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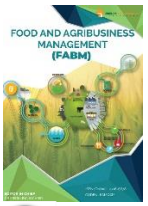

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REVIEW ARTICLE

PROFITABILITY ANALYSIS OF BORO RICE FARMING: THE CASE OF NAOGAON DISTRICT OF BANGLADESH

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ABSTRACT

Agriculture is one of the major sectors in the economy of Bangladesh, because of its contribution to Gross Domestic Product (GDP), employment, and its interconnection with other sectors of the economy. This study was conducted to examine the measurement of farm profitability in Boro rice cultivation in the Naogaon district of Bangladesh. A total of 45 farmers were selected randomly from 4 villages in Naogaon District. Data were collected through a well-structured questionnaire with a simple random sampling technique. Descriptive statistics, cost-benefit analysis, and Cobb-Douglas production function were used to analyze this study. The Ordinary Least Square (OLS) is applied to the data set of all farmers. Empirical results obtained from production function analysis considering hired labor, pesticides, planting, harvest and transport, and machinery costs positively affect Boro rice production while seed, fertilizer, plowing, and irrigation cost negatively affect Boro rice production. It is found that Boro rice cultivation is profitable in the study area. The average per bigha net return of Boro farming was Tk. 1694.11. The study also found some challenges to cultivate Boro rice in the study area. In the end, the study suggests some policies to enhance profitability in Boro rice cultivation in the Naogaon district and overcome the challenges.

KEYWORDS

Boro rice; Profitability; Socio-economic conditions; Bangladesh; Agriculture

1. INTRODUCTION

Bangladesh is predominantly an agrarian country that has scarce land resources and a higher population density. With over 2.2% of the world's population, Bangladesh is the eighth most populous nation. According to the World Bank Data 2021 of Bangladesh, the country's population is over 169 million and the population is still rising by 1.1% every year. Agriculture is the backbone of the Bangladesh economy. Agriculture is the single largest producing sector of the economy since it contributes around 14.23% of the Gross Domestic Product (GDP) and provides employment for around 40.60% of the total labor force of the country (BBS, 2019). Bangladesh's farmland has been decreasing at the rate of 0.19 percent every year according to the Agriculture Census-2019 report. According to the census conducted by the Bangladesh Bureau of Statistics the country's net arable land has declined to 18.68 million acres in 2019 from 19.09 million in 2008 (BBS, 2019). However, there has been remarkable progress in food production over the last three and a half decades in Bangladesh despite the high pressure of the population on land and other natural resources.

The agriculture sector of Bangladesh is mainly divided into four sub-sectors viz. crop, fisheries, livestock, and forestry. Rice, jute, tea, wheat, meat, milk, poultry, etc. are the major agricultural products. Among all the crops, rice is the strength of Bangladesh's agriculture. The cultivation of rice is one of the major sources of income for most farmers and it also provides employment opportunities to landless farmers. Bangladesh is third ranked country in the world in rice production for fourth consecutive year and it has a projected output of 38.4 million tonnes. The Food and Agriculture Organisation (FAO) revealed the ranking of rice producing countries in its report titled 'Food Outlook-June 2022'.

Rice is one of the prevalent cereal dietary items of almost 15 million farm families in Bangladesh (BBS, 2015). It provides half of the agricultural GDP, one-sixth of rural household income, half of the rural employment (nearly 48%), two-thirds of per capita daily calorie intake, and half of per capita daily protein intake (Yeasmin et al., 2019). In Bangladesh, three varieties of rice, namely Aus, Boro, and Aman, are cultivated throughout the year as Aus, Aman, or Boro. Aman (broadcast and transplanted) is generally cultivated in December to January, Boro in March to May, and Aus in July to August cropping seasons.

Bangladesh has a long history of rice cultivation. Despite a loss in actual total arable land, the nation has already made tremendous strides in maintaining rice output over the past three decades through the adoption of modern varieties (MVs). It is commonly known that rice plays a significant part in Bangladesh's economy. Rice is grown throughout the country except in the southeastern hilly areas. The agro-climatic conditions of the country are suitable for growing rice year-round. However, the country's average rice yield is much lower (2.94 t/ha) than that of other rice-farming countries (BBS, 2012).

Rice is grown on about 24.21 million acres which have remained almost stable over the past three decades. About 81 percent of the total cropped area and over 80 percent of the total irrigated area is planted for rice (BBS, 2015). Singly around 96% share of total cereal supply derives from rice (Alam and Islam, 2013, p. 257).

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Table 1.1: Nutrients from Per 100 gm Rice	
Composition	**Rice**
Calories (kcal)	325
Moisture content (percent)	13.3
Carbohydrate (percent)	79
Protein (gm)	6.4
Fat (gm)	0.4
β-carotene (µg)	0
Vit-B (mg)	0
Thiamine	0.21
Riboflavin	0.09
Vit-C (mg)	0
Ca (mg)	9
Fe (mg)	1

Source: Wahed and Anjan (2008); Zaved (2018)

The extension services department deserved credit for encouraging the farmers to adopt modern production technologies which have enabled Bangladesh to achieve nearly self-sufficient status in rice production. The rapid population expansion and rapidly declining per-person land area assert a challenge to maintaining a sustainable level of output in the ensuing decades. Therefore, rice cultivation growth rate has to be increased with increasingly fewer resources in land, labor, water and chemicals (Alam and Islam, 2013).

Rice is the paramount food for about 169 million people in the country. Population increases 2 million per year, and if the growth rate continues to increase at this rate, the total population of the country will reach 238 million by 2050. Rice production needs to increase to feed this ever-increasing population. At the same time, the total arable land is decreasing at a rate of more than one percent per year owing to the construction of industries, houses, factories, roads, and highways. On the other hand, because of the effects of urbanization, food patterns tend to change, demanding the production of new crops that must share land used for rice farming (Shelley et al., 2016).

Therefore, the yield of rice per rice-growing area needs to be increased. Additionally, due to climate change, agriculture is experiencing a variety of challenging circumstances, including drought, flood, salt, extremely high temperatures, and reduced soil fertility. In these circumstances, effective policies should be implemented to increase rice production in an efficient manner for the food and nutritional security of this highly populated economy of Bangladesh. For these reasons the purpose of our study is to measure profitability in Boro rice cultivation.

In the past, there was no distinguished study on the production of Boro rice with the factors affecting the profitability of Boro rice farming of Bangladesh in different years. The findings of the study are likely to be helpful to the researchers and policymakers in the formulation of policies regarding the efficient production of rice in all categories of the farmer of Bangladesh.

The main objectives of this study are-

- To assess the present socio-economic characteristics of Boro rice farmers
- To measure the profitability of Boro rice farming
- To determine the key factors affecting the gross return of Boro rice farming
- To identify the problems and challenges that Boro rice farmers faced in the study area
- To recommend some policies for the improvement of Boro rice farming

2. Literature Review

Literature review can be defined as a thorough summary of earlier empirical studies on a subject. This review examines scholarly journal articles, books, conference papers, and other sources that are relevant to a particular field of study. An appropriate research problem, theoretical framework, and research methodology can all be defined by a thorough literature review. To be more precise, a review of literature serves to conduct the current study within the body of the relevant literature and to provide context for the reader.

There is a large amount of literature addressing agriculture and rice cultivation. To understand the research, it is necessary to review the literature for the researcher, especially as a beginner. There are many studies done mainly on rice cultivation and its productivity. Some studies have mentioned the existing and emerging challenges of rice farming all over the economy of Bangladesh. A literature review works as a road map and provides the foundation for the conceptual framework. Most recent publications on rice farming have been discussed in the second section.

The conducted research in eleven districts namely (Comilla, et al., 2019). The data were collected from International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) under the Village Dynamics Studies in South Asia (VDSA) project as secondary data. They used a total of 280, 318, 365 and 349 sample farmers were selected for the years of 2009, 2010, 2011 and 2012, respectively and the selected farmers were categorized into marginal, small, medium and large categories. This study used descriptive statistics to measure the profitability of rice production. They found that rice production is profitable and small farmers earned higher profits compared to medium and large farmers. However, the return-cost (benefit-cost) ratio was decreasing during the period. The rice farmers require great concern on fertilizer costs, machinery costs, human labor costs, seed costs, and herbicides costs.

