinions) = (97/200 × 1/10) + (121/200 × 1/10) + (88/200×1/10) + (91/200 × 1/10) + (132/200 × 1/10) + (73/200 × 1/10) + (80/200 × 1/10) + (65/200 × 1/10) + (25/200 × 1/10) + (109/200×1/10) = 0.44
Calculation of depth of agreement for positive impacts (agreed opinions) = 0.56 × 100 = 56%
Calculation of depth of agreement for positive impacts (disagreed opinions) = 0.44 × 100 = 44%
Calculation of index score and depth of agreement for negative impacts (both agreed and disagreed opinions) were performed consequently.

Major problems and constraints associated with production practices and livelihood

Table 15 represents major problems and constraints faced by the farmers in the study areas. It is seen that high price of seed and fertilizer was the most frequently faced problem (ranked 1st) by the farmers. About 59.1 percent farmers stated about this problem. It was followed by low price of output (ranked 2nd), and lack of good quality seed and fertilizer (ranked 3rd) which were frequently faced by 57.5 and 59.1 percent farmers, respectively. Other problems and constraints included insufficient institutional credit, lack of storage of product during harvesting, lack of farmers' knowledge, lack of transportation facility and lack of grading knowledge which were ranked as 4th, 5th, 6th, 7th and 8th, respectively according to the farmers' opinion (Table 15).

Table 15. Problems and constraints faced by the farmers

Problems identified	Extent of problem (% of farmers)			Rank
	Frequent	Occasional	Rare	
Input related problems				
High price of seed and fertilizer in the market	59.1	26.7	14.2	1
Lack of good quality seed and fertilizer	55.0	24.2	20.8	3
Output related problems				
Low price of output	57.5	29.2	13.3	2
Lack of storage of product during harvesting	43.3	31.7	25.0	5
Product marketing related problems				
Lack of transportation facility	40.8	34.2	25.0	7
Lack of grading knowledge	38.3	31.7	30.0	8
Technical problems				
Lack of farmers' knowledge	41.7	40.0	18.3	6
Insufficient institutional credit	49.1	36.7	14.2	4

Conclusion and Recommendation

The study concludes that the *char* dwellers were recurrent victims of frequent natural calamities though they were in a struggle of coping with those climatic hazards with diversified production practices. The major enterprises of the farming systems followed by the farmers were crop, livestock, poultry, homestead and agroforestry. Almost all of the most common farming practices like C-L-P, C-P-HA and C-L-HA were more or less profitable that had a considerable impact on increasing their monetary income. Per capita daily calorie intake by the *char* dwellers was still under the national level average which was a great issue of concern. The production practices tagged with the farmers had a great influence on their livelihood components. Majority of the farmers experienced positive impacts of farming systems practiced in the mirror of asset possession, activities and strategies, well being, and external policies and institutions. Attachment with frequent natural calamities like river erosion, flood, etc. caused a colossal destruction to the farming, non-farming and livelihood activities of the *char* people. Cultivable land, household assets and agricultural enterprises (i.e., crop, livestock, etc.) were relentlessly affected by those natural hazards. Based on the findings of the study, some indispensable policy recommendations have been arisen which are: appropriate pre-disaster and post-disaster measures as well as input subsidy and output price support to the farmers should be properly implemented by government to continue their productive activities in the crisis period and strengthen safety net programmes for enhancing their food security.

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