PROFITABILITY AND TECHNICAL EFFICIENCY OF TRANSPLANTED AMAN RICE CULTIVATION IN SOME SELECTED AREAS OF PATUAKHALI DISTRICT

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CERTIFICATE

This is to certify that the thesis entitled “ ***PROFITABILITY AND TECHNICAL EFFICIENCY OF TRANSPLANTED AMAN RICE CULTIVATION IN SOME SELECTED AREAS OF PATUAKHALI DISTRICT”*** *submitted to the Faculty of Agribusiness Management, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of* ***MASTER OF SCIENCE in AGICULTURAL ECONOMICS,*** *embodies the result of a piece of bona fide research work carried out by* **REBEKA SULTANA SUPTI**, *Registration No.* **12-05150** *under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.*

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

Dated: 30May, 2019
Place: Dhaka, Bangladesh

Prof. Dr. Rokeya Begum
Department of Agricultural Economics
Supervisor

DEDICATED TO

MY BELOVED
PARENTS
■
HUSBAND

ABSTRACT

The present study was designed to measure the profitability and technical efficiency of transplanted Aman farmers in selected areas of Patuakhali district. Primary data was collected from 118 farmers. A random sampling was followed. Cobb Douglas Stochastic Frontier Model was used for efficiency analysis and undiscounted Benefit Cost Ratio (BCR) was used for profitability analysis. The major findings of the study reveal that T. Aman production is profitable. Total cost of production was Tk. 34869.76 per hectare. Gross returns was Tk. 43882.58 and net returns was Tk. 9013.58. Per hectare yields of T. Aman rice was found 2149.00 kg. Benefit Cost Ratio (BCR) was found to be 1.26 which implies that one-taka investment in T. Aman production generated Tk. 1.26. The coefficients of parameters like human labor, land preparation, fertilizers, and insecticides were positive and significant indicated positive effect on T. Aman production. In the technical inefficiency effect model, education, and training have negative coefficients indicating that this helps in reducing technical inefficiency of T. Aman farmers. The average efficiency is found to be 68 percent, which indicates that inefficiency effects have a significant contribution in determining the level and variability of output of T. Aman farms. The study revealed that a considerable improvement took place to increase household income of the farmers in the study area and to improve the socioeconomic conditions with the introduction of large-scale commercial T. Aman production. The study also identified some problems and constraints faced by the T. Aman farmers and suggested some recommendations to improve the present production situation so that per hectare yield of T. Aman would possibly be increased and farmer can get proper price benefit by the T. Aman yield.

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May, 2019

Rebeka Sultana Supti

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ABBREVIATIONS AND ACRONYMS

BARI	: Bangladesh Agricultural Research Institute
BBS	: Bangladesh Bureau of Statistic
BCR	: Benefit Cost Ratio
BDT	: Bangladeshi Taka
BER	: Bangladesh Economic Review
DAE	: Department of Agricultural Extension
et al.	: and others (at elli)
GR	: Gross Return
gm	: Gram
ha	: Hectare
HIES	: Household Income and Expenditure Survey
HYV	: High Yielding Variety
IOC	: Interest on Operating Capital
kg	: Kilogram
MoP	: Muriate of Potash
mt	: Metric Ton
NGO	: Non-Government Organization
T	: Ton
TC	: Total Cost
TFC	: Total Fixed Cost
Tk.	: Taka
TSP	: Triple Super Phosphate
TVC	: Total Variable Cost
US	: United States
USDA	: United States Department of Agriculture
$	: Dollar

CHAPTER 1

INTRODUCTION

1.1 Background

Bangladesh is mainly an agricultural country. Agriculture is the single largest producing sector of the economy and contributes about 14.70% to the total Gross Domestic Product (GDP) of the country. This sector also accommodates around 39.07% of labor force. GDP growth rate of Bangladesh mainly depends on the performance of the agriculture sector. The economic development is inextricably linked with the performance of this sector. The performance of this sector has an overwhelming impact on major macroeconomic objectives like employment generation, poverty alleviation, human resources development and food security. Agriculture sector plays an important role in overall economic development of the country. The broad agricultural sector (crops, animal farming, forests and fishing) contributes 14.23 percent to GDP, provides employment about 40.62 percent of the labour force according to Quarterly Labour Force Survey 2016-17. Moreover, agriculture is the source of wide range of agricultural commodity markets, especially in rural areas. . In Bangladesh, food security of the vast population is associated with the development of agriculture. Besides this, agriculture has a direct link to the issues like poverty alleviation, improved standard of living and employment generation. In order to ensure long-term food security for the people, a profitable, sustainable and environment-friendly agricultural system is critical. Broad agriculture sector and rural development sector have been given the highest priority in order to make Bangladesh self-sufficient in food. Over the last few years, there has been an increasing trend in food production. According to preliminary estimate of BBS, in FY2017-18, food grains production stood at around 413.25 lakh metric tons (MT). In the same fiscal year, the total internal procurement of food grains was 16.7 lakh MT against the target of 17.3 lakh MT. In addition, an amount of Tk.20,400 crore was targeted to be disbursed as agricultural credit against that Tk.21,393 crore was disbursed till June 2018, which was 104.87 percent of the target. In order to scale up productivity, subsidy in agricultural inputs was increased, as well as enhanced coverage and increased availability of agricultural credit was ensured. Programmes have been launched to popularise the use of organic and balanced fertilser to maintain soil fertility and productivity. Considering the importance of increased productivity of agricultural products, an amount of Tk.6,000 crore was allocated in the revised budget of FY2017-18 to provide subsidy on fertiliser and other agricultural inputs. In recent years, there has been a tremendous increase in food grain production. Agricultural holding in Bangladesh is generally small but use of modern varieties, inputs and equipment is gradually increasing. Rice, jute, sugarcane, potato, pulses, wheat, tea and tobacco are the principal crops of Bangladesh. Crop diversification program, credit supply, extension work, research and input distribution policies pursued by the government are yielding positive results. The country is now on the threshold of attaining self-sufficiency in food grain production.

1.2 Agriculture in Bangladesh

Agriculture sector has performed remarkably well over the years. Between 1973/74 and 2016/17, agricultural GDP has increased by 5.8 times. Value of agriculture GDP has increased from 5.21 billion dollars to 28.92 billion dollars. All sub-sectors of agriculture (crop, livestock, fisheries and forestry) have increased substantially. Crop GDP has increased by 4.4 times, livestock GDP has increased by 5.8 times and forestry GDP has increased by eight times. On the other hand, fisheries GDP has increased by more than six times. During this period, Total GDP has grown by 20.8 times, increased from 8.92 billion dollars to 185.43 billion dollars. (Deb, 2016). High population pressure and the rapid pace of human activity including urbanization, industrialization and other economic activities have led to a dwindling supply of arable land per capita and a process of agricultural intensification in South Asia. While this process has significantly increased food production to feed the growing population. Bangladesh economy has been growing over the last three decades. Among the three subsectors of economy, agriculture plays an important role to generate employment for its population by increasing productivity and growth. Bangladesh is a country with a population of almost 160 million (BER, 2016) increasing at a rate of 1.3 percent adding about 2 million labor force every year. If we only consider the rural economy, agriculture alone provides employment for more than 70 percent of the rural labor force. (Md. Tanjil Hossain). The growth rate of area, production and yield were found increasing steadily from the year 1980-81. A substantial change has been started from the year 1998-99. The trend of inputs used was found increasing. Almost all the partial as well as the input, output and total factor productivity indices were also found increasing. (M. A. Baset, 2009).The varying performance of crop sector has emphasized the need for evolving regionally differentiated strategies for ensuring sustainable and inclusive agricultural growth in a state and consequently in the country. The instability in productivity continues to persist and there are wide variations in instability across different districts. To mitigate the consequences of persisting instability, large-scale promotion of stabilization measures like insurance should be pursued vigorously. The analysis of district level data has revealed the important role of modern inputs in enhancing the productivity of crop sector. The use of fertilizers has turned out to be the most important input. Along with fertilizer-use, rainfall, irrigation, source of irrigation, better human resources and road connectivity have emerged as the other critical determinants of agricultural productivity. These results signify the importance of use of modern inputs and prudent management of rainfall water, particularly in the low productivity districts. (Kumar, 2013)

1.3Contribution of Agriculture to GDP

Until the 1980s, share of the crop and horticulture sector to the total Agricultural GDP was slightly less than eighty percent. Forestry contributed about 5.5 percent to the agriculture sector in the early seventies which has gradually increased to about 11 percent in 2016/17 Animal farming particularly poultry, dairy, egg production and animal fattening for meat production has contributed towards many-fold increase in livestock production.

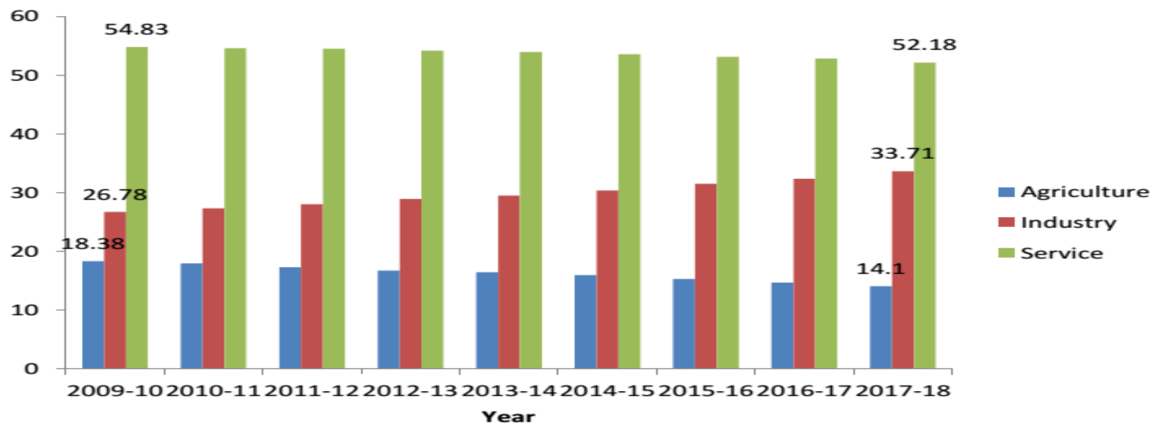

Figure 1.1 Contribution of Different Sector in GDP, 2009-2018

Source: BER, 2018

Small scale commercial poultry farming has expanded in the periphery of towns and cities. Share of animal farming to the Agricultural GDP has increased from about 7 percent in the seventies to about 11 percent in 2016/17. In the early seventies, fisheries sector contributed about 10 percent which was declining in the seventies and eighties. Fisheries sector contributed about 23 percent of the total agricultural GDP in the recent years. Thus, Bangladesh agriculture has successfully been transformed to a diversified sector in the recent years from mostly crop oriented agriculture in the seventies.

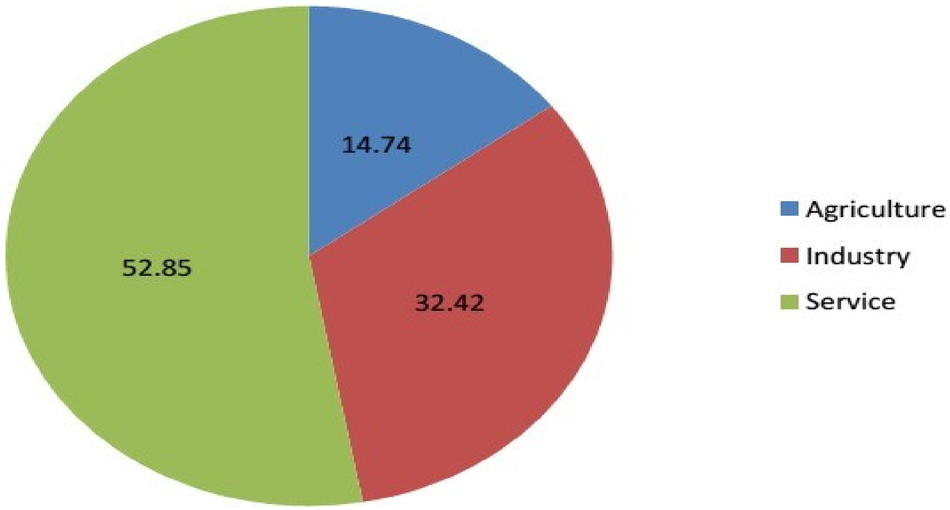

Figure 1.2 Sectorial Share of GDP at Constant Price, 2016-17

Source: BER, 2017

Figure 1 and figure 2 shows that during 2009-10 to 2016-17 the share of agricultural GDP has decreased. In 2009-10 the share of agriculture in GDP was 18.38%, but in 20016-17 this share has fallen to 14.74%. Figure 2 shows that the largest share of GDP is by the service sector. The growth rate also shows the same evident (figure 3).

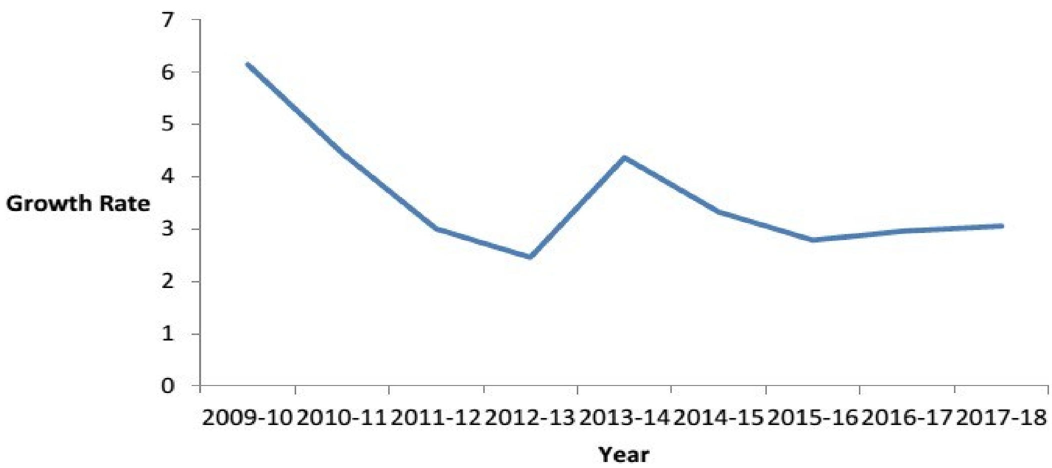

Figure 1.3: Growth rate of agricultural GDP at Constant Price, 2009-2018

Source: BER, 2018

Though share and growth rate of agricultural GDP compared to other sector has decreased in last few decades but in terms of volume agricultural GDP shows an increasing trend. In 2009-10 agricultural GDP was 1065108 million BDT, but in 2016-17 it becomes 1340511 million BDT.

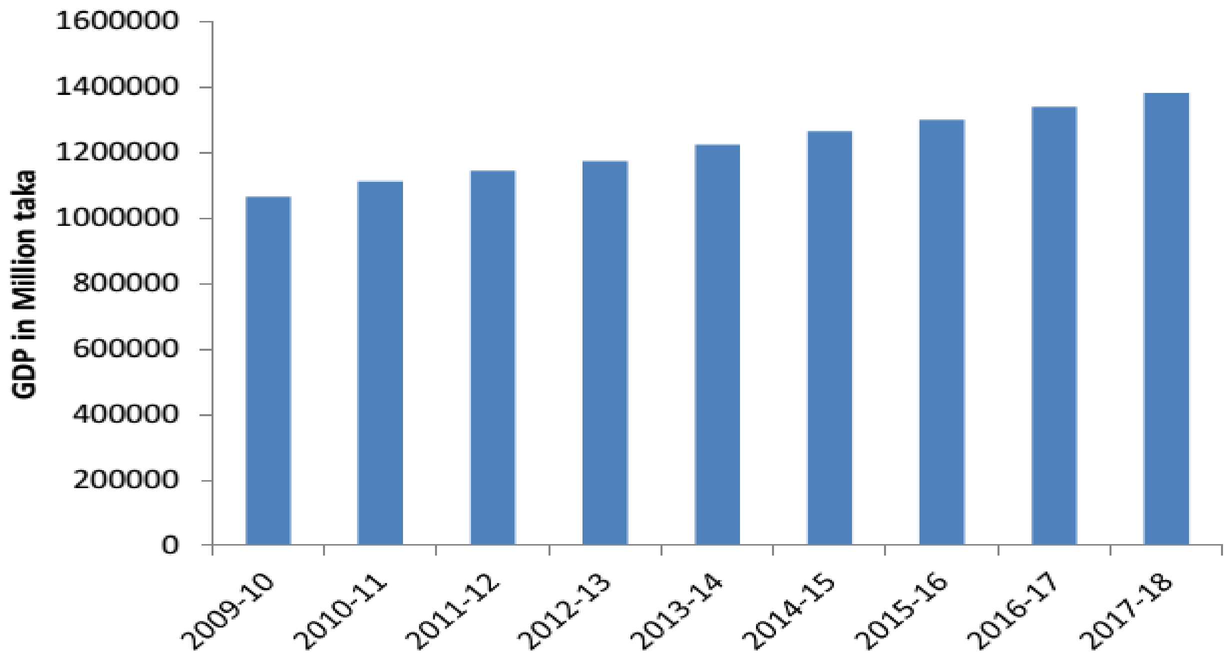

Figure1.4: Trends in Agricultural GDP at Constant Prices

Source: BBS, 2018

In terms of growth, Bangladesh agriculture performed remarkably well both in the long-term (FY1973/74 to FY2007/08) and in the short term or recent years (FY2008/09 to 2014/15). Annual growth rate in the overall agriculture sector ranged between 1.6 percent in FY2013 and 4.4 percent in FY2014. For crop & horticulture subsector it varied between 0.6 percent (in FY2013) and 3.9 percent (in FY2011). Animal farming experienced annual growth between 2.6 percent (in FY2011) and 3.1 percent (in FY2015). On the other hand, forest and related services had annual growth in the range of 5.0 percent in FY2014 and 6.0 percent in FY2012. Fishing had annual growth between 5.3 percent in FY2012 and 6.5 percent in FY2015. (Deb, 2016).

