PROFITABILITY ANALYSIS AND RESOURCE USE EFFICIENCY OF T.AMAN RICE PRODUCTION IN SOME SELECTED AREAS OF PIROJPUR DISTRICT IN BANGLADESH

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CERTIFICATE

This is to certify that the thesis entitled **"PROFITABILITY ANALYSIS AND RESOURCE USE EFFICIENCY OF T.AMAN RICE PRODUCTION IN SOME SELECTED AREAS OF PIROJPUR DISTRICT IN BANGLADESH"** submitted to the department of Agricultural Economics, Faculty of Agribusiness Management, Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka in partial fulfillment of the requirements for the degree of Master of Science (M.S.) in Agricultural Economics, embodies the result of a piece of bona fide research work carried out by **MD. SHAHJALAL AKON, Registration No. 12-05026** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.

I further certify that any help or source of information, as has been availed of during the course of this investigation has been duly acknowledged by the Author.

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BELOVED PARENTS

PROFITABILITY ANALYSIS AND RESOURCE USE EFFICIENCY OF T.AMAN RICE PRODUCTION IN SOME SELECTED AREAS OF PIROJPUR DISTRICT IN BANGLADESH

Abstract

This study was designed to assess the profitability and resource use efficiency analysis of T.Aman rice farming at Pirojpur district in Bangladesh. In total, 60 farmers were randomly selected for the study. Descriptive statistics, activity budgets, Cobb-Douglas production function models were employed to achieve the objectives of the study. The estimated total variable costs, fixed cost, and operating costs for T.Aman rice per hectare were found to be Tk. 42679 , Tk. 13423 and Tk. 1423 respectively whereas total cost, total return, and net return were measured Tk. 56102 , Tk.74400, and Tk. 18298 respectively. This study calculated benefit cost ratio which was 1.32 for T.Aman rice. It was observed that the coefficient of human labor, seed, insecticide, and education was positive and had significant impacts on gross returns of T. Aman rice production. In the study area seed, and gypsum were underutilized which used should be increased to attain more productivity and human labour, urea, TSP, and MoP were over utilized these variable used should be decreased to attain the optimum productivity. In the study area farmers appeared some barriers such as lack of labor, lack of money, lack of market for selling products, lack of education, poor agricultural extension service delivery, lack of knowledge, etc. About 93 % of farmers mentioned the low price of rice and 47% of farmers mentioned a lack of money. This study suggests to ensure financial support, extension services and marketing facilities towards increasing productivity resources use efficiency for T.Aman rice in Bangladesh

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DEDICATED
TO
MY BELOVED PARENTS

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CHAPTER ONE

INTRODUCTION

1.1 Background of the study

Bangladesh is an agrarian nation. The agriculture sector plays an important role in the overall economic development of Bangladesh. Rice is the staple food for concerning 166 million individuals of the country. The agricultural sector (crops, animal farming, forests, and fishing) contributes 14.23 percent to the country's GDP which provides about 40.62 percent employment of the labor force (Bangladesh Economic Review, 2018). The population is increasing by about 2 million every year, and if the population increments in light of present conditions, the all-out population will be 38 million by 2050 (Shelly *et al.*, 2016).

The agriculture sector had also performed relatively well in the last decade due to increased productivity, emerging diversification into value-added products, such as fruits, vegetables, poultry, dairy and fish and almost self-sufficiency in rice production, the main cereal crop for the people. This performance was achieved in spite of a large population, scarce cultivable land, a very high population density and the regular occurrence of natural calamity. Bangladesh is the fourth largest rice-producing country in the world (FAOSTAT, 2017) and third-largest (FAPRI, 2009) consumer of rice in the world. About 79 percent of the total cropped area is planted to rice (BBS, 2015).

However, during the period 2009-2012, the nation could considerably boost rice output by cultivating high yielding varieties and maintaining the growths. Rice cultivation for most Bangladeshis is the cornerstone of Bangladesh's economy and a significant diet. Rice is cultivated in Aus season (mid-March–August) and T.Aman season (July–December) in Bangladesh (BBS, 2014). Apparently, T.Aman season productivity is continually growing based on an extensive irrigation system, since there is no water scarcity threatens it. In addition, extensive monsoon irrigation places pressure on the accessibility of soil and surface water (Alauddin and Quiggin, 2008). Optimum temperatures for maximum photosynthesis range from 25 °C to 30 °C for rice under the climatic conditions of Bangladesh (Basak, 2010).

Rain-fed T.Aman rice is also susceptible to enhanced variability in rainfall and heavy runoff from time to time. The arable land is constantly decreasing during the Aus season owing to low productivity and constant and extremely dry periods in summer (Islam *et al.*, 2017; Sarker *et al.*, 2014; Ruane *et al.*, 2013).

Aman is one of the main crops in Bangladesh. The rice which is harvested in the month of November and December is said to be Aman rice. Two types of Aman rice are grown in this country. One is called broadcast Aman which is sown in the month of mid-March to mid-April in the low lands and another is transplant Aman, which is planted from late June to August. At present, it is the second-largest crop in the country in respect of the volume of production. Consequently, the area coverage of Aman is highest as a single crop. The total area under Aman crop has been estimated at 13.79 million acres in 2016-17 (BBS, 2017). The number of days without rain is increasing, although the total annual rainfall remains almost the same. Rainfall produces extreme events like floods and droughts which have noticeably adverse impacts on rice yields and production of Aman rice was declined by 20% to 30% in the northwestern region in 2006 when a drought occurred (UNDP, 2007; GOB & UNDP, 2009).

In Bangladesh's economy, the grain sector is particularly important because many areas are dedicated to rice production and a wide range of farmers is involved. In Bangladesh, Aus, Aman and T.Aman are cultivated with various rices. In Bangladesh there are two types of Aman rice broadcast by Aman and transplanted by Aman. Aman rice, the transplant which occupies 46.30 per cent of the rice grown, is the key to the total rice Aman produced in the state (BBS 2017). Currently a number of improved varieties are being transplanted such as BR-11, BR-22, BR-23 etc., which are increasing the production highly and are also helping to meet the surplus demand for food. Transplanted Aman is grown throughout Bangladesh and broadcast. Aman is grown in low-lying areas. In recent years, crop production in Bangladesh has undergone some changes in terms of yields as well as crop distribution. Rice is by far the most important crop along with jute, wheat, potato, oilseeds, sugarcane, pulses, and tea (BBS, 2013).

Rice is very susceptible to climate change. The National Capacity Self-Assessment (NCSA) for implementing the provisions of multilateral agreements, including the UNFCCC and UNCCD, was launched in 2007 to reducing the damage of rice production. It has put a high priority on capacity building for climate change adaptation. The government prepared the Bangladesh Climate Change Strategy and Action Plan (BCCSAP) in 2008 and revised it in 2009. The Sixth Five Year Plan approved in 2011 emphasized mainstreaming and strengthening climate change adaptation across various sectors including improved crop production practices, enhancing public awareness, climate research, and data collection

Table 1.1: Aman cultivated total area in million acres.

Year	Area (million acres)
2007-08	13.78
2008-09	13.95
2009-10	13.99
2010-11	13.58
2011-12	12.47
2012-13	13.86
2013-14	13.67
2014-15	13.67
2015-16	13.81
2016-17	13.80

Source: BBS, 2018.

It is evident from table 1.1 that the area of cultivation and production of Aman is increasing every year. In 2007-08 the area was 13.78 million acres and in 2016-17 area is 13.80 million acres. To fullfl the demand of the the growing population the area of land for Aman cultivation is accelerating year by year.

Table 1.2: Production of Aman rice in million metric ton 2007-08 to 2016-17

Year	Production (million MT)
2007-08	12.80
2008-09	12.80
2009-10	12.20
2010-11	11.61
2011-12	9.67
2012-13	12.90
2013-14	13.02
2014-15	13.19
2015-16	13.48
2016-17	13.66

Source: BBS, 2018.

The table 1.2 illustrates that the production of Aman is increasing remarkably. It allows comparisons between the years from 2007-80 to 2016-2017. It can been seen that in 2007-08 the production was 12.80 million mt and in 2016-17 the prodution is 13.67 million mt.

1.2 Justification of the Study

About 80 percent of the people of Bangladesh live in rural areas and they depend on agricultural activity. But the population is increasing day by day which causes the decrease of farm size in a horrid manner. Land for the people of Bangladesh is the single most important asset. Agriculture plays a vital role through employment generation, poverty alleviation, food security enhance, standard of living by increasing income level of the rural people. The majority of households in Bangladesh largely depend on land-based activities for their livelihoods. As almost 65 percent of the total population (and above 80 percent of the rural population) were depend on agriculture. In order to meet the demand of food grain for the increasing population and to achieve self-sufficiency in food grain, the government of Bangladesh has given much emphasis on rice production. Significant compositional changes occurred within rice production. T.Aman rice increased by several times over the past two decades due to the diffusion of new technologies such as HYV seeds, fertilizer, irrigation, pesticides, power tiller etc. This has definitely changed the cost structure of rice production.

