



## **Comparative Contribution of Crops and Homestead Forest Enterprises to Rural Household Economy: A Case Study of Keshorita Village in Bangladesh**

**Muhammad Ziaul Hoque<sup>1,2\*</sup>, Md. Ashiqur Rahman<sup>1</sup>, Md. Enamul Haque<sup>1</sup>,  
Md. Safiul Islam Afrad<sup>1</sup> and Md. Mizanur Rahman<sup>3</sup>**

<sup>1</sup>*Department of Agricultural Extension and Rural Development, Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU), Gazipur, Bangladesh.*

<sup>2</sup>*Department of Environmental Management and Economy, Institute of Urban Environment, Chinese Academy of Sciences, China.*

<sup>3</sup>*Department of Soil Science, Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU), Gazipur, Bangladesh.*

### **Authors' contributions**

*This work was carried out in collaboration between all authors. Author MZH finalized the design, wrote the protocol, performed the statistical analysis and their interpretation, assisted in writing first draft report. Author MAR planned the design, managed literature search, collected data and wrote the first draft of the manuscript. Authors MEH, MSIA and MMR finalized the design and protocol and improved the draft report. All authors read and approved the final manuscript.*

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### **ABSTRACT**

Despite over-dependence on the crop based farming economy, homestead forestry practices have immense potential to ensure sustainable livelihoods in the rural and peri-urban areas of Bangladesh. A clear understanding of the physical characteristics and economic role of both sectors in rural livelihoods is vital for sustainable resource management. This study focused on the crop and homestead forest tree species diversity, profitability and their relative contribution to the household

\*Corresponding author: E-mail: [mziahoque@yahoo.com](mailto:mziahoque@yahoo.com), [hoque@iue.ac.cn](mailto:hoque@iue.ac.cn);

economy. A questionnaire survey was conducted with 90 sampled respondents for gathering primary data. Statistical software SPSS was employed for necessary data analysis. Findings revealed that rice remained as a single cereal crop whereas species richness of vegetables, timber and fruit trees was 3.20, 11.64 and 11.76, respectively. It was found that Mango and Jackfruit are abundant and profitable fruit trees whereas Mahogany and Jackfruit are the dominant timber trees. On average, crop and homestead forests contributed 36.42% and 20.65% to household income, respectively. Production and income from crops and homestead forests on a per hectare basis were found to vary widely among different landholding size classes, level of education and farming experiences. It is suggested that diversification of crops and forests production along with the improvement of education level amongst farmers could improve family income and ensure better livelihoods.

*Keywords: Homestead forests; crops; diversity; profitability; contribution; household income.*

## 1. INTRODUCTION

The economy of Bangladesh primarily depends on agriculture [1] and allied fields where crop, forests, livestock, and poultry are the major enterprises [2]. Despite the impressive achievements in agricultural production, ever increasing population and climate change vulnerabilities poses an imminent threat to ensure food and livelihood security for the agrarian peoples. To keep pace with the added population, the country will have to be producing more food grains in future. However, the net cultivable land is continuously decreasing by the establishment of the homestead to afford increased population [3]. So, apart from significant dependence on cropland, the homestead areas may be a potential enterprise of the country which can play an important role to meet food requirements and boost the household economy.

A homestead forest, or often regards as “home-garden,” is a combination of intentionally planted vegetation, typically with a complex structure, and intended to fabricate natural products for the households or market sale [4,5,6]. In rural and peri-urban areas of Bangladesh, people usually plant and maintain a wide range of plants for meeting household requirements including fruits, vegetables, fuelwood and timber [7]. Their homesteads are a unique feature of the combination of trees, shrubs, vegetables, livestock, ducks, poultry, and pigeon from ancient time. About 20 M of homesteads covered 2% (0.27Mha) of country's total land area and met the demand of more than 80% timber and 70% bamboo [8,9,10,11]. Also, homestead forests can act as a safety net in providing alternative livelihood sources for the people during crisis periods including natural hazards [6]. It also

provides a wide source of biodiversity [12,13] and termed as “Biodiversity Island” [14]. Moreover, homestead cultivation can be a source of substantial income [6] for the rural people, especially, people who don't have any land for crop cultivation. In general, homestead forests are managed by subsistence farmers in developing countries that could have a potential for achieving multiple goals including poverty reduction and sustainable development [15].

In order for bringing the country's homesteads under production enterprise, the most challenging task will have to be motivating the homeowners. As stated, socio-economic profile of the farmers highly influences their adoption behavior [16,17,18,19]. Field information also indicated that all the farmers do not use their resources and technologies properly. Variation in productivity and profitability strongly demand to assess the resource and technology use performance of the farmers. Unfortunately, in Bangladesh, research on homestead forests got less emphasis than desirable based on their contribution to the economy, ecology, and livelihoods [6]. Previous studies on homestead forests mostly focused on plant composition and structure [20,21,22,23,5], peoples' perceptions and preferences of growing plants in homesteads [11,14], biodiversity conservation [24,25], quantitative analysis of home garden characteristics [6] and contribution to rural economy and climate [7]. However, there is hardly any study can be found on the relative contribution of different farming enterprises to the household economy for ensuring better livelihoods of the farmers. Moreover, there is a lack of adequate understanding as to how crop production and homestead forest contributed to the household economy. These facts indicate the need for an investigation to ascertain the crop

production and homestead forest adding to the socio-economic condition of the farmers. Considering the above-mentioned facts, the study was conducted with the following objectives to: a) investigate the diversity, profitability and distribution pattern of crop and homestead forest production system in the study area; b) estimate the contribution of crop and homestead forest production to the annual household income; and c) explore the association of selected socio-economic characteristics with income from crops and homestead forest production.

Bangladesh. The area is located between latitude 23.78° - 24.02° and longitude 90.26° - 90.32°. Gazipur is situated in Old Brahmaputra (floodplains) (AEZ-9) and Madhupur tract (terraces) (AEZ-28). Old Brahmaputra, Shitalakshya, Turag, Bangshi, Balu, and Banar are the major rivers in this district. Annual average temperature varies from 13 to 36°C. Annual rainfall is around 2400 mm. Agriculture has a relatively high economic impacts where rice (local and high yielding varieties), vegetables, fruits and homestead forests are dominant.