1.4 Present Status of Rice in Bangladesh

Rice is the staple food of about 135 million people of Bangladesh. It provides nearly 48% of rural employment, about two-third of total calorie supply and about one-half of the total protein intake of an average person in the country. Rice sector contributes one-half of the agricultural GDP and one-sixth of the national income in Bangladesh. Almost all of the 13 million farm families of the country grow rice. Rice is grown on about 10.5 million hectares which has remained almost stable over the past three decades. About 75% of the total cropped area and over 80% of the total irrigated area is planted to rice. Thus, rice plays a vital role in the livelihood of the people of Bangladesh. Total rice production in Bangladesh was about 10.59 million tons in the year 1971 when the country's population was only about 70.88 millions. However, the country is now producing about 25.0 million tons to feed her 135 million people. This indicates that the growth of rice production was much faster than the growth of population. This increased rice production has been possible largely due to the adoption of modern rice varieties on around 66% of the rice land which contributes to about 73% of the country's total rice production. However, there is no reason to be complacent. The population of Bangladesh is still growing by two million every year and may increase by another 30 millions over the next 20 years. Thus, Bangladesh will require about 27.26 million tons of rice for the year 2020. During this time total rice area will also shrink to 10.28 million h hectares. Rice yield therefore, needs to be increased from the present 2.74 to 3.74 t/ha.

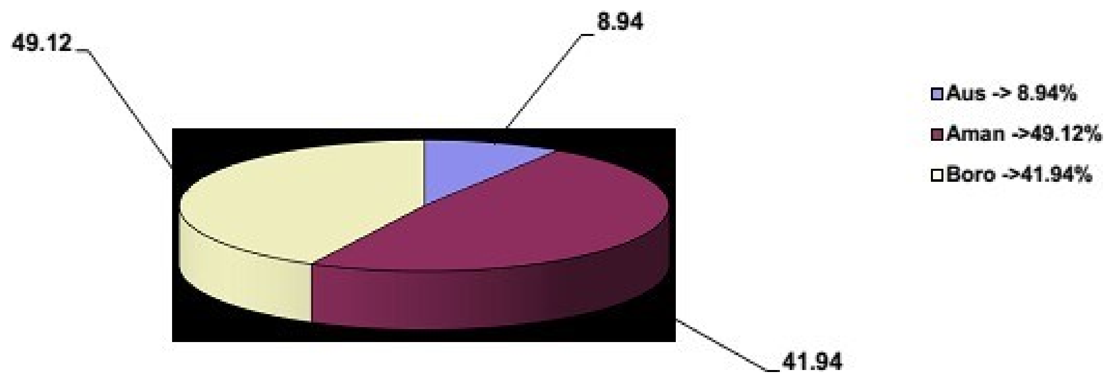

Figure 1.5: Area under Rice cultivation in Bangladesh

Source: BBS, 2018

According to the final estimate of BBS, the volume of food grains production in FY2016-17 stood at 386.96 lakh MT of which Aus accounted for 21.34 lakh MT, T. Aman 136.56 lakh MT, Boro 180.16 lakh MT, wheat 13.12 lakh MT. In FY2017-18 food grains production stood at 413.25 lakh MT of which Aus accounted for 27.09 lakh MT, T. Aman 139.94 lakh MT, Boro 195.76 lakh MT, wheat 11.53 lakh MT and maize 38.93 lakh MT. Table 1 shows the food grains production status during the period from FY2010-11 to FY2017-18.

Table 1.1: Food grains production status during the period from FY2010-11 to FY2017-18

(In lakh MT.)								
Food Grains	**2010-11**	**2011-12**	**2012-13**	**2013-14**	**2014-15**	**2015-16**	**2016-17**	**2017-18**
Aus	21.33	23.33	21.58	23.26	23.28	22.89	21.34	27.09
Aman	127.91	127.98	128.97	130.23	131.9	134.83	136.56	139.94
Boro	186.17	187.59	187.78	190.07	191.92	189.38	180.16	195.76
Total Rice	**335.41**	**338.9**	**338.33**	**343.56**	**347.1**	**347.1**	**338.06**	362.79

Source: BBS, 2018

Table 2 shows the rice production from 2000 to 2016 and its growth rate in MMT(million metric ton)

Table 1.2: Rice Production in Bangladesh, from 2000-2010 to 2016-2017

Year	Aus Rice (MMT)	Aman Rice (MMT)	Boro Rice (MMT)	Total Production (MMT)
2000-2001	1.916	11.249	11.92	25.085
2001-2002	1.808	10.726	11.766	23.834
2002-2003	1.85	11.115	12.222	25.187
2003-2004	1.832	11.521	12.837	26.19
2004-2005	1.5	9.82	13.837	25.157
2005-2006	1.745	10.81	13.975	27.52
2006-2007	1.512	10.841	14.965	27.326
2007-2008	1.507	9.662	17.762	28.931
2008-2009	1.895	11.613	17.809	31.317
2009-2010	1.709	12.207	18.811	32.727
2010-2011	2.133	12.792	18.617	33.542
2011-2012	2.332	12.798	18.759	33.988
2012-2013	2.158	12.897	18.778	33.826
2013-2014	2.326	13.023	19.007	34.356
2014-2015	2.328	13.19	19.192	34.71
2015-2016	2.281	13.483	18.937	34.701
2016-2017	2.134	13.656	18.014	33.804
Growth rate (%)	**0.63**	**1.14**	**2.43**	**1.75**

Source: BER, 2017

1.5 Why T. Aman Rice?

Aman is one of the main crops in Bangladesh. It is the second largest rice crop in the country in respect to the volume of production while Boro tops the production. It is notable that the area coverage of Aman is the largest as a single crop and Boro remains the second. The production of Aman depends on the weather condition of the country and farmers usually cultivate Aman in their land. In the year 2015, favourable weather condition prevailed all over the country from sowing to harvesting period of Aman. 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 during 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.

Total Aman production of Financial Year 2015-16 has been estimated 1,34,83,437metric tons compared to 1,31,90,163 metric tons of Financial Year 2014-15 which is 2.22%higher. Average yield rate of Aman for the Financial Year 2015-16 has been estimated 2.412metric tons per hectare which is 1.13%higher than that of last year. In coastal areas of Bangladesh, mainly T. Aman is produced among all varieties of rice. In a subjective manner, farmers were interviewed on some points relating to management system of seed, fertilizer, and rural electricity supply. They opined that proper management and timely distribution of seed, fertilizer, uninterrupted supply of electricity, Adequate rain water led to increase in area and production of Aman rice in 2015.In following two figures show the forty five years data of Aman production statistics based on area and production and also the yield rate of Aman .In 1970-71, the yield rate was 1.01 M.Ton per hactre but in 2014-15, it increases the amount 2.385 hactre.

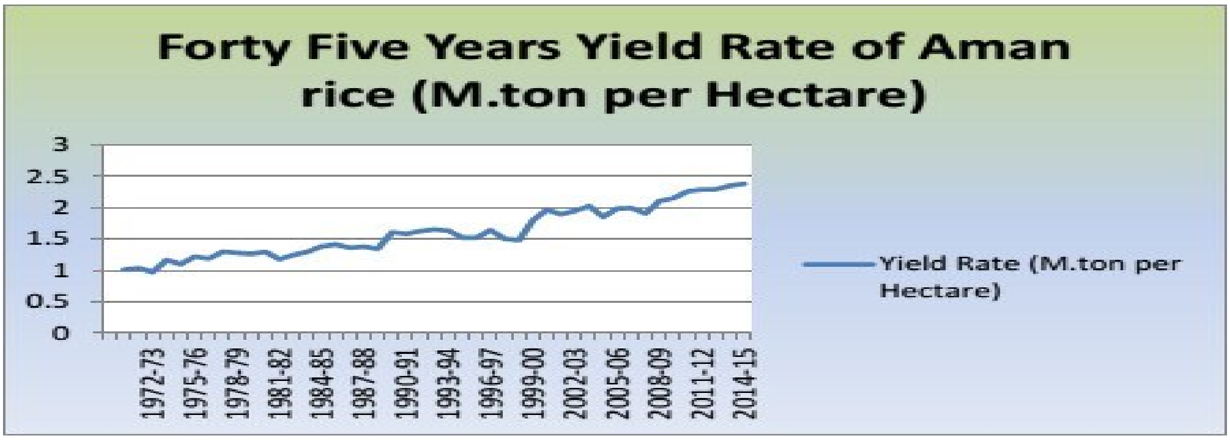

Figure1.6: 45 years yeild rate of T. Aman rice

Source: BBS, 2016

Table 1.3: Estimates of Total Area by Type of Aman Crop

Variety	2014-2015		2015-2016		Percentage previous year
	Area (in acres)	Area (in hectares)	Area (in acres)	Area (in hectares)	
Broadcast Aman	8,09,645	3,27,646	8,13,209	3,29,088	(+) 0.44%
Local Transplant (L.T.) Aman	28,69,352	11,61,164	27,46,745	11,11,547	(-) 4.27%
High Yielding Variety (HYV)	99,86,220	40,41,204	1,02,54,336	41,49,705	(+) 2.68%
Total Aman	1,36,65,217	55,30,014	1,38,14,290	55,90,340	(+) 1.09%

Source: BBS, 2017

Yield Rate:

Average yield rate of Aman for the Financial Year 2015-16 has been estimated 2.412 metric tons per hectare which is 1.13%higher than that of last year. Comparison of estimated yield rates are shown below:

Table 1.4 : Estimates of Yield Rate by Types of Aman Crop

Variety	**2014-2015**		**2015-2016**		**Changes over previous year**
	Yield per Acre (Maunds)	**Yield per Hectare (M.Ton)**	**Yield per Acre (Maunds)**	**Yield per Hectare (M.Ton)**	
Broadcast Aman	12.72	1.173	12.92	1.192	(+)1.62%
Local Transplant (L.T.) Aman	17.91	1.652	18.06	1.665	(+) 0.79%
High Yielding Variety (HYV)	29.21	2.694	29.36	2.709	(+)0.56%
Total Aman	**25.86**	**2.385**	**26.15**	**2.412**	**(+) 1.13%**

Source: BBS, 2017

Production:

Total Aman production of Financial Year 2015-16 has been estimated 1,34,83,437metric tons compared to 1,31,90,163 metric tons of Finacial Year 2014-15 which is 2.22%higher. Comparative estimates of Aman production are shown below:

Table 1.5: Estimates of Production by Type of Aman(husked) Crop

Variety	2014-2015	2015-2016	Percentage changes over previous year
	Production (M.tons)	Production (M.tons)	
Broadcast Aman	3,84,411	3,92,331	(+) 2.06%
Local Transplant (L.T.) Aman	19,17,882	18,51,163	(-) 3.48%
High Yielding Variety (HYV)	1,08,87,870	1,12,39,943	(+) 3.23%
Total Aman	1,31,90,163	1,34,83,437	(+) 2.22%

Source: BBS, 2017

1.6 Statement of the Problem

Agriculture plays a vital role in the economic development of the country. Agricultural development is considered to be a prerequisite for the economic development of most Asian countries. In Bangladesh, agricultural (mainly crop) production has remained constant over the past few years whereas population increased several times. At present, the Government of Bangladesh has to import some major crops and industrial goods. Although Bangladesh exports many agricultural products, the export earnings from these products are unable to pay the import costs. Consequently, balance of trade is always negative. The excess import costs are paid by foreign currency retained in the country and by foreign loans. Production of agricultural crops including rice will have to increase to boost the economy.

As agriculture evolves, several factors ranging from institutional to economic, and from physical to natural calamities can limit agricultural development. An increase in Aman rice production by increasing area is not possible since total cultivable area is decreasing day by day due to the increased use of land for non-agricultural purposes. Production can be increased by increasing the technical efficiency of Aman rice using existing technology. If farmers are found to be technically inefficient, production can be increased to a large extent using the existing level of inputs and available technology. A decline in agricultural production could also be caused by sub-optimal utilization of the existing technology or due to productive inefficiency. Several studies in other countries have shown that there is significant potential for raising agricultural output or profitability by improving productive (technical and allocative) efficiency using existing resources. Moreover, these studies have also indicated that there may be significant efficiency differentials between different groups of farms and between different regions among all farms and it should be possible to improve the performance of the less efficient farms or regions without major investment from outside at least in the short run.

The possibilities of economic growth solely through the more efficient use of existing resources will obviously be exhausted when an efficient production technology is reached. In other words, the process of increasing output only by improving efficiency cannot continue indefinitely, since under perfect technically efficient conditions the frontier output level will be reached. Thus, other growth promoting strategies need to be considered when it is not possible to increase output only through efficient utilization of existing resources. The use of modern technology in agriculture to raise output per unit of input is one such strategy. In the case of technically efficient farmers, production can also be increased by substituting existing technology with more advanced technology and with a sound and realistic agricultural policy.

1.7 Justification of the study:

The economic growth of an agro-based country like Bangladesh mainly depends on the development of agriculture sector. The agro-climatic conditions of Bangladesh are suitable for the cultivation of a wide variety of crops but 80 percent of the gross cropped areas are at present confined to the production of cereal crops mainly rice. However, the accelerated rice research and production program in Bangladesh has enabled the country to achieve rice self-sufficiency in 2000-01. This achievement is mainly due to increased growth rate of rice production rather than increase in yield growth rate. The increase in production growth rate is mainly due to conversion of area from local varieties to HYVs. To make rice cultivation profitable and to bridge the demand-supply gap, this study looked at production efficiency of farms producing rice. This was done to understand the determinants of inefficiency of transplanted Aman rice producers, and also to suggest future research directions for the benefit of both farmers and society.

Production of T. Aman rice can be increased by increasing the technical efficiency of T. Aman rice using existing technology. In the southern part of our country, farmer are used to grow T. Aman from very long time. And it's a matter of fact that I found no study, it was done before regarding the topic or title I have chosen specially for T. Aman rice for my study . For this reason, the present study makes an attempt to analyze the profitability of T. Aman rice production and to estimate the technical efficiency of T. Aman producing farmers which depends on the different socio-economic variables like farm size, age, education, experience and training of the farmers. The study may be informative in this field and may serve as a foundation for the further research to the researchers. Finally, it is expected that the findings of the study will be helpful for the individual farmers for increasing the profitability and productive efficiency and will be helpful for policy makers and extension workers to frame out a useful policy.

1.8 Objectives of the Study

The present study was undertaken to achieve the following objectives:

1. To identify the socio-economic status of the rice growers;
2. To determine the profitability of the rice yield in the study area;
3. To assess the technical efficiency level of the rice growers; and
4. To identify the constraints and provide guidelines for improvement

1.9 Organization of the Study

The study consists of 9 chapters. Chapter 1 describes introduction of the study. Relevant review of literature, methodology, description of the study area, socioeconomic characteristics of the sample farmers, profitability analysis, technical efficiency analysis of T. Aman rice, problems and constraints of T. Aman growers and summary, conclusion and recommendations are presented in Chapter 2, Chapter 3, Chapter 4, Chapter 5, Chapter 6, Chapter 7, Chapter 8 and Chapter 9, respectively.

CHAPTER 2

REVIEW OF LITERATURE

The main purpose of this chapter is to review some related studies in connection with the present study. Only a few studies have so far conducted related to technical efficiency and profitability of Aman in Bangladesh. Again, some of these studies may not entirely relevant to the present study, but their findings, methodology of analysis and suggestions have a great influence on the present study. Review of some research works relevant to the present studies, which have been conducted in the recent past, are discussed below.

Wadud (2000) studied on Farm household efficiency in Bangladesh: a comparison of stochastic frontier and DEA methods. This study compared estimates of technical efficiency obtained from the stochastic frontier approach and the Data Envelopment Analysis (DEA) approach using farm level survey data for rice farmers in Bangladesh . Technical inefficiency effects were modelled as a function of farm-specific socio economic factors , environmental factors and irrigation infrastructure . The results from both the approaches indicated that efficiency is significantly influenced by the factor s measuring environmental degradation and irrigation infrastructure.

Coali *et al.,* (2001) carried out an experiment on technical, allocative, cost and scale efficiencies in Bangladesh Rice Cultivation: A Non-parametric Approach. The study showed applying programming techniques to detailed data for 406 rice farms in 21 villages, for 1997, produces inefficiency measures, which differ substantially from the results of simple yield and unit cost measures. For the Boro (dry) season, mean technical efficiency was 69.4percent,allocative efficiency was 81.3percent,cost efficiency was 56.2 per cent and scale efficiency 94.9 per cent. The Aman (wet) season results were similar, but a few points lower. Allocative inefficiency was due to overuse of labour, suggesting population pressure, and of fertiliser, where recommended rates may warrant revision. Second-stage regressions showed that large families are more inefficient, whereas farmers with better access to input markets, and those who do less off-farm work, tend to be more efficient. The information on the sources of inter-farm performance differentials could be used by the extension agents to help inefficient farmers. There was little excuse for such sub-optimal use of survey data, which was often collected at substantial costs.