This work will lead to a successful T.Aman picture that encourages individual researchers to carry out more research of a similar nature and to promote more studies in this particular field of the study. The study will ultimately help farmer's productive operation and maintenance by pointing to their problems and planners to improve management and planning. The research would help extension staff learn about several problems related to T.Aman rice production and recommend that farmers copy the problems.

1.3 Objectives of the study

The objectives of the study are given below:

- To determine the socio-economic characteristics of the farmers in the study area.
- To assess the profitability of the T.Aman rice in the selected areas of Bangladesh
- To determine the factors affecting the resource use efficiency of the T.Aman rice.
- To identify the major problems make and some recommendations associated with T.Aman rice production.

1.4 Outline of the study

The study consists of seven chapters. Chapter 1 describes the introduction of the study, Chapter 2 provides the review of literature. Chapter 3 deals with the methodology of the study. In Chapter 4, the socioeconomic characteristics of the sample farmers are presented. Chapter 5 presents cost and return of T.Aman rice production and chapter 6 describes the factors affecting of resource use efficiency of T.Aman rice production. Finally, the conclusion, and recommendations of the study are presented in Chapter 7.

CHAPTER TWO

REVIEW OF LITERATURE

2.1 Introduction

This chapter aims at representing some review of the past research works that are related to the present study. However, analysis of profitability and resource use efficiency of T.Aman rice production is hardly ever found in this country. Some important studies on T.Aman rice production, which have been conducted in the recent past, are discussed below:

Zakaria *et al.*, (2017) conducted a study to see the effect of climate variables (rainfall, maximum temperature) on Aman rice production and mapping in Bangladesh. They used time series data for the last decade (2003-2012) for rainfall and maximum temperature from BMD (Bangladesh Meteorological Department) and BBS (Bangladesh Bureau of Statistics) respectively. Geographically Bangladesh is divided into four regions such as; North-Eastern Region, South-Eastern Region, South-western Region and North-Western Region, in this research. In North-Eastern regions Aman production is proportional to rainfall and maximum temperature does not prominent variables which indicate the rainfall effect the rice production prominently. In the South-Eastern region rainfall and maximum temperature both are in repetitive and show less effect on production which indicates other variables are prominent in this region. There may have salinity and soil condition effect on the Aman rice production of this region. In South-Western region the both variables are prominent in this region. We know that most the area of the region is situated under tidal effect which may be the cause of production decrease

Islam *et al.,* (2017) conducted to assess the profitability, constraints and factors affecting rice production in coastal area of Shamnagar upazila, Satkhaira district, Bangladesh by using stratified random sampling method. Simple statistical technique as well as the Cobb-Douglas production function was used to achieve the objectives of the study. The study found that the small farmers (Tk. 10292.89) got higher net returns than the medium (Tk. 6894.39) and large (Tk. 4798.70) farmers per hectare, respectively. The undiscounted BCR was 1.38, 1.23 and 1.15 for small, medium and large farmers respectively. It is found that the coefficient of seed, fertilizer, power tiller, irrigation cost and human labor have significantly impact on gross return. Lack of saline tolerable good quality seeds, high price of inputs, low price of outputs and natural calamity were the major problems for rice farming in the study area though rice farming was a profitable enterprise.

Rahman *et al.*, (2015) studied a comparative study was conducted within a selected coastal empoldered area of Bangladesh, with a view to comparing the profitability and technical efficiency of T. Aman rice growers between two locations with different level of salinity. Two unions (Pankhali and Tildunga) under polder 31 of Dacope upazila were selected to fulfill the intention of the study. The study revealed that T. Aman rice production was profitable in both of saline water controlled and uncontrolled areas but the realistic favor viewed that economic return was reasonably in controlled area. The returns per taka investment in controlled and uncontrolled areas were 1.70 and 1.60, respectively. The estimated result showed that the average level of technical efficiencies of the sample farmers were about 70.70% and 87.50% for the uncontrolled and controlled areas' farms, respectively. That means, at the given technology and level of inputs, the output could be increased by 29.30% and 12.50%, respectively. Farmer's education and training had positive significant effect on T. Aman rice production. The age of the sampled farmers' had significant positive impact on farming efficiency in the controlled farms but it was negative on the uncontrolled area. The saline water controlling had significant impact on the farming efficiency of T. Aman rice farmers'.

Tama *et al*., (2015) undertaken to assess the financial profitability of aromatic rice production. A total of 45 farmers of some selected villages of Chirirbandar upazila of Dinajpur district were considered as sample for achieving these objectives. Collected data were analyzed with descriptive statistics. Total costs for aromatic rice was estimated at Tk. 64446.51 per hectare and per hectare gross return of aromatic rice was Tk. 114243.71. Gross margin for aromatic rice was estimated at Tk. 59999.29 per hectare. Thus, the net return was estimated at Tk. 49797.20 for aromatic rice production. The undiscounted Benefit Cost Ratio on the basis of total cost was 1.77 implying that the aromatic rice production was highly profitable.

Fatema *et al.,* (2014) designed to assess the comparative profitability of T. Aman rice farming in saline and nonsaline area at Dacope Upazila of Khulna district of Bangladesh. In total, 240 farmers were randomly selected for the study among which 120 from the saline area and rest 120 from the nonsaline area. Descriptive statistics, activity budgets, Cobb-Douglas production function models were employed to achieve the objectives of the study. The study confirmed that T. Aman rice production of nonsaline area were profitable than saline area. Per hectare total cost, gross return and net return of T. Aman farming in nonsaline area were Tk 33,097.00; 59,723.00 and 26,626.00, respectively. Similarly, Per hectare total cost, gross return and net return of T. Aman farming in saline area were estimated at Tk 37,003.00; 50,666.00and 13,663.00, respectively. It was observed that the coefficient of human labour, power tiller and insecticide were positive and had significant impacts on gross returns of T. Aman rice production in nonsaline area.

Reza *et al.,* (2013) investigated to find out the input productivity and resource use efficiency of boro rice farm in Sylhet District. In total 120 farmers were selected randomly from three thanas of Sylhet District named Gohainghat, Fenchugonj and Balagonj, where equal number of samples were collected from each thana. Data were collected through farm survey by using a suitable pretested questionnaire. Cobb-Douglas Production Function, Marginal Value Product (MVP) and Marginal Factor Cost (MFC) are used for analysis. The use of inputs like human labour, seed, irrigation, insecticides, power tiller/animal power are also statistically significant but not for all the crops. Findings of the study revealed that the farmers were inefficient of the use of resources, generally, inputs such as fertilizer, seed and insecticides were under-utilized in Boro Paddy under three categories of farms (animal, power and pooled farm). The ratios of the MVP to the MFC were less than unity for Boro and Aman Paddy of all categories of farms except Boro Paddy in animal operated farm.

Bhuyan *et al.,* (2012) evaluated the water and fertilizer application efficiency of rice cropping system under bed planting method. Results showed that the bed planting method increased grain yield of rice up to 16% than the conventional method. Bed planting also increased the number of panicle m^{-2}, number of grains $panicle^{-1}$, and 1000-grain weight of rice than conventional method. Sterility percentage and weed infestation were lower in bed planting than conventional method. This study concluded that bed planting method is a new approach for optimum fertilizer and water use efficiency as well as higher yield compared to conventional flat method.

Kabir *et al.,* (2011)`attempted to assess the profitability of producing both Golda and Aman paddy farming and to explore the effects of key inputs on production processes of Golda and Aman paddy. Two villages of Pankhali Union in Dacope Upazila of Khulna district in Bangladesh were selected purposively for the study and 120 farmers, at the rate of 60 from each enterprise, were randomly selected for the study. Descriptive statistics, activity budgets, Cobb-Douglas production function model were employed to achieve the objectives. The major findings of the study were that both T. Aman paddy and Golda production were profitable. Per hectare total cost, gross return and net return of Golda farming were estimated at Tk169,274.00, 123,256.00 and 75,226.00, respectively. Similarly, per hectare total cost, gross return and net return of T. Aman farming were Tk 33,097.00, 59,723.00 and 26,626.00, respectively. It was observed that coefficients of post larva, human labour, feed and stocking of others fish fry were positive and had significant impact on gross returns of Golda. Similarly, the coefficient of human labour, power tiller and insecticide were positive and had significant impacts on gross returns of T. Aman paddy production

Fatema *et al.,* (2011) designed to assess the relative profitability of rice and shrimp farming in two villages of Tildanga Union in Dacope Upazila of Khulna district in Bangladesh. In total, 120 farmers were randomly selected for the study.

Descriptive statistics, activity budgets, Cobb-Douglas production function model were employed to achieve the objectives of the study. The study confirmed that both T. Aman rice and shrimp production were profitable. Shrimp production is more profitable than the rice production. Despite the fact, a large number of farmers prefer rice to shrimp due to environmental effects and welfare grounds of the common people. The present study, of course, assessed the profitability of growing transplanted Aman rice and shrimp in Polder 31 and has given some important clues to make the right decisions regarding better options for more environment-friendly profitable crop farming for individual farmers in Polder 31.