## 2. METHODOLOGY

### 2.1 Study Area and Sampling Technique

The study was conducted in Kheshorita village of Gazipur sadar upazila (Fig. 1) which is situated in the northern fringes of the capital city (Dhaka) of

The total number of households in the study village was 320 which constituted the population of the study, from which, ninety (90) household heads were selected as sampled respondents following simple random sampling technique representing 28.1% of the total households of the village.

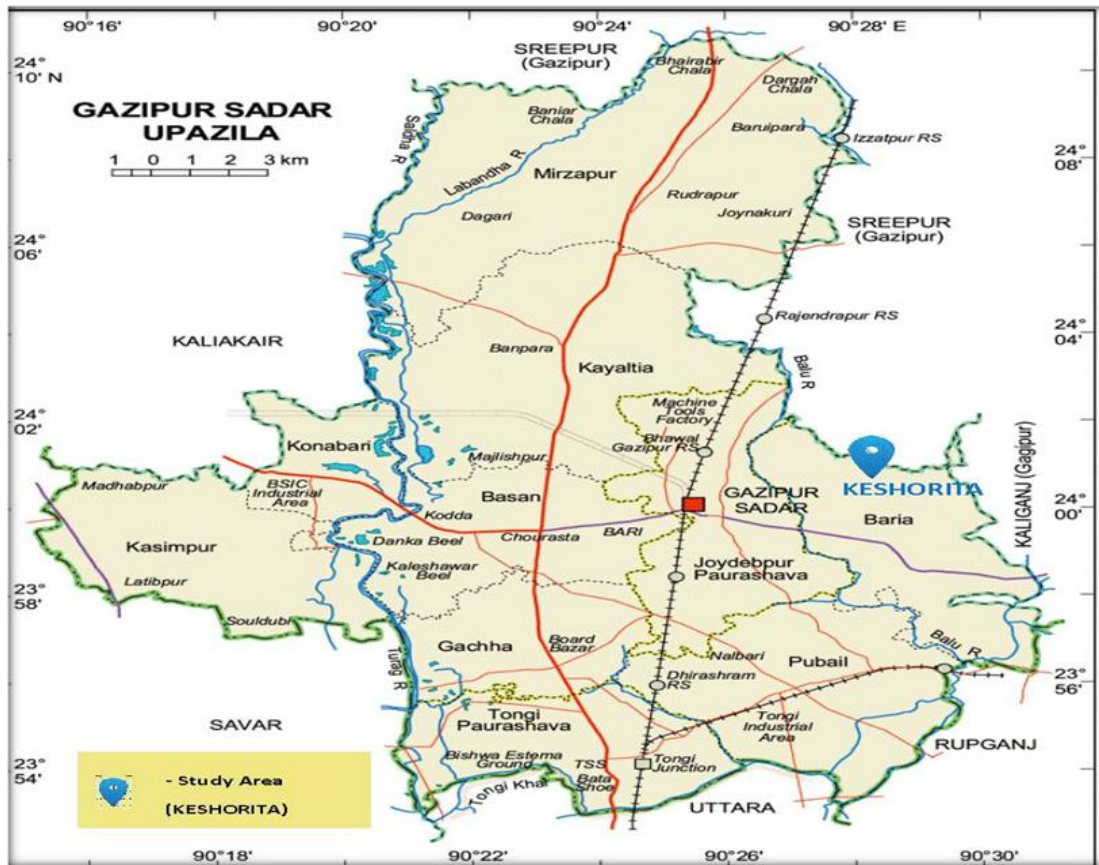


Fig. 1. Map of Gazipur Sadar upazila showing the study area

## 2.2 Questionnaire Survey

Household level survey was carried out to gather primary data during January to February 2015. A semi-structured draft questionnaire was developed after finalizing the research design. The draft questionnaire was then pre-tested with 15 household heads taking 5 from each of the small, medium and large category farmers. Based on the experience and results of pilot test, necessary modifications on the draft questionnaire was made for the ease of data collection. Apart from 90 selected respondents, a reserve list of 15 respondents was kept to taken consideration in the case of absence of a pre-selected respondent. A prior appointment was taken before going to conduct interview with the respondent farmers to get maximum participation. Data were collected on different dimensions ranging from socio-demographic profile, farming practices, crop and forest diversity, production and disposal pattern, profitability, income sources and problems being faced.

## 2.3 Farmholding Size Class

Farm holding size refers to the size of land area devoted to the maintenance of farming enterprise(s) by a farmer which includes the homestead, own land under own cultivation, land taken from or given to others as barga, land taken from or given to others as the lease. But the total land area of a farm family doesn't measure by a simple sum of all category lands instead follow a definite formula. The farm size of the respondent was computed by using the following formula 1 as used by Uddin et al. [26].

$$F_s = A_1 + A_2 + 0.5(A_3 + A_4) + A_5 + A_6 \quad (1)$$

Where,

- F<sub>s</sub> = Farm size
- A<sub>1</sub> = Homestead area excluding pond and garden area
- A<sub>2</sub> = Own cultivated area
- A<sub>3</sub> = Own land given to others on barga
- A<sub>4</sub> = Land taken from others on barga
- A<sub>5</sub> = Own land given to/taken others on lease
- A<sub>6</sub> = others (fruit garden, pond)

The respondents were classified into following three categories as per there land possession.

| <u>Categories</u> | <u>Land</u>    |
|-------------------|----------------|
| Small             | up to 0.50 ha  |
| Medium            | 0.50 to 1.0 ha |
| Large             | above 1.0 ha   |

## 2.4 Profitability of Crop Production

Profitability of the farm produces was measured by computing BCR (Benefit Cost Ratio) following formula 2 [27].

$$BCR = \frac{\text{Gross return}}{\text{Total cost}} \quad (2)$$

Where, total cost represents sum total of inputs, cultural and intercultural operation, post-harvest operation and related other costs. Gross return was measured by the market price of agricultural products and sub-products, e.g., grain and straw for rice.