Haque (2003) analysed the technical efficiency and profitability of Aman . The major findings of the study revealed that Aman production was profitable. Total cost of production was Tk. 40643.03 per hectare. Gross returns was Tk. 380423.04 and net returns was Tk. 174759.75. Per hectare yields of T. Aman was found 13704.00 kg. Per hectare human labour was used 362 man-days. Benefit Cost Ratio (BCR) was found to be 1.85 which implies that one taka investment in Aman production generated Tk. 1.85. The study revealed that a considerable improvement took place to increase household income of the farmers in the study area and to improve the socioeconomic conditions with the introduction of large-scale commercial Aman production. The study also identified some problems and constraints faced by the Aman farmers and suggested some recommendations to improve the present production situation so that per hectare yield of Aman would possibly be increased.

Rahman (2003) examined the profit efficiency among Bangladeshi rice farmers. Production inefficiency is usually analyzed by its three components—technical, allocative, and scale efficiency. In this study, he provided a direct measure of production efficiency of the Bangladeshi rice farmers using a stochastic profit frontier and inefficiency effects model. The data, which were for 1996, include seven conventional inputs and several other background factors affecting production of modern or high yielding varieties (HYVs) of rice spread across 21 villages in three agro-ecological regions of Bangladesh. The results showed that there were high levels of inefficiency in modern rice cultivation. The mean level of profit efficiency was 77% suggesting that an estimated 23% of the profit is lost due to a combination of technical, allocative and scale inefficiency in modern rice production. The efficiency differences were explained largely by infrastructure, soil fertility, experience, extension services, tenancy and share of non-agricultural income.

Kibaara (2005) conducted an economic study on technical efficiency in Kenyan's maize production. There was distinct intra and interregional variability in technical efficiency in the maize producing regions. In addition, technical efficiency varies by cropping system; the mono-cropped maize fields had a higher technical efficiency than the intercropped maize fields. The number of years of school the farmer had has in formal education, age of the household head, health of the household head, gender of the household, use or none use of tractors and off-farm income impact on technical efficiency.

Balcombe*et et al., (*2006) conducted a study on technical efficiency of rice growers in Bangladesh through Stochastic Frontiers Analysis (SFA) or Data Envelopment Analysis (DEA) The results showed evidence of technical inefficiency although this is of a lesser degree than other studies have reported. This was especially the case for MV production. There was also significant differences in the results for the two rice production technologies (LVand MV). He found that based on the conventional assumption for frontier studies that at least some of the farmers in the sample are progressive farmers who differ from others in adapting available knowledge and technologies to local conditions to attain high yields, the technical efficiency estimates suggest that the scope to narrow the 'yield gap' in Barisal district may be less than was anticipated from both earlier studies and characterizations of the area as relatively 'backward' in terms of farming practice. If so, efforts to develop improved technologies, including new varieties and hybrids with higher yield potential should not be neglected. Given the existing technology the sample farmers could on average only enhance their rice production by eight per cent and four per cent for LV and MV growers, respectively.

Hasan (2008) conducted a study on technical efficiency of rice farmers in Northern Ghana. Examining the level of farm-specific technical efficiency of farmers growing irrigated and non-irrigated rice in Northern Ghana, this study fitted cross-sectional data into a transcendental logarithmic (translog) production frontier. The study concluded that rice farmers were technically inefficient. There was no significant difference in mean technical efficiencies for non-irrigators (53%) and irrigators (51%). The main determinants of technical efficiency in the study area were education, extension contact, age and family size. Providing farmers with both formal and informal education would be a useful investment and a good mechanism for improving efficiency in rice farming. There was also need for training more qualified extension agents and motivating them to deliver.

Goldman (2013) studied on India's rice production and its technical efficiency. He found that the determinants of technical efficiency that might help designing rice production profitably and minimizing farmers' yield gap with given technology and resource constraints and to provide future policy guidelines for researchers and public support services. Farm -level crosssection data was collected from one of the intensive rice -growing areas of Dinajpur. A set of statistical and non-statistical stochastic approaches to frontiers had been used to estimate production efficiency. The application of the translog stochastic production frontier model gave the best fit for technical efficiency analysis. The estimated mean efficiency was 97% for aromatic, 98% for fine, and 85% for coarse rice farmers indicating that there was little scope of increasing yield without breaking the yield frontier particularly for aromatic and fine rice through introduction of high yield potential varieties. For coarse rice varieties, 15 -16% yield could be increased even with the existing varieties, if the management practices of the parameters identified in this study was improved.

Fatema *et al.,* (2014) studied on Comparative economic analysis of T. Aman rice under saline and nonsaline area of Dacope upazilla of Khulna distit of Bangladesh. This study was 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 saline area and rest 120 from non saline area. Descriptive statistics, activity budgets, Cobb-Douglas production function model 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. 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. Similarly, the coefficient of seedling, power tiller, human labour, TSP and insecticide were positive and had significant impacts on gross returns of T.Aman rice production in saline area.

Anik *et al.,* (2015) studied on impact of resource ownership and input market access on Bangladeshi paddy growers' efficiency. The result of the study indicated that a farmer can significantly raise productionby increasing quantity of land, total labour and fertilizer in the paddy production. Use of organic manure also significantly contributed in paddy production. Among all the production inputs land had the most dominant impact on production. The estimated mean technical efficiency score of 78% implied that there are substantial scopes to increase paddy production through enhancing farm efficiency. The important efficiency influencing factors were ownership of land and machinery, farm location, access to credit, share of own supplied labour and seed to total requirement and capital constraint. The small farmers were more efficient than the marginal, medium and large farmers. Among different categories of households, higher mean technical efficiency scores were found with the food secured households, households having no earning from outside agriculture, households belonging to lower expenditure group and farmers cultivating paddy only in own land.

Finally, the article offered some explanations for these results and suggests some policy options for improving farm efficiency.

Anik and Salam (2017) carried out an experiment that was assessing and explaining vegetable growers' efficiency in the south-eastern hilly districts of Bangladesh. They identified drivers of production and technical efficiency in okra and eggplant production. The estimated efficiency scores revealed that around 67% and 99% of the production in okra and eggplant, respectively, was lost due to inefficiency factors. Among different production inputs, land has the highest production elasticity. Land fragmentation and land slope were positively associated with inefficiency, whereas extension service, rented in land and credit had negative associations. Compared to the lager farmers, the smaller are relatively efficient. Efficiency level is also sensitive to ethnicity, annual income, education and farming practices. The important policy outcomes of the study was land reform to ensure land entitlement; land consolidation and farmers' organizations for better access to land; off-farm employment creation; and investment in extension service, especially for the indigenous people and for diffusion of the soil preservation technologies.

The past time, researcher studied Transplanted Aman rice efficiency level rarely but few studies were based on profitability. Fatema *et al.,* (2014) studied on Comparative economic analysis of T. Aman rice under saline and non saline area of Dacope upazilla of Khulna district of Bangladesh. This study was designed to assess the comparative profitability of T. Aman rice farming in saline and nonsaline area. Haque (2003) analysed the technical efficiency and profitability of Aman . Both study lack some fact and I found the gap of it, especially for transplanted Aman, the technical efficiency analysis is new thought, on the other hand there are so many study I have found already based on Boro rice. For that reason, I wanted to conduct my MS thesis on this title.

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CHAPTER 3

METHODOLOGY

3.1 Introduction

Methodology is an indispensable and integral part of any study. The reliability of a specific study finding depends to a great extent on the appropriate methodology used in the study. Improper methodology very often leads to misleading result. So, careful considerations are needed by an author to follow a scientific and logical methodology for carrying out the study. The author has great responsibility in describing clearly what sorts of method and procedure is to be followed in selecting the study areas, the sources of data and the analyses as well as interpretations to arrive at a meaningful conclusion. This study was carried out by using a primary data collection from selected T. Aman rice producers in selected areas of Bangladesh for estimation of technical efficiency and profitability of T. Aman rice production. The methodological framework is presented in this chapter, which consists of three main sub-sections. The first section describes sampling procedure, sample frame, sample size and survey design. Second section describes data collection procedure, formal and informal survey, and primary and secondary data. Data analysis techniques are described in detail in the third section.

3.2 Sampling Procedure

In an empirical investigation it is impossible to collect information from the whole population. Therefore, researchers are often forced to make inferences based on information derived from a representative sample of the population. The size of the sample, and amount of variation, usually affect the quantity and quality of information obtained from the survey. Using appropriate sampling methods, both factors can be controlled (Scheaffer, 1979). The aim is to devise a sampling scheme, which is economical and easy to operate, and provides unbiased estimates with small variance (Barnett, 1991). The main characteristics of sampling theory applied in this study are discussed below.

3.2.1 Sampling Method

The selection of a sample from the population is commonly used in economics, marketing and other disciplines because of limitations of covering the whole population (Barnett, 1991; Kinnear and Taylor, 1987). The authors consider that cost is the main constraint to carrying out interview of the whole population. Given limitations in terms of money, time, efforts and data management, a sample is a more appropriate method. They argue that sampling not only saves cost and time but can also give more accurate results than a census. In a census survey more staff is required to carry out the task, therefore, supervision of staff and management problems will arise. Sampling theory provides an opportunity to minimize cost and to achieve acceptable results (Casley and Kumar, 1988; Kinnear and Taylor, 1987). However, a sampling procedure involves the following steps: defining the population, sample frame, sample size and sample selection procedure.

3.2.2 Defining the Population

Classification of the population is the first step in the sampling procedure, namely, the sector or element under investigation, the sampling unit, the area or extent of investigation, and the duration of investigation (Kinnear and Taylor, 1987). The sector under investigation was crop sector with crop including T. Aman. The sampling units were T. Aman rice producers of Patuakhali district.

3.2.3 Sampling Frame

The farm management research requires some fundamental information in relation to the objectives of the study. The sampling frame for the present study were selected purposively as to select the area where the T. Aman cultivation was intensive. On the basis of higher concentration of rice crop production, two villages namely Betagi and Bashbaria under Patuakhali district were selected for the study. The main considerations in selecting the study areas were as follows-

i. A large number of T. Aman rice growers are available and rice grows well and farmers use a good portion of their land for producing rice in these study areas.

ii. These villages had some identical characteristics like topography, soil and climatic conditions for producing T. Aman rice.

iii. Easy accessibility and good communication facilities in these villages.
iv. The researcher was familiar with the local language and other socio- economic characteristics of the farmers in the selected villages and the anticipated cooperation from respondents was high which indicated the likelihood of obtaining a reasonably accurate set of data.
v. To conduct a socioeconomic study in these study areas.

3.2.4 Sample Size

In a sample survey, a first question that commonly arises is "how large should the sample be?" Casley and Kumar (1988) and Kinnear and Tayler (1987) suggested that a good survey sample should have both a small sampling error and minimum standard error. This can be obtained if one has unlimited resources. However, given constraints, such as finance, time and data management, compromises have to be made in selecting the sample size.

As a rule, the larger the sample size the higher the reliability, the lower the error and the greater the confidence one can place on the findings reflecting the characteristics of the population as a whole. But, faced with the inevitable constraints of time and money, the researcher invariably has to compromise between optimum and acceptable levels of confidence, reliability and error. Simple guidelines to determine the sample size provided by Poate and Daplyn (1993) were considered for selecting a representative sample size of T. Aman producers. A sample size of 60 is generally regarded as the minimum requirement for larger population that will yield a sufficient level of certainty for decision-making (Poate and Daplyn, 1993). A total of 118 farmers who were cultivating different varieties of T. Aman in the selected areas were selected as samples.

3.2.5 Sample Selection Procedure

The investigator wishes to avoid bias in the sample selection process to achieve accuracy in the estimates, which is to have a small standard error (Kinnear and Taylor, 1987). The best way to avoid bias in the sample selection process is use of simple random sampling in which each unit of the population has an equal chance for selection (Scheaffer, 1979). Either increasing the sample size or imposing various restrictions and modifications on the simple random sampling procedure can achieve an increase in precision of the sampling procedure.

At first, T. Aman dominated upazila was selected purposively from each district. Then two villages were selected by simple random sampling method and the ultimate sampling units (Households) were selected by random sampling method. The procedure was comprehensive and representative of the whole population.

3.3 Data Collection Procedure

Primary data has been collected by conducting survey of T. Aman rice producers from the selected areas. The fieldwork also involved gathering data on T. Aman production practices, input use, labor utilization, natural and socio-economic constraints, prices and market activities. The methodology consisted of field survey, review of previous studies, and interviews with knowledgeable T. Aman producers, and also direct observation by the researchers. In the direct observation, emphasis was placed to assess the existing management practices, input use and marketing system of T. Aman producers.

3.3.1.Informal Survey

An informal survey was carried out to achieve the stated objectives. The purpose of this survey was to gather quick information on various aspects of the study, organize fieldwork plan, testing the validity of the questionnaire and estimating the various cost components such as financial costs, travel time, interview time etc. This preliminary survey provided an opportunity to understand the existing labour use, input and output costs. During the informal survey, interviews were held with a producer or group of producers on one or more aspects of the study and field notes prepared. Based on this preliminary information the investigator developed the questionnaire for further in-depth investigations.

3.3.2 Formal Sample Survey

Gaining the farmers' confidence and obtaining accurate information was a key during the fieldwork. To achieve these objectives, producers were assured absolute privacy, interviews were held in places of their choice and they were assured that the researchers are not related to any government tax agency and information would be used for academic purposes. Most of the interviews were held at the farm or in the farmer's house. The interview usually started with an introduction about the background of the researcher, the objectives of the study and the way in which the respondent was chosen. The discussion started with general topics of interest of the farmers, such as social life, family and the T. Aman production and contracting system etc. This method has been found useful in establishing confidence with producers; its only disadvantage was increasing the time of the interview. Gradually, the researcher converted the discussion to the related issues of T. Aman production practices and problems. Then specific questions from the questionnaire were asked and the answers were recorded.

3.3.3 Design of Questionnaire

Design of questionnaire is a difficult exercise at the planning stage of a survey (Casely and Lury, 1981). During the development of a questionnaire, two main problems are commonly noted:

a) the questionnaire tends to be long or too many topics are covered
b) the sequence of question has not been well organized.

Thus time and money are wasted for collecting, checking and entering data in a computer, which are not required. The poor sequences of questions also make it difficult at the time of data analysis. As the survey mainly depends upon the preparation of the survey schedule, therefore, a draft schedule was prepared for pre-testing to verify the relevancy of the questions and nature of response of the farmers. After making necessary correction, modification and adjustment, a final survey schedule was developed.

In this study the questionnaires were designed with the following heads-

i. General information of the sample farmers;
ii. Family composition of the sample farmers;
iii. Occupational and educational status of sample farmers;
iv. Information about land;
v. Production cost of T. Aman;
vi. Source of capital;
vii. Amount of yield obtained from T. Aman and
viii. Problem faced by the farmers in producing T. Aman.

The questionnaires were in English but questions were asked in the local languages from the respondents.

3.3.4 Data Collection Techniques

Primary data was collected through conducting field survey, while secondary data was gathered from publications and statistical bulletins. Due to the absence of producers' records regarding farm activities, data collection depended on a combination of methods, which rely on memory recall for basic information such as labor use, wages, input costs.

3.3.4.1 Primary Data Collection

Since farming is seasonal one, a farm business survey should cover a whole crop year in order to have a complete sequence of crops. The researcher must determine to what extent the information for a particular year represents normal or average conditions, particularly for crop yields, annual production and price level. Farmers generally plant T. Aman rice from mid-june to July and harvest in the month of November to December. Data for the present study collected during the period of January 2019. Primary data were collected from primary producers. Selected respondents were interviewed personally with the help of pre-tested questionnaires. Farmers' fields were also visited in order to get clear understanding, observations and perceptions about the production and marketing systems in the study area. Primary, secondary and terminal markets were also visited for primary data collection, field perception and observation. Primary data collected from producers has been used in estimating production function.

3.3.4.2 Secondary Data Collection

Secondary data had been collected from various research documents and papers like-

- Statistical Yearbook of Bangladesh,
- Yearbook of Agricultural Statistics
- Bangladesh Economic Reviews
- The national and international journals, articles and publications and

- Internet

3.4 Accuracy of the Data

Adequate measures were taken during the period of data collection to minimize the possible errors. The measures taken were-

- Field checking; and
- Independent re-interviewing of the respondents.

In case of any inconsistency and lapses, the neighboring farmers were asked for necessary verification and data were checked and corrected through repeated visits. In order to ensure consistency and reliability of the parameters being generated out of the data, follow up visits were also made to the field to obtain supplementary information.

3.5 Processing, Editing and Tabulation of Data

The collected data were checked and verified for the sake of consistency and completeness. Editing and coding were done before putting the data in computer. All the collected data were summarized and scrutinized carefully to eliminate all possible errors. Data were presented mostly in the tabular form, because it was of simple calculation, widely used and easy to understand. Besides, functional analysis was also adopted in a small scale to arrive at expected findings. Data entry was made in computer and analysis was done using the concerned software Microsoft Excel and statistical software STATA.

3.6 Analytical Techniques

Data were analyzed with a view to achieving the objectives of the study. Several analytical methods were employed in the present study. Tabular method was used for a substantial part of data analysis. This technique is intensively used for its inherent quality of purporting the true picture of the farm economy in the simplest form. Relatively simple statistical techniques such as percentage and arithmetic mean or average were employed to analyze data and to describe socioeconomic characteristics of T. Aman growers, input use, costs and returns of T. Aman production and to calculate undiscounted benefit cost ratio (BCR). In order to estimate the level of technical efficiency in a manner consistent with the theory of production function, Cobb-Douglas type stochastic frontier production function will be used in the present study.