Dey (2001) analysed for estimating the returns of BR11 variety of rice in T. Aman season has been conducted using Akino and Hayami model (1975) and Masters model (1996). Using the Akino and Hayami model it was found that the IRR to the total investment in BR11 rice variety research and extension was calculated at 85%. The increased production from BR11 saved foreign exchange of Tk. 109.83 billion, which is 86% of the total foreign exchange savings from HYV T. Aman rice. Under various assumptions of shift multiplier and expenditure, the magnitude of the IRR varies from 64 to 122%. Therefore, the variety BR11 has proved to be as an outstanding contributing variety for increasing rice production in Bangladesh.

Razzaque *et al.*, (2007) carried out at Multilocation testing site Barguna in kharif - II seasons of 1999 and 2000 to find out the probable reason of yield gap of T. Aman rice (BR-23) between demonstration plot (DP) with Research management and Non-demonstration plot (NDP) with Farmer management practices. Across the years there exists a big gap in yield (1220 kg ha-1) between DP and NDP. DP gave about 25.15% higher yield than NDP due to use of best quality seed, appropriate age of seedlings (30 days), closer spacing, and optimum number of seedlings per hill, use of balanced fertilizer and pest control in proper time. Although cultivation cost of DP was higher (Tk.2218 ha-1) than that of NDP. Demonstration plots showed higher benefit cost ratio (2.28) than non-demonstration plot (1.98).

Anik *et al.,* (2002) analyzed to evaluate the economic and financial profitability of aromatic and fine rice production, using both primary and secondary data. Forty farmers who cultivated both Kataribhog and Chinigura, and fifteen farmers each producing Pajam and Nizershail were selected from Dinajpur district. The net returns per hectare for the aromatic varieties were higher due to the higher market prices and less production cost of the varieties. Domestic Resource Cost (DRC) ratios showed that Bangladesh had comparative advantage in the production of aromatic and fine rice both from the point of view of export and import substitution, except the Nizershail variety which was marginally unprofitable under export proposition. The study also identified some problems faced by the farmers in producing aromatic and fine rice.

Kadian *et al.,* (2007) determined that T. Aman (wet season rice)- Fallow- Boro (summer) rice is the dominant cropping system in Bangladesh. The introduction of both double transplanting of boro rice and high yielding potato varieties into the rice based cropping system proved beneficial as higher productivity and returns were obtained from the T. Aman rice- Potato-double transplanted Boro rice compared to the other systems. In spite of higher cost of double transplanted technology of boro rice over traditional system, the T. Aman-Potato-DT Boro system gave about 35-47% higher gross margin (net profit) than the conventional T.Aman-Potato-Boro Rice pattern. Including double transplanting of boro rice in the T.Aman-Potato-Boro rice pattern, the margin of gross profit was increased between US$ 700 to 1000/hectare. The double transplanting of boro rice can be practiced successfully in the upper and middle highlands as an option for optimizing the productivity of T.Aman-Potato-Boro rice cropping pattern.

Ismail (2001) conducted a study with the problems of T.Aman cultivation on farm youth of haor area of Mohangonj upazila. Study revealed that there were six top problems in rank order were (1) no arrangement of loan for the farm youth for fishery cultivation, (ii) lack of government programmes in agriculture for the farm youth, (iii) absence of loan giving agencies for establishing agricultural farm, (iv) general people face problem for fishery due to government leasing of Jalmohal, lack of government programs for establishing poultry farm. (vi) lack of agricultural loan for the farm youth.

Sarker *et al.,* (2003) conducted a study on allocation efficiency in irrigated boro rice production: the case of Mymensingh farms. They observed that most of the rice farmers in the study area are predominantly inefficient in allocating their resources. Further efficient use of chemical fertilizer, land preparation and weeding for irrigated MV boro rice would enable farmers to achieve higher economic return.

Sarker *et al.,* (2004) conducted a study on resource exploitation for irrigated boro rice cultivation under favorable production environments. They observed that most of the rice farms under study are predominantly inefficient in allocating their resources. More efficient application of chemical fertilizers and land preparation for irrigated HYV rice would enable farms to achieve productivity under similar production environments.

Ali (2000) attempted to measure and compare resource use and land productivity within tenure groups. Total gross cost for producing Aman, boro and aus were the highest in owner farms and the lowest in tenant farms. It observed that owner operators used higher level of inputs than owner-cum-tenant and tenant operators. Rice owner-cum-tenant operators obtained higher yield in Aman and Aus production then owner and tenant operators. Finally, it was concluded that tenancy affects positively on resource use and production in a predictable fashion even in small scale peasant agriculture.

Hasan (2000) studied on the economic potential of alok hybrid rice and found that per hectare total cost for hybrid alok was Tk. 36,276.33 per hectare variable cost was calculated as Tk. 2,927.05 and per hectare yield was 6,557.07 kg. The price of alok paddy was Tk. 7.81/kg. Taking the by product into account the gross return of hybrid alok per hectare was Tk. 5,465.02. The net return per hectare was Tk. 18,375.50 and the gross margin was Tk. 26,409.97.

Mustafi and Azad (2000) conducted a study on adoption of modern rice varieties in Bangladesh. They examined the comparative profitability of BR-28 and BR-29 and found that the average yields 5,980 kg and 6,670 kg per hectare respectively. The gross margin was higher for BR-29 which was Tk. 27,717.02 per hectare. The farm level data also showed that the unit cost of BR-29 and BR-28 were Tk. 4.70 and Tk. 5.12 per kg. They also compared to BR-28 return from BR-29 is higher by Tk. 3,759 per hectare.

2.2 Research gaps

From the above discussion it is clear that several studies were conducted in Bangladesh concerning the issue related to profitability and resource use efficiency of T. Aman. But no studies were accomplished in my study area to focus on the effects of input to the production process and on the resource use efficiency of different inputs used. Therefore, this study has attempts to analyze the profitability, input output relationship, and resource use efficiency of T. Aman in the study area. It is believe that the present study will contribute significantly to generate new knowledge in the field of T. Aman cultivation.

CHAPTER THREE
METHODOLOGY

3.1 Introduction

In several steps, the study methodology is used to select the best approach to achieve the stated research goals. Methodology is a set of practices, not a formula. Each chapter addresses the methods involved in the investigation, which involves choice of research areas, sample selection, data collection and analysis techniques. Data on individual farmers are generally collected in the agricultural management report. The quality of scientific research depends largely on the correct methods of study. The purpose, goals and aims of the research primarily decide the layout of any survey. This study was based on field level data where primary data were collected from different jute producers. There are several methods of collecting this basic information. For the present study farm survey method was adopted for collecting the primary data. There are three methods by which farm survey data can be gathered (Dillon and Hardaker 1993). These are:

i. Direct observation

ii. Interviewing respondents, and

iii. Records kept by the respondents

Because Bangladesh's farmers do not usually maintain their farming records and accounts, the second method was used to achieve the aims of this report. The following section includes the following: the choice of the study area, the study period, sampling technique and sample size, survey schedule planning, data entry and processing and analytical techniques:

3.2. Topography of Bangladesh

The location of the country in South Asia is between 20º34' and 26º 38' north latitude and 88º01' and 92º41' east longitude (BBS, 2017). Bangladesh is a subtropical monsoon country. The average winter temperature is 17-20.6ºC, average summer temperature remains at 26.9-31.1ºC and average rainfall varies across regions (Shahid, 2010; Shahid and Behrawan, 2008).