## 2.5 Contribution of Crop and Homestead Forest Production to Household Economy

Relative contribution of each of the farming/non-farming enterprises to household's total annual income have been considered as the contribution of that specific sector to the household economy. Contribution of each farming enterprise to household economy was calculated following Hoque et al, 2013 [28].

$$\text{Contribution (\%)} = \frac{\text{Income from specific farming or non farming enterprise}}{\text{Total annual income}} \times 100 \quad (3)$$

## 2.6 Statistical Analysis

Statistical measures such as 't' test was employed to test the hypothesis "there is no significant differences between crop and homestead forest production to household economy" whereas 'F' test was used to test the hypothesis "there is no significant differences among the small, medium and large farmers in respect of their income from crop and homestead forests production. Chi-squared tests of independence were used to detect relationships of selected socio-economic characters with income from crops and homestead forest production.

### 3. RESULTS AND DISCUSSION

#### 3.1 Status of Crops and Forests Practices

The diversity of crop species primarily depends on the land type, different climatic factors, and availability of new varieties. Farmers of the study area cultivated cereals and vegetables in their cultivable lands to sustain their livelihoods. Maximum of their cultivable land undergoes stagnant water for eight to nine months of the year which compel them to cultivate rice as principal cereal crop along with different vegetables in the homestead and surrounding areas.

Results presented in Table 1 show that only a single type of cereal crop (rice) was cultivated in the study area. As the area is low lying, usually Boro rice is cultivated in the winter season and kept under flood for rest of the time. The overall quantity and quality of vegetable species were also low due to constraints of the new variety and proper knowledge available to the farmers. It is evident that improper cropping design, lack of

technical knowledge, inadequate crop specific cultivation information, quality seed and decreasing cultivable land might have triggered the low diversity of both crops and vegetables.

The study area is famous for different types of fruits, and timber production. Farmers produce different fruits and timbers in their homestead areas not only for their consumption but also sale their produces to get an economic return as income.

Results shown in Table 2 indicate the number and percentage distributions of various types of forest species. Table 2 presents a complete list of woody species found in the sample households along with their own usage and an average number of stems per household. It revealed that the study area has around 13 species in total, including eight fruit species, four timber species, and bamboo species. Jackfruit was the most abundant species, at 3.85 trees/household, followed by giant bamboo 0.40 culms/household and mango 3.35 trees/household.

**Table 1. Diversity of crop species across landholding size classes**

| Type of plant      | Land holding size class |        |       | Overall |
|--------------------|-------------------------|--------|-------|---------|
|                    | Small                   | Medium | Large |         |
| Cereal crop (Rice) | 1.0                     | 1.0    | 1.0   | 1.0     |
| Vegetable crops    | 3.13                    | 3.16   | 3.50  | 3.20    |
| All                | 4.13                    | 4.16   | 4.50  | 4.20    |

**Table 2. Stems of fruits, timber and bamboo species across landholding size classes**

| Name of the tree | Average no. of tree/hh | Avg. income by selling (Tk.)/hh | Consumption (Tk.)/hh |
|------------------|------------------------|---------------------------------|----------------------|
| <b>Timber</b>    |                        |                                 |                      |
| Mango            | 3.35 (1.8)             | 1150 (2862.8)                   | 300 (957.9)          |
| Jackfruit        | 3.85 (2.1)             | 2950 (6266.9)                   | 1200 (3670)          |
| Neem             | 2.35 (3.42)            | 2150 (3379.7)                   | -                    |
| Mahogany         | 2.15 (3.08)            | 6250 (8902)                     | 350 (1532)           |
| <b>Fruits</b>    |                        |                                 |                      |
| Mango            | 3.35 (1.8)             | 3960 (22057.6)                  | 1215 (602.3)         |
| Jackfruit        | 3.85 (2.16)            | 5775 (3240.2)                   | 1155 (648)           |
| Tal              | 1.65 (1.62)            | 1170 (1241)                     | 230 (404.3)          |
| Coconut          | 0.95 (1.16)            | 700 (857.5)                     | 175 (364.6)          |
| Litchi           | 0.25 (.538)            | 245 (533.7)                     | 470 (1742.8)         |
| Sapota           | 0.30 (.643)            | 60 (183.5)                      | 85 (174.7)           |
| Date palm        | 0.65 (1.06)            | 165 (295)                       | 45 (120.8)           |
| Kamranga         | 0.25 (0.538)           | -                               | 73 (167.5)           |
| Bamboo           | 0.40 (0.738)           | 420.05 (1531)                   | 40 (124.6)           |

*Numbers in the parenthesis indicates SD (standard deviation), hh= household*

Apart from Jackfruit and Mango, Tal, Coconut, Litchi, Sapoda, Date palm, and Kamranga were the main fruit trees, with Mango, Jackfruit, Mahogany, and Neem the main timber species. However, most of the fruit and timber species occurred in relatively smaller numbers. A high percentage of fruit species may be linked with multipurpose usage of fruit trees as food, fodder, fuelwood, and timber. Jackfruit and mango were recognized as two significant fruit trees which jointly represent more than half of the total stems (7.2%) and contribute to the household by providing food, cash income, leaves as fodder and valuable timber. It also observed that next to Mahogany, Jackfruit was the most valuable timber in the local market.

Information presented in Table 3 reveal that average no. of timber and fruit trees per households was 11.64 and 11.76, respectively which was almost same among the respondents of different landholding size classes. The overall quantity and quality of fruit and timber species were relatively low due to constraints of germplasm available in the country. Farmers reported that in the past they were not concerned about the source of planting materials, and usually allowed wildings to grow. This practice could lead to a selection of genetically inferior individuals with low yield. Although farmers grew

some species in designated areas, for instance, bamboo in the northwest corner for shade management and protection from storms. They did not follow any particular spacing or planting design for species grown, due to lack of technical knowledge. Lack of specific planting design and standard spacing may affect growth, form, and yield of the trees as well as tie-up space that could otherwise be used to grow more trees.