3.6.1 Economic Profitability Analysis

The net economic returns of T. Aman were estimated using the set of financial prices. The financial prices were market prices actually received by farmers for outputs and paid for purchased inputs during the period under consideration in this study. The cost items identified for the study were as follows-

- Land preparation
- Human labour
- Seed
- Urea
- TSP
- Insecticide
- Interest on operating capital
- Land use

The returns from the crops were estimated based on the value of main products. In this study variable cost, fixed cost and total cost had been described. Total variable cost (TVC) included land preparation, human labour, seedlings, urea, TSP, MoP, insecticides, and interest on operating capital. Fixed cost (FC) included only rental value of land. Total cost (TC) included total variable cost and fixed cost.

3.6.1.1 Cost of Land Preparation

Land preparation considered one of the most important components in the production process. Land preparation for T. Aman production included ploughing, laddering and other activities needed to make the soil suitable for planting seedling. It was revealed that the number of ploughing varied from farm to farm and location to location.

3.6.1.2 Cost of Human Labour

Human labour cost was considered one of the major cost components in the production process. It is generally required for different operations such as land preparation, sowing and transplanting, weeding, fertilizer and insecticides application, irrigation, harvesting and carrying, threshing, cleaning, drying, storing etc. In order to calculate human labour cost, the recorded man-days per hectare were multiplied by the wage per man-day for a particular operation.

3.6.1.3 Cost of Seed

Cost of seed varied widely depending on its quality and availability. Market prices of seeds of respected T. Aman were used to compute cost of seed. The total quantity of seed needed per hectare was multiplied by the market price of seed to calculate the cost of seeds for the study areas.

3.6.1.4 Cost of Urea

Urea was one of the important fertilizers in T. Aman production. The cost of urea was computed on the basis of market price. In order to calculate cost of urea the recorded unit of urea per hectare were multiplied by the market price of urea.

3.6.1.5 Cost of TSP

The cost of TSP was also computed on the basis of market price. In order to calculate cost of TSP the recorded unit of TSP per hectare were multiplied by the market price of TSP.

3.6.1.6 Cost of MoP

Among the three main fertilizers used in T. Aman production, MoP was one of them. To calculate the cost of MoP per hectare, the market price of MoP was multiplied by per unit of that input per hectare for a particular operation.

3.6.1.7 Cost of Insecticides

Farmers used different kinds of insecticides for 2-3 times to keep their crop free from pests and diseases. Cost of insecticides was calculated based on the market price of the insecticides which was used in the study areas per hectare.

3.6.1.8 Interest on Operating Capital

Interest on operating capital was determined on the basis of opportunity cost principle. The operating capital actually represented the average operating cost over the period because all costs were not incurred at the beginning or at any single point of time. The cost was incurred throughout the whole production period; hence, at the rate of 10 percent per annum interest on operating capital for four months was computed for T. Aman. Interest on operating capital was calculated by using the following formula: IOC= AIit

Where,

IOC= Interest on operating capital, i= Rate of interest

AI= Total investment

t = Total time period of a cycle

3.6.1.9 Land Use Costs

Land use cost was calculated on the basis of opportunity cost of the use of land per hectare for the cropping period of four months. So, cash rental value of land has been used for cost of land use.

3.6.1.10 Calculation of Returns

3.6.1.10.1 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 by-product.

3.6.1.10.2 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

3.6.1.10.3 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 profit equation was used to assess the profitability of T. Aman production at the farm level:

□ = PrQr + PbQb - □(Pxi.Xi) - TFC

Where,

Pr = Per unit price of T. Aman (Tk. /Kg)

Qr = Quantity of T. Aman (Kg/ha)

Pb= Per unit price of T. Aman straw (Tk. /kg)

Qb= Quantity of T. Aman (Kg/ha)

Pxi= Per unit price of the i^{th} (Variable) inputs (Tk. /kg)

Xi = Quantity of the i^{th} inputs (Kg/ha)

i = 1, 2, 3………..n and

TFC = Total fixed cost

3.6.1.10.4 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.

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

3.6.2 Technical Efficiency Analysis

Technical efficiency refers to the ability of a firm to produce the maximum possible output from a given set of inputs and given technology. A technically efficient farm will operate on its frontier production function. Given the stated relationship the firm is technically efficient if it produces on its outer-bound production function to obtain the maximum possible output which is feasible under the current technology. Putting it differently a firm is considered to be technically efficient if it operates at a point on an isoquant rather than interior to the isoquant.

The homogeneity of inputs is a vital factor for achieving technically efficient output. No one would dispute that the output produced from given inputs is a genuine measure of efficiency, but there is room for doubt whether, in a particular application, the inputs of a given firm are really the same as those represented by the corresponding point on the efficient isoquant. But it is important to note that mere heterogeneity of factors will not matter, as long as it is spread evenly over firms, it is when there are differences between firms in the average quality (or more strictly, in the distribution of qualities) of a factor, that a firm's technical efficiency will reflect the quality of its inputs as well as the efficiency of its management. If these differences in quality are physically measurable, it may be possible to reduce this effect by defining a large number of relatively homogeneous factors of production, but in practice it is never likely to be possible to completely eliminate it (Farrell 1957).

3.6.2.1 Farrell's Approach

Farrell illustrated his ideas using a simple example involving firms which use two inputs (X1 and X2) to produce a single output (Y), under the assumption of constant returns to scale. Knowledge of the unit isoquant of fully efficient firms, represented by SS' in Figure 3.1, permits the measurement of technical efficiency. If a given firm uses quantities of inputs, defined by the point P, to produce a unit of output, the technical inefficiency of that firm could be presented by the distance QP, which is the amount by which all inputs could be proportionally reduced without reduction in output. This is expressed as a percentage by the ratio QP/OP, which represents the percentage by which all inputs need to be reduced to achieve technically efficient production. The technical efficiency (TE) of a firm is most commonly measured by the ratio

$$TE_i = OQ/OP \qquad (3.1)$$

Which is equal to one minus QP/OP. It will take a value between zero and one, and hence provides an indicator of the degree of technical inefficiency of the firm. A value of one indicates that the firm is fully technically efficient. For example, the point Q is technically efficient because it lies on the efficient isoquant.

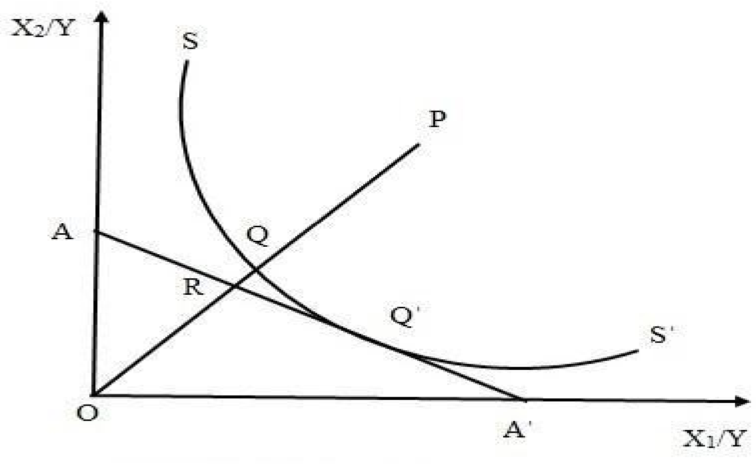


Fig 3.1: Technical Efficiency

3.6.2.2 Frontier Efficiency Models

The text book definition of a production function holds that it gives the maximum possible output which can be produced from given quantities of a set of inputs. Similarly, a cost function gives the minimum level of cost at which it is possible to produce the same level of output, given input prices. Finally, a profit function gives the maximum profit that can be attained, given output price and input prices.

For each of the above functions, the concept of maximality or minimality is important. The word frontier may meaningfully be applied in each case because the function sets a limit on the range of possible observations. Thus one may, for example, observe points below the production frontier (firms producing less than maximal possible output) but no points can lie above the production frontier; similar comments apply to suitably defined cost and profit frontiers.

The amount by which a firm lies below its production and profit frontiers, and the amount by which it lies above its cost frontier, can be regarded as measures of inefficiency. The measurement of inefficiency has been the main motivation for the study of frontiers.

The conventional production function approach is the most widely used measure in the analysis of the production efficiency of farmers. The traditional approach is to estimate an average production function by a statistical technique such as least squares. The average production functions have received far more attention for the simple statistical reason that the mean of the error terms is zero. This is, however, not consistent with the definition of the production function.

Thus finding a measure of production efficiency that is consistent with the definition of production function has been a major concern for many researchers. The production technology is represented by the transformation (production) function that defines the maximum attainable outputs from different combinations of inputs. Alternatively, if considered from an input orientation side, it describes the minimum amount of input required to achieve the given output level. In other words the production function describes a boundary or a frontier.

Given the definition of a production function, interest has now centered more on specifying and locating the production frontier. Alternatively, production models have often been proposed and the frontier model, which is based on the concept of maximality and minimality is one of these models. There seems to be a consensus in the recent literature on production function estimation that the production frontier rather than the average production function corresponds to the theoretical notion of the production function. Farrell was the pioneer who introduced the frontier measure of efficiency which reflects actual firm performances and can include all relevant factors of production. This is consistent with the textbook definition of the production function.

The frontier production function approach has some obvious advantages over the traditional methodologies and its use is, therefore, becoming increasingly widespread. The primary advantage of the method is that it is more closely related to the theoretical definition of a production function which relates to the maximum output attainable from a given set of inputs and which is consistent with the underlying economic theory of optimizing behaviour. The second advantage of the method lies in the fact that estimates of technical or production efficiency of a firm in the sample may be obtained by comparing the observed output with the predicted (or attainable) output. Deviations from the frontier have acceptable interpretations as measures of the inefficiency which economic units have attained. This approach provides a benchmark against which one can measure the relative efficiency of a firm. Finally, information about the structure of the frontier and about the relative efficiency of economic units has many policy applications. The production frontier is, however, unknown and it has to be empirically constructed from observed data in order to compare the position of a firm or a farm relative to the frontier.

3.6.2.3 The Stochastic Frontier Models

The most widely discussed, theoretically reasonable and empirically competent method of measuring efficiency is the stochastic frontier model. It is an improvement on the traditional average production function and on all types of deterministic frontiers in the sense that it introduces in addition to one-sided error component a symmetric error term to the model. This permits random variation of the frontier across farms, and captures the effects of measurement error, other statistical noise arid random shocks outside the firm's control. A one-sided component captures the effects of inefficiency relative to the stochastic frontier.

The stochastic frontier model is also called the 'composed error' model introduced by Aigner, Lovell and Schmidt (1977) and Meeusen and van den Broeck (1977). It was later extended and elaborated by Schmidt and Lovell (1979; 1980) and Jondrow *et al*. (1982). The notion of a deterministic frontier shared by all farms ignores the very real possibility that a farm's performance may be affected by factors entirely outside its control (such as poor machine performance, bad weather, input supply breakdowns, and so on), as well as by factors under its control (inefficiency). But stochastic frontiers consider all the factors while estimating the model and accordingly it separates firm-specific efficiency and random error effect. Thus the efficiency measurements as well as the estimated parameters are unbiased.

3.6.2.3.1 The Stochastic Frontier Production Function

Aigner, Lovell and Schmidt (1977) and Meeusen and van den Broeck (1977) independently proposed the stochastic frontier production function, in which an additional random error, Vi, is added to the non-negative random variable, Ui, in equation (3.2) to provide

$$Yi = f(Xi, \beta) + \varepsilon i \qquad (3.2)$$

Or

$$Yi = f(Xi, \beta) + Vi - Ui \qquad (3.3)$$

.

where Yi = output for observation i, β = vector of parameters, Ɛi = error term for observation i. The error term Ɛi is made up of two independent components,

$$\varepsilon i = Vi - Ui \qquad (3.4)$$

Where Vi is the two-sided symmetric, normally distributed random error $\{Vi \sim N(0, \sigma v^2)\}$ representing the usual statistical noise found in any relationship and $Ui \geq 0$ is one-sided error term representing technical inefficiency with a half normal distribution $\{Ui \sim |N(0,\sigma u^2)|\}$. That is, Uiis distributed as the absolute value of a $N(0,\sigma u^2)$ variable. Onemay note that Ui measures technical inefficiency in the sense that it measures the shortfall of output (Yi) from its maximum possible value given byb the stochastic frontier [f(Xi, β) + Vi]. The maximum likelihood estimation of equation (3.2) provides estimators for β, λ and σ, where β was defined earlier, $\lambda = \sigma u / \sigma v$ and $\sigma^2 = \sigma u^2 + \sigma v^2$. For notational simplicity, we have dropped the observation subscript (i).

When a model of this form is estimated, one readily obtains residuals $\tilde{\varepsilon} i = Yi - f(Xi, \tilde{\beta})$, which can he regarded as estimates of the error terms Ɛi. However the problem of decomposing these estimates into separate estimates of the components Vi and Ui remained unsolved for some time until Jondrow *et al.* (1982) produced a method for decomposing the total error term. Of course, the average technical inefficiency - the mean of the distribution of the Ui - is easily calculated. For example, in the half-normal case of Ui the mean technical inefficiency is $\sigma u \sqrt{(^2)}$, and this can be evaluated given one's estimate of σu, as in Aigner, Lovell and Schmidt (1977) or Schmidt and Lovell (1979). On average technical inefficiency can be estimated by the average of $\tilde{\varepsilon} i$. It is also clearly desirable to be able to estimate the technical inefficiency Ui for each observation or farm. Indeed this was Farrell's (1957) original motivation for introducing production frontiers, and the ability to compare levels of efficiency across observations or farms remains the most compelling reason for estimating frontiers.

Intuitively, this should be possible because εi = Vi- Ui can be estimated and it obviously contains information on Ui. Now we can show the conditional distribution of Ui given εi as presented by Jondrow *et al.* (1982). This distribution contains whatever information εi yields about Ui. Either the mean or the mode of this distribution can be used as a point estimate of Ui. Jondrow *et al.* (1982) have shown that the assumptions made on the statistical distributions of V and U, as mentioned above, make it possible to calculate the conditional mean of U given ε as

$$E(U/\varepsilon) = \sigma\left(f\frac{(\frac{\varepsilon\lambda}{\sigma})}{1-f(\frac{\varepsilon\lambda}{\sigma})} - \varepsilon\lambda/\sigma\right) \qquad (3.5)$$

Where f and F are, respectively, the standard normal density and distribution functions, evaluated at $\varepsilon\lambda/\sigma$ and $\sigma.^2 = \sigma^2\ \sigma v^2/\sigma u^2$. Thus, equations (3.2) and (3.5) provide estimates for U and V after replacing ε, σ. and λ by their estimates.

Equation (3.5) measures the firm-specific technical inefficiency. We may recall that the technical efficiency of i-th farm is defined by TEi = exp. (-Ui), which is inversely related to technical inefficiency effect Ui. This firm-specific technical inefficiency effect Ui is unobservable. Even if the true value of the parameter vector, β, in the stochastic frontier production function (3.2) was known, only the difference εi = Vi- Ui could be observed. The best predictor for Ui is the conditional expectation of Ui, given the value of εi, which is shown in equation (3.5). The measure of the individual technical efficiency is then computed as TEi = exp. {-E(Ui/εi)}. This measure represents the technical efficiency of the farmer relative to the practice of the efficient frontier.

The second point estimator for U, the mode of the conditional distribution, is the minimum of $\mu^{\cdot}$ ($\mu^{\cdot} = -\varepsilon\lambda\sigma^{\cdot}/\sigma$) and zero, which can be written as

$$M(U/\varepsilon) = -\varepsilon(\sigma u^2/\sigma v^2) \quad \text{if } \varepsilon\leq 0,$$
$$= 0 \quad \text{if } \varepsilon\geq 0 \qquad (3.6)$$

The mode M (U/ε) can be given an appealing interpretation as a maximum likelihood estimator; it can be derived by maximizing the joint density of U and V with respect to U and V, subject to the constraint that V-U= ε. Incidentally, it is easily verified that the expressions in (3.5) and (3.6) are non-negative, and monotonic in ε. Of courses, $\mu^{\cdot}$ and $\sigma^{\cdot}$ are unknown, and thus in using any of the above results we will have to replace $\mu^{\cdot}$ and $\sigma^{\cdot}$ by their estimates $\tilde{\mu}^{\cdot}$

and σ̄˙ respectively.

As with the specifications of stochastic frontier production functions, estimation of them is also important. The direct estimates of the parameters of the stochastic frontier production function can be obtained using either the maximum-likelihood (ML) method or by using a variant of the COLS method, suggested by Richmond (1974). The COLS approach is not as computationally demanding as the ML method, which requires numerical maximization of the likelihood function. However, this distinction has lessened in recent years with the availability of computer software, such as the LIMDEP econometrics package (Greene 1992) and the Frontier Version 4.1 programme (Coelli, 1996), both of which automatically estimate the parameters of stochastic frontier models using ML method. The ML estimator is asymptotically more efficient that than the COLS estimator. Coelli (1995a) investigated the finite-sample properties of the half- normal frontier model in a Monte Carlo experiment showed that ML estimator was significantly better than the COLS estimator when the contribution of the technical inefficiency effects to the total variance term is large.