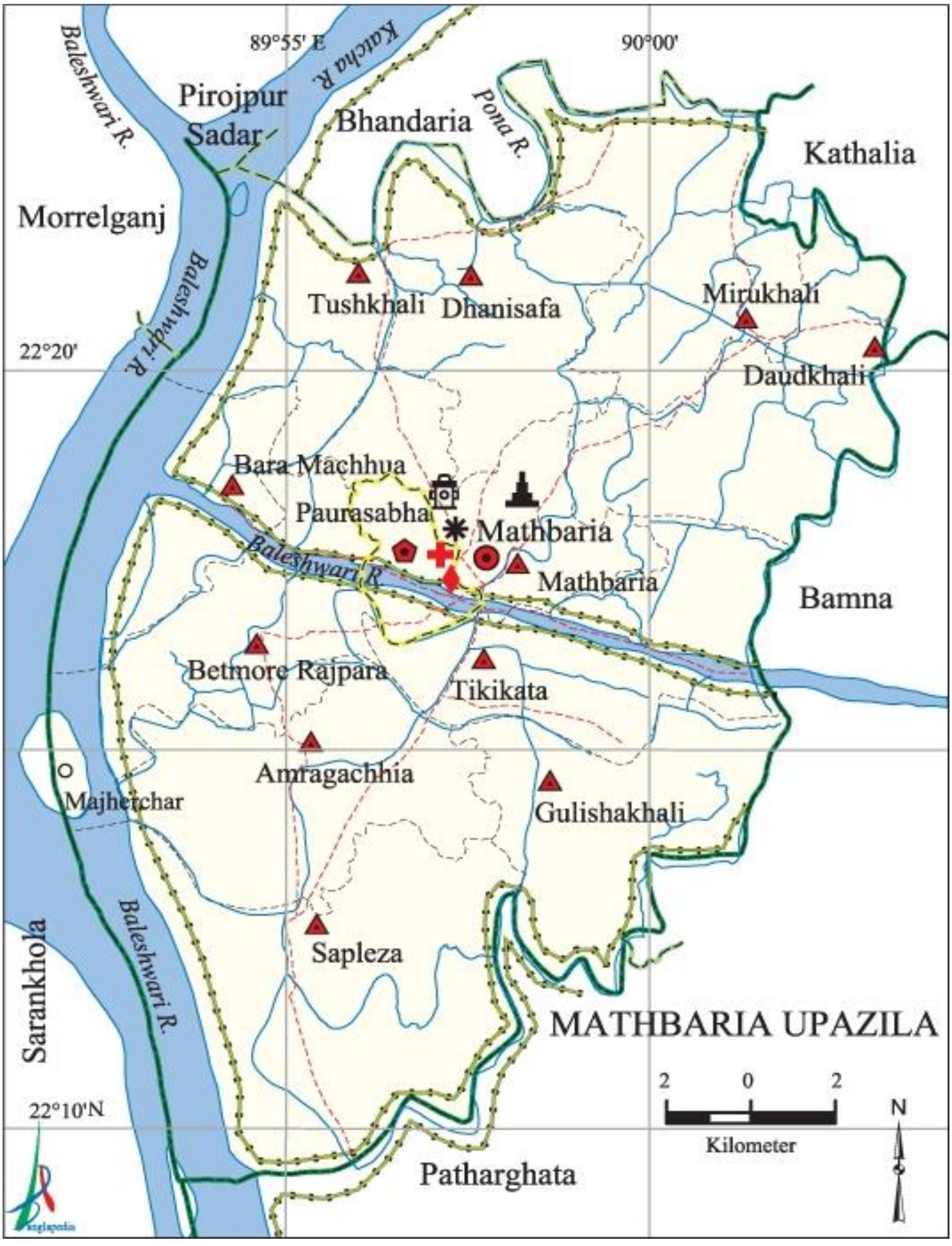
Agriculture is the predominant source of livelihood in rural areas and contributing 14.70% in GDP and employing 42.7% of labour force (BBS, 2017). Bangladesh is the fourth largest rice producing country in the world. In 2015-2016 financial year, 51.804 million metric tons of rice was produced (BBS, 2017). Average size of farm holdings was 3.1 acres in 1960 (Rashid, 1978) and it reduced to 123 acres/person in 2014 (WB, 2015). Land holdings are largely fragmented and there is a predominance of small and marginal farmers. There has been also significant land use change by bringing crop diversification from double to triple crops (Islam, 2003). In the year 2014-2015, Aman rice was cultivated in 48.44% and boro was42.40% of land (BBS, 2014). T. Aman is a rainfed crop and in other two seasons, irrigation is the source of water. Approximately, 60% of the cultivated area is under irrigation coverage (FAO, 2013) and rice accounts for 75.01% area of total cultivated area (BBS, 2014).

However, Bangladesh confronted loss in Boro rice production in changing climate (GAIN, 2015) and Aman season rice faces the most production losses due to natural hazards like floods, heavy downpour and water rush (BBS, 2014).

3.3 Selection of the study area

Pirojpur district was selected purposively. There are seven upazila in Pirojpur district, among them T.Aman rice grows well in Mathbaria upazila.The upazila is the second lowest tier of administrative government in Bangladesh. The districts of Bangladesh are divided into sub-districts called Upazila (Sarker, 2010). Mathbaria Upazila is the upazila of Pirojpur district which area is 353.25 sq km, and it is located in between 22°09' and 22°24' north latitudes and in between 89°52' and 90°03' east longitudes. It is bounded by Pirojpur sadar and Bhandaria upazilas on the north, Patharghata upazila on the south, Bamna and Kanthalia upazilas on the east, Sarankhola and Morrelganj upazilas on the west. Total population of this upazila is 263527 where male is 131940 and female 131587.

The literacy rate is 62.8% whereas male is 62.8%, female 37.2%.The sources of income of the inhabitant are agriculture 59.89%, non-agricultural labourer 4.49%, commerce 12.81%, transport and communication 2.86%, service 7.10%, construction 1.36%, religious service 0.24%, rent and remittance 3.13% and others 7.12%. Land ownership of agricultural land is 65.16% and landless 34.84%. The percentage oflandowner of agriculture is in urban 54.04% and rural 66.32%. There are several main agricultural crops are paddy, wheat, sugarcane, pulse, vegetables etc. Some extinct or nearly extinct crops are betel leaf, jute, sesame, mustard etc. Mango, coconut, jackfruit, banana, betel nut, hog-plum etc are the main fruits of this upazila. (BBS, 2011).



Source: Banglapedia.com/map/pirojpur

The reasons for selecting this study area for the present study are given below:
*Comparatively higher concentration of T. Aman farming.
*These villages have certain similar characteristics, such as homogeneous type of soil, topography and climatic conditions for T. Aman production.
*Facilities for comfort and easy access.
*The researchers ' assumption that the selected respondents are working well together and
* No such study has been carried out in this area.

3.4. Study population and sampling strategy

The population of this study is all farm households residing in the selected villages (Table. 3.1). Thus there are many farm households. The standard statistical formula for selecting a sample size results in a huge number which is impractical for an individual researcher because of time and funding constraints (Blaikie 2010; Gilbert 2008). Since all the farmers in the area face similar socio-economic, environmental and climate conditions in their farming activities, they make up a mostly homogeneous group which validates the use of a small sample size which can be representative of the whole population (Alam, 2016; Blaikie 2010; Gilbert 2008). Therefore, sample size is determined purposively depending on the context rather than a statistical formula. This study aimed to survey a sample of 60 rice farming households. Respondents were selected randomly within the villages. This was expected to reflect the farming features of all farmers in the villages.
A completed list of all rice farming households in the respective villages was collected from the Sub-Assistant Agricultural Officers (SAAOs) in the study areas. The numbered list provided names and addresses of farmers with their farm sizes. Afterwards, a computer-generated random number table was applied to the list to select 60 farm households. In this way the randomness in the sampling procedure was ensured.

Table 3.1 Selected study areas for primary data collection:

Upazilla	Villages
Mathbaria	1. Betmore
	2. Amragachia
	3. Shapleza
	4. Mithakhali

3.5 Sources of data

Data required for the present study were collected from primary and secondary sources. Primary data were obtained from farmers and secondary data were collected from various published sources. Secondary sources were Bangladesh Bureau of Statistics (BBS), Department Agricultural Extension (DAE), Department of Agricultural Marketing, and other related agencies in Bangladesh.

3.6 Preparation of the survey schedule

Preparation of survey schedules is of crucial importance in this study. A comprehensive survey schedule was prepared to collect necessary information from the concerned respondent in such a way that all relevant information needed for T.Aman farming could be easily obtained within the shortest possible time. The interview schedule was pretested for judging their suitability. After pre testing, the schedule was finalized.

3.7 Collection of data

To satisfy the objectives of the study, necessary data were collected by visiting each farm personally and by interviewing them with the help of a pretested interview schedule. Usually most of the respondent does not keep records of their activities. Hence it is very difficult to collect actual data and the researcher has to rely on the memory of the respondent. Before going to an actual interview, a brief introduction of the aims and objectives of the study was given to each respondent.

The question was asked systematically in a very simple manner and the information was recorded on the interview schedule. When each interview was over the interview schedule was checked and verified to be sure that information to each of the items had been properly recorded. In order to minimize errors, data were collected in local units. These were subsequently converted into appropriate standard unit. Data collection period was 1st August to 31st August, 2019. In order to obtain reliable data the researcher initially visited for several times to introduces himself with the people of the study areas during the season. Secondary data were collected through literature and different publications.

3.8 Editing and tabulation of data

After collection of primary data, the filled schedules were edited for analysis. These data were verified to eliminate possible errors and inconsistencies. All the collected data were summarized and scrutinized carefully. For data entry and data analysis, the Microsoft Excel programs and SPSS program were used. It might be observed here that information was collected initially in local units and after checking the collected data, it was converted into standard units. Finally, a few relevant tables were prepared according to necessity of analysis to meet the objectives of the study.

3.9 Analytical techniques

Data were analyzed with the purpose of fulfilling the objectives of the study. Both descriptive and statistical analysis was used for analyzing the data.

3.9.1 Descriptive analysis

Tabular technique of analysis was generally used to find out the socio-demographic profile of the respondent, to determine the cost, returns and profitability of T.Aman farm enterprises. It is simple in calculation, widely used and easy to understand. It was used to get the simple measures like average, percentage etc.