### 3.2 Profitability of Crop Production to Land Holding Class

Food security in Bangladesh is defined by the availability of rice. Results displayed in Table 4 reveal that average yield of rice by different landholding classes in the study area was 138.57 mounds/ha, total cost 82132.95 Tk/ha, total income 103414.01 Tk/ha, net income 21281.06 Tk/ha and BCR 1.26. It also reveals that medium farmers have the highest BCR of rice (1.32) compare with the small (1.26) and large farmers (1.21). Large farmers have the lowest BCR rate of rice production because of high production cost. Optimum use of natural resources is the main reason for high BCR value of the medium class farmers as they used less amount of pest and chemical fertilizer compared with the large farmers.

**Table 3. Stems of fruit and timber species across land holding size classes (average no. of tree/household)**

| Types       | Land holding size class |        |       | Mean  |
|-------------|-------------------------|--------|-------|-------|
|             | Small                   | Medium | Large |       |
| Timber tree | 10.58                   | 12.57  | 11    | 11.64 |
| Fruit tree  | 12.93                   | 10.66  | 12.71 | 11.76 |
| All         | 23.51                   | 23.24  | 23.71 | 23.41 |

**Table 4. Profitability of rice production (per hectare)**

| Cost item                   | Land holding size class |           |          | Mean      |
|-----------------------------|-------------------------|-----------|----------|-----------|
|                             | Small                   | Medium    | Large    |           |
| Land preparation            | 6002.01                 | 5993.88   | 6034.43  | 6010.1    |
| Manure                      | 3751.25                 | 3746.18   | 8031.93  | 5176.45   |
| Fertilizer                  | 4501.52                 | 4495.41   | 9428.56  | 6141.83   |
| Irrigation                  | 3237.05                 | 3256.88   | 3142.86  | 3212.26   |
| Seed                        | 15005.07                | 14984.71  | 15438.44 | 15142.74  |
| Intercultural operation     | 11456.11                | 12958.71  | 23106.85 | 15840.56  |
| Pest and disease management | 3001.02                 | 2996.94   | 11823.3  | 5940.42   |
| Harvesting and processing   | 20804.76                | 20643.73  | 20922.73 | 20790.41  |
| Land rent                   | 0                       | 6574.92   | 0        | 2191.64   |
| Others                      | 1500.5                  | 1498.47   | 2060.66  | 1686.54   |
| Total cost (Tk)             | 69259.29                | 77149.82  | 99989.75 | 82132.95  |
| Total production (mounds)   | 124.34                  | 135.71    | 155.68   | 138.57    |
| Total return (Tk)           | 87036.59                | 101778.96 | 121426.5 | 103414.01 |
| Net return (Tk)             | 17777.3                 | 24629.14  | 21436.75 | 21281.06  |
| BCR                         | 1.26                    | 1.32      | 1.21     | 1.26      |



It is found from Table 5 that majority of the respondents cultivated Brinjal (60%), Chilli (57.78%), Tomato (53.33%) and Red Amaranth (51.11%). They usually produce Brinjal, Chilli, Tomato and Bottle Gourd for commercial purpose whereas Spinach, Bean, and Red Amaranth are mainly cultivated for own consumption. Among the vegetables, Bean has the highest BCR value (2.15) compared to Spinach (2.43) and Chilli (1.92). Red amaranth has the lowest BCR value (1.31) compared to Potato (1.57) and Sweet gourd (1.59) because of high production cost and low market price. This finding supports the previous study of Hoque et al, 2014 [27].

### 3.3 Distribution Pattern of Crops and Homestead Forest Products

Crop and homestead forests are common features in rural Bangladesh. Crop and forests are described as a multi-storied vegetation of shrubs, bamboos, palms, and trees surrounding the homesteads that produce materials for a multitude of purposes, including fuel, shelter, structural materials, fruits and fodder, resins, and medicines [29]. This dual enterprise is a major source of income that play an important role in the economic life by supplying the bulk of food, timber, fruit other forest products in the market [30].

Results presented in Table 6 indicate a complex interaction between landholding size and disposal pattern of crop production where large farmers have the highest amount of crop

production rate (126328.57 Tk) than the small and medium sized farmers. Accordingly, large farmers also have the high cereal and vegetable production rate because of their large farm size. On the other hand, medium level farmers consumed the highest amount (33131.11Tk) from their own produces compare with the small (30582.58 Tk) and large (29514.29Tk) farmers. Medium class farmers consumed the highest amount of cereal crops, but large farmers consumed a large portion of their produced vegetables to meet up family requirements. Large farmers have the most upper net income from the crop production (96814.29 Tk) in both cereal and vegetable sector compared with the medium (50146.67 Tk) and small (9332.26 Tk) land holding farmers.

Small farmers sold only 21.77% and consumed the highest amount (78.23%) of their total produced crops. Medium class farmers sold 58.70% and consumed 41.50% whereas the large farmers consumed only 23.30% of entire crop they produced. However, the large farmers mainly produced crops for commercial purpose and sold 76.80% of their total produced crops (Fig. 2).

Small farmers used highest amount of cereal (80.91%) and vegetable crops (67.21%) for their household consumption compared with the medium farmers. But the large-scale farmer's sold a considerable portion of both cereal (69.60%) and vegetable (87.40%) crops than the small and medium class (Fig. 2).