The above discussion deals with the case of the half-normal distribution for the technical inefficiency effects, because it has been most frequently assumed in empirical investigations. Aigner, Lovell and Schmidt (1977) derived the log- likelihood function for the model, defined by equation (3.2), in which the Uis are assumed to be i.i.d. truncations (at zero) of a N(0, σu^2) random variable, independent of the Vis which are assumed to be i.i.d. N(0, σv^2). Assuming a random sample of N observations and using a joint density function of Ui and Vi of the aforesaid form. . Aigner, Lovell and Schmidt (1977) have shown that the log- likelihood function is given as

$$\text{Ln } L(Y/\beta\lambda\sigma^2) = N \ln \frac{\sqrt{2}}{\pi} + N \ln \sigma^{-1} + \sum_{i=1}^{N} ln\, [1\text{-}F\,(\varepsilon_i\lambda\sigma^{-1})] - (1/2\sigma^2) \sum_{i=0}^{n} \varepsilon_i^2$$

The maximum likelihood estimator is then obtained by the numerical maximization of the above likelihood equation with respect to the parameters (β, σ^2, λ).

The most important advantage of the stochastic frontier model is the introduction of a two sided symmetric random error which accounts for statistical noise, measurement error and exogenous shocks that are beyond the control of the production until in addition to one-sided inefficiency component to be the model. The second important advantage of this model is that it provides a method of separating the error term into its two components for each observation of firm.

This enables one to estimate the level of technical inefficiency for each observation in the sample, and largely removes what had been viewed as a considerable disadvantage of the stochastic frontier model relative to other models (so-called deterministic frontiers) for which technical inefficiency is readily measured for each observation. Since it separates technical inefficiency effects from other random effects, the estimated efficiency measurement is unbiased and competent.

Nevertheless, the stochastic frontier model is not without problems. The main criticism is that there is generally no a priori justification for the selection of any particular distributional form for the Uis. The specifications of more general distributional forms, such as the truncated-normal (Stevenson 1980) and two- parameter gamma (Greene 1990), have partially alleviated this problem, but the resulting efficiency measures may still be sensitive to distributional assumptions.

3.6.2.3.2 The Stochastic Frontier with Cobb-Douglas Production Function

The Cobb-Douglas production function is probably the most widely used form for fitting agricultural production data, because of its mathematical properties, ease of interpretation and computational simplicity (Heady and Dillion, 1969; Fuss and Mcfadden, 1978). The Cobb-Douglas function has convex isoquants, but as it has unitary elasticity of substitution; it does not allow for technically independent or competitive factors, nor does it allow for Stages I and III along with Stage II. That is, MPP and APP are monotonically decreasing functions for all X- the entire factor-factor space is Stage II-given $0 < b < 1$, which is the usual case. However, the Cobb-Douglas may be good approximation for the production processes for which factors are imperfect substitutes over the entire range of input values. Also, the Cobb-Douglas is relatively easy to estimate because in logarithmic form it is linear in parameters; it is parsimonious in parameters (Beattie and Taylor, 1985).

A stochastic Cobb-Douglas production frontier model may be written as

$$Yi = f(Xi,\beta)\ \text{exp.}(Vi-Ui) \qquad i = 1, 2, 3, \ldots\ldots\ldots.., N \qquad (3.8)$$

Where the stochastic production frontier is f(Xi,β)exp.(Vi), Vi having some symmetric distribution to capture the random effects of measurement error and exogenous shocks which cause the placement of the deterministic kernel f(Xi,β) to vary across firms. The technical inefficiency relative to the stochastic production frontier is then captured by the one-sided error component $Ui \geq 0$.

The explicit form of the stochastic Cobb-Douglas production frontier is given by

$$Y = a \prod_{i=1}^{\lambda} X_i^{bi}\ \text{exp.}\,(\varepsilon) \qquad (3.9)$$

Where Y is the frontier output, X is physical input, b the elasticity of Y with respect to X,, a is intercept and Ɛ = V-U is a composed error term as defined earlier. For simplicity, we have ignored the subscript. The above model also can be expressed in the following logarithmic form;

$$\ln Y = b0 + \sum bi \ln Xi + V - U \quad (3.10)$$

Where b0 = In a.

The estimation of the model and derivation of technical efficiency is the same as described earlier.

3.6.2.3.3 Specification of Production Model

We have specified the Cobb-Douglas Stochastic Frontier Production Function in order to estimate the level of technical efficiency. The functional form of stochastic frontier is as follows:

$$Y = \beta 0\ X1^{\beta 1}\ X2^{\beta 2} \ldots\ldots\ldots\ldots X6^{\beta 6}\ e^{Vi\text{-}Ui} \quad (3.11)$$

The above function is linearized double-log form:

$$\ln Y = \ln\beta 0 + \beta 1 \ln X1 + \beta 2 \ln X2 + \beta 3 \ln X3 + \beta 4 \ln X4 + \beta 5 \ln X5 + Vi\text{-}Ui \quad (3.12)$$

Where,

Y = Output (kg/ha)

X1 = Human labour (man days/ha)

X2 = Land preparation cost (Tk./ha)

X3= Seed (Kg/ha),

X4 = Fertilizer (kg/ha)

X5 = Cost of insecticide (Tk./ha)

The model of the technical inefficiency effects in the stochastic production frontier equation is defined by

$$Ui = \delta 0 + \delta 1 Z1 + \delta 2 Z2 + \delta 3 Z3 + \delta 4 Z4 + \delta 5 Z5 + Wi \quad (3.13)$$

Where,

Z1…….. Z6 are explanatory variables.

The equation can be written as:

Ui = δ0 + δ1 T. Aman farming experience + δ2Education + δ3 Contact with AEO+δ4Training + δ5Credit service + Wi (3.14)

V is two-sided uniform random variable beyond the control of farmer having $N(0, \sigma v^2)$ distribution, U is one-sided technical inefficiency effect under the control of farmer having a positive half normal distribution {Ui~|N(0, σu^2)|} and Wi is two-sided uniform random variable. W is unobservable random variable having a positive half normal distribution. The model was estimated simultaneously using STATA software.

CHAPTER 4

DESCRIPTION OF THE STUDY AREA

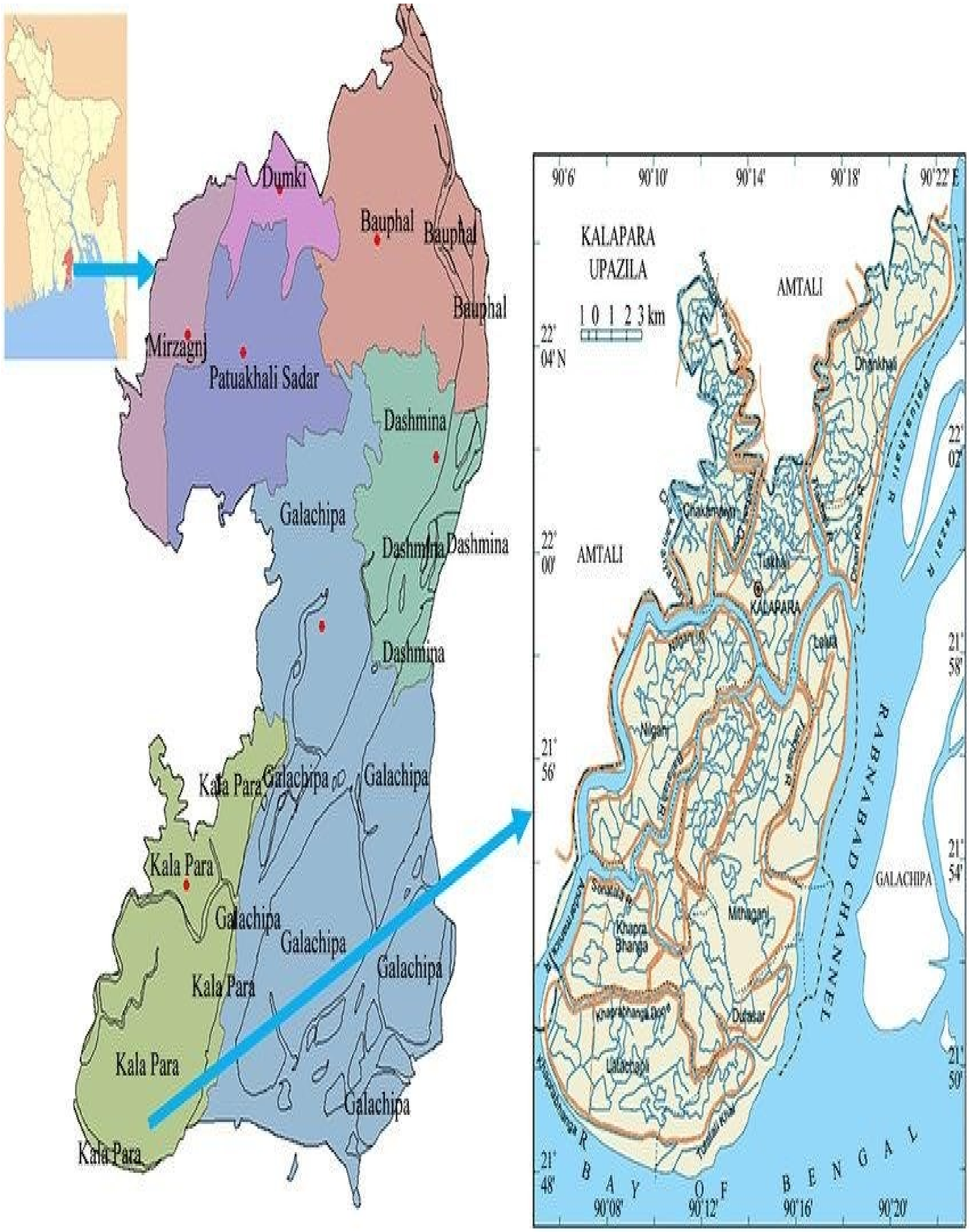
4.1 Introduction

A short description has been presented in this chapter to know the overall features of the study area. It is essential to know the agricultural activities, possible development opportunities and potentials of the study area. Location, area, population, monthly average temperature and rainfall, agriculture, occupation, cropping patterns, communication and marketing facilities of the study area are discussed in this chapter. However, for the production of T. Aman, it is very essential to know the climate and topography of the study areas.

4.2 Location

The selected sample farmers are located in two villages namely Betagi, Bashbaria under Dashmina upazila is under the patuakhali district. These two villages are located from 10 to 15 km of the upazila headquarters. Patuakhali is a district in South-westernBangladesh. It is a part of the Barisal Division. This is the main entrance for the beach of Kuakata. This district is famous for watching both the sun rise and sun set. It is situated at the fringe of the Bay of Bengal. It became a sub division of Barisal district 1871 and was upgraded to a separate district on December 1, 1983. It is bounded on the north by Barisal district, on the east by Bhola district, on the south by the Bay of Bengal and on the west by Barguna. It lies between 21º48' and 22º36' north latitudes and between 90º08' and 90º41' east longitudes. The total area of the district is 3221.31 sq. km and 71.33 sq. km is under forest.

The locations of the upazilla are presented in the Map 4.1, 4.2 respectively.



Source: www. administrative+unit+map+of+bangladesh.com

Figure 4.1: Map of Study Area

Source:www.administrative+unit+map+of+bangladesh.coM

Figure 4.2 : Location of study area

4.3 Climate, Temperature and Rainfall

Annual average temperature of this district varies from maximum25.3°C to minimum 12.2°C and anual rainfall 2377 mm.

Table 4.1: Temperature, Rainfall, Humidity of Patuakhali District from 2008-2011

3.01 Temperature, rainfall, humidity during the years 2008-2011				
	Temperature (centigrade)			
Years	Maximum	Minimum	Rainfall (millimeter)	Humidity (%)
2008	35.1	12.1	2512	81
2009	34.9	14.2	2326	81
2010	35.1	12.2	1400	71.8
2011	25.3	12.2	2377	80.9

Source: District Statistics,2011

4.4 Area and Population

The total area, population and density of population of the selected upazilas are presented in Table 4.2 .The highest population density (873 per sq.km) is Patuakhali Sadar and the lowest population density (625 sq. km) is in Bauphal Upazilla.

Table 4.2: The total area, population and density of population of study area

Upazila	**Household**	**Population**			**Sex ratio**	**Average size**	**Density**
		Male	Female	Total	(M/F)	of household	per sq. km.
Bauphal	67833	144545	159739	304284	90	4.5	625
Dashmina	28490	60241	63147	123388	95	4.3	351
Dumki	15542	33802	36853	70655	92	4.5	765
Galachipa	80054	179652	181866	361518	99	4.5	285
Kalapara	57525	120514	117317	237831	103	4.1	484
Mirzaganj	28205	59292	62424	121716	95	4.3	728
Patuakhali Sadar	68813	155395	161067	316462	96	4.6	873
Total	**346462**	**753441**	**782413**	**1535854**	**96**	**4.4**	**477**

Source: BBS, 2016

4.5 Physical Features, Topography and Soil Condition

Patuakhali is a district in South-westernBangladesh. It is a part of the Barisal Division. This is the main entrance for the beach of Kuakata. This district is famous for watching both the sun rise and sun set. It is situated at the fringe of the Bay of Bengal. It became a sub division of Barisal district 1871 and was upgraded to a separate district on December 1, 1983. It is bounded on the north by Barisal district, on the east by Bhola district, on the south by the Bay of Bengal and on the west by Barguna. It lies between 21º48' and 22º36' north latitudes and between 90º08' and 90º41' east longitudes. The total area of the district is 3221.31 sq. km and 71.33 sq. km is under forest. This dristict is under AEZ 13, Ganges Tidal Floodplain This region occupies an extensive area of tidal floodplain land in south-west of the country. The greater part of this region has smooth relief. There is a general pattern of grey, slightly calcareous, heavy soils on river banks and grey to dark grey, noncalcareous, heavy silty clays in the extensive basins. Noncalcareous Grey Floodplain soil is the major component of general soil types. Acid Sulphate soil also occupies significant part of the area where it is extremely acidic during dry season. In general, most of the topsoils are acidic and subsoils are neutral to mildly alkaline. Soils of Sundarban area are strongly alkaline. General fertility level is high with medium to high organic matter content. Location: All or most of Barisal, Jhalakati, Pirojpur, Patuakhali, Barguna, Bagerhat, Khulna, Satkhira districts including Khulna and Bagerhat Sundarban Reserved Forests.

Table 4.3: Soil Type of Study area

Upazila	**Total**	**Soil classification(sq km)**				
		Doash	Bele	Etel	Kankar	Others
Bauphal	114477	74100	27039	2470	10	108608
Dashmina	51	37300	10	3299	0	0
Dumki	19846	13820	466	5560	0	0
Galachipa	313420	203450	420	109550	0	0
Kalapara	303500	203510	518	107225	0	0
Mirzaganj	39000	3500	1000	345	0	0
Patuakhali Sadar	80754	48700	26934	5120	0	0
Total	**871048**	**584380**	**56387**	**233569**	**10**	**108608**

Source: BBS, 2016

4.6 Study Area

Dashmina Upazila (PATUAKHALI DISTRICT) area 351.74 sq km, located in between 22° and 22°22' north latitudes and in between 90°28' and 90°39' east longitudes. It is bounded by BAUPHAL upazila on the north, GALACHIPA upazila on the south, LALMOHAN and CHAR FASSON upazilas on the east, Galachipa upazila on the west. Population Total 117037; male

58280, female 58757; Muslim 109088, Hindu 7939 and others 10.Water bodies Main river. Administration Dashmina Thana was formed in 1979 and it was turned into an upazila in 1983.

4.7 Agriculture holding

An agriculture holding is a techno-economic unit of agricultural production under single management comprising all livestock kept and all land used wholly or partly for agricultural production purposes without regard to title, legal form or size. Single management may be exercised by either an individual holder or jointly by two or more individuals or holders or by a judicial person such as a corporation, co-operative or government agency. A holding may consist of one or more parcels (fragments of land) located in one or more areas or mauzas or in more than one administrative unit or division provided that all separate parcels of fragments form parts of same technical unit under operational control of same management. The definition covers practically all holdings/households engaged in agricultural production of both crops and livestock. Some agriculture holdings may have no significant agricultural land, e.g. holdings keeping livestock, poultry and hatcheries for which land is not an indispensable input for production.

4.8 Farm holding

A farm holding is defined as being an agricultural production unit having cultivated land equal to or more than 0.05 acres. Farm holdings are classified into following three broad groups:

c) **small:** Farm holdings having minimum cultivated land 0.05 acre but operated land more thanthis minimum but upto 2.49 acres.
d) **medium:** Farm holdings having operated land in between 2.50 to 7.49 acres.
e) **large**: Farm holdings having operated land 7.50 acres and above.

Small cultivated land 0.04 acre or less is generally used for kitchen garden growing mainly vegetables. Often seeds of white gourd, water gourd, pumpkin and other strains are sown on households; but these creepers spread out around house roofs and other structures. As such, the minimum cultivated land considered for qualifying to be a farm holding is 0.05 acres.

Table 4.4: Area and production of rice crops 2010-2011

Upazila	Aus		T. Aman		Boro	
	Area(acre)	Production	Area	Production	Area	Production(M.ton)
Bauphal	31245		89288	64561	4000	3290
Dashmina	16000		46200	43491	1800	1144
Dumki	10348		14900	7099	2800	941
Galachipa	51870		171665	130000	2470	2200
Kalapara	52770		161229	140900	2815	2400
Mirzaganj	17200		27875	13907	86	16125
Patuakhali Sadar	33650		61845	37120	69	49
Total	**213083**		**573002**	**437078**	**14040**	**26149**

Source: District Statistics, 2011

4.9 Land description:

Small cultivated land 0.04 acre or less is generally used for kitchen garden growing mainly vegetables. Often seeds of white gourd, water gourd, pumpkin and other strains are sown on households; but these creepers spread out around house roofs and other structures. As such, the minimum cultivated land considered for qualifying to be a farm holding is 0.05 acres.