3.9.2 Production function analysis

The production function represents the technological relationship between output and factor inputs. To estimate the production function, one requires development of its properties leading to specification of an explicit functional form. One of the most widely used production function for empirical estimation is the Cobb Douglas production. This function was originally used by C.W. Cobb and P.H. Douglas in twenties to estimate the marginal productivities of labor and capital in American manufacturing industries. Their main purpose was to estimate the shares of labor and capital in total product; hence they used this function with the constraint that the sum of elasticities or regression coefficients should total one. Later on, they relaxed this restraint. Cobb and Douglas originally fitted the function to time series 1930s and 1940s; the same form was used for cross section of industries. This form of the function was subsequently used in many production function studies for technical units (crops, livestock) and farm-firms in agricultures. The popularity of this function is because of the following characteristics of the function:

(i) It directly provides the elasticities of production with respect to inputs;

(ii) It allows more degrees of freedom than other algebraic forms (like a quadratic function) which allow increasing or decreasing marginal productivities, and

(iii) It simplifies the calculations by reducing the number of regression to be handled in regression analysis. The original form used by Cobb and Douglas was

$\mathbf{Q = aL^{\beta}K^{1-\beta}U}$

This forces sum of elasticities to one. Their later modification was

$\mathbf{Q = aL^{\alpha}K^{\beta}U}$

Where, $\boldsymbol{\alpha} + \boldsymbol{\beta}$ need not equal one. In agriculture, this form of function has not been used in its original form. Neither the sum of elasticities is kept equal to one nor is the number of variables limited to two. Even then as the basic idea of functional form was provided by Cobb and Douglas, various forms of this function have continued to be called as Cobb-Douglas production function. The Cobb–Douglas production function, in its stochastic form, may be expressed as

$Yi = \beta_1 X_{2i}^{\beta 2} X_{3i}^{\beta 3} e^{ui}$ ……………….. (3.1)

Where,

Y = output

X_2 = labor input

X_3 = Capital input

u = stochastic disturbance term,

e = base of natural logarithm.

From Eq. (3.1) it is clear that the relationship between output and the two inputs is nonlinear. However, if we log-transform this model, we obtain:

$\ln Y_i = \ln\beta_1 + \beta_2 \ln X_{2i} + \beta_3 \ln X_{3i} + u_i$

$= \beta_0 + \beta_2 \ln X_{2i} + \beta_3 \ln X_{3i} + u_i$ ………….. (3.2)

Where $\beta_0 = \ln\beta_1$.

Thus written, the model is linear in the parameters β_0, β_2, and β_3

The properties of the Cobb–Douglas production function are quite well known and is, therefore, a linear regression model. Notice, though, it is nonlinear in the variables Y and X but linear in the logs of these variables. In short, (3.2) is a log-log, double-log, or log-linear model, the multiple regression counterpart of the two-variable log-linear model.

The properties of the Cobb–Douglas production function are quite well known:

1. β_2 is the (partial) elasticity of output with respect to the labor input, that is, it measures the percentage change in output for, say, a 1 percent change in the labor input, holding the capital input constant.

2. β_3 is the (partial) elasticity of output with respect to the capital input, holding the labor input constant.

3. The sum ($\beta_2 + \beta_3$) gives information about the returns to scale, that is, the response of output to a proportionate change in the inputs. If this sum is 1, then there are constant returns to scale, that is, doubling the inputs will double the output, tripling the inputs will triple the output, and so on. If the sum is less than 1, there are decreasing returns to scale—doubling the inputs will less than double the

output. Finally, if the sum is greater than 1, there are increasing returns to scale—doubling the inputs will more than double the output.

Before proceeding further, note that whenever you have a log–linear regression model involving any number of variables the coefficient of each of the X variables measures the (partial) elasticity of the dependent variable Y with respect to that variable.

Thus, if you have a k-variable log-linear model:

$lnY_i = \beta_0 + \beta_2 lnX_{2i} + \beta_3 lnX_{3i} + \dots \dots + \beta_k lnX_{ki} + u_i$ ………….. (3.3)

Each of the (partial) regression coefficients, β_2 through β_k, is the (partial) elasticity of Y with respect to variables X_2 through X_k. Assuming that the model (3.2) satisfies the assumptions of the classical linear regression model; we obtained the regression by the OLS. (Acharaya, 1988).

3.9.3 Specification of the Cobb-Douglas Production Function

The input-output relationships in T.Aman farming was analyzed with the help of Cobb-Douglas production function approach. To determine the contribution of the most important variables in the production process of T.Aman farming, the following specification of the model was used.

$Y = aX_1b_1X_2b_2X_3b_3X_4b_4X_5b_5X_6b_6e^{ui}$ .... (3.4)

The Cobb-Douglas production function was transformed into following logarithmic form so that it could be solved by ordinary least squares (OLS) method.

$lnY = lna + \beta_1 InX_1 + \beta_2 lnX_2 + \beta_3 lnX_3 + \beta_4 lnX_4 + \beta_5 lnX_5 + U_i$ ………….(3.5)

Where, Y= Gross income from year round T.Aman (Tk/ha);

Y= Return per hectare (Tk/ha)

Ina= Intercept of the function

X_1= Cost of human labor (Tk/ha)

X_2= Cost of seed (Tk/ha)

X_3= Cost of fertilizer (Tk/ha)

X_4= Cost of manure (Tk/ha)

X_5 = Cost of insecticide (Tk/ha);

b_1, b_2. . ….. b_5 = Coefficients of the respective input to be estimated; and

U_i = Error term. Coefficient of the respective variable; i= 1, 2,…….5

.

3.10 Measurement of resource use efficiency

In order to test the efficiency, the ratio of Marginal Value Product (MVP) to the Marginal Factor Cost (MFC) for each input were computed and tested for its equalto 1. i.e.,

MVP/MFC = 1.

The marginal productivity of a particular resource represents the additional to gross returns in value term caused by an additional one unit of that resource, while other inputs are held constant. When the marginal physical product (MPP) is multiplied by the product price per unit, the MVP is obtained. The most reliable, perhaps the most useful estimate of MVP is obtained by taking resources (Xi) as well as gross return (Y) at their geometric means.

In this study the MPP and the corresponding values of MVP were obtained as follows:

$MPPx_i *Py_i=MVP$

But, MPP = b_i*(Y/X_i),

So, MVP = b_i* (Y/X_i) Py_i

Where,

Y = Mean value output

b_i = regression coefficient per resource use

X_i = Mean value of inputs

Py_i= price per uni output

MFC = price per unit of input.

Decision criteria:

The decision criteria for choosing efficiency will be-

*When the ratio of MVP and MFC is equal to unity indicates that the resource is efficiently used.

*When the ratio of MVP and MFC is more than unity implying the resource is underutilized.

*When the ratio of MVP and MFC is less than unity implying the resource is overused.

3.11 Profitability analysis

Cost and return analysis is the most common method of determining and comparing the profitability of different farm household. In the present study, the profitability of T.Aman farming is calculated by the following way

3.11.1 Calculation of gross return

Per hectare gross return was calculated by multiplying the total amount of product and by-product by their respective per unit prices.

Gross Return= Quantity of the product * Average price of the product + Value of byproduct.

3.11.2 Calculation of gross margin

Gross margin is defined as the difference between gross return and variable costs. Generally, farmers want maximum return over variable cost of production. The argument for using the gross margin analysis is that the farmers are interested to get returns over variable cost. Gross margin was calculated on TVC basis. Per hectare gross margin was obtained by subtracting variable costs from gross return. That is, Gross margin = Gross return – Variable cost.

3.11.3 Calculation of net return

Net return or profit was calculated by deducting the total production cost from the total return or gross return. That is,

Net return = Total return – Total production cost.

The following conventional profit equation was applied to examine farmer's profitability level of the T.Aman producing farms in the study areas.

Net profit, $\pi = \Sigma P_m Q_m + \Sigma P_f Q_f - \Sigma (P_{xi} X_i) - TFC$.

Where, π = Net profit/Net return from T.Aman farming (Tk/ha);

P_m = Per unit price of T.Aman (Tk/kg);

Q_m = Total quantity of the T.Aman production (kg/ha);

Q_f = Per unit price of other relevant T.Aman (Tk/kg);

P_f = Total quantity of other relevant T.Aman (kg/ha);

P_{xi} = Per unit price of i-th inputs (Tk);

TFC = Total fixed cost (Tk); and

X_i = Quantity of the i-th inputs (kg/ha);

i = 1, 2, 3,..............., n (number of inputs).

3.11.4 Undiscounted Benefit Cost Ratio (BCR)

Average return to each taka spent on production is an important criterion for measuring profitability. Undiscounted BCR was estimated as the ratio of total return to total cost per hectare.