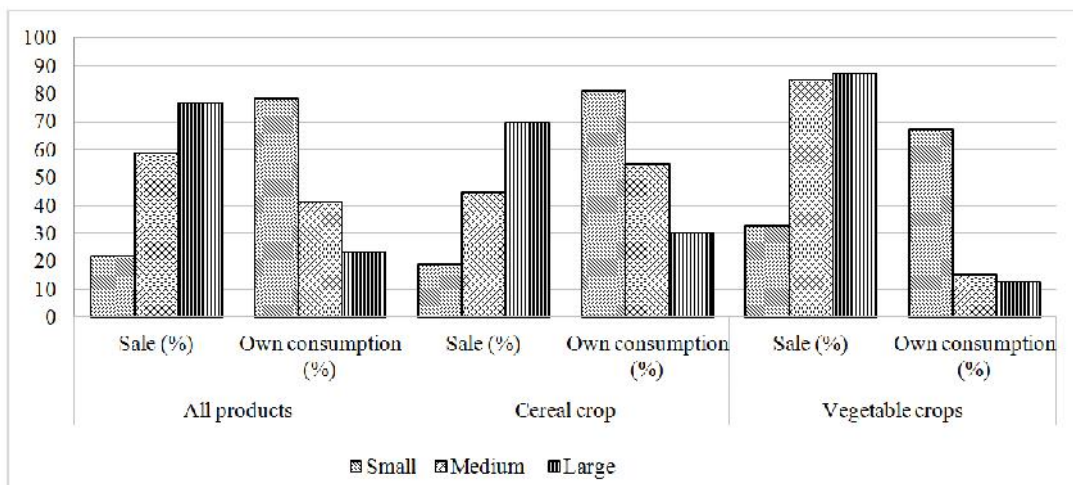


Fig. 2. Percentage distribution of crop products sale and own consumption

**Table 5. Profitability of different vegetable cultivation**

| Cost items                     | Name of the vegetables |               |                  |                   |                         |                        |                    |                    |                            |
|--------------------------------|------------------------|---------------|------------------|-------------------|-------------------------|------------------------|--------------------|--------------------|----------------------------|
|                                | Brinjal<br>(60%)       | Bean<br>(50%) | Chili<br>(57.7%) | Tomato<br>(53.3%) | Bottle gourd<br>(46.6%) | Sweet gourd<br>(33.3%) | Potato<br>(37.78%) | Spinach<br>(34.4%) | Red<br>amaranth<br>(51.1%) |
| Land preparation               | 18190.76               | 11096.97      | 9417.3           | 5714.2            | 6453                    | 11403.5                | 8597.8             | 6631.5             | 2798.5                     |
| Manure                         | 14749.26               | 10044.44      | 6470.19          | 6637              | 4926.1                  | 13377.1                | 9457.6             | 5913.15            | 6230                       |
| Fertilizer                     | 16715.83               | 10445         | 7860             | 6696.4            | 7069                    | 13370                  | 10912.7            | 7657.8             | 5527                       |
| Irrigation                     | 16715.83               | 8818.3        | 5135.5           | 8720.2            | 5049.2                  | 9868.4                 | 10978.8            | 7736.8             | 3100                       |
| Seed                           | 20403.15               | 14827.8       | 8252             | 10476             | 7093.6                  | 12938.6                | 14682.5            | 8052.6             | 5562.5                     |
| Intercultural operation        | 30481.81               | 11651.79      | 8875.3           | 15654.7           | 24044.33                | 20394.7                | 12335.4            | 11842.1            | 4876.8                     |
| Pest and disease<br>management | 18436.58               | 9805.48       | 7561             | 9360.1            | 5615.7                  | 15790                  | 11111.11           | 7563.1             | 4706.9                     |
| Harvesting and processing      | 39906.59               | 20950.26      | 8983.7           | 13839             | 11330.5                 | 19298.2                | 12857.4            | 10815.7            | 3358.2                     |
| Others                         | 8603.74                | -             | 5298             | 7232              | 5172.4                  | 9868.4                 | 8597.8             | 7342.1             | 2028.9                     |
| Total cost                     | 179203.5               | 96840         | 67852            | 84330.3           | 99753.6                 | 126315.8               | 99431.2            | 73555.2            | 38225.6                    |
| Production (mound)             | 562.25                 | 220.5038      | 55.725           | 234.1875          | 353.75                  | 251.535                | 661.7              | 218.09             | 122.782                    |
| Total return                   | 312192.7               | 254862        | 135501           | 162053            | 179803                  | 200877                 | 156350             | 157089             | 50210                      |
| Net return                     | 132989.2               | 158023        | 67649            | 77723             | 80050                   | 74562                  | 56918              | 32234.2            | 11954.2                    |
| BCR                            | 1.74                   | 2.63          | 2                | 1.92              | 1.8                     | 1.59                   | 1.57               | 2.14               | 1.31                       |

Numbers in parenthesis indicates percentage of farmers cultivating specific vegetables

**Table 6. Production, own consumption and income from crops (Tk.)**

| LHSC   | TCP       | CP       | VP       | TCOC     | COC      | VOC     | TCI      | CI       | VI       |
|--------|-----------|----------|----------|----------|----------|---------|----------|----------|----------|
| Small  | 39914.84  | 35225.81 | 4689.03  | 30582.58 | 27806.45 | 2776.13 | 9332.26  | 7419.35  | 1912.9   |
| Medium | 83277.78  | 55000    | 28277.78 | 33131.11 | 29288.89 | 3842.22 | 50146.67 | 25711.11 | 24435.56 |
| Large  | 126328.57 | 77714.29 | 48614.29 | 29514.29 | 23428.57 | 6085.71 | 96814.29 | 54285.71 | 42528.57 |
| All    | 75038.44  | 51722.22 | 23316.22 | 31690.67 | 27866.67 | 3824    | 43347.78 | 23855.56 | 19492.22 |

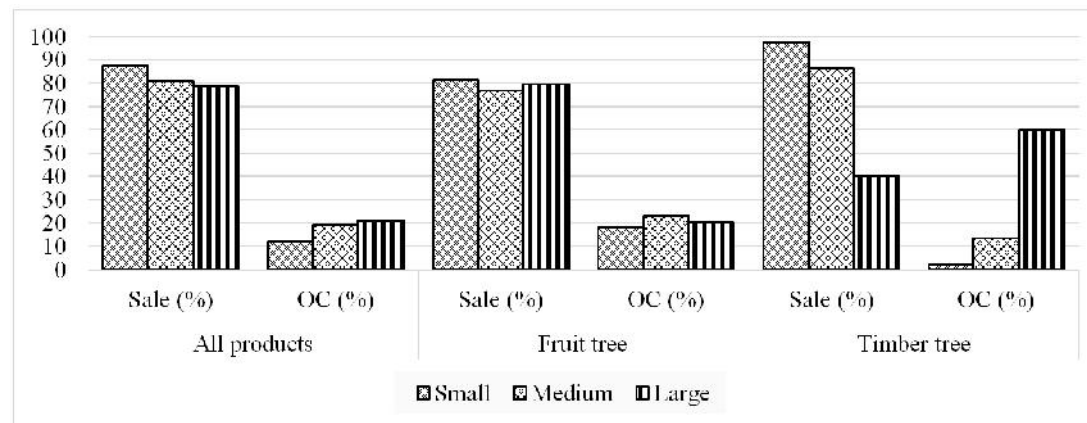
Key: LHSC=landholding size class, TCP=total crop production, CP=cereal production, VP=vegetable production, TCOC=total crop for own consumption, COC=cereal for own consumption, VOC=vegetable for own consumption, TCI=total crop income, CI=cereal income, VI= vegetable income