As a examined the factors which determine the profitability of rice farming in Bangladesh (Akter et al., 2019). This study utilized the multistage sampling technique to collect cross-sectional data from seven rice-producing districts in Bangladesh in 2016. It included a sample size of 140 respondents. Alongside the descriptive analysis of the socioeconomic variables of the selected respondents, the benefit-cost and functional profitability analysis of rice were performed as well. The study found that rice production is profitable in Bangladesh because the cost-benefit analysis expresses that the cost of production was lower than the net return or net profit in the study areas. However, the researcher found that large farmers earn more profit in rice farming than small and medium farmers. Finally, this study also revealed that power tiller, hired labor, and fertilizer cost are significant determinants to analyse the profitability of rice farming in the study areas.

It is examined the cost and revenue of rice production in two districts namely, Bogura and Gaibandha in Bangladesh. They used primary data to accomplish the study. Farmer's production efficiency was analyzed by using net farm incomes and benefit-cost ratio (BCR) considering the variable cost and total cost. The results showed that the total cost of rice production was higher in Bogura (Tk. 44,555.3/acre) compared to Gaibandha (Tk. 42,199.5/acre) but net revenue was higher in Gaibandha (Tk. 32992.2/acre) than Bogura (Tk. 32475.9/acre). The results showed that paddy production was profitable in both areas. In Bogura district, BCR based on variable cost was 2.7 while BCR based on total cost was 1.7. In the Gaibandha district, BCR based on variable cost was 2.6 while BCR based on total cost was 1.8.

That are conducted a research study to examine profitability and productivity of rice production in selected coastal area of Satkhira district in Bangladesh. They used stratified random sampling method (Islam et al., 2017). This study used different simple statistical technique as well as Cobb-Douglas production function to reach the objectives of the study. The study found that the small farmers (Tk. 10292.89) got higher net revenue than the medium (Tk. 6894.39) and large (Tk. 4798.70) farmers per hectare, respectively. The benefit-cost ratio (BCR) for small, medium, and large farmers were respectively 1.38, 1.23, and 1.15. This study found that seed, fertilizer, human labor, power tiller, and irrigation have a significant impact on gross revenue. The main problems for rice cultivation in the research area were the lack of saline acceptable excellent quality seeds, high input costs, lower price of output, and natural disasters, despite the fact that rice production was profitable in the study area.

This carried out a study on the present scenarios, problems, and prospects of rice cultivation in Bangladesh. Bangladesh is self-sufficient in rice farming, yet the yield is still low (Shelley et al., 2016). Bangladesh is capable of increasing rice production and export, which can contribute to the national economy. Targeted breeding is very necessary to accommodate the diverse environments of Bangladesh. Rice production and nutrition will increase when more high-yielding, early maturing, drought-resistant, salt-tolerant, disease-resistant, submersion-resistant, cold-tolerant, high-temperature-tolerant varieties are created. In addition, suitable crop management policies will increase rice production.

The conducted research on farm size and profitability of rice farming under rising input costs (Mottaleb and Mohanty, 2015). The study found that, for both small and large farms, wages, chemical fertilizer, tilling and tilling costs increased more significantly in 2010 than in 2000; however, small farm households increasing rate was higher than the rate of large farm households increasing. The total cost of per acre rice production for small farm households increased more rapidly in 2010 than for large farm households. Because of that the profitability of per acre rice production for small farms decreased more than for large farms in 2010. This study expressed that the provision of basic technical support for small and marginal farmers, should be continued, for example, the development and dissemination of input-efficient high-yielding rice, such as rice with biological nitrogen fixation and C4 rice (rice with an efficient photosynthetic pathway like maize). The input-efficient high-yielding rice will need fewer inputs; thus, production costs will be lower. Improved yield can increase gross revenue and rice production will be profitable.

It has a evaluated the financial profitability of aromatic rice production and its impacts on farmers' livelihood in selected areas of the Tangail district (Nasrin, 2013). She took a sample size of 60 farmers from some selected areas. The relevant data were collected with a structured questionnaire through face-to-face interviews. The result of the descriptive analysis revealed that the average farmer's family size was 4.9. The estimated total cost of aromatic rice farming was Tk. 51299.5 per hectare. The average gross revenue per hectare of aromatic rice was Tk. 82666.4. The gross margin for aromatic rice was Tk. 37269.6 per hectare. Thus, the net return was estimated at Tk. 31366.9 for aromatic rice The return-cost (benefit-cost) ratio of aromatic rice production was 1.61 which implies that the aromatic rice production was profitable in the study areas. Moreover, the result of the partial budget analysis revealed that aromatic rice production has higher income and better livelihood than those who are producing non-aromatic rice in the study area. The study found that average annual income of aromatic rice farming in the study areas was Tk. 177606.6. Close to 60 percent of aromatic rice farmers in the study areas are enjoying good health conditions. The researcher found that total human labour, seed, fertilizer, power tiller and irrigation had a significant impact, while insecticides had an insignificant impact on the per hectare rice yield.

The carried out a research study on the long-term assessment of the rice production scenario in Bangladesh. After its independence, the Bangladesh Rice Research Institute (BRRI) significantly contributed to the recent development of 59 high-yielding rice varieties (HYVs) suitable for various production ecologies (Alam and Islam, 2013). Although the progress in variety development was slower during the seventies and eighties, it was triggered in the later decades and a quantum of achievement was made after 2000. The rate of varietal development was almost double in the last quarter of the decade compared to that made in the seventies From 1972 to 1980, the share of modern rice in total production of rice was only 29%, but by the year 1985, it increased to 41% and at the end of 2010, it jumped to 90% which implies a highly impressive contribution to the diffusion of modern rice technologies in the overall supply of cereal foods in the country.

To be conducted a study to examine the determinants of technical efficiency in rice farming in Bangladesh. This study is based on Primary data. Data were collected from twelve villages in the north-central region and north-western region of Bangladesh by using multi-stage random sampling (Bäckman et al., 2011). The technical efficiency of rice farming was very variable, ranging from 0.16 to 0.94 with a mean technical efficiency of 0.83, which suggests significant output increases with current resources and technologies. Age and educational level of family heads, the availability of off-farm incomes, land fragmentation, accessibility to microfinance, extension visits, and regional variance were shown to be the main causes of efficiency differences among the farm households surveyed. In order to improve technical efficiency, the report suggests solutions include enhanced extension services and farmer training programs, access to agricultural microfinance, minimizing land fragmentation, and boosting farmers' educational levels.

carried out a study of the profit efficiency among Bangladesh rice farmers (Rahman, 2003). In this study, he provided a direct measure of the production efficiency of Bangladeshi rice farmers using a stochastic profit frontier and inefficiency effects model. The data were collected from 21 villages in three agro-ecological regions of Bangladesh. The result of the study showed that modern rice cultivation has high level of inefficiency. The average level of profit efficiency is 77% which suggests that an estimated 23% of the profit is lost due to a combination of both technical and allocative inefficiency in modern rice production.

It's the carried out a study to evaluate the economic and financial profitability of aromatic and fine rice production in Bangladesh (Anik and Talukder, 2002). This study used primary and secondary data for research purposes. They took a sample size of 100 farmers from the Dinajpur and Sherpur districts. The study also mentioned some problems faced by the farmers in producing aromatic and fine rice. Pajam had the highest yield per hectare among the aromatic and fine rice varieties. However, because of the high market price and low production cost of aromatic rice varieties, they had higher per-hectare net returns. Domestic Resource Cost (DRC) ratios expressed that the Nizershail variety was only marginally unprofitable. The researchers found that Bangladesh had a comparative advantage in the production of aromatic and fine rice from both an export and import substitution point of view. The researchers also identified a few challenges faced by farmers in growing aromatic and fine rice.