BCR= Total Return /Total Cost

3.12 Problem faced in collecting data

During the period of data collection, the researcher faced the following problems.

a. Most farmers were disturbed to answer questions because the researcher thought the information could be used against their interests. A lot of time was spent gaining the trust of the peasants.

b. Farmers do not keep daily expenses or records of their operations. The farmers must depend on his memory.

c. The farmers have usually been involved in their activities. Sometimes the researcher had to contact the farmer in addition.

CHAPTER FOUR
SOCIO-ECONOMIC CHARACTERISTICS

Introduction

The socioeconomic characteristics of sample farmers are covered in this section. In inferring the planning of production, the socioeconomic features of farmers are significant. The sample households finished by studying socioeconomic aspects. These included age distribution and family size. Occupation, employment, women's participation, pattern of land ownership, etc. These aspects are discussed briefly below.

4.1Age distribution

The table 4.1 showed that the majority of farmers in the study area are middle aged. Out of the samples, 20% were in the 20-30-year age group, 58.33% belonged to the 31-50-year age group and, 21.67% fall into the over 45-year age group. This result suggests that the majority of sampling farmers were in the most involved 31-50-year age group suggesting that more physical efforts have been made for agriculture.

Table 4.1 Age Distribution

Age category	No. of Persons	Percentage (%)
20-30 years	12	20.00
31-50 years	35	58.33
Above 51 years	13	21.67

Source: Field Survey, 2019.

4.2 Educational status

Education is a tool which increases the people's effectiveness. Table 4.2 indicates that 6.67% of the farmers were illiterate, 36.67% have a primary school, 21.66% of the farmers have a J.S.C level education, 20% were secondary school graduates and 15% were HSC and above.

Table 4.2 Educational status

Level of education	No. of Persons	Percentage (%)
Illiterate	4	6.67
Primary school certificate	22	36.67
Junior school certificate	13	21.67
Secondary School Certificate	12	20
Higher Secondary School Certificate and above	9	15

Source: Field Survey, 2019.

4.3 Occupational status

Farmers employment status is listed in table 4.3 below. From the figure, it is evident that 86.67% of income came from agriculture where 66.67%, 11.67%,3.33% and 5% income earned from T.Aman cultivation, others agricultural crops, fisheries and livestock respectively. Non-agricultural agricultural income was 13.33% that came from service, business, rickshaw-van pulling and others.

Table 4.3 Occupational status

Types of occupation	No. of Persons	Percentage (%)
Agriculture		
T. Aman	38	63.33
Others agricultural crops	7	11.67
Fisheries	2	3.33
Livestock	3	5
Non-agriculture		
Service	2	3.33
Business	3	5
Rickshaw, van pulling and others	3	5

Source: Field Survey, 2019.

4.4 Farm size and ownership

The study farmers are differentiated as landless farmers (less than 49 decimal), small farmer (50-249 decimal), medium farmer (250-749 decimal) and large farmer (above 750 decimal) (GOB, 2009). Table 4.4 shows that in the sample, 33.33percent were landless farmer, 38.33 percent were small farmer, 21.67 percent were a medium farmer and only 6.67 percent were large farmer.

Table 4.4 Farm size and ownership

Types of farmers	No. of Persons	Percentage (%)
Land less (less than 49 decimal)	20	33.33
Small Farmer (50-249 decimal)	23	38.33
Medium Farmer (250-749 decimal)	13	21.67
Large Farmer (above 750 decimal)	4	6.67

Source: Field Survey, 2019.

4.5 Income status

In the study area, the rice farmers ' incomes were divided into less than Tk.150,000, from Tk.150,000 to Tk.250,000 and more than Tk.250,000. It is evident from the table 4.7 that most of the farmer’s yearly income belonged to the category of less than Tk.150,000. About 48.33 percent of the rice farmers were earned Tk. 150,000 to 250,000 per year, 41.67 percent of the farmers were earned Tk. less than 150,000 per year and 10 percent farmers were earned Tk. Above 250,000 per year.

Table 4.5 Income status

Level of income	No. of Persons	Percentage (%)
Less than 150,000 Tk.	25	41.67
150,000-250,000 Tk.	29	48.33
Above 251,000 Tk.	6	10

Source: Field Survey, 2019.

4.6 Sources of credit facilities of the respondent

For all forms of agriculture, the funding available is an important factor. Banks, NGOs, relatives and their own funds are the source of credit facilities for shrimp farmers. Around 11.67% of the farmers were borrowing from banks, 38.33% were borrowing from NGOs and 13.33% were borrowing loans from their family members as stated by the farmers. 36.67% of farmers used their own money (Table 4.6).

Table 4.6 Sources of credit facilities of the sample farmers

Items No.	No. of Persons	Percentage (%)
Bank	7	11.67
NGOs	23	38.33
Relatives	8	13.33
Own	22	36.67

4.7 Size of land holdings of the sample farmers

The scale of the land held by T.Aman rice farmers is listed in various categories in the present study. Size of land holdings includes homestead area, orchard, pond, cultivated land, fellow land, leased in, leased out and mortgage in as reported by the sample farmers. It is evident from the table 4.11 that the average area 9.8 decimal, 67 decimal, 14 decimal, 21 decimals were homestead area, cultivated land, rented in, and rented out leased in respectively.

Table 4.7 Size of land holdings of the sample farmers

Types of land	Average area (Decimal)
Own cultivated land	67
Homestead land	9.8
Rented in	14
Rented out	21
Mortgage in	26
Mortgage out	18
Fellow land	1.3
Total	79.1

Source: Field survey, 2014.

4.8 Barriers of T. Aman cultivation

In the study area farmers appear some barriers such as lack of labor, lack of money, lack of water for irrigation, lack of market for selling products, lack of education, poor agricultural extension service delivery, lack of knowledge etc. (Figure 4.8). About 93 % farmers mentioned low price of rice regularly. This survey depicts that 47% of farmers mentioned lack of money. High cost of improved varieties is noted by 78 % farmers. Marketing problem is also face by 53 % farmers in the study area.

Table 4.8 Barriers of T.Aman cultivation

Problems	Percentage
Shortage of labor	68
Lack of money	47
Lack of processing and storing facilities	38
Natural calamities	53
Lack of education	21
High cost of improved varieties	78
Poor agricultural extension service	43
Low price	93
Lack of market	62

CHAPTER FIVE
COST AND RETURN OF T. AMAN PRODUCTION

5.1 Introduction

The main aim of this chapter is to evaluate T.Aman costs and returns. In addition, the costs and returns of cultivation per ha of the T.Aman rice have been measured. Therefore, this chapter estimates cost and return for T.Aman. Cost items are divided into two categories for the cost estimation and return of T.Aman production: (1) variable cost and (2) fixed cost. Variable cost included the cost of all variable factors like human labor, tillage, seed, fertilizer, manure, and insecticides. On the other hand, fixed cost was calculated for interest on operating capital. On the return side net return and undiscounted benefit cost ratio (BCR) were determined in thischapter.

5.2 Variable cost

5.2.1 Labour cost

The most important and mostly used input for the development of T.Aman was human labor. As the T.Aman production is the labor-intensive work. It reduces the unemployment problem. Group based T.Aman cultivation in the selected area plays vital role for the reduction of the poverty.It contributed a large scale of the total cost of production of T.Aman.

Human labour, including preparing ground, weeding, fertilization, using insecticides and harvesting, is required for various activities and management. In the study area, there were two sources of work for human beings, one for families and one for hired labor. The appraisal of the hired labor was made as compensation of the farmers ' marginal cash salaries. The amount of work used for the production of T.Aman is 65-man days per ha from Table 5.1. Total human labor costs are equal to Tk. 22750 /ha.

The valuation of family supplied labor was done as the average wage of the hired labour was taken as the opportunity cost of the family supplied labor. It can be observed that T.Aman growers used on an average 65 man-days/ha total human labour where on an average 31 man-days/ha was family supplied labor. In the study area on an average wage rate was Tk

350 per man-day. So, total cost of family supplied labor for T.Aman amounted to Tk 10850 per ha. The number of hired labor was 34 and the hired labor cost was Tk. 11900.

Table 5.1: Variable Cost of labour in T.Aman rice production

Items of returns/costs	**Hired labour**	**Family labour**	**Unit**	**Quantity**	**Priceper unit(Tk)**	**Total value (Tk)**
Land preparation	10	5	Man-day	15	350	5250
Sowing	9	3	Man-day	12	350	4200
Weeding	5	8	Man-day	13	350	4550
Fertilizer	1	2	Man-day	3	350	1050
Harvesting	8	11	Man-day	19	350	6650
Pest Management	1	2	Man-day	3	350	1050
Total	**34**	**31**		**65**	**350**	**22750**

Source: Field Survey, 2019

5.2. 2 Cost of tillage

For T.Aman production the average per ha tillage cost was Tk 5300 (Table 5.2)

5.2.3 Cost of seeds

The seed cost is the main cost item for the production of T.Aman rice. In the area under consideration, farmers were found to use both seeds supplied and bought at home. The total seed demand for T.Aman per ha was 50 kg / ha. The average prices of seeds were Tk. 42 per kg. Table 6.2 shows that the total cost of seeds for T.Aman production was Tk. 2100. To maintain the higher production high yield verity is required for the production.