Table 4.5: Land type of study area(in acre)

Upazila	High land	Medium land	Low land	Total land
Bauphal	30570	82684	7112	120366
Dashmina	37300	10085	3299	50684
Dumki	217	15956	0	16233
Galachipa	526	175975	0	176501
Kalapara	722	165880	2370	168972
Mirzaganj	937	28081	1556	30574
Patuakhali Sadar	15863	47591	0	63454
Total	**86135**	**526252**	**14337**	**506418**

Source: BBS, 2016

4.10 Tenancy

Owner holdings are those having and operating their owned land and who may or may not be leasing out land. Tenant holdings are those having no owned land but operating land taken from others on share cropping basis or on other terms. Owner-cum-tenant holdings are those having owned land and who may or may not be leasing out their own land to others and who may be taking land from others on share cropping basis or on other terms.

Table 4.6: Number of agriculture holding by tenure(in acre)

Upazila	Total farm holding	Owner holding	Owner cum tenant	Tenant holding
Bauphal	42949	50055	12037	2639
Dashmina	18720	20801	4685	1110
Dumki	10733	11656	2924	172
Galachipa	50910	59393	11564	5542
Kalapara	30448	30772	9907	8649
Mirzaganj	19540	20846	6193	373
Patuakhali Sadar	40079	47871	11013	5300
Total	**213379**	**241394**	**58323**	**23785**

Source: BBS, 2016

4.11Occupations

The major occupations of the peoples under study areas are agriculture, non-agricultural labourer, wage labourer, industrial labourer, service holder and others. Average wage rate of agricultural labour varies in different areas. Day labours were charged with high wage rate and they became scarce during harvesting period.

4.12 Transportation, Communication and Marketing Facilities

Transportation and communication is the pre-condition for the development of a particular region or a country. The selected areas for the study are well communicated with the different places of Bangladesh. The road network of this area facilitates the local people to market their agricultural as well as other products to the nearby and distance market places. Most of the roads in the study areas are concreted and some of the roads are muddy. Due to well communication with the different markets, usually farmers do not deceive from having good prices of their produced commodities. The modes of transportation of this area are rickshaw, van, bullock carts, truck, by-cycle, motorcars and boats. There are many hats, which are sit on more than one day in a week and the local bazars are held on every morning and afternoon.

CHAPTER 5

SOCIO-ECONOMIC PROFILE OF SAMPLE FARMERS

5.1 Introduction

The aim of this chapter is to present a brief description of the socio-economic characteristics of the farmers producing T. Aman. Socioeconomic aspects of the farmers can be looked upon from different points of view depending upon a number of variables related to their level of living, the socio-economic environment in which they live and the nature and the extent of the farmers' participation in national development activities. It was not possible to collect all the information regarding the socio-economic characteristics of the sample farmers due to limitation of time and resources. Socioeconomic condition of the sample farmers is very important in case of research planning because there are numerous interrelated and constituent attributes characterizes an individual and profoundly influences development of his/her behavior and personality. People differ from one another for the variation of socioeconomic aspects. However, for the present research, a few of the socioeconomic characteristics have been taken into consideration for discussion.

5.2 Age and Sex

The sample of 118 household in study area in Dashmina upazilla, 51.78 percent of the sample populations were male and 48.22 percent were female. About 20.75 percent of sample farmers were below 15 years of age, about 58.89 percent of the populations were under 15-49 years age group and only 20.36 percent were of 49 years or above (Figure 5.1).

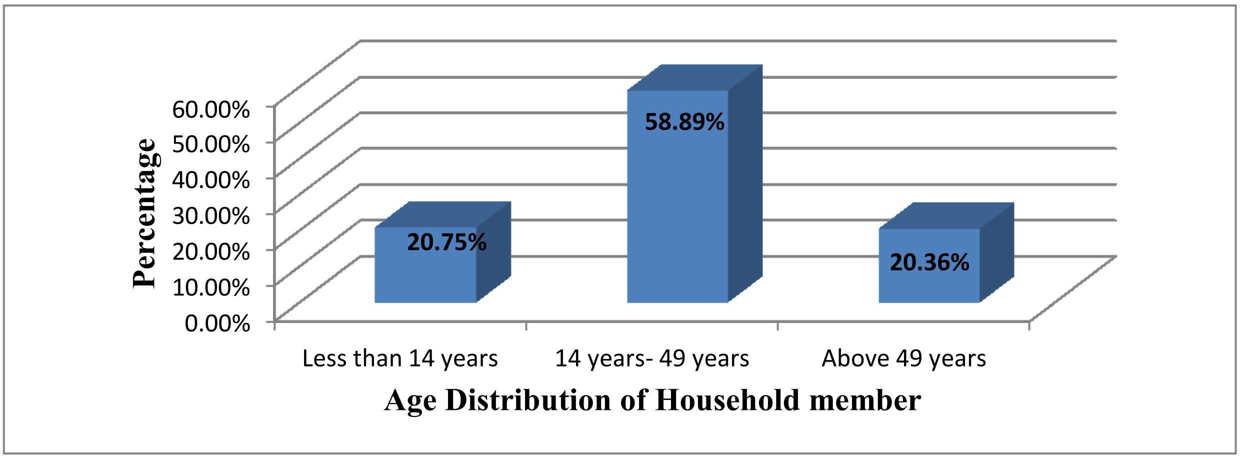


Figure 5.1: Age of the Household Members by Study Area

Source: Field Survey, 2019

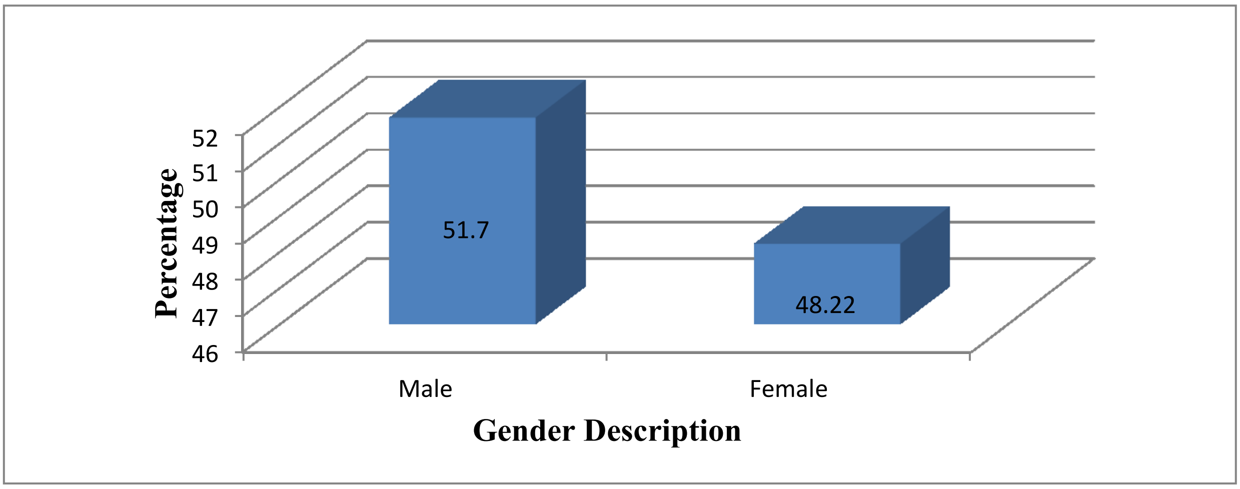


Figure 5.2: Sex Ratio of the Household Members by Study Area

Source: Field Survey, 2019

5.3 Marital Status

In Dashmina upazila, marital status of the sample farmers (at the time of survey) indicated that about 67.59% percent were married and about 32.41 percent were unmarried (Figure 5.3). The proportion of unmarried people was found lower for female population in comparison with that of male population.

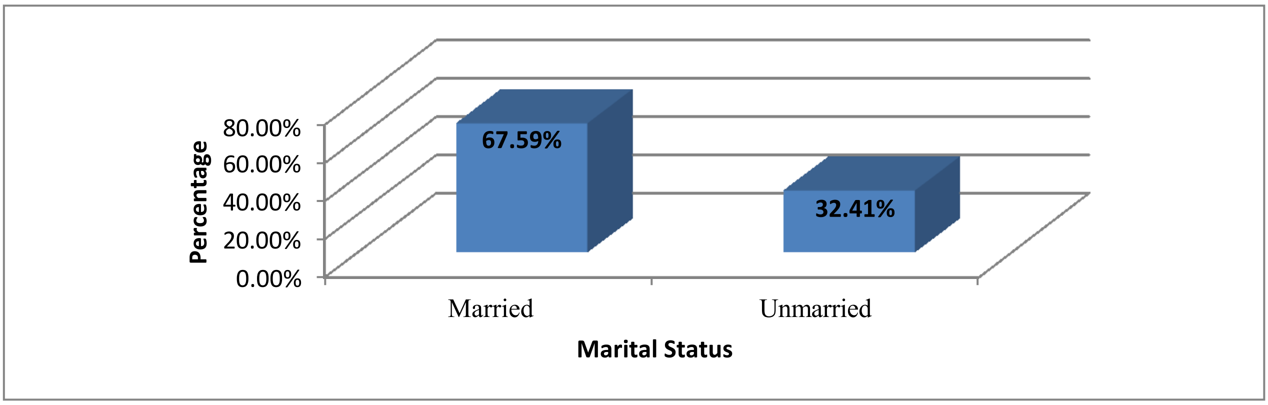


Figure 5.3: Marital Status of the Household Members by Study Area

Source: Field Survey, 2019

5.4 Education

Figure 5.4 showed that, in Dashmina upazila, about 17 percent of the study sample aged 5 years or more were found to have no education and/or read/write, about 56.72% percent were found to have primary level education, about 11 percent were found to have secondary, 9 percent has higher secondary level education and only 4.15 percent people were found to have attained/completed graduation level of education.

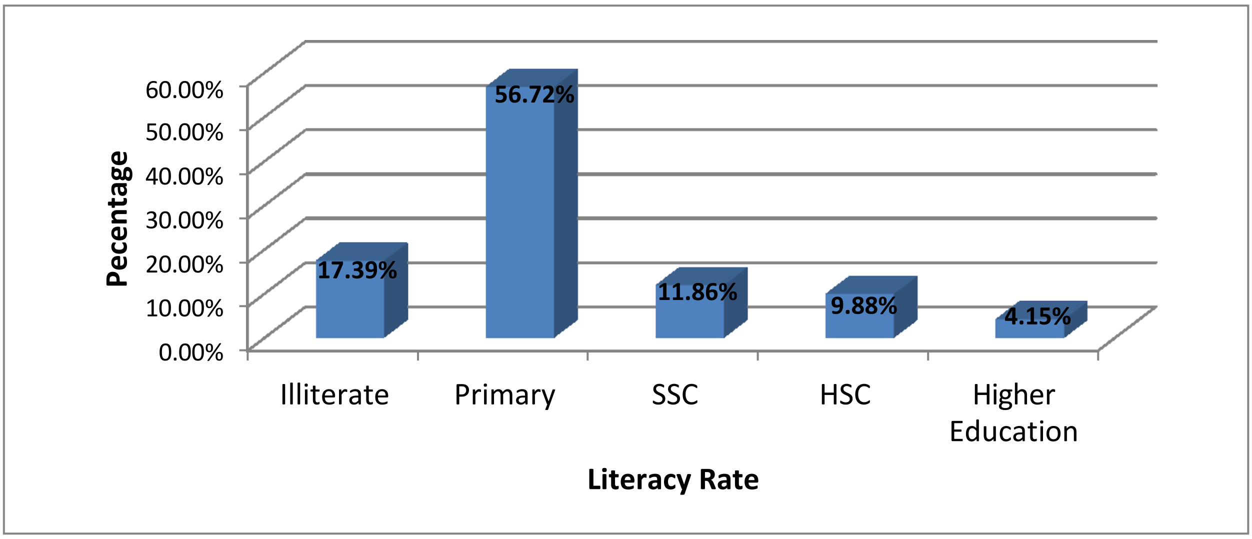


Figure 5.4: Education of the Household Members by Study Area

Source: Field Survey, 2019

5.5 Income

Figure 5.5 showed that in Dashmina Upazilla , the sample population earn their 29 percent income from T. Aman selling, 15 percent of income from other crop selling,8 percent of income from fisheries , 9 percent of income from livestock and 38 percent of income from other sources.

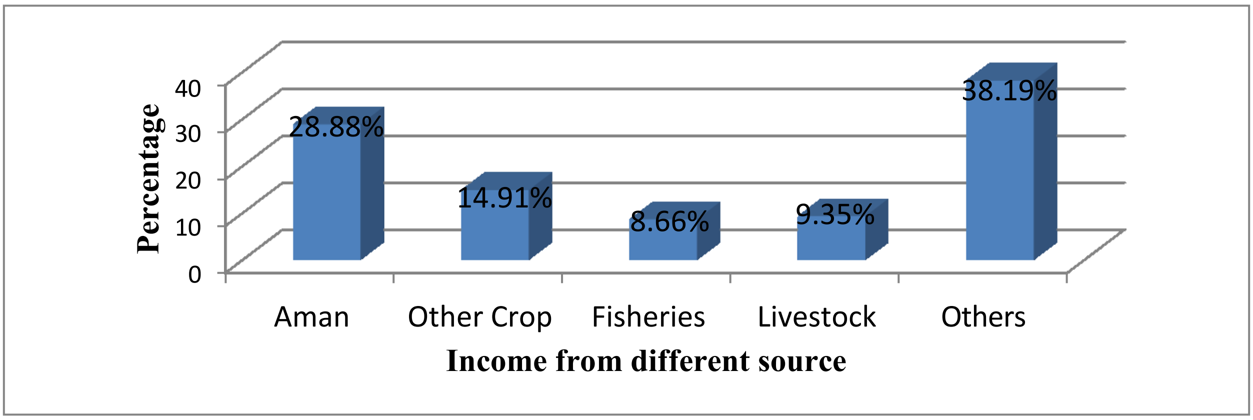


Figure 5.5: Income of the Household Members by Study Area

Source: Field Survey, 2019

5.6 Membership

Among the respondent farmers in Dashmina upazila, 25 percent T. Aman producers were found to have membership in different Cooperatives and/or farmers' organizations whereas 75.42 percent of T. Aman farmers had no membership in different Cooperatives and/or farmers' organizations.

Table 5.1: Membership of the Respondent Farmers by the study area

Membership	No of respondent	percent
Yes	39	33.05
No	79	66.94

Source: Field Survey, 2019

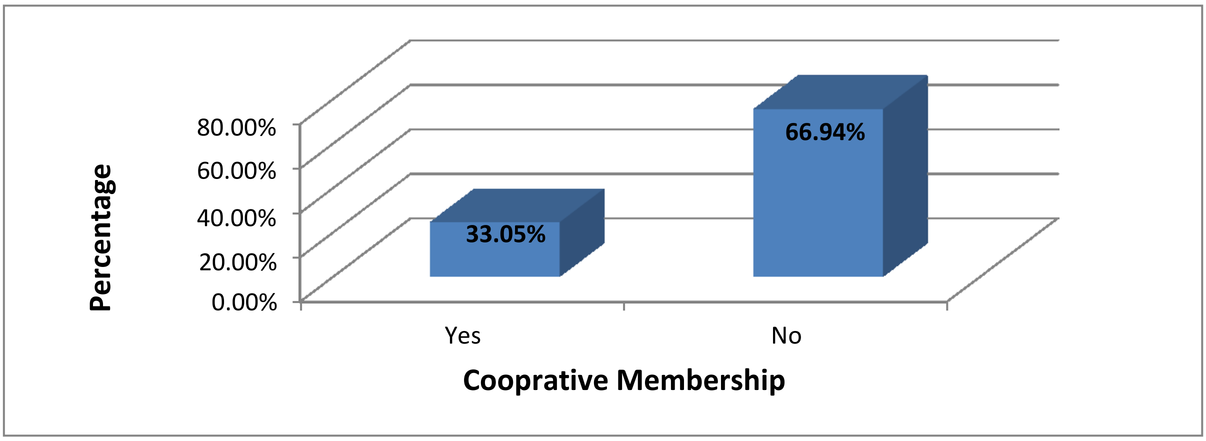


Figure 5.6: Membership of the household by the study area

Source: Field Survey, 2019

5.7 Agricultural Training

Among the respondent farmers in Dashmina upazila, 56.78 percent farmers got training on different agricultural technologies of T. Aman farming whereas, 43.22 percent farmers didn't get training on different agricultural technologies of others crops. These training have improved their perceptions of good seed use, use of resistant varieties, application of insecticides and pesticides, water management, and so on.