We have reviewed about eleven works of literature relevant to our study. We found some empirical studies which suggest that small farmers earned higher profits compared to medium and large farmers, whereas some other studies suggest contradictory opinions. Most of the empirical studies agree that the productivity and profitability of rice farming depend on several factors such as seeds, fertilizer, pesticides, price of rice, etc. However, some of the researchers completely failed to show the impact of those determinants to measure the farm profitability of rice cultivation. Most of the researchers used primary data, some others used secondary data, and some of them used both primary and secondary data. This may be one of the reasons behind the contradictory results among them. From the methodological point of view, most of the studies could not use the econometric tools efficiently and effectively. Finally, there are several pieces of literature within the country, but very few pieces of literature are found within Naogaon District located in the northern part of Bangladesh and no study found within Atrai upazila. These areas are heavily dependent on rice farming. Boro rice is one of the most important crops of Atrai upazila of Naogaon District. We hardly find any separate study of Boro rice cultivation. So, our study is to analyze the profitability of Boro rice farming in Atrai upazila of Naogaon District.

3. Data Collection and Methodology

This section highlights a description of the data and research methodology which are used in our study. Research methodology is a process of prevailing how a researcher contemplates conducting their research. It involves data on what they're going to collect and where from, and also involves how it's being collected and analyzed. This section encompasses the selection of the study area, sample and sampling procedure, sources of data, types of data, specification of the model, and profitability analysis.

3.1 Selection of Study Area

The area that is selected for the study is Atrai upazila, located in Naogaon district.

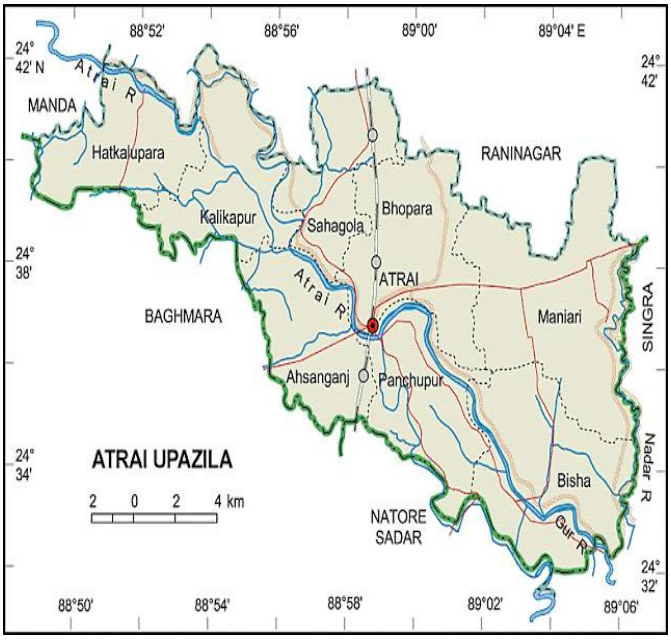


Figure 3.1: Maps of the Study Areas (Source: Maps of Bangladesh)

There are eleven upazilas in the Naogaon district, but Atrai upazila is mostly dependent on rice farming than any other upazilas. That is why we have selected this area as the study area.

3.2 Sample and Sampling Technique

The research is conducted with a sample size of 45 respondents. These respondents are chosen from four different villages of Atrai upazila, namely Maria, Nouduli, Boropukuria, and Maniari. Kothari and Garg (2014) define sampling as the process of selecting representative elements from a given population that will form the sample. We used simple random probability sampling for the convenience of the study.

3.3 Sources of Data

The source of data is the location where the data that is being used originates from. We used both primary and secondary data in conducting the research study

3.3.1 Primary Data

This study is mainly survey research, then it mostly depends on primary data. Primary data were collected from those farmers who cultivate Boro rice through a face-to-face interview using a predefined questionnaire.

3.3.2 Secondary Data

To conduct good research, the researcher has used secondary data as well. However, the result of the research study mainly relies on primary data that were gathered from a face-to-face interview. The secondary data were collected from books, journal articles, conference papers, thesis papers, and various published and unpublished research materials.

3.4 Specification of the Model

We used descriptive statistics to measure the profitability of Boro rice production. The Cobb-Douglas production function was used to explore the relationship between production and input. This function is very famous on both theoretical and econometric grounds.

The following model is used for the study:

$$Y_i = \beta_0 X_{1i}^{\beta 1} X_{2i}^{\beta 2} X_{3i}^{b3\beta 3} X_{4i}^{\beta 4} X_{5i}^{\beta 5} X_{6i}^{\beta 6} X_{7i}^{\beta 7} X_{8i}^{\beta 8} X_{9i}^{\beta 9} e^{ui} \ldots\ldots\ldots\ldots \quad (1)$$

This equation can be linearized in the logarithmic form as below:

$$\ln Y_i = \ln\beta_0 + \beta \ln X_{1i} + \beta_2 \ln X_{2i} + \beta_3 \ln X_{3i} + \beta_4 \ln X_{4i} + \beta_5 \ln X_{5i} + \beta_6 \ln X_{6i} + \beta_7 \ln X_{7i} + \beta_8 \ln X_{8i} + \beta_9 \ln X_{9i} + U_i \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (2)$$

Where,

Y = Gross return (Tk./bigha);

X_1 = Plowing cost (Tk./bigha);

X_2 = Hired labor cost (Tk./bigha);

X_3 = Irrigation cost (Tk./bigha);

X_4 = Seed cost (Tk./bigha);

X_5 = Planting cost (tk./bigha);

X_6 = Fertilizer cost (tk./bigha);

X_7 = Pesticides cost (tk./bigha);

X_8 = Machinery cost (tk./bigha);

X_9 = Harvest & transportation cost (tk/bigha);

ln = Natural logarithm

β = Constant/Intercept term;

u = error/disturbance term;

$\beta_1, \beta_2 \ldots\ldots\ldots\ldots \beta_9$ = production coefficients of the respective variable

By using Ordinary Least Square (OLS) method, we can estimate different parameters of this model. Definitions of the variables used are briefly discussed below:

Plowing Cost: Plowing cost means land preparation cost. In the study area, farmers use power tillers and tractors for plowing. Farmers need to hire a power tiller or tractor to cultivate, and they need to pay the owner of the power tiller or tractor. These pays refer to as plowing costs.

Hired Labor Cost: In the study, hired labor cost is the initial hired labor cost that farmers need to pay to their hired labor during the period of land preparation.

Irrigation Cost: In the study area, farmers use both Shallow Tube Wells (STWs) and Deep Tube Wells (DTWs) for irrigation. Most of the farmers use Motorised Pumps as a tool for irrigation. The money they need to pay for this is called irrigation.

Seed Cost: Seed cost is the price of seed that farmers used. In the study area, most of the farmers use local varieties of seed, and few of them use high-yielding varieties (HYVs).

Planting Cost: In the study, planting cost refers to the cost involved to plant paddy seedlings, mainly this cost goes to the hands of laborers who are being hired to plant paddy seedlings on the land.

Fertilizer Cost: In the study area, farmers use Urea, MOP, TSP, and DAP as fertilizer to cultivate Boro rice. Fertilizer cost is determined by the price of these fertilizers. Different farmers use different quantities of fertilizer input, so the fertilizer cost varies from farmer to farmer.

Pesticides Cost: Different farmers use different types of pesticides, depending mostly on the diseases of the rice. The price of those pesticides refers to pesticides cost. Pesticides cost varies farmer to farmer.

Machinery Cost: In the study, the cost of buying/hiring different machinery is referred to as machinery cost.

Harvest & Transport Cost: In the study, harvest and transport cost includes the cost of cutting and threshing the crop, as well as transporting the crop. This cost varies from area to area.

3.5 Method of Profitability Analysis

Cost-benefit (cost-return) analysis is the most popular method of measuring and comparing the profitability of different farmers. In the present study, the profitability of Boro rice production is calculated by the following formula-

$$\text{Net Return, NR} = \text{GR} - \text{TVC} - \text{TFC} \ldots\ldots\ldots\ldots\ldots \quad (3)$$

Where,

NR = Net return from Boro rice production (Tk/bigha);

GR = Gross return from Boro rice production (Tk/bigha);

TVC = Total variable cost (Tk/bigha);

TFC = Total fixed cost (Tk/bigha)

Definitions of these variables are discussed in below:

Gross Return (GR): The gross return or gross revenue is the sum of rice revenue and by-product or straw revenue from producing Boro rice.