Table 5.2: Total Variable cost of T.Aman rice production

Items of returns/costs	**Unit**	**Quantity**	**Price per unit (Tk)**	**Total value (Tk)**
Human (hired labor)	Man-day	34	350	11900
Human (family labor)	Man-day	31	350	10850
Tillage	Tk	N/A	N/A	5300
Seeds	Kg	50	42	2100
Urea	Kg	153	20	3060
TSP	Kg	87	25	2175
MoP	Kg	54	18	972
Gypsum	Kg	78	10	780
Zinc Sulphate	Kg	22	52	1144
Cow dung	Kg	824	2	1648
Insecticides	Tk	n.a	-	2750
Total	**Tk**	**-**	**-**	**42679**

Source: Field Survey, 2019

5.2.4 Cost of fertilizer

The cost of urea is TK 3060. It is very useful to get the bumper production. The cost of TSP is TK 2175. It provides nutrient to plant to become more vigor. The cost of MoP is TK 972. The cost of Gypsum is TK 780. The cost of Zinc Sulphate is TK 1144.

5.2.5 Cost of cowdung

In this study total manure cost is Tk 1648 per ha when per unit manure cost is 2.00 Tk (Table 5.2).

5.2.6 Cost of pesticide

In the study area, farmers applied insecticides to protect from the attack of pests and diseases. Cost of insecticides amounted to Tk 2750 per ha for T.Aman (Table 5.2).

5.2.7 Total variable cost

Summation of the costs of variable inputs gave the total variable costs which were Tk 42679 per ha for T.Aman production.

5.3 Total fixed cost

5.3.1 Interest on operating capital

Interest on operating capital was calculated by taking into account all the operating costs incurred during the production period of T.Aman. Per ha interest on operating capital was Tk 1423 and rental value of one-ha land is Tk 12000 for T.Aman production. So total fixed cost is Tk. 13423.

Table 5.3: Fixed cost of T.Aman rice production

Items of returns/costs	Unit	Quantity	Price per unit (Tk)	Total value (Tk)
Interest on OC for 4 months	Tk	42679	@10%	1423
Rental value	Tk	12000.00	N/A	12000
Total	Tk	-	-	13423

5.4 Total cost

In order to estimate total cost per ha all the resources used in T.Aman production has been recapture together. Per ha total cost of T.Aman production was Tk. 56102 (Tables 5.4).

Table 5.4: Total cost (Variable cost + Fixed cost) of T.Aman rice production

Items of returns/costs	Unit	Variable cost	Fixed cost	Total (Tk)
Total cost	Tk	42679	13423	56102

Source: Field Survey, 2019

5.5: Gross returns

Here gross returns of the T.Aman production is= (Main product+ By-product). Total value of by products is Tk. 5000. The quantity of main product is 3470 Kg. If the price of the T.Aman per unit is Tk. 20 then it becomes the total value of T.Aman main product is Tk. 69400. So the gross return of the T.Aman production is Tk. 74400.

Table 5.5: Gross return of T.Aman rice production

Items of returns/cost	Unit	Quantity(Kg)	Priceper unit(TK)	Total Value (Tk)
Main product	Kg	3470	20	69400
By-product	TK	n.a	-	5000
Gross returns	TK	-	-	74400

Source: Field Survey, 2019

5.6 Net return

The net return of T.Aman production is depending on both gross return and total cost of the T.Aman production.Net return is Tk. 18298

Table 5.6: Net return (Gross return – Total cost) of T.Aman rice production

Items of returns/costs	Unit	Gross return	Total cost	Total value (Tk)
Net return	Tk	74400	56102	18298

Source: Field Survey, 2019

5.7 Undiscounted BCR

Benefit cost ratio was calculated by dividing gross return by gross cost or total cost. It implies return per taka invested. It helps to analyze financial efficiency of the farm. It was evident from the study that the benefit cost ratio of T.Aman farming was accounted for 1.32 implying that Tk. 1.32 would be earned by investing Tk. 1.00 for T.Aman production. So, the T.Aman farming was found to be profitable for farmers (Table6.7).

Table 5.7: Undiscounted BCR

Items of returns/cost	Gross Return	Gross cost	Ratio
Undiscounted BCR	74400	56102	1.32

Source: Field Survey, 2019

CHAPTER SIX

RESOURCE USE EFFICIENCY OF T.AMAN PRODUCTION

6.1 Introduction

The aim of this chapter to identify and measure the effects of the major variables on T.Aman production. Cobb-Douglas production function was chosen to estimate the contribution of key variables on the production process of T.Aman farming. The estimated values of the model are presented in Table7.1.

6.2 Functional analysis for measuring resource use efficiency

Production function is a relation or a mathematical function specifying the maximum output that can be produced with given inputs for a given level of technology. Keeping in mind the objectives of the study and considering the effect of explanatory variables on output of T.Aman farming, six explanatory variables were chosen to estimate the quantitative effect of inputs on output.

Management factor was not included in the model because specification and measurement of management factor is almost impossible particularly in the present study, where a farm operator i**s** both a labor and manager.

Production function is a relation or math function that specifies the maximum output to be obtained by specified inputs at a certain technical level. In order to estimate the quantitative effect of inputs on performance, taking into account the study objectives and the influence from explanatory variables on the production of yields, six explanatory variables were chosen. The management factor was not included in the model because it is almost impossible, in particular in this study, to specify and measure the management factor, where both work and manage is a farmer. Other independent variables like water quality, soil condition, time etc., which might have affected production of farm enterprises, were excluded from the model on the basis of some preliminary estimation. A brief description is presented here about the explanatory variables included in the model.

6.3 Estimated values of production function analysis

- F-value was used to measure the goodness of fit for different types of inputs
.
- The coefficient of multiple determinations (R^2) indicates the total variations of output explained by the independent variables included in the model.

- Coefficients having sufficient degrees of freedom were tested for significance level at 1 percent, 5 percent and 10 percent levels of significant.

- The estimated coefficients and related statistics of the Cobb-Douglas production function for T.Aman production are shown in Table 6.3.

Table 6.3 Determinants the resource use of Coefficients and Related Statistics of Cobb-Douglas Production Function Model for T.Aman.

	Coefficients	*t value*
Intercept	0.796	0.917
Human labor	0.794***	8.357
Seed	0.403***	5.631
Urea	0.020	0.363
TSP	0.036	1.471
MOP	0.004	0.062
Gypsum	0.034	0.369
Insecticide	0.090***	3.738
R^2	0.6957	
F	23.71***	

Note:

* 10% level of significant

** 5% level of significant

*** 1% level of significant

Source: Authors Estimation

6.4 Interpretation of the results

Labor cost (X_1). The magnitude Cobb-Douglas regression coefficient of labor cost was 0.794 for T.Aman. It was positive and significant at one percent probability level. This indicates that an increase in one taka labor cost, remaining other factors constant, would result in an increase in the gross return by 0.764 taka.

Seed cost (X_2). The magnitude of the regression coefficient of seed cost was 0.403 with a positive sign. It was highly significant at one percent probability level. It implies that one taka increase of seed cost, keeping other factors constant, would lead to an increase in the gross return by 0.403 taka for T.Aman (Table 6.3).

Cost of fertilizers (X_3, X_4, X_5, X_6): It is observed from the regression that the coefficient of the use of Urea, TSP, MoP and Gypsum were positive and insignificant. The higher cost of fertilizers keeping others factor remaining constant would decrease the return by 0.020, 0.036, 0.004 and 0.034 taka respectively.

Cost of Insecticide (X_7): The Cobb-Douglas regression coefficient of inseticides cost was 0.090 and significant at one percent probability level for T.Aman farming. It indicates that one taka increase of cost of insecticide, remaining other factors constant, would increase gross returns by 0.090 taka.

Coefficient of multiple determinations (R^2). It is evident from Table 6.3 that the value of the coefficient of multiple determinations (R^2) was 0.6957 for T.Aman. It indicates that about 69 percent of the total of the gross returns are explained by the explanatory variables included in the model.

Goodness of fit (F - value). The F-value was 23.71 for T.Aman, which implies good fit of the model. That is, all the explanatory variables included in the model were important for explaining variation of T.Aman production.

6.5 Resource use efficiency in T.Aman production

A ratio equal to the unit indicated an optimal use of that variable to determine the status of the efficiency of resource use and a ratio greater than the unit indicated the output could be improved by the use of more resources. The unprofitable resource use was indicated by a value less than unit that should be reduced, to reduce losses, as farmers used this factor above. The ratio of MVP and MFC of human labor (0.148) for T.Aman production was positive and less than one which indicated that labor application was over utilized. So, farmers should decrease the use of fertilizer to attain efficiency in T.Aman production.

Table 6.5 showed that the ratio of MVP and MFC of seed (6.79) for T.Aman farming was positive and greater than one, which indicated that labor application was underutilized. So, farmers should increase the use of fertilizer to attain efficiency in T.Aman production.