Table 5.2: Agricultural Training of the Respondent Farmers by Crop

Training of respondent	No of respondent	Percent
Yes	66	53.31
No	55	46.61

Source: Field Survey, 2019

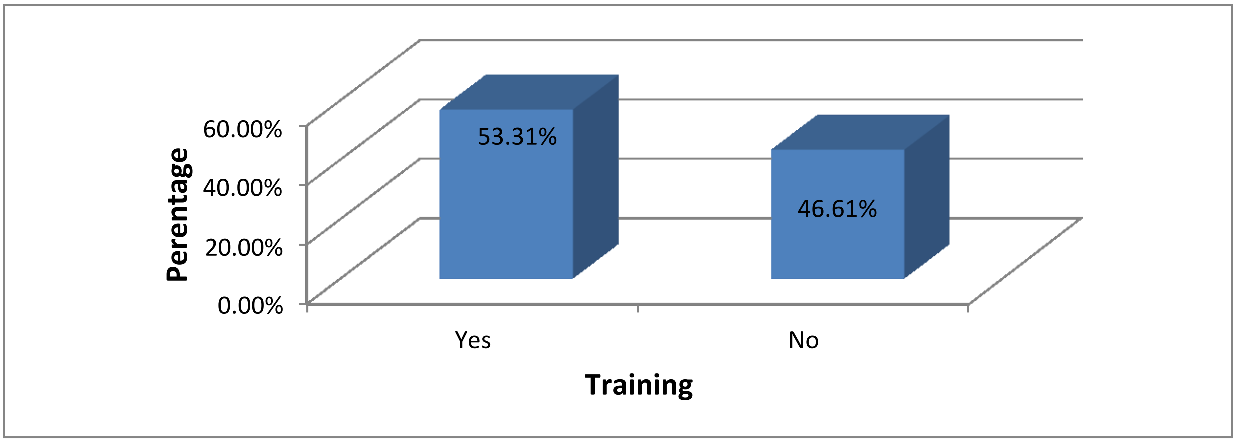


Figure 5.7 Agricultural Training of the Respondent Farmers by Crop

Source: Field Survey, 2019

5.8 Credit

Among the respondent farmers in Dashmina upazila, 74.58 percent farmers got credit from different bank and NGO of T. Aman farming whereas, 25.42 percent farmers didn't get credit fom any kind of bank and non bank financial institution.

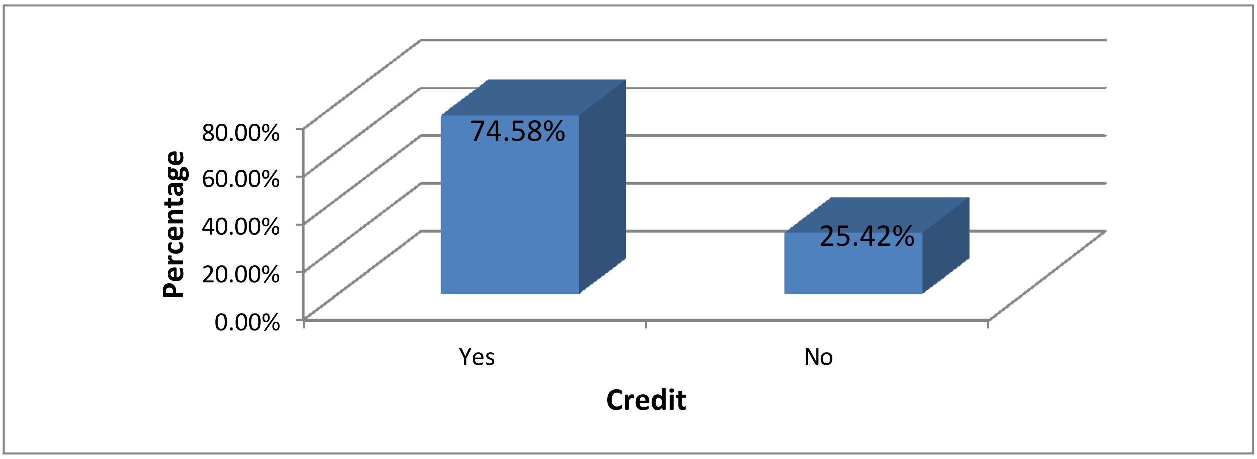


Figure 5.8: Credit facility of the sample population by the study area

Source: Field Survey, 2019

CHAPTER 6

PROFITABILITY OF T. AMAN RICE PRODUCTION

6.1 Introduction

The main purpose of this chapter is to assess the costs, returns and profitability of growing T. Aman rice. Profitability is a major criterion to make decision for producing any crop at farm level. It can be measured based on net return, gross margin and ratio of return to total cost. The costs of all items were calculated to identify the total cost of production. The returns from the crops have been estimated based on the value of main products and by-products.

6.2 Profitability of T. Aman Production

6.2.1 Variable Costs

6.2.1.1 Cost of Land Preparation

Land preparation is the most important components in the production process. Land preparation included ploughing, laddering and other activities needed to make the soil suitable for T. Aman cultivation. For land preparation in T. Aman production, no. of tiller was required 3 with Tk. 150 per tiller. Thus, the average land preparation cost of T. Aman production was found to be Tk. 4981.53 per hectare, which was 14.29 percent of total cost (Table 6.1).

6.2.1.2 Cost of Human Labour

Human labour cost is one of the major cost components in the production process. It is one of the most important and largely used inputs for producing T. Aman. It is generally required for different operations such as land preparation, sowing, weeding, fertilizer and insecticides application, irrigation, harvesting and carrying, threshing, cleaning, drying, storing etc. The quantity of human labour used in T. Aman production was found to be about 65 man-days per hectare and average price of human labour was Tk. 500 per man-day. Therefore, the total cost of human labour was found to be Tk. 21751 representing 62.37 percent of total cost (Table 6.1).

6.2.1.3Cost of Seed

Cost of seed varied widely depending on its quality and availability. Per hectare total cost of seed for T. Aman production was estimated to be Tk. 1980, which constituted 5.68 percent of the total cost (Table 6.1).

6.2.1.4 Cost of Urea

In the study area, farmers used different types of fertilizers. On an average, farmers used urea 41 kg per hectare. Per hectare cost of urea was Tk. 818, which represents 2.35 percent of the total cost (Table 6.1).

6.2.1.5 Cost of TSP

Among the different kinds of fertilizers used, the rate of application of TSP (77 kg) was almost double to urea fertilizers. The average cost of TSP was Tk. 1605 which representing 4.60 percent of the total cost (Table 6.1).

6.2.1.6 Cost of MoP

The application of MoP per hectare (21 kg) was found lower than other fertilizers. Per hectare cost of MoP was Tk. 411, which represents 1.18 percent of the total cost (Table 6.1).

Table 6.1: Per Hectare Cost of T. Aman Production

Items of Cost	Quantity (kg/ha)	Rate (Tk./Kg)	Cost (Tk./Ha)	% of Total Cost
Land preparation	3	150	4981.53	14.29
Human labor	65	500	21751	62.37
Seed			1980	5.68
Urea	41	20	818	2.35
TSP	77	30	1605	4.6
MoP	21	20	411	1.18
Cost of Insecticides			1596	4.58
A. Total Operating Cost (TOC)			**33142**	**95.05**
Interest on operating capital @ of 10% for months			1104.73	3.17
B. Total Variable Cost (TVC)			**34246**	**98.21**
Rental value of land			623.03	1.78
C. Total Fixed Cost (TFC)			**623.03**	**1.78**
D. Total cost (B+C)			**34869.76**	**100**

Source: Field Survey, 2019

Note: Quantity and rate for land preparation are expressed in no. of tiller per hectare and Tk. per tiller units, respectively. Quantity and rate of human labor are expressed in man-days per hectare and Tk. per man-days units, respectively

6.2.1.7 Cost of Insecticides

Farmers used different kinds of insecticides to keep their crop free from pests and diseases. The average cost of insecticides for T. Aman production was found to be Tk. 1596 which was 4.58 percent of the total cost (Table 6.1).

6.2.1.8 Interest on Operating Capital

It may be noted that the interest on operating capital was calculated by taking in to account all the operating costs incurred during the production period of T. Aman. Interest on operating capital for T. Aman production was estimated at Tk. 1104.73 per hectare, which represents 3.17 percent of the total cost (Table 6.1).

6.2.1.9 Total Variable Cost

Therefore, from the above different cost items it was clear that the total variable cost of rice production was Tk. 34246 per hectare, which was 98.21 percent of the total cost (Table 6.1).

6.2.2 Fixed Cost

6.2.2.1 Rental Value of Land

Rental value of land was calculated on the basis of opportunity cost of the use of land per hectare for the cropping period of three months. Cash rental value of land has been used as cost of land use. On the basis of the data collected from the T. Aman rice farmers the land use cost was found to be Tk. 623.03 per hectare, and it was 1.78 percent of the total cost (Table 6.1).

6.2.3 Total Cost (TC) of T. Aman rice Production

Total cost was calculated by adding all the cost of variable and fixed inputs. In the present study per hectare total cost of producing rice was found to be Tk. 34869.76 (Table 6.1).

6.2.4 Return of T. Aman Production

6.2.4.1 Gross Return

Return per hectare of T. Aman rice cultivation is shown in table 7.2. Per hectare gross return was calculated by multiplying the total amount of product with respective per unit price. It is evident from table that the average yield of T. Aman per hectare was 2149 kg and the average price of T. Aman was Tk. 17.5.And the by product of 2149 kg was TK. 2.98 Therefore, the gross return was found to be Tk. 43882.58 per hectare (Table 6.2) by adding the value of main product and by product of rice.

6.2.4.2 Gross Margin

Gross margin is the gross return over variable cost. Gross margin was calculated by deducting the total variable cost from the gross return. On the basis of the data, gross margin was found to be Tk. 9636.58 per hectare (Table 6.2)

6.2.4.3Net Return

Net return or profit was calculated by deducting the total production cost from the gross return. On the basis of the data the net return was estimated as Tk. 9013.58per hectare (Table 6.2).

Table 6.2: Per Hectare Cost and Return of T. Aman rice Production

Measuring Criteria	**Quantity (Kg/Ha)**	**Rate (Tk/Ha)**	**Cost (Tk/Ha)**
Main Product Value	2149	17.5	37607.5
By Product value	2149	2.92	6275.08
Gross Return (GR)			43882.58
Total Variable Cost (TVC)			34246
Total Cost (TC)			34869.76
Gross Margin (GR-TVC)			9636.58
Net Return (GR-TC)			9013.58
BCR (undiscounted)(GR/TC)			**1.26**

Source: Field survey, 2019

6.2.5 Benefit Cost Ratio (Undiscounted)

Benefit Cost Ratio (BCR) is a relative measure, which is used to compare benefit per unit of cost. Benefit Cost Ratio (BCR) was found to be 1.26 which implies that one taka investment in T. Aman rice production leads Tk.1.26 (Table 6.2). From the above calculation it was found that T. Aman rice cultivation is profitable in Bangladesh.

6.3 Concluding Remarks

From the above discussion it is easy to understand about the different cost items and their application doses of farmers, yields and returns per hectare of T. Aman rice cultivation. T. Aman production is a labour intensive enterprise. It is most essential to use modern inputs such as seeds, fertilizers, human labour, power tiller, pesticides and irrigation efficiently. Timely and efficient use of these inputs are the most important to increase production and profitability. On the basis of above discussions it could cautiously be concluded here that cultivation of T. Aman rice is profitable.

CHAPTER 7

TECHNICAL EFFICIENCY OF THE T. AMAN RICE FARMERS

7.1 Introduction

The estimation of efficiency with the help of production function has been a popular area of applied econometrics. Technical efficiency reflects the ability of a farmer to obtain the maximum possible output from a given level of inputs and production technology. It is a relative concept, since each farmers production performance is compared to a best-practice input-output relationship or production frontier. A farmer is technically inefficient in the sense that if it fails to produce maximum output from a given level of inputs. Technical inefficiency is then measured as the deviation of a farmer from the best-practice frontier. The main objective of this chapter is to estimate the technical inefficiency as well as frequency distribution of T. Aman farmers through technical efficiency analysis. The technical efficiency in production was estimated by using the stochastic frontier production. The primary advantage of a stochastic frontier production function is that it enables one to estimate U, (non-negative random variable which is under the control of the farmers).

Since the pioneering work on technical efficiency by Farrell in 1957, which drew upon the works of Debreu (1951) and Koopmans (1951), considerable effort has been directed at refining the measurement of technical efficiency. Empirical studies suggest that farmers in developing countries fail to exploit the potential of technology perhaps due to inefficient decision making due to various reasons of which management capacity is important one.

7.2 Interpretation of ML Estimates of the Stochastic Frontier Production Function

Maximum likelihood estimation begins with writing a mathematical expression known as the Likelihood Function of the sample data. The likelihood of a set of data is the probability of obtaining that particular set of data, given the chosen probability distribution model. This expression contains the unknown model parameters. The values of these parameters that maximize the sample likelihood are known as the Maximum Likelihood Estimates or MLE's. The maximum likelihood estimates for parameters of the Cobb-Douglas stochastic frontier production function and technical inefficiency effect model for T. Aman production for all farmers are presented in Table 7.1.

7.2.1 Human Labour (X1)

The regression coefficients of Human labour (X1) was positive and significant at 1 percent level of significance. The regression coefficients of human labour (X1) was 0.73, which implied that, other factors remaining the same, if expenditure on human labour was increased by 1 percent then the yield of T. Aman rice would be increased by 0.73 percent (Table 6.1).

7.2.2 Land Preparation Cost (X2)

The regression coefficients of land preparation cost was found to be positive and significant at 1 percent level for T. Aman (Table 7.1). Co-efficient of land preparation cost (X2) was .26. The result of the analysis indicated that, keeping other factors constant, a 1 percent increase in additional expenditure on land preparation would increase the yield of T. Aman by 0.26 percent.

7.2.3 Seed (X3)

The regression coefficients of seed was found to be negative and it is 10% level of significance, the coefficient of seed cost was -.22 which implied that, holding other factors constant, 1 percent increase in the amount of seed would decrease the yield of T. Aman by 0.22 percent (Table 7.1).Overused of seed decrease the yield of T. Aman.

7.2.4 Fertilizer (X4)

The regression coefficients of fertilizer (X4) was positive and significant at 1 percent level of significance (Table 7.1). The regression coefficients of fertilizer (X4) was 0.49, which implied that, other factors remaining the same, if amount of fertilizer was increased by 1 percent then the yield of T. Aman would be increased by 0.49 percent.

7.2.5 Cost of Insecticide (X5)

The regression coefficient of insecticides cost (X5) of T. Aman production was positive and significant at 5 percent level of significance, which implied that if the expenditure on insecticides was increased by 1 percent then the yield of T. Aman would be increased by 0.15 percent, other factors remaining constant (Table 7.1).

Table 7.1: ML Estimates for Parameters of Cobb-Douglas Stochastic Frontier Production Function and Technical Inefficiency Model for T. Aman rice Farmers.

Variable	Parametre	Co-efficient	P value
Stochastic Frontier			
Constant	β0	-.37	0.720
Human Labor (X1)	β1	.73***	.000
Land Preparation (X2)	β2	.26***	0.001
Seed (X3)	β3	-.22*	0.076
Fertilier (X4)	β4	.49***	0.000
Insecticide (X5)	β5	.15**	0.026
Inefficiency Model			
Constant	δ0	-1.39*	0.102
Experience (Z1)	δ1	.012	0.395
Education (Z2)	δ2	-.06	0.265
Extension Service (Z3)	δ3	1.02*	0.057
Taining (Z4)	δ4	-1.34**	0.013
Credit Service (Z5)	δ5	.13	0.793

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

Source: Field Survey, 2019

7.3 Interpretation of Technical Inefficiency Model

In the technical inefficiency effect model, education, and training have expected (negative) coefficients. The negative coefficient of education implies that educated farmers are technically more efficient than non educated farmers, although this coefficient is not statistically significant. The negative and significant (5 percent) coefficient of training indicates that training of farmers helps reduce technical inefficiency (Table 7.1).

The coefficients of experience, credit service and extension service are positive meaning that these factors have no impact on the technical inefficiency. Although the coefficient of extension service is significant at 10 percent level of significance. That is, these factors do not reduce or increase technical inefficiency of producing T. Aman.

7.4 Technical Efficiency and Its Frequency Distribution

Table 7.2 shows frequency distribution of farm-specific technical efficiency for T. Aman farmers. It reveals that average estimated technical efficiencies for T. Aman are 68 per cent which indicate that T. Aman production could be increased by 32 per cent with the same level of inputs without incurring any further cost. Increase of only managerial skills result a substantial increase of output for T. Aman. It was observed that 32.20 per cent of sample farmers were found to have received outputs which were very close to the maximum frontier outputs maintaining the efficiency level 0-65. On the other hand, 9.32 per cent of sample farmers obtained 65 to 70 per cent technical efficiency level respectively 19.50 percent fo 70- 75,14.41 percent for 75-80, 16.95 percent for 80-85 and 8 percent sample farmer attain efficiency at 85-90 level. The minimum and maximum technical efficiencies were observed to be 16 and 91 percent respectively, where standard deviation was maintained at 16.3.

Table 7.2 Frequency Distribution of Technical Efficiency of T. Aman Farms

Efficiency	No. of farms	Percentage of farms
0-65	38	32.20%
65-70	11	9.32%
70-75	23	19.50%
75-80	17	14.41%
80-85	20	16.95%
85-90	8	6.79%
90-95	1	.87%
Total number of observation	118	
Minimum	0.15	
Maximum	0.91	
Mean	0.680	
Standard Deviation	0.163	

Source: Field Survey, 2019

CHAPTER 8

PROBLEMS OF T. AMAN RICE GROWERS

8.1Introduction

Farmers faced a lot of problems in producing T. Aman rice in Bangladesh. The problems were social and cultural, financial and technical. This chapter aims at represent some socioeconomic problems of producing T. Aman rice. The problems faced by the farmers were identified according to opinions given by them. The major problems and constraints related to T. Aman rice cultivation are discussed below:

8.2 Low Price of Output

Most of the farmers had to sell a large portion of their product at the harvest period to meet various obligations like, household's expenditure and repayment of loan. But harvest time price of T. Aman rice remained low because of ample supply. The market price of rice is so high ,but the farmer cannot get the proper price for rice. So they could not get reasonable return for their products. It can be seen from Table 8.1 that 97.46 percent T. Aman growers reported this problem.