Total Variable Cost (TVC): Total variable cost (TVC) is the sum of all the explanatory variables. The total variable cost (TVC) is equal to the sum of plowing cost, irrigation cost, hired labor cost, seed cost, planting cost, pesticides cost, harvest & transport cost, fertilizer cost, and machinery cost.

Total Fixed Cost (TFC): The total fixed cost includes both land use cost and family labor cost.

- **Land Use Cost:** Land use cost is the opportunity cost that occurs because of cultivating rice on the land. This is mainly rental cost which means a farmer would receive a certain amount of rent if he did not cultivate the land and lease it to other farmers.
- **Family Labor Cost:** Most of the farmers in the study area work on their own land, and other members of the family also work on their own land. This cost is referred to as family labor cost.

Total Cost (TC): The sum of total variable cost (TVC) and total fixed cost (TFC) is total cost (TC) in the present study. Mathematically-

$$\text{TC} = \text{TVC} + \text{TVC} \quad (4)$$

4. Data Analysis and Results

This section emphasizes data analysis and result discussion of this study. There are three major parts of this section. These parts are demographic characteristics of the respondents and their socio-economic conditions which are discussed in section 4.2, estimated results of Cobb-Douglas production function analysis, which is discussed in section 4.3, and

profitability analysis of Boro rice farming in the study area. Finally, this section ends by concluding the major findings.

4.1 Socio-economic and Demographic Characteristics

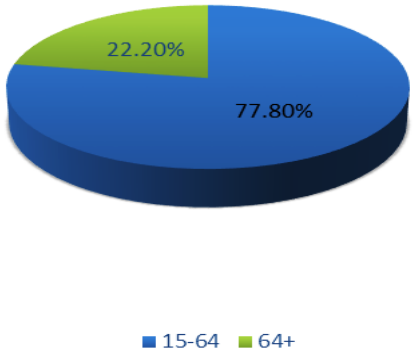
4.1.1 Distribution of Respondents by Age

Age of the respondents reflects as the demographic characteristics of the farmers.

Table 4.1: Age Distribution of the Farmers		
Age (in years)	**Frequency**	**Percentage**
0-14	0	0
15-64	35	77.8
64+	10	22.2
Total	45	100
Mean: 50.78; Minimum: 26; Maximum: 75; Median: 50.00; Mode: 45; Std. Dev.: 12.813;		

(Source: Author's Calculation based on Field Survey Data, 2023)

Table 4.1 depicts that no farmer belongs to the age group of 0-14 years, there are 35 farmers (77.8%) who belong to the age group of 15-64 years, and there are 10 farmers (22.2%) who belong to the age group of 64+ (65 and above). Therefore, most of the respondents of our study belong to the working-age population which implies the demographic dividend.



Source: Field Survey, 2023

Figure 4.1: Age Distribution of the Farmers

4.1.2 Distribution of Respondents by Gender

Table 4.2: Gender Distribution of the Farmers		
Gender	**Frequency**	**Percentage**
Male	45	100
Female	0	0
Total	45	100

(Source: Author's Calculation based on Field Survey Data, 2023)

Table 4.2 reflects that in the study area, the gender of all the farmers (100%) is male. That means there is no female farmer in the study area.

4.1.3 Distribution of Respondents by Religion

Table 4.3: Religion of the Farmers		
Religion	**Frequency**	**Percentage**
Islam	30	66.67
Hinduism	15	33.33
Christianity	0	0
Buddhism	0	0
Others	0	0
Total	45	100

(Source: Author's Calculation based on Field Survey Data, 2023)

Table 4.3 indicates that most of the farmers of our study area belong to the religion of Islam (66.7%), and some others belong to the religion of Hinduism (33.3%). There is no other farmer who belongs to any other religions.

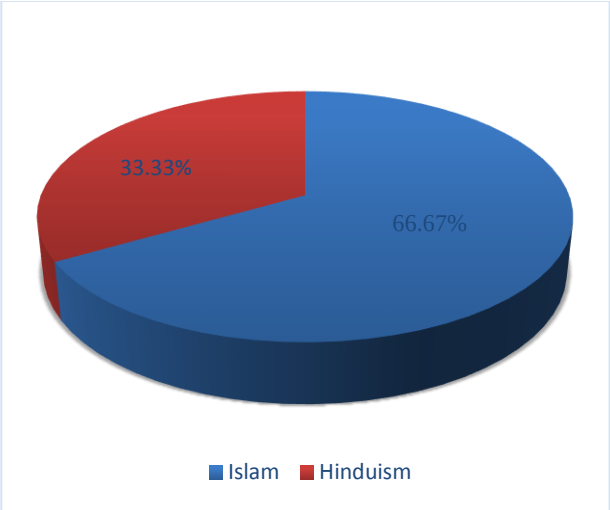


Figure 4.2: Distribution of the Farmers by Religion

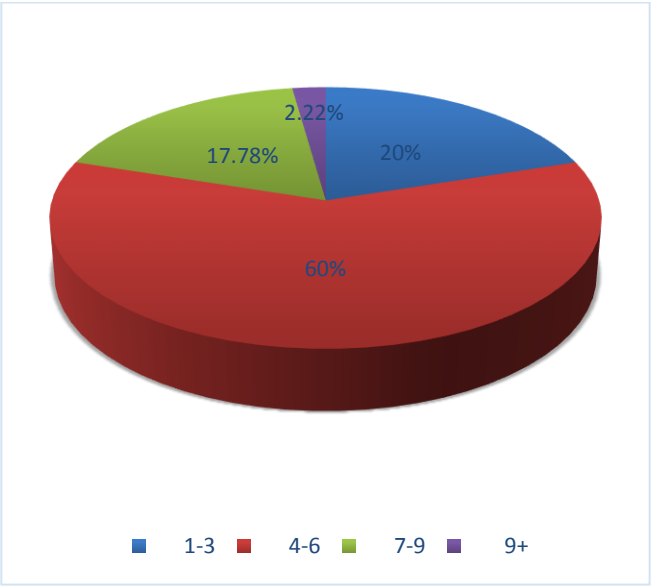
Source: Field Survey, 2023

4.1.4 Distribution of Respondents by Family Size

Table 4.4: Family Size Distribution of the Farmers		
Family Size	**Frequency**	**Percentage**
1-3	9	20
4-6	27	60
7-9	8	17.78
9+	1	2.22
Total	45	100
Mean: 5.13; Minimum: 2; Maximum: 10; Median: 5.00; Mode: 4; Std. Dev: 1.766;		

(**Source**: Author's Calculation based on Field Survey Data, 2023)

Table 4.4 indicates that most of the respondents (60%) belong to a family size of 4-6 members. 20% of respondents belong to a family size of 1-3 members, 17.78% of respondents belong to a family size of 7-9 members, and other 2.22% of respondents belong to a family size of 9+ (more than 9) members.



Source: Field Survey, 2023

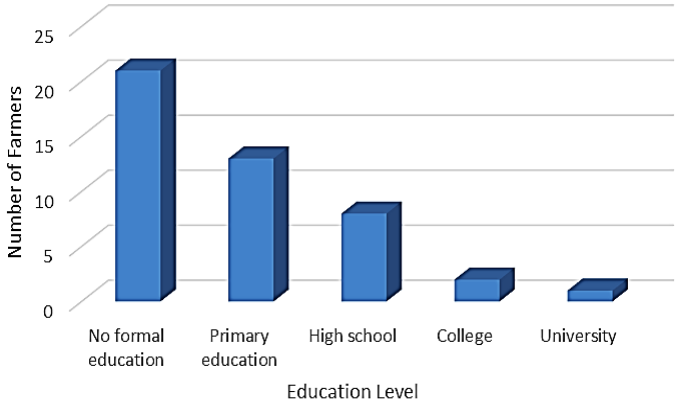
Figure 4.3: Family Size Distribution of the Farmers

4.1.5 Distribution of Respondents by Education Level

Table 4.5: Education Level of the Farmers		
Education Level	**Frequency**	**Percentage**
No formal education	21	46.7
Primary education	13	28.9
High school	8	17.8
College	2	4.4
University	1	2.2
Total	45	100

(Source: Author's Calculation based on Field Survey Data, 2023)

Table 4.5 reflects that 21 (46.90%) farmers have no formal education, 13 (28.90%) farmers have primary education, 8 (17.80%) farmers have a high school education, 2 (4.40%) farmers have a college education, and 1 (2.20%) farmer has a university education.



