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 insecure 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.
Char people’s production practices and livelihood status

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
- \(\Sigma C_v\) = 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:

\[
NR = GR - \sum C_v - \sum C_f
\]

Where,

- \( GR \) = Gross return;
- \( \sum C_v \) = Total variable cost per unit area; and
- \( \sum C_f \) = 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:

\[
BCR = \frac{GR}{GC}
\]

Where,

- \( GR \) = Gross return; and
- \( GC \) = Gross cost (i.e., \( \sum C_v + \sum C_f \)).

**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:

\[
Z_i = \frac{Y_i}{R}
\]

Where,

- \( Z_i \) = Food security index for \( i^{th} \) households
- \( Y_i = \) Daily per capita calorie intake of \( i^{th} \) households;
- \( R = \) Daily per capita calorie required for \( i^{th} \) households; and
- \( i = 1, 2, 3, \ldots, 200 \).

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:

\[
P = \frac{1}{M} \sum_{i=1}^{m} G_i
\]

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, \( G_i = \frac{(Y_i - R)}{R} \).

The head count ratio (H) measures the percentages of the households that are food secure or insecure which was defined as:

\[
H = \frac{M}{N}
\]

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:

\[
\text{CSS}_N = (N_E \times SP_E) + (N_H \times SP_H) + (N_M \times SP_M) + (N_L \times SP_L)
\]

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:

\[
\text{MSS} = \text{CSS}_R + \text{CSS}_F + \text{CSS}_C + \text{CSS}_D
\]

Where,

- \(\text{CSS}_R\) = Component severity score in case of river erosion;
- \(\text{CSS}_F\) = Component severity score in case of flood;
- \(\text{CSS}_C\) = Component severity score in case of cyclone; and
- \(\text{CSS}_D\) = 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:

\[
\text{Depth of agreement} = \sum \omega \times 100
\]

Where,

- \(\sum\) = Farmers agreed or disagreed with the statements; and
- \(\omega\) = 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             | 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               | C-L-P | C-L-HA |
|--------------------------|-------|--------|
| **Cost of livestock rearing** |       |        |
| 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   |
| 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, shopkeeping, 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)%  |                           |
| Livestock                                | 13059 (23.4)%  |                           |
| Poultry                                  | 2454 (4.4)%    | 59.6                      |
| Homestead and agroforestry               | 7500 (13.4)%   |                           |
| Others                                   | 1500 (2.8)%    |                           |
| Total farm income                        | 55763 (100.0)% |                           |
| Non-farm income                          |                |                           |
| Small business                           | 11468 (30.5)%  |                           |
| Wage labour                              | 8457 (22.5)%   |                           |
| Shopkeeping                              | 9567 (25.4)%   | 30.4                      |
| Van/rickshaw pulling                     | 5615 (14.9)%   |                           |
| Others                                   | 2500 (6.7)%    |                           |
| Total non-farm income                    | 37607 (100.0)% |                           |
| 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         | 1.05                   | 0.51                    |
| Head count index (H)                   | 68.0         | 32.0                   | 68.0                    |
| Per capita daily calorie availability  | 2268.9       | 1882.4                 | 2268.9                  |
| Food shortfall/surplus index (P)       | 0.01         | –0.33                  | 0.01                    |

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

The value of food surplus index in states 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 | Negative effects |
|------------------------------------------------|--------------------------------------------------------------------------|------------------|------------------|
| Impact of production practices on farmers’ asset possession |                                                                          |                  |                  |
| Human capital                                   | Income used for educational purposes                                     | 36.0             | -                |
|                                                | Income used to buy food, modern agricultural equipments, housing construction, etc. |                  |                  |
| Physical assets                                 | Increased savings and cash at hand, reduced borrowing tendency of capital | 39.5             | -                |
| Financial assets                                |                                                                          |                  |                  |
| Natural capital                                 | Increased land use efficiency                                            | 25.0             | 55.0             |
| Social capital                                  | Reduced dowry system, increased training facilities, etc.               | 34.0             | 47.0             |

| Impact of production practices on farmers’ activities and strategies |                                                                                     |
|---------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------|
| Farming, schooling and other activities                             |                                                                                                                                  |
| Increased cropping intensity                                         |                                                                                                                                  |
| Increased child enrollment                                          |                                                                                                                                  |
| Work can be shared within household                                  | Reduced involvement in other income generating activities                                                                     |
| Further reducing tradeoff with other works                           | 20.0                                                                               |
| 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                                         |                                                                                                                                  |
| Helps to ensure households’ food security                           | 43.0                                                                               |
| Food security                                                       |                                                                                                                                  |
| Contributors to livelihood sustainability                            |                                                                                                                                  |
| Contributes to livelihood sustainability                             | 62.0                                                                               |
| Empowerment                                                         |                                                                                                                                  |
| Increased empowerment, especially char women                         |                                                                                                                                  |
| 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 picture 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 | Severity of damage | MSS | SR |
|------------------|--------------------|--------------------|-----|----|
|                  | River erosion | Flood | Cyclone | Drought | CSS | E | H | M | L | CSS | 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 | 46   | 18  | 75  | 61  | 449 | 93 | 27 | 60 | 20 | 593 | 35 | 62 | 29 | 74 | 458 | 42 | 34 | 46 | 40 | 470 | 1970 | 9  |
|                  | agroforestry  |                  |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| 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    |
| Enhanced 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) = \((103/200 \times 1/10) + (79/200 \times 1/10) + (112/200 \times 1/10) + (109/200 \times 1/10) + (68/200 \times 1/10) + (127/200 \times 1/10) + (120/200 \times 1/10) + (135/200 \times 1/10) + (175/200 \times 1/10) + (91/200 \times 1/10) = 0.56\)

Calculation of index score for positive impacts (disagreed opinions) = \((97/200 \times 1/10) + (121/200 \times 1/10) + (88/200 \times 1/10) + (91/200 \times 1/10) + (132/200 \times 1/10) + (73/200 \times 1/10) + (80/200 \times 1/10) + (65/200 \times 1/10) + (25/200 \times 1/10) + (109/200 \times 1/10) = 0.44\)

Calculation of depth of agreement for positive impacts (agreed opinions) = 0.56 \times 100 = 56%\)

Calculation of depth of agreement for positive impacts (disagreed opinions) = 0.44 \times 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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