The ratio of MVP and MFC of urea was found to be (0.486) for T.Aman farming was was positive and less than one, which indicated that labor application was over utilized. So, farmers should decrease the use of fertilizer to attain efficiency in T.Aman production.

Table 6.5 revealed that the ratios of MVP and MFC of MOP used for T.Aman production was positive and less than one (0.34), which indicated that MOP application was over utilized. So, farmers should decrease the use of fertilizer to attain efficiency in T.Aman production.

Table 6.5 revealed that the ratios of MVP and MFC of gypsum used for T.Aman production was negative and less than one (6.486), which indicated that gypsum application was over utilized. So, farmers should decrease the use of fertilizer to attain efficiency in T.Aman production.

Table 6.5 Estimated Resource Use Efficiency in T.Aman Production

Variables	Geometric mean (GM)	Y(GM)/Xi(GM)	Co-efficient	MVP(Xi)	MFC	r=MVP/MFC	Comments
Yield	74400						
Human labour	22750	3.27	0.794	51.9	350	0.148	Over utilized
Seed	2100	35.43	0.403	285.52	42	6.79	Under utilized
Urea	3060	24.31	0.020	9.72	20	0.486	Over utilized
TSP	2175	34.21	0.036	22.46	25	0.898	Over utilized
MoP	972	76.54	0.004	6.12	18	0.34	Over utilized
Gypsum	780	95.38	0.034	64.86	10	6.486	Under utilized

Source: Field survey, 2019

CHAPTER SEVEN
CONCLUSION AND RECOMMENDATION

This chapter summarizes the main finding of the study and provides some recommendations and future research direction. The organization of this chapter is as follows: Section 7.1summarizes the main findings to answer the three research objectives. Section 7.2 provides some policy recommendations based on the findings. and Section 7.3 presents further research directions.

7.1 **Conclusion**

The present study revealed that 20% were in the 20-30-year age group, 57% belonged to the 31-50-year age group and, 23% fall into the over 45-year age group. Around 11% of the farmers were illiterate, 44% have a primary school, 23% of the farmers have a J.S.C level education, 9% were secondary school graduates and 5% were HSC and above. Farmers employment status was that 87% of income came from agriculture where 67%, 12%,3% and 5% income earned from T.Aman cultivation, others agricultural crops, fisheries and livestock respectively. Non-agricultural agricultural income was 13% that came from service, business, rickshaw-van pulling and others. Farmers were differentiated as landless farmers (less than 49 decimal), small farmer (50-249 decimal), medium farmer (250-749 decimal) and large farmer (above 750 decimal) (GOB, 2009) and where 35 percent were landless farmer, 49 percent were small farmer, 11 percent were a medium farmer and only 5 percent were large farmer. About 49 percent of the rice farmers were earned Tk. 150,000 to 250,000 per year, 41 percent of the farmers were earned Tk. less than 150,000 per year and 10 percent farmers were earned Tk. Above 250,000 per year. Around 9% of the farmers were borrowing from banks, 39% were borrowing from NGOs and 13% were borrowing loans from their family members as stated by the farmers. 39% of farmers used their own money. It is evident that the average area 9.8 decimal, 67 decimal, 14 decimal, 21 decimals were homestead area, cultivated land, rented in, and rented out leased in respectively.

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In the study area farmers appear some barriers such as lack of labor, lack of money, lack of water for irrigation, lack of market for selling products, lack of education, poor agricultural extension service delivery, lack of knowledge etc. About 93 % farmers mentioned low price of rice regularly. This survey depicts that 47% of farmers mentioned lack of money. High cost of improved varieties is noted by 78 % farmers. Marketing problem is also face by 53 % farmers in the study area. Cost items are divided into two categories for the cost estimation and return of T.Aman production: (1) variable cost and (2) fixed cost. Variable cost included the cost of all variable factors like human labor, tillage, seed, fertilizer, manure, irrigation water, and insecticides. On the other hand, fixed cost was calculated for interest on operating capital. The most important and mostly used input for the development of T.Aman was human labor. As the T.Aman production is the labor-intensive work. The amount of work used for the production of T.Aman is 65-man days per hactre . where on an average 31 man-days/ha was family supplied labour and human labor costs are equal to Tk. 22750 /ha. For T.Aman production the average per ha tillage cost was Tk 6000. In the study area, farmers applied insecticides to protect from the attack of pests and diseases. Cost of insecticides amounted to Tk 2750 per ha for T.Aman. The total variable costs, fixed cost and operating ost were which were Tk 42679, Tk. 13423 and Tk. 1423 per ha for T.Aman production. The total cost, total return and net return were Tk. 56102, Tk 74400 and Tk. 18298 respectively. Benefit cost ratio was 1.32.

Cobb-Douglas production function was chosen to estimate the contribution of key variables on the production process of T.Aman farming, four variables were found which were very significant in production of T.Aman such as human labor, seed, insecticide and education. The value of the coefficient of multiple determinations (R^2) was 0.6975 for T.Aman. It indicates that about 69 percent of the total of the gross returns are explained by the explanatory variables included in the model. The F-value was 23.71 for T.Aman, which implies good fit of the model. That is, all the explanatory variables included in the model were important for explaining variation of T.Aman production. A ratio equal to the unit indicated an optimal use of that variable to determine the status of the efficiency of resource use and a ratio greater than the unit indicated the output could be improved by the use of more resources. In the study area seed and gypsum were underutilized which used should be increased to attain more productivity and human labour, urea, TSP, and MOP were over utilized these variable used should be decreased to attain the optimum productivity.

7.2 Recommendations

- Marketing for agricultural products should be a key question for policy-makers, because this is a very common scenario nowadays; farmers do not receive a fair price of their products and become looser each year. In the field of study, we saw that the sales of agricultural products are a problem. In reality, the agricultural marketing system is not monitored by an active governing institution. The Department of Marketing is also responsible for supervising this system, but it is regrettable that, in the absence of effective officials, it is completely inactivated by its institution. Government should redesign it with the official who are expert about agricultural marketing and agribusiness like graduate of agricultural economics and agricultural marketing.
- In the study it was observed that some resource were over used and some under used. In this regard, the officials of DAE should make more meeting with farmers, celebrate campaign after a certain period of time through these activities farmers would be aware regarding using the resources.
- There should be a greater extension service by the officials of DAE. The new technology will be disseminated to farmers to increase T.Aman rice production. Further exposure to agricultural products through modern technologies can offer economic well-being.
- Therefore, for small and landless farmers, government subsidies are also necessary but very marginal percentages of the farmers receive government subsidies. Here too, some maladministration occurred as a result of which the state announced that it could not achieve the subsidy. Politicians should therefore rethink the subsidy system. We believe that it is better to pay cash because the system of subsidies and

dissemination should not traditional. SAASs can provide a list of real beneficiaries, so that the ministry of agriculture can provide the subsidy as cash on the farmers ' bank account.

- Lack of finance is a common phenomenon of our farmers. Policymakers have to reconsider about the financial facility of farmers because farmers are maker of the nation; their sound existence is the sign of wellbeing. Krishi Bank can provide loan without any interest to small and landless farmers because they are more vulnerable to climate change or any natural calamities. But real scenario is different farmers go to rural usury for finance and they victims with the high interest rate; they get impoverished day by day and vicious cycle of poverty. To survive our farmers government should be attentive on financial facility of farmers and create an easiest way of providing loan to small and landless farmers.

- An inconsistency in the finance of our farmers is a common phenomenon. Politicians must rethink farmers ' financial facilities, because farmers are the country's makers; their sound existence is a sign of wellbeing. Krishi Bank can lend small and landless farmers without any interest because they are more susceptible to climate change or natural disasters. But the real scenario is different, farmers had to go for finance to lenders and they become the victims of high interest rates. For our farmer government should pay attention to farmers ' financial facilities and create the simplest way.

- Agricultural marketing should be a vital issue of policy makers, because now-a-days it's a very common scenario; farmers don't get fair price of their products and become looser every year. In the study area we saw that they are facing problem of selling agricultural products. In true sense there is no active government institute to monitor the agricultural marketing system. Department of Agricultural Marketing is also liable to monitor and supervise this system but it is a matter of regret that its totally an inactive institute for lack of efficient officials. To ensure the fair price of agricultural products government should deeply rethink about the DAM.

7.3 Limitations and future research focus

Due to shortage of fund and time the study could not cover wide areas for collection of necessary information from the farmers; only 60 farmers were selected for the purpose of thestudy. The researcher had to depend on the memory of the farmers for collecting necessary information because many of them did not keep any written record or kept record partially. Despite a few limitations, the findings of the present study may provide some valuable information for the farmers, extension workers and researchers. It could be mentioned here that the future researchers could take up a broad - based study with largesamples, a further study can be undertaken by taking into account different farm sizes to assess the impacts on income generation through T.Amancultivation. This may provide an avenue for policymakers to devise region-specific adaptation policies that will have the potential to address way of producing employment to reduce poverty.

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