Source: Field Survey, 2023

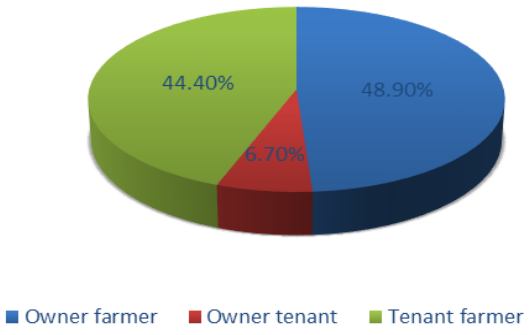
Figure 4.4: Education Level of the Farmers

4.1.6 Distribution of Respondents by Farmer's Type

Table 4.6: Distribution of Farmers by Their Type		
Farmer's Type	**Frequency**	**Percentage**
Owner farmer	22	48.9
Owner tenant	3	6.7
Tenant farmer	20	44.4
Total	45	100

(**Source**: Author's Calculation based on Field Survey Data, 2023)

From above Table 4.6, we can see that most of the farmers (22) belong to the owner-farmer category, 20 farmers belong to the tenant farmer category and 3 farmers belong to the owner-tenant category. That means 48.90% of farmers cultivate their land, 44.40% of farmers cultivate other's land and 6.70% cultivate both their own and others' land.



Source: Field Survey, 2023

Figure 4.5: Distribution of the Farmers by Their Type

4.1.7 Distribution of Respondents by Occupation

Table 4.7: Occupational Distribution of the Respondents		
Occupation	**Frequency**	**Percentage**
Farming only	23	51.1
Farming + Job	1	2.2
Farming + Business	6	13.3
Farming + Others	15	33.3
Total	45	100

(Source: Author's Calculation based on Field Survey Data, 2023**)**

Table 4.7 indicates that 23 (51.0%) respondents' occupation is only farming, 1 (2.20%) respondent does a job alongside farming, 6 (13.30%) respondents do business alongside farming, and 15 (33.33%) respondents do other works alongside farming.

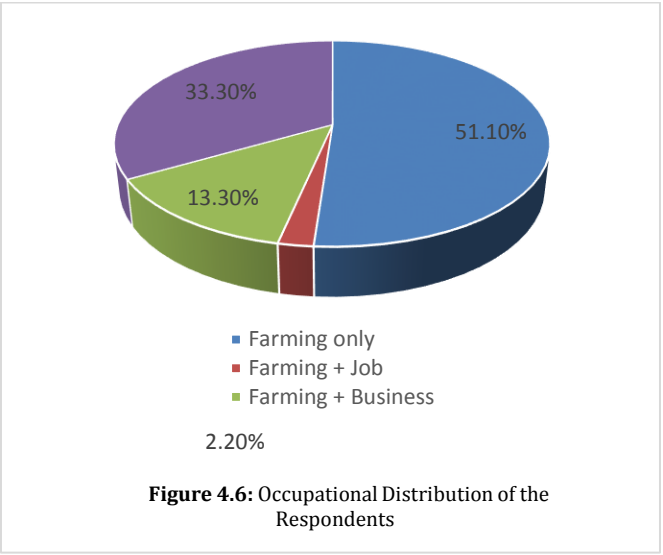


Figure 4.6: Occupational Distribution of the Respondents

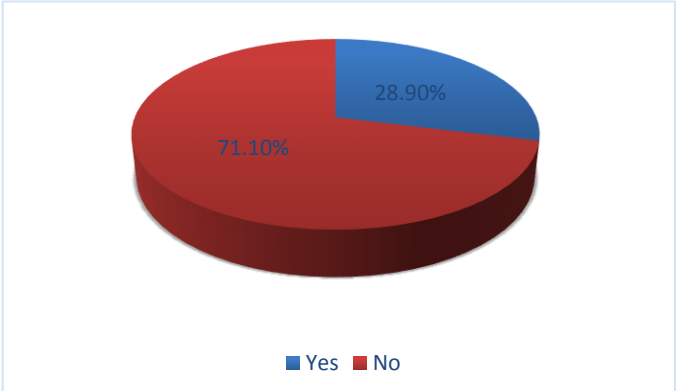
Source: Field Survey, 2023

4.1.8 Distribution of Respondents by Savings Account

Table 4.8: Distribution of Farmers by Savings Account		
Savings Account	**Frequency**	**Percentage**
Yes	13	28.9
No	32	71.1
Total	45	100

(Source: Author's Calculation based on Field Survey Data, 2023**)**

Table 4.8 indicates that there are 13 (28.90%) respondents who have a savings account in banks or other financial institutions, whereas 32 (71.10%) respondents do not have any savings account.



Source: Field Survey, 2023

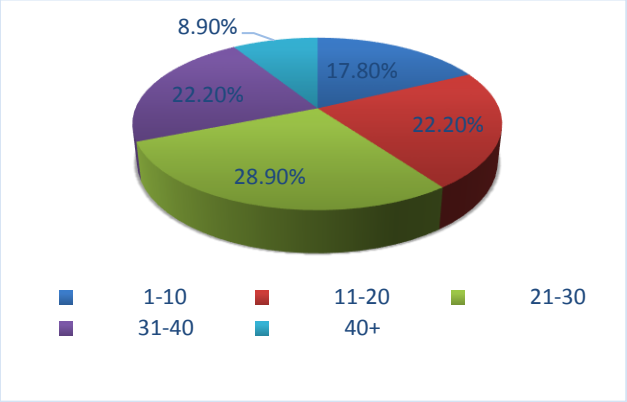
Figure 4.7: Distribution of the Farmers by Savings Account

4.1.9 Distribution of Respondents by Farming Experience

Table 4.9: Distribution of Farmers by Experience		
Farming Experience (in years)	**Frequency**	**Percentage**
1-10	8	17.8
11-20	10	22.2
21-30	13	28.9
31-40	10	22.2
40+	4	8.9
Total	45	100

(Source: Author's Calculation based on Field Survey Data, 2023)

Table 4.9 indicates that 8 (17.80%) farmers have farming experience of 1 to 10 years. 10 (22.20%) farmers have 11 to 20 years of farming experience, 13 (28.90%) farmers have 21 to 30 years of farming experience, 10 (22.20%) farmers have 21 to 30 years of farming experience, and 4 (8.90%) farmers have more than 40 years farming experience.



Source: Field Survey, 2023

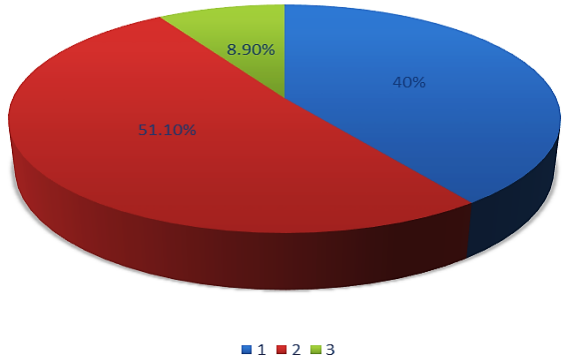
Figure 4.8: Farming Experience of the Farmers

4.1.10 Distribution of Respondents by Family Labor

Table 4.10: Distribution of Farmers by Family Labor		
Family labor	**Frequency**	**Percentage**
1	18	40
2	23	51.1
3	4	8.9
Total	45	100

(Source: Author's Calculation based on Field Survey Data, 2023)

Table 4.10 indicates 18 (40%) farmer families have 1 family/household farm labor, 23 (51.10%) farmer families have 2 family/household farm labor, and 4 (8.90%) farmer families have 3 family/household farm labor.