**Table 7. Production, own consumption and income from homestead forest (Tk.)**

| LHSC   | HFP      | FP       | TP       | THFOC   | FOC     | TOC     | THFI     | FI       | TI       |
|--------|----------|----------|----------|---------|---------|---------|----------|----------|----------|
| Small  | 27132.26 | 16229.03 | 10903.23 | 3425.81 | 3103.23 | 322.58  | 23706.45 | 13125.81 | 10580.65 |
| Medium | 33159.56 | 15270.67 | 17888.89 | 6831.78 | 3631.78 | 3200    | 26327.78 | 11638.89 | 14688.89 |
| Large  | 26321.86 | 18893.29 | 7428.57  | 5492.86 | 3778.57 | 1714.29 | 20829    | 15114.71 | 5714.29  |
| All    | 30019.84 | 16164.29 | 13855.56 | 5450.33 | 3472.56 | 1977.78 | 24569.51 | 12691.73 | 11877.78 |

LHSC=landholding size class, HFP = homestead forest production, FP = fruit production, TP = timber production, THFOC = total homestead forest for own consumption, FOC = fruit own consumption TOC = timber own consumption, THFI = total homestead forest income, FI = income from fruit, TI = Income from timber



**Fig. 3. Percentage distribution of homestead forest products sale and own consumption**

The overall sale and consumption rate of their produces was 48.80% and 51.20%, respectively. Due to small farm size and large family size, around half of the total produced cereal and vegetable crops were used for household consumption (Fig. 2). Mainly the large farmers and few medium class farmers cultivated crops and vegetables for commercial purpose.

Results enclosed in Table 7 show that medium landholding farmers have a high number of forestry species have the highest production (33159.56 Tk) from the forestry sector. Large farmers have the highest fruit production rate compare to medium and small farmers, but medium level farmers mainly plant timber species and earn a large amount (17888.89Tk) of money per year. Medium and large farmers use a high amount of forestry product for their use compare with the small farmers. They use the fruit for their consumption and timber for different household works, but the small or poor farmers sell almost everything of the forestry products for extra money. Medium class farmers get highest net income (26327.78Tk) compared with the small class farmers (23706.45 Tk). Small farmers earn around 13000Tk from the timber, and medium farmers earn around 15000 Tk from the fruit trees.

Homestead forestry mainly deals with the fruits and timber production and their distribution. Percentage of sale and own consumption from Fig. 3 indicates that small farmers sold highest amount (87.67%) of forestry product they produce in their homestead area compare with the medium (80.92%) and large size (78.82%) farmers. Small farmers also sold the high amount of fruits (81.63%) and timbers (97.70%) for earning extra money and improve their livelihood status. Medium and large class farmers also sold above 75% of their total produced forestry products. Overall, more than 80% of the forestry products were sold in the market for better economic life.

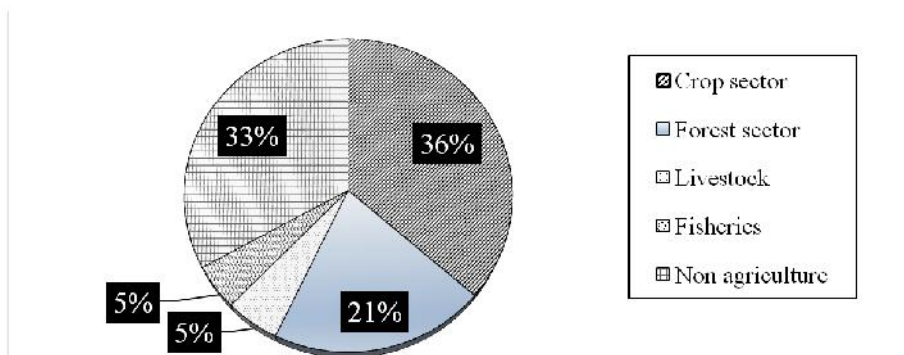
### 3.4 Annual Family Income

Money is the most powerful, influential and potential component that determines the level of status of an individual to the society. It is well known that the higher is the income of a family, the higher will be the scope to lead better livelihoods.

As shown in Table 8, the farmers having small farm size mainly depend on non-agricultural sectors like service or foreign income. But they also earn a good amount of profit around 23000 Tk per year from the forest sector. Medium and large farm size holding farmers mainly depend on crop and forestry sector.

**Table 8. Average annual income from different sectors across land holding size classes**

| LHSC   | Total Annual income (Tk.) | Crop sector | Forest sector | Livestock | Fisheries | Non agriculture |
|--------|---------------------------|-------------|---------------|-----------|-----------|-----------------|
| Small  | 134425.81                 | 9332.26     | 23706.45      | 10580.65  | 5967.74   | 84838.71        |
| Medium | 93696.67                  | 50146.67    | 26327.78      | 3888.89   | 5555.56   | 7777.78         |
| Large  | 166214.71                 | 96814.29    | 20829         | 3928.57   | 4642.86   | 40000           |
| All    | 119006.18                 | 43347.78    | 24569.51      | 6200      | 5555.56   | 39333.33        |



**Fig. 4. Comparative annual income from different sector**

Information displayed on Fig. 4 show that around 36% of the total annual income came from the crop sector whereas 33% comes from the non-agricultural sector. Forestry sector also has a significant contribution to the annual income of the respondents which is around 21% of the total annual income. Livestock and fisheries sector jointly contribute around 10% of the total family income of the farmers. It may be concluded that crop, non-agriculture, and forests are the dominant income sources of the respondents. Average income from homestead forest in entire study area was found Tk. 24569 is lower than Tk. 39490 in Cox's Bazar [7] and much higher than Tk. 3850 in south-western region of Bangladesh [6].