8.3 High Labor cost

In recent time the problem of high labor cost is a big issue for rice growers in Bangladesh. From production to harvest,farmer bear the burden of high labor cost. Almost each and evry household claim about this problem.It can be seen in table 8.1 that 94.92% T. Aman grower reported this problem.

8.4 High Price of Inputs

Non-availability of inputs like seeds, fertilizers, insecticides, human labour etc. at fair price was a problem in the way of producing enterprises. During the production period price of some inputs tend to rise due to their scarcity. It appears from Table 8.1 that 94.07 percent T. Aman growers reported that they had to purchase some inputs at a high price during the production period.

8.5 Natural Calamities

It was found that T. Aman growers faced some acute problems relating to the nature in their production process. Natural calamities like hailstorm, thunderstorms, excessive rainfall, flood caused substantial damage to the crop in the field. Farmers said that excessive rainfall and flood during the harvesting period reduces both the quantity and storability of T. Aman. Table 8.1 shows that almost 90.6 percent T. Aman growers in Dashmina upazila reported this as exteme problem .

8.6 Attack of Pest and Diseases

The growers of T. Aman rice were also affected by the problem of attack of pests and diseases. Pests and diseases attack reduce crop yield and increase cost of production. In the study area 86.44 percent T. Aman growers reported this problem (Table 8.1).

8.7 Lack of Quality Seed

Lack of quality seed was one of the most important limitations T. Aman rice in the study area. From Table 8.1 it is evident that about 56 percent T. Aman growers reported this problem. Farmers told that they were cheated by buying so called hybrid seeds from the local markets and from the seed dealers.

8.8 Lack of Operating Capital

The farmers of the study area had capital constraints. For cultivation T. Aman rice a huge amount of cash money was needed to purchase various inputs like, human labour, seed, fertilizers, pesticides, etc. In the study area 51 farmers reported that they did not have sufficient amount of money for purchasing the required quantity of inputs for the relevant enterprises (Table 8.1).

Table 8.1 :Problems and Constraints of T. Aman Production by no. of Farmers

Name of the problem	Number	Percent	Rank
Low price of Rice	115	97.46	1
High Labor cost	112	94.92	2
High price of other input	111	94.07	3
Natural disaster	107	90.6	4
Pest and Disease Attack	102	86.44	5
Lack of quality seed	56	47.46	6
Lack of operating capital	51	43.22	7
Lack of extension services	36	30.51	8
Lack of scientific knowledge	S2	18.64	9

Source: Field Survey, 2019

8.9 Inadequate Extension Service

During the investigation some tanners complained that they did not get any extension services regarding improved method rice cultivation from the relevant officials of the Department of Agricultural Extension (DAE). As an agricultural extension personnel block supervisor's the main advisor of technical knowledge to the fanners about their farming problems. But in the study area about 36 percent rice growers (Table 8.1) reported that they hardly ever got help from the block supervisor.

CHAPTER 9

SUMMARY, CONCLUSION AND RECOMMENDATIONS

9.1 Introduction

This chapter focuses on the summary in the light of the discussions made in the earlier chapters. Conclusion has been made on the basis of empirical result. Policy recommendations are drawn for improvement of the existing inefficiency of T. Aman rice production in Bangladesh. Section 9.2 presents a summary of the major findings of the study, conclusion, policy recommendations, limitation of the study and scope for further study are given in Section 9.3, 9.4, 9.5 and 9.6, respectively.

9.2 Summary

Bangladesh has made remarkable progress in agricultural development and structural transformation has taken place over the years. Production of various agricultural commodities (crops, livestock, fisheries and agro-forestry) has increased and diversified. Increased rural credit for farm and non-farm sectors and separate credit program for the tenant farmers with opening Bank Accounts for more than 10 million farmers contributed towards financial inclusion of the rural households. More than 70 new varieties and hybrids of different crops were developed and released along with new breeds for poultry during last six years. In FY2015, compared to FY2010, value of exports of agricultural commodities has increased by 49 percent. During the same period, import of agricultural commodities has also increased by 18 percent. The performance of this sector has an overwhelming impact on major macroeconomic objectives like employment generation, poverty alleviation, human resources development and food security. Agriculture provides employment to nearly about 42.7 percent of its total labor forces (BER, 2016). Agriculture occupies a key position in the overall economic sphere of the country in terms of its contribution to Gross Domestic Product (GDP). Broad agriculture sector which includes crops, livestock, fisheries and forestry contributes 11.70 percent to the gross domestic product (GDP) as a whole in the FY 2016-17 (BBS, 2017).

Rice is the staple food of about 135 million people of Bangladesh. It provides nearly 48% of rural employment, about two-third of total calorie supply and about one-half of the total protein intake of an average person in the country. Rice sector contributes one-half of the agricultural GDP and one-sixth of the national income in Bangladesh. Almost all of the 13 million farm families of the country grow rice. Rice is grown on about 10.5 million hectares which has remained almost stable over the past three decades. About 75% of the total cropped area and over 80% of the total irrigated area is planted to rice. Thus, rice plays a vital role in the livelihood of the people of Bangladesh.

T. Aman is one of the main crops in Bangladesh. It is the second largest rice crop in the country in respect to the volume of production while Boro tops the production. It is notable that the area coverage of T. Aman is the largest as a single crop and Boro remains the second. The production of T. Aman depends on the weather condition of the country and farmers usually cultivate T. Aman in their land.In the year 2015, favourable weather condition prevailed all over the country from sowing to harvesting period of T. Aman. Total
T. Aman production of Financial Year 2015-16 has been estimated 1,34,83,437metric tonscompared to1,31,90,163 metric tons of Finacial Year 2014-15 which is 2.22%higher. Average yield rate of T. Aman for the Financial Year 2015-16 has been estimated 2.412metric tons per hectare which is been estimated 2.412metric tons per hectare which is 1.13**%**higher than that of last year. In coastal areas of Bangladesh, mainly T. T. Aman is produced among all varieties of rice.

The sample of 118 household in study area was surveyed through simple random sampling technique. The sampling frame for the present study were selected purposively as to select the area where the T. Aman cultivation was intensive. . Data for the present study collected during the period of January 2019. Primary data were collected from T. Aman producers. Selected respondents were interviewed personally with the help of pre-tested questionnaires. The collected data were checked and verified for the sake of consistency and completeness. Editing and coding were done before putting the data in computer. All the collected data were summarized and scrutinized carefully to eliminate all possible errors. Data entry was made in computer and analysis was done using the concerned software Microsoft Excel and statistical Software STATA.

Socioeconomic condition of sample household considered composition of family size and household earning members, educational status, occupational status, and sources of income of the sample farmers. The sample of 118 household in study area in Dashmina upazila, 51.78 percent of the sample populations were male and 48.22 percent were female. About 20.75 percent of household populations were below 15 years of age, about 58.89 percent of the populations were under 15-49 years age group and only 20.36 percent were of 49 years or above. In Dashmina upazila, about 17 percent of the study population aged 5 years or more were found to have no education and/or read/write, about 56.72% percent were found to have primary level education, about 11 percent were found to have secondary,9 percent has higher secondary level education and only 4.15 percent people were found to have attained/completed graduation level of education. the sample population earn their 29 percent income from T. Aman selling, 15 percent of income from other crop selling,8 percent of income from fisheries , 9 percent of income from livestock and 38 percent of income from other sources. Among the respondent farmers in Dashmina upazila, 25 percent T. Aman producers were found to have membership in different Cooperatives and/or farmers' organizations whereas 75.42 percent of T. Aman farmers had no membership in different Cooperatives and/or farmers'organizations .

Economic profitability is a major criterion to make decision for producing any crop at farm level. It can be measured based on net return, gross margin and ratio of return to total cost. For land preparation in T. Aman production, no. of tiller was required 3 with Tk. 150 per tiller. Thus, the average land preparation cost of T. Aman production was found to be Tk. 4981.53 per hectare, which was 14.29 percent of total cost. The quantity of human labour used in T. Aman production was found to be about 65 man-days per hectare and average price of human labour was Tk. 500 per man-day. Therefore, the total cost of human labour was found to be Tk. 21751 representing 62.37 percent of total cost. Per hectare total cost of seed for T. Aman production was estimated to be Tk. 1980, which constituted 5.68 percent of the total cost. . On an average, farmers used urea 41 kg per hectare. Per hectare cost of urea was Tk. 818, which represents 2.35 percent of the total cost. The rate of application of TSP (77 kg) was almost double to urea fertilizers. The average cost of TSP was Tk. 1605 which representing 4.60 percent of the total cost. Per hectare cost of MOP was Tk. 411, which represents 1.18 percent of the total cost. . The average cost of insecticides for T. Aman production was found to be Tk. 1596 which was 4.58 percent of the total cost. . Interest on operating capital for T. Aman production was estimated at Tk. 1104.73 per hectare, which represents 3.17 percent of the total cost. The total variable cost of rice production was Tk. 34246 per hectare, which was 98.21 percent of the total cost. On the basis of the data collected from the T. Aman rice farmers the land use cost was found to be

Tk. 623.03 per hectare, and it was 1.78 percent of the total cost. Total cost was calculated by adding all the cost of variable and fixed inputs. In the present study per hectare total cost of producing rice was found to be Tk. 34869.76. The gross return was found to be Tk. 43882.58 per hectare. On the basis of the data, gross margin was found to be Tk. 9636.58 per hectare. Net return or profit was calculated by deducting the total production cost from the gross return. On the basis of the data the net return was estimated as Tk. 9013.58 per hectare. Benefit Cost Ratio (BCR) was found to be 1.26 which implies that one taka investment in T. Aman rice production leads Tk.1.26. T. Aman production is a labour intensive enterprise. It is most essential to use modern inputs such as seeds, fertilizers, human labour, power tiller, pesticides and irrigation efficiently. Timely and efficient use of these inputs are the most important to increase production and profitability. On the basis of above discussions it could cautiously be concluded here that cultivation of T. Aman rice is profitable.

Technical efficiency reflects the ability of a farmer to obtain the maximum possible output from a given level of inputs and production technology. Technical inefficiency is then measured as the deviation of a farmer from the best-practice frontier. The regression coefficients of Human labour (X1), Land preparation cost (X2), Fertilizer (X4), and Insecticides cost (X5) were positive but the coefficient of Seed cost (X3) was found negative. It indicates that if Human labour (X1), Land preparation cost (X2), Fertilizer (X4) and Insecticides cost (X5) were increased by one per cent, the production T. Aman would increase by 0.7307059, 0.2693103, 0.4990024 and 0.1571354 per cent of sample farmers respectively.

In the technical inefficiency effect model, education, and training have expected (negative) coefficients. The negative coefficient of education implies that educated farmers are technically more efficient than non educated farmers, although this coefficient is not statistically significant. The negative and significant (5 percent) coefficient of training indicates that training of farmers helps reduce technical inefficiency. The coefficients of experience, credit service and extension service are positive meaning that these factors have no impact on the technical inefficiency, although the coefficient of extension service is significant at 10 percent level of significance and later discussed about frequency distribution of farm-specific technical efficiency for T. Aman farmers. It reveals that average estimated technical efficiencies for T. Aman are 68 per cent which indicate that T. Aman production could be increased by 32 per cent with the same level of inputs without incurring any further cost. Increase of only managerial skills result a substantial increase of output for T. Aman. It was observed that 32.20 per cent of sample farmers were found to have received outputs which were very close to the maximum frontier outputs maintaining the efficiency level 0- 65. On the other hand, 9.32 per cent of sample farmers obtained 65 to 70 per cent technical efficiency level respectively 19.50 percent fo 70-75,14.41 percent for 75-80, 16.95 percent for 80-85 and 8 percent sample farmer attain efficiency at 85-90 level. The minimum and maximum technical efficiencies were observed to be 16 and 91 percent respectively, where standard deviation was maintained at 16.3. Farmers faced a lot of problems in producing T. Aman rice in Bangladesh. The problems were social and cultural, financial and technical. Low price of output was one of the most important limitations of producing T. Aman in the study area. Lack of operating capital, high price of quality seed, high cost of input, shortage of human labour, lack of extension service, and natural calamities were the major problems faced by farmers. These are the major constraints for the producers of T. Aman in the study area. Public and private initiatives should be taken to reduce or eliminate these problems for the sake of better production of T. Aman.

9.3 Conclusion

T. Aman rice is one of the important crops grown by farmers mainly for market purpose. The study areas have tremendous potential for T. Aman cultivation. The findings of the present study indicate that T. Aman production is profitable and it would help to improve the socioeconomic condition of sample farmers in the study areas. As T. Aman is a labour intensive crop, it would help to create employment opportunities. In Bangladesh, it is difficult to increase T. Aman production by increasing the area of land under cultivation due to the limitation of land. But, there is an opportunity to increase production of T. Aman by improving the existing production technology. Farmers are relatively inefficient due to land fragmentation, less training, less experience, illiteracy, etc. The present study indicates that farmers are technically inefficient that means there is an opportunities to increase production to a large extent using the existing level of agricultural inputs, the agricultural extension services and the available technology. If the modern inputs could be made available to the farmers in time, products of this crop might be increased which could help them in alleviating rural poverty in many areas. T. Aman is only produced in one season. But now the BARI introduced some verities of different season. Farmers were not known about the application of inputs in right time with right dose. Thus, well-planned management training in accordance with their problems, needs, goals and resources base lead to viable production practices and sustainable income from T. Aman cultivation.

9.4 Recommendations

On the basis of the finding of the study it was evident that T. Aman was profitable enterprises and they can generate income earnings and employment opportunity to the rural people of Bangladesh. But some problems and constraints bared to attain the above mentioned objectives. The policy makers should, therefore, take necessary measures. According to the findings of the study; some policy recommendations may be advanced which are likely to be useful for policy formulation. On the basis of the findings of the study, the following specific recommendation may be made for the development of T. Aman sector.

a) To maintain food security and farmer's secured life, the government should focus on low price issue of rice. Government should fix the procurement price before planting season that is profitable to the farmer because farmers profit is close to its cost. Price taken by the farmer should be high as like as market price.

b) Adequate training on recommended fertilizer dose, insecticides, use of good seed, intercultural operations, etc., should be provided to the T. Aman rice farmers which will enhance production as well as technical efficiency by improving the technical knowledge of the farmers.

c) Cost of input is so high in rice cultivation. Government can take measure to reduce the cost of input. Government should take necessary measures to lower the price of inputs which have positive significant impact on yield. It will increase the net benefit of T. Aman producers.

d) As most of the T. Aman rice farmers are technically efficient at present production technology, improved method of production technology with sufficient storage ability should be introduced.

e) As T. Aman are profitable enterprise, government and concern institutions should provide adequate extension programme to expand their area and production production.

f) T. Aman production is labor intensive, it charges high labor cost from the farmer.So threre need some production technology that will shift the labor, some agricultural operation can be done automatically with the help of new machinery. So adoption of technology can reduce the labor cost or cost of production of the farmer.

g) Education and scientific knowledge about farming can increase T. Aman production as well as technical efficiency by providing the technical knowledge of the farmer.

h) Weather is a great factor for T. aman production. In coastal region huge amount of production is destructed by flood, excess rainfall and many other natural calamities. It will be helpful for the farmer if there can be introduced some weather forecasting technology like apps that will be built in their mobile phone, then they wiil be capable of taking preventive action to protect the rice field.

9.5 Limitations of the Study

There are some limitations of the study as the study conducted on the farmers of the country through interview schedules.

a) Most of the data collected through interview of the farmers so sometimes they were not well-cooperated with the interviewer.

b) The information gathered mostly through the memories of the farmers which were not always correct.

c) In the resource and time constraints, broad and in-depth study got hampered to some extent.

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APPENDICES

Table A1.2: Rice Production in Bangladesh, from 2000-2010 to 2015-2016 (In lack MT.)

Food Grains	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16
Aus	*19.16*	*18.08*	*18.51*	*18.32*	*15*	*17.45*	*15.12*	*15.07*	*18.95*	*17.09*	21.33	23.33	21.58	23.26	23.28	22.89
T. Aman	*112.49*	*107.26*	*111.15*	*115.21*	*98.2*	*108.1*	*108.41*	*96.62*	*116.13*	*122.02*	127.91	127.98	128.97	130.23	131.9	134.83
Boro	*119.21*	*117.66*	*122.22*	*128.37*	*138.37*	*139.7*	*149.65*	*177.68*	*178.09*	*183.41*	186.17	187.59	187.78	190.07	191.92	189.38
Total Rice	**250.86**	**243**	**251.88**	**261.9**	**251.57**	**265.25**	**273.18**	**289.37**	**313.17**	**322.52**	**335.41**	**338.9**	**338.33**	**343.56**	**347.1**	**347.1**

Table A.5.3: Education of the Household Members by Sex and Study Area

Educational status (Age>5 years)	**Dashmina, Patuakhali**					
	Male		**Female**		**Total**	