Source: Field Survey, 2023

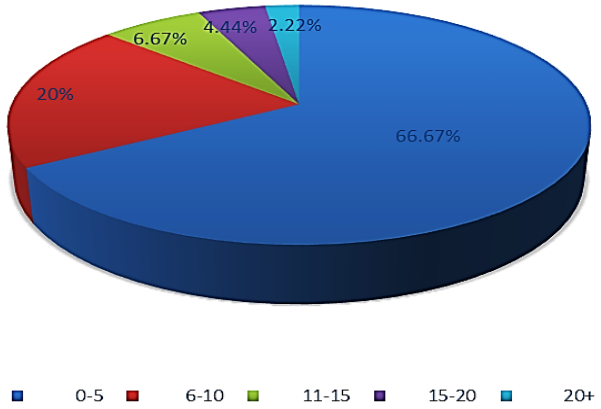
Figure 4.9: Family Labor of the Farmer Family

4.1.11 Distribution of Respondents by Annual Farm Size

Table 4.11: Annual Farm Size of the Farmers		
Annual Farm Size (in bighas)	**Frequency**	**Percentage**
0-5	30	66.67
6-10	9	20
11-15	3	6.67
15-20	2	4.44
20+	1	2.22
Total	45	100

(Source: Author's Calculation based on Field Survey Data, 2023)

Table 4.11 indicates that 30 (66.67%) farmers have an annual farm size of 0-5 bighas, 9 (20%) farmers have an annual farm size of 6-10 bighas, 3 (6.67%) farmers have an annual farm size of 11-15 bighas, 2 (2.22%) farmers have annual farm size of 15-20 bighas, and 1 (2.22%) farmer has annual farm size of more than 20 bighas.



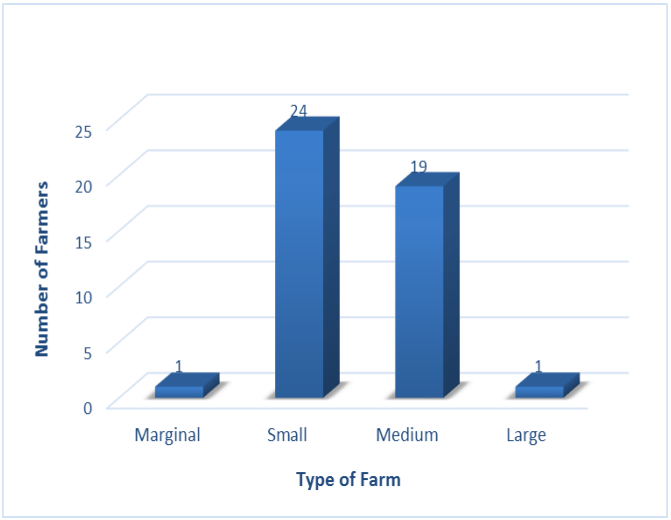
Source: Field Survey, 2023

Figure 4.10: Annual Farm Size of the Respondents

4.1.12 Distribution of Respondents by Period of Rice Cultivation

All of the farmers in our study areas cultivate rice twice a year.

4.1.13 Distribution of Respondents by Boro Land Size



Source: Field Survey, 2023

Figure 4.11: Boro Land Size of the Farmers

Table 4.12 indicates that 1 (2.22%) farmer's cultivated Boro rice land size is 0.15-1.49 bighas (marginal farm), 24 (53.33%) or most of the farmers' cultivated Boro land size is 1.50-7.49 bighas (small farm), 19 (42.22%) farmers' cultivated Boro land size is 7.50-22.49 bighas (medium farm), and 1 (2.22%) farmer's cultivated Boro land size is 22.50 and more bighas (large farm).

Table 4.12: Distribution of Respondents by Boro Land Size			
Type of Farm	**Boro Land Size (in bighas)**	**Frequency**	**Percentage**
Marginal	0.15-1.49	1	2.22
Small	1.50-7.49	24	53.33
Medium	7.50-22.49	19	42.22
Large	22.50+	1	2.22
Total		45	100

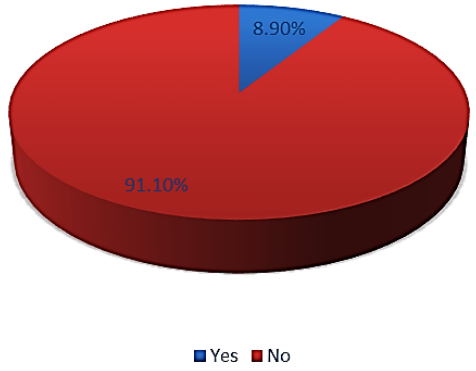
(Source: Author's Calculation based on Field Survey Data, 2023*)*

4.1.14 Distribution of Respondents by Agricultural Loan

Table 4.13: Agricultural Loan Distribution of the Farmers		
Agricultural Loan	**Frequency**	**Percentage**
Yes	4	8.9
No	41	91.1
Total	45	100

(Source: Author's Calculation based on Field Survey Data, 2023)

Table 4.13 indicates that most of the farmers (91.10%) did not receive any agricultural loan, while only 8.90% of farmers received agricultural loans/credit in our study areas.



Source: Field Survey, 2023

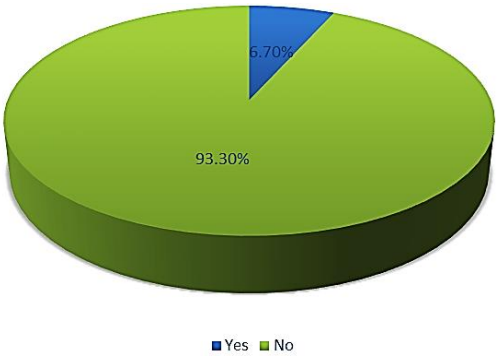
Figure 4.12: Agricutral Loan Received by the Farmers

4.1.15 Distribution of Respondents by Government's Input Subsidy

Table 4.14: Government's Input Subsidy Received By The Farmers		
Subsidy Received	**Frequency**	**Percentage**
Yes	3	6.7
No	42	93.3
Total	45	100

(Source: Author's Calculation based on Field Survey Data, 2023)

Table 4.14 shows that only 6.70% (3) farmers received input subsidies from Government, and most of the farmers (93.30%) did not receive any subsidy from Government in our study areas.



Source: Field Survey, 2023

Figure 4.13: Input Subsidy Received by the Farmers

4.2 Estimated Results of the Analysis of Production Function

The estimated results of the coefficients and other related statistics based on the Cobb-Douglas production function analysis are discussed below using suitable tables for better understanding.

Table 4.15: Summary of the Model					
Model	**R**	**R Square**	**Adjusted R Square**	**Std. Error of the Estimate**	**Durbin-Watson**
1	.867	.751	.687	802.82621	2.007

(Source: Author's Calculation based on Field Survey Data, 2023**)**

In above table 4.15, the value of R square is 0.751 implying that about 75.10% of the variations in gross return have been explained by the explanatory variables. And the value of the Durbin-Watson statistic is 2.007, which is very close to 2 (the normal range is 1.50 to 2.50) and this value indicates that the data are free from serial autocorrelation.

Table 4.16: Analysis of Variance (ANOVA)					
Source of Variation	**Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
Regression	67996572.699	9	7555174.744	11.722	.000
Residual	22558547.301	35	644529.923		
Total	90555120.000	44			

(Source: Author's Calculation based on Field Survey Data, 2023**)**

The value of the F test statistic shows the overall significance of the model. Since the above table 4.16 shows that the value of the F test statistic falls in the rejected region because the p-value is less than 0.05. There is evidence that at least one independent variable affects gross return. So, it can be said that the model is a good fit.

Table 4.17: Estimated values of the Coefficient and Related Statistics of Cobb-Douglas Production Function of Boro Rice Production of Atrai Upazila in 2022.					
Explanatory Variables	**Unstandardized Coefficients**		**Standardized Coefficients**	**t-statistic**	**Sig.**
	B	**Std. Error**	**Beta**		
Constant	5731.764	5927.472		.967	.340
Ploughing Cost (X_1)***	-4.994	1.252	-.499	-3.988	.000
Hired Labor Cost (X_2)*	4.648	2.673	.167	1.739	.091
Irrigation Cost (X_3)	-2.811	1.734	-.150	-1.621	.114
Seed Cost (X_4)	-.057	3.106	-.002	-.018	.985
Planting Cost (X_5)***	5.424	2.006	.247	2.704	.011
Fertilizer Cost (X_6)*	-4.527	2.333	-.523	-1.940	.060
Pesticides Cost (X_7)***	12.406	2.889	1.254	4.294	.000
Machinery Cost (X_8)	4.471	3.577	.113	1.250	.220
Harvest & Transport Cost (X_9)**	1.783	.846	.295	2.107	.042

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

(Source: Author's Calculation based on Field Survey Data, 2023)

Interpretation of the results from table 4.17 are discussed below:

Plowing Cost (X_1): The regression coefficient of plowing cost was -4.994, the negative sign implies that plowing cost negatively affected the gross return. The p-value was 0.000, which was significant at a 1% significance level. That means that the null hypothesis can be rejected. This also indicated that an increase of one percent in plowing cost, remaining other factors constant, would result in a decrease in the gross return by 4.994 percent.