### 3.5 Contribution of Crops and Homestead Forests Production to the Household Economy

Agriculture has been associated with the production of essential food crops. At present, agriculture above and beyond farming includes forestry, dairy, fruit cultivation, poultry, bee keeping, mushroom, arbitrary, etc. Crop production and homestead forests play a critical role in the entire life of a given economy. Crop production is the backbone of the economic system and employs many people it contributes to economic development. As a result, the national income level, as well as people's standard of living, is improved. The fast rate of growth in crop and forestry sector offers progressive outlook as well as increased

motivation for development. Hence, it aids to create a pleasant atmosphere for the overall economic development of a country. Therefore, economic development relies on the crop production and homestead forests growth rate.

The average annual value of gross production of crop and homestead forest is 43347.78 Tk and 24569.51 Tk per household. The overall contribution of crop and homestead forest income to average household income is 36.42% and 20.65% (Table 9). Large category farmers received the highest crop income (58.25%), whereas small farmers received the minimum crop income (6.94%). Medium category farmers received the highest forest income (28.09%), whereas large category received the minimum forest income (12.53%) (Table 9). These findings show that crop sector is the main source of income and homestead forestry is a more profitable option than other land-use systems, and the diverse species composition of homestead forests leads to higher gross production on a per hectare basis than other monocultures.

Results contained in Table 10 hint that crop sector has contributed 36.42 percent of annual family income whereas 20.65 percent has contributed to homestead forest production. Calculated 't' value was found 4.74\*\* at 1% level of significance which indicates that there is a significant difference between crop and homestead forest production to contribute to annual family income.

**Table 9. Contribution of crop and homestead forest production to household economy**

| LHSC    | Total Annual income (Tk.) | Contribution of crop sector to annual income (%) | Contribution of forest sector to annual income (%) |
|---------|---------------------------|--|--|
| Small   | 134425.81                 | 6.94   | 17.64  |
| Medium  | 93696.67                  | 53.52  | 28.09  |
| Large   | 166214.71                 | 58.25  | 12.53  |
| All     | 119006.18                 | 36.42  | 20.65  |
| F-value | 8.812**                   | 78.81**  | 4.51**   |

LHSC=landholding size class; \*\* indicate 'F' value significant at 1% level of significance

**Table 10. Differences between crops and homestead forests contribution to farm economy**

| Sector             | Mean  | SD    | t-value | Sig. (2-tailed) |
|--------------------|-------|-------|---------|-----------------|
| Crops              | 36.42 | 28.35 | 4.74    | .000**          |
| Homestead forestry | 20.65 | 7.93  |         |                 |

\*\* indicate 't' value significant at 1% level of significance

**Table 11. Relationship between crop income and socio-economic characteristics**

| Socio-economic characters | Category         | Crop income (Tk.) category |             |           |           | Chi-Square | Sig. (2-sided)     |
|---------------------------|------------------|----------------------------|-------------|-----------|-----------|------------|--------------------|
|                           |                  | <25000                     | 25000-50000 | >50000    | Total     |            |                    |
| Farm size                 | Small            | 31(100)                    | -           | -         | 31(100)   | 65.969     | .000**             |
|                           | Medium           | 8 (17.8)                   | 4 (8.9)     | 33 (73.3) | 45 (100)  |            |                    |
|                           | Large            | -                          | -           | 14 (100)  | 14 (100)  |            |                    |
|                           | Total            | 39 (43.3)                  | 4 (4.4)     | 47 (52.2) | 90 (100)  |            |                    |
| Education                 | Primary          | 8(17.0)                    | 4(8.5)      | 35(74.5)  | 47(100.0) | 30.991     | .000**             |
|                           | Secondary        | 25(67.6)                   | -           | 12(32.4)  | 37(100.0) |            |                    |
|                           | Higher secondary | 6(100.0)                   | -           | -         | 6(100.0)  |            |                    |
|                           | Total            | 39(43.3)                   | 4(4.4)      | 47(52.2)  | 90(100.0) |            |                    |
| Family size               | Small            | 11(52.4)                   | -           | 10(47.6)  | 21(100.0) | 4.533      | .339 <sup>NS</sup> |
|                           | Medium           | 19(36.5)                   | 4(7.7)      | 29(55.8)  | 52(100.0) |            |                    |
|                           | Large            | 9(52.9)                    | -           | 8(47.1)   | 17(100.0) |            |                    |
|                           | Total            | 39(43.3)                   | 4(4.4)      | 47(52.2)  | 90(100.0) |            |                    |
| Farming experience        | Short            | 5(100.0)                   | -           | -         | 5(100.0)  | 12.69      | .013**             |
|                           | Moderate         | 19(51.4)                   | -           | 18(48.6)  | 37(100.0) |            |                    |
|                           | Long             | 15(31.2)                   | 4(8.3)      | 29(60.4)  | 48(100.0) |            |                    |
|                           | Total            | 39(43.3)                   | 4(4.4)      | 47(52.2)  | 90(100.0) |            |                    |
| Age                       | Young            | 6(66.7)                    | -           | 3(33.3)   | 9(100.0)  | 10.151     | .038*              |
|                           | Middle           | 16(61.5)                   | -           | 1(38.5)   | 26(100.0) |            |                    |
|                           | Old              | 17(30.9)                   | 4(7.3)      | 34(61.8)  | 55(100.0) |            |                    |
|                           | Total            | 39(43.3)                   | 4(4.4)      | 47(52.2)  | 90(100.0) |            |                    |

\* & \*\* indicates Chi-square value significant at 5% and 1% level of significance; NS= Non Significant

### 3.6 Relationships between Crop Income and Socio-economic Characteristics

The total crop production and total income from the crop sector sometimes influenced by a range of socio-economic factors like farm size, education, family size, farming experience, and age. These socio-economic factors also have a great impact on the livelihood status of the respondents. The relationship between socio-economic characteristics and income from crop production has been presented in Table 11.