Hired Labor Cost (X_2): The regression coefficient of hired labor cost was 4.648, which implies that hired labor costs positively affected the gross return. The p-value was 0.091, which was significant at a 10% significance level. That means that the null hypothesis can be rejected. This indicated that an increase of one percent of hired labor cost, remaining other factors constant, would increase the gross return by 4.648 percent.

Irrigation Cost (X_3): The regression coefficient of irrigation cost was -2.811, the negative sign implies that irrigation cost negatively affected the gross return. But the p-value was 0.114, which was insignificant. That means that the null hypothesis cannot be rejected, because the irrigation cost did not have any significant impact on the gross return of Boro rice.

Seed Cost (X_4): The regression coefficient of seed cost was -.057, the negative sign implies that seed cost negatively affected the gross return. But p-value was 0.985, which was insignificant. That means that the null hypothesis cannot be rejected, because the seed cost did not have any impact significant on the gross return of Boro rice.

Planting Cost (X_5): The regression coefficient of planting cost was 5.424, which implies that planting cost positively affected the gross return. The p-value was 0.011, which was significant at a 1% significance level. That means that the null hypothesis can be rejected. This indicated that an increase of one percent in planting cost, remaining other factors constant, would increase the gross return by 5.424 percent.

Fertilizer Cost (X_6): The regression coefficient of fertilizer cost was -4.527, the negative sign implies that fertilizer cost negatively affected the gross return. The p-value was 0.060, which was significant at a 10% significance level. That means that the null hypothesis can be rejected. This also indicated that an increase of one percent in fertilizer cost, remaining other factors constant, would result in a decrease in the gross return by 4.527 percent.

Pesticide Cost (X_7): The regression coefficient of pesticide cost was 12.406, which implies that pesticide cost positively affected the gross return. The p-value was 0.000, which was significant at a 1% significance level. That means that the null hypothesis can be rejected. This indicated that an increase of one percent in pesticides cost, remaining other factors constant, would increase the gross return by 12.406 percent.

Machinery Cost (X_8): The regression coefficient of machinery cost was 4.471, which implies that machinery cost positively affected the gross return. But the p-value was 0.220, which was insignificant. That means that the null hypothesis cannot be rejected, because the machinery cost did not have any impact significant on the gross return of Boro rice.

Harvest and Transport Cost (X_9): The regression coefficient of harvest and transport cost was 1.783, which implies that harvest and transport cost positively affected the gross return. The p-value was 0.042, which was significant at a 5% significance level. That means that the null hypothesis can be rejected. This indicated that an increase in one percent of harvest and transport cost, remaining other factors constant, would increase the gross return by 1.783 percent.

4.3 Profitability Analysis of Boro Rice Farming

Farmers can earn profit only if the gross return is greater than the total cost of production. The total cost has two parts, namely total variable cost (TVC) and total fixed cost (TFC). The gross return of Boro rice farming is the sum of rice revenue and straw or by-product of rice revenue.

The following Table 4.18 shows the profitability of Boro rice farming.

Table 4.18: Profitability Analysis of Per Bigha Boro Rice Farming in Atrai Upazila of Naogaon district in 2022.

Variables	Mean	Minimum	Maximum	Std. Deviation
Plowing cost	1588.89	1500	2000	143.37
Hired labor cost	591.11	500	700	51.44
Irrigation cost	2022.22	2000	2400	76.54
Seed cost	521.11	450	600	43.29
Planting cost	1473.33	1300	1600	65.37
Fertilizer cost	1862.11	1574	2248	165.78
Pesticides cost	1816.67	1500	2100	144.99
Machinery cost	219.56	180	300	36.37
Harvest and transport cost	5791.11	5000	6200	237.24
Total Variable Cost (TVC)	**15886.11**			
Land use cost	9022.22	8500	9500	300.67
Family labor cost	1635.56	1200	2000	189.68
Total Fixed Cost (TFC)	**10657.78**			
Rice Revenue	29092.22	24200	31250	1433.68
Straw Revenue	854.22	750	1000	57.86
Gross Return (GR)	**28238.00**			
Net Return (NR)	**1694.11**			

(Source: Author's Calculation based on Field Survey Data, 2023**)**

Interpretation of the results from table 4.18 are discussed below:

Total Variable Cost (TVC): In this work, plowing cost, irrigation cost, seed cost, planting cost, hired labor cost, harvest & transport cost, pesticides cost, fertilizer cost, and machinery cost are counted in the estimation of per bigha variable cost. In the study area, the average per bigha total variable cost during Boro rice farming in 2022 was Tk. 15886.11.

Total Fixed Cost (TFC): The sum of the land use cost and family labor cost is counted as the total fixed cost of Boro rice production in the study area. The average per bigha land use cost was Tk. 9022.22 and the average per bigha family labor cost was Tk. 1635.56. Therefore, the average per bigha total fixed cost was Tk. 10657.78 in the study area during Boro rice farming in 2022.

Gross Return (GR): The gross return or gross revenue is the sum of rice revenue and by-product or straw revenue from Boro rice production in 2022. In the study area, the average per bigha rice revenue was Tk. 29092.22 and the average per bigha straw revenue was Tk. 854.22. Therefore, the average per bigha gross return was Tk. 28238.00 from Boro rice farming in the study in 2022.

Net Return (NR): The net return or net revenue or net profit was

calculated by using the following formula:

Net Profit = Gross Return – (TFC+TVC)

The above table 4.18 shows that the average per bigha net profit or net return from Boro rice farming in the study in 2022 was Tk. 1694.11.

This section identified some demographic characteristics of the respondents and their socio-economic conditions. This section also portrayed the results of regression analysis using the ordinary least square (OLS) method and the profitability analysis of Boro rice production. The study found that Boro rice farming is profitable in the study area. It is found that some variables viz. hired labor cost, planting cost, harvest and transport cost, pesticides cost and machinery cost positively affected the gross return of Boro rice, whereas some other variables viz. fertilizer cost, irrigation cost, plowing cost, and seed cost negatively affected the gross return. However, some variables had a significant impact on the gross return of Boro rice, while other variables did not have any significant impact on gross return.

5. Discussion and Conclusions

The key message of this research is to examine the profitability of Boro rice farming of Atrai upazila of Naogaon district. The key findings of this research are summarized in this section. In section 5.1, a summary of the key findings of this study is discussed. In section 5.2, the major challenges that the farmers face during Boro rice cultivation are recapitulated. Similarly, the conclusion, policy recommendations, limitations of this study, and scope for further study are discussed respectively in sections 5.3, 5.4, 5.5, and 5.6.

5.1 Summary of the Key Findings

Bangladesh is mostly an agrarian economy. Agriculture is one of the main sources of income and employment in the Bangladesh economy. Rice is the major agricultural crop of this country. The findings of this research study discussed in those previous sections are recapitulated below. This research paper begins with an introductory discussion in the earlier section. This section is divided into three parts, namely the background of the study, the rationale of the study, and the objective of the study. In section two, some of the major literature relevant to the profitability of Boro rice farming are reviewed. The literature is mainly based on secondary data, some researchers used both primary and secondary data. Most of the studies tried to explain the relationship between different agricultural inputs and the production of rice farming. They only showed the dependence of output on different agricultural inputs rather than analyzing the profitability of rice farming. Some researchers failed to explain a specific relationship between them as well. Most of them did not use specific econometric models and methodologies. Few studies have been found which are based on Boro rice farming. Moreover, no study has been done on the profitability of Boro rice farming in Atrai upazila of Naogaon district. These research gaps in the previous literature uphold the necessity of this work.

In section three, data collection techniques and research methodology have been discussed. A simple random probability sampling technique is used to collect data from 45 respondents from four different villages of Atrai upazila. The ordinary least square (OLS) method is used to regress Cobb Douglas production function which shows the dependence of gross return or gross revenue on different agricultural inputs. Cost-return (cost-benefit) analysis is used to determine net profit or net return.

Section four starts with the demographic characteristics and socioeconomic conditions of the respondents and finishes with a profitability analysis. The findings of this section are below-

- The study area is enjoying the characteristics of demographic dividend as most of the respondents' age structure is 15 to 64 years.
- There is no female farmer in the study area, all of them are male.
- Most of the farmers are Muslim, others are Hindu.
- Most of the farmers' family is medium (4-6 members) in size.
- The majority of the farmers have no formal education, some have primary education and very few have other levels of education.
- Nearly half of the farmers cultivate their own land, a greater proportion of other farmers cultivate others' land, and a few of them cultivate both their own and others' land.
- Most of the respondents do only farming as an occupation, and some of the other respondents do other jobs or work.
- A greater portion of the farmers has no savings account in banks or other financial institutions.
- The majority of the farmers have more than ten years of farming experience.
- Most of the farmers' families have two or three family/household farm labor.
- All of the farmers cultivate rice twice a year.
- In the study area, most of the farmers belong to small and medium farmer categories, few farmers belong to marginal and larger farmer categories.
- The majority of the farmers did not receive agricultural loans/credit.
- Most of the respondents did not get input subsidies from the government.
- Boro rice farming is profitable in the study area, but not good enough.
- Hired labor cost, planting cost, harvest & transport cost, pesticides cost and machinery cost positively affected the gross return of Boro rice, whereas some other variables viz. fertilizer cost, irrigation cost, plowing cost, and seed cost negatively affected the gross return.
- Some variables had a significant impact on the gross return of Boro rice, while other variables did not have any significant impact on the gross return.

5.2 Problems and Challenges

Farmers faced several problems and challenges when they produced Boro rice in the study area. Some of the major problems and challenges are pointed out below-

Low Price of Yield: The majority of the farmers had to sell their rice yield at the time of harvesting period at a very low price to meet various obligations like payment to labor, household expenditure, and repayment of the loan. At that time, they did not get a higher yield price.

Higher Input Prices: In the study area, the prices of different agricultural inputs like fertilizer, pesticides, seeds, hired labor, etc. were very high, that's why all the farmers could not afford an adequate amount of input at a higher price. The price of these inputs became very high because of the problem of scarcity.

Unavailability of Quality Seed: Adequate amount of high-yielding variety (HYV) seeds were not available in the study area. Because of the scarcity of quality seeds, farmers could not produce the desired amount of output at that period.

Natural Calamities: Farmers faced heavy storms of Baishakh like 'Kalbaishakhi' during the period of Boro rice farming which caused lower per bigha rice yield. Farmers also faced some other natural calamities during that period.

Lack of Adequate Capital: The study found that most of the farmers faced the problem of an adequate amount of capital supply. Most of them were not able to get agricultural loans or credit from banks or any other financial institutions. Lack of capital hindered farmers to operate the farming process properly.

Lack of Proper Training: Farmers did not get any proper agricultural training which could enhance them to produce a larger amount of rice yield.

Pests and Diseases: Farmers in the study area also faced the problem of pests and diseases which caused them to pay more for pesticides.

Lack of Hired Labor: Although the price of hired labor was very high during the period of Boro rice farming, still there was a lack of the required amount of hired labor.

Lack of Input Subsidy: As we mentioned above the high price of the input, yet most of the farmers did not get any input subsidy from the government or governmental authority.

5.3 Conclusions

In the research, the researcher examined the profitability of Boro rice farming. From the result of this study, it can be concluded that Boro rice

farming is profitable in Atrai upazila of Naogaon district. This study also finds that there is an ample amount of scope exists in the study area to increase the productivity or profitability of Boro rice farming. In the study area, non-rice crop farming is more profitable than rice crops. In this research, we conducted the relationship between inputs and Boro rice production to see the dependence of output on inputs. From the regression it is found that some variables viz. hired labor cost, planting cost, harvest & transport cost, pesticides cost, and machinery cost positively affected the gross return of Boro rice, whereas some other variables viz. fertilizer cost, irrigation cost, ploughing cost and seed cost negatively affected the gross return. This present study shows that there are some variables that have significant impact on Boro rice production, while some other variables are insignificant.

5.4 Policy Recommendations

Based on the findings of this research, it can be disclosed that Boro rice farming is profitable in the study area. But this study also found some problems and challenges which were faced by the farmers during the period of Boro rice cultivation as mentioned in section 5.3. Therefore, it is necessary to recommend some policies regarding the profitability of Boro rice farming.

The following policy recommendations can be very useful to increase the profit of Boro rice production-

i. To make more profit, first of all, a fair price of rice yield needs to be ensured. Farmers will not produce Boro rice if they have to sell their output at a lower price for a long period. A fair price of rice yield is much needed to encourage the farmers to produce Boro rice. A minimum price policy can be very effective in this case.

ii. The fair price of agricultural inputs like fertilizer, and pesticides also needs to take into account. The supply of fertilizer was inadequate during the period of Boro rice production in the study. For this reason, farmers had to pay more than the government-stated price in the study area. A government price support policy needs to be imposed to make sure that farmers are buying these inputs at a fair price. The country's food supply chain can be saved only if the government can save our farmers (Xames et al., 2022).

iii. An adequate supply of quality seeds can be very useful to produce more per bigha rice yield, thus increasing profit. High-yielding variety (HYV) seeds in appropriate quantity are acknowledged to be one of the core elements to enhance agricultural production.

iv. Lack of adequate capital resources is a major problem for the poor farmers of the study area. An adequate supply of agricultural loans or credit needs to be ensured by establishing a favorable institutional credit program. Short-term low-interest loans by banks or any other financial institution can be proved effective in this case.

v. The land use policy should be renewed to stop the further loss of arable land in the study. It has to be made sure that a small portion of land is used for housing, and 'khas' land should be used for farming.

vi. Proper agricultural training facilities need to be enlarged. In rural areas, farmers do not get proper training and technical information facilities which may increase their efficiency and build them as human capital. It will also solve the problem of a shortage of hired labor.

vii. Adoption of modern technology can be a very effective solution to increase production and reduce the depreciation of resources. Modern technology also saves time. Moreover, sustainable agricultural development is impossible without modern technology.

viii. To face the problems of natural calamities and pests and insecticides, mobile phone SMS and internet information services can be more useful. It will be more effective if it can be ensured that at least every union has an institution that provides valuable information to face these problems.

ix. As in the study area, most of the farmers did not get an input subsidy from the government or governmental authority, government needs to make sure that every poor farmer is getting an input subsidy from the government or governmental authority to encourage the farmers to produce more Boro rice.

5.5 Limitations of the Study

This research is a microeconomic study, and it may not be useful for the economy as a whole. Because this study has a few limitations. These limitations are pointed out below-

- This study used a sample size of 45 respondents which is a relatively large sample size, but it is not good enough to represent the overall economy.
- Collecting data from different farmers of different villages was very difficult. Most of the farmers have no formal education, therefore, they might not able to recall the correct information from their memory because they usually do not keep any written documents.
- This study was also limited by time and other resource constraints.

5.6 Scope for Further Study

Although the research is conducted to provide some valuable information that can be useful for farmers and policymakers, this study failed to cover some important areas. That is why the present research opens the door for further research.

- A further study can be undertaken to examine and compare the profitability of Boro rice farming among marginal, small, medium, and large farms.
- A further study can also be undertaken by taking Aman and Aus rice into account. This study can be helpful to compare the profitability of three different types of rice (Boro, Aman, and Aus).
- A further study can be conducted on the determinants that affect the productivity of Boro rice farming.

Disclosure Statement

The authors declare that they have no potential conflict of interest or financial conflict to disclose.

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