Results presented in Table 11 indicate that there is a positive relationship between the farm size and income from the crop sector. Around 50% of the farmers belong to the medium class and mainly depend on crop production for their livelihood. In that village, 34.4% farmers had small farm size and received less than Tk. 25000 as yearly incomes from crop sector. Among the medium class farmers, 70.2% respondent has more than 50,000 Tk. Incomes per year from the crop sector. Among the respondents, only 15.6% farmers have large farm size and have more than 50,000 Tk. Profits from crop sector. It may conclude that there is a trend of increasing

income with increasing farm size, and significantly more numbers of higher income category farmers were under medium and large farm size category. Education, farming experience and age also shows a positive significant relation with income from crop production. It implies that with increasing value of these variables the income from crop production will be increased. On the other hand, family size shows a non-significant relationship with income from crop production. More than fifty percent of the respondent has the medium sized family and mainly depend on crop sector for their livelihood compared with the small family sized farmers. Only 18.9% of the respondents have large family size and have the lowest rate of income from the crop sector. Findings of this study supports the earlier study [31,27] with some exceptions.

### 3.7 Relationship between Forest Income and Socio-economic Characteristics

Homestead forest production has a close relationship with the socio-economic status of a farm household as significant part of the management has performed by household members. Chi-squared tests of independence were computed to test the relationships

**Table 12. Relationship between forest income and socio-economic characteristics**

| Socio economic characters | Category         | Forest income (Tk.) category |             |          |           | Chi-Square | Sig. (2-sided)     |
|---------------------------|------------------|------------------------------|-------------|----------|-----------|------------|--------------------|
|                           |                  | <25000                       | 25000-50000 | >50000   | Total     |            |                    |
| Farm size                 | Small            | 6(19.4)                      | 15(48.4)    | 10(32.3) | 31(100.0) | 0.673      | .955 <sup>NS</sup> |
|                           | Medium           | 9(20.0)                      | 23(51.1)    | 13(28.9) | 45(100.0) |            |                    |
|                           | Large            | 4(28.6)                      | 6(42.9)     | 4(28.6)  | 14(100.0) |            |                    |
|                           | Total            | 19(21.1)                     | 44(48.9)    | 27(30.0) | 90(100.0) |            |                    |
| Education                 | Primary          | 5(10.6)                      | 29(61.7)    | 13(27.7) | 47(100.0) | 20.607     | .000**             |
|                           | Secondary        | 14(37.8)                     | 9(24.3)     | 14(37.8) | 37(100.0) |            |                    |
|                           | Higher secondary | -                            | 6(100.0)    | -        | 6(100.0)  |            |                    |
| Family size               | Total            | 19(21.1)                     | 44(48.9)    | 27(30.0) | 90(100.0) | 22.73      | .000**             |
|                           | Small            | 0                            | 16(76.2)    | 5(23.8)  | 21(100.0) |            |                    |
|                           | Medium           | 11(21.2)                     | 19(36.5)    | 22(42.3) | 52(100.0) |            |                    |
|                           | Large            | 8(47.1)                      | 9(52.9)     | -        | 17(100.0) |            |                    |
| Farming experience        | Total            | 19(21.1)                     | 44(48.9)    | 27(30.0) | 90(100.0) | 18.915     | .001**             |
|                           | Short            | -                            | 5(100.0)    | -        | 5(100.0)  |            |                    |
|                           | Moderate         | 15(40.5)                     | 14(37.8)    | 8(21.6)  | 37(100.0) |            |                    |
| Age                       | Long             | 4(8.3)                       | 25(52.1)    | 19(39.6) | 48(100.0) | 5.149      | .272 <sup>NS</sup> |
|                           | Total            | 19(21.1)                     | 44(48.9)    | 27(30.0) | 90(100.0) |            |                    |
|                           | Young            | 1(11.1)                      | 4(44.4)     | 4(44.4)  | 9(100.0)  |            |                    |
|                           | Middle           | 9(34.6)                      | 12(46.2)    | 5(19.2)  | 26(100.0) |            |                    |
| Age                       | Old              | 9(16.4)                      | 28(50.9)    | 18(32.7) | 55(100.0) |            |                    |
|                           | Total            | 19(21.1)                     | 44(48.9)    | 27(30.0) | 90(100.0) |            |                    |

\*\* indicate Chi-square value significant at 1% level of significance; NS= Non Significant

of socio-economic factors and income from forest production (Table 12). These findings may imply to improved management of homestead forests, causing an increase in forest production and forest income.

Information presented in Table 12 indicate that education, family size, farming experience shows a positive significant relationship with income from forest production. It is usual that educated person always conscious about the nutritious food and sound environment that's why they might stress on planting more forest trees around there household and received more income from the forest products. Homestead forest production activities mainly done by the family members. Hence, a family having more members might plant more trees on their homestead areas and received more income. Farm size shows a non-significant relationship with income from forest production. It implies that income from forestry doesn't depend on farm size of the respondents. Practically every farmer has their homestead area, and they plant some forest trees either fruit or timber trees for their consumption as well as income by selling extra products after meeting family consumption. Age also shows a non-significant relationship with forest income. Mainly the old and middle age farmers have high forest production, and forest income compares with the young aged farmers. Influences of socio-economic factors like education, family size, farm size, age and farming experience were found in many other Asian countries with some exceptions [32,33,34].

#### 4. CONCLUSION

Findings of the present study reveal that homestead forest cultivation has huge potential to contribute to household economy and improve livelihoods of the rural people. However, it requires policy to encourage farmers, especially those with marginal and small landholdings who represent the vast majority of villagers, to diversify their crops by selecting a judicious mixture of crop, fruit, timber and vegetable species. Apart from that, modeling research may be encouraged for selection of appropriate mixtures, species optimization and economic potential of rare species. Also, maximum of the unused homestead land can be taken under crop and homestead forest production. To do so, attention may be given to nearby wastelands and uplands that usually surround homesteads. It is vital that extension education programs need to be imperative, especially targeting farming

families who depend most on crop and forest income and usually lack educational opportunities. Furthermore, crop and forest policy should address the concerns of the farmers in different landholding classes and focus on their specific requirements to enhance sustainable crop and forest management.

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#### COMPETING INTERESTS

Authors have declared that no competing interests exist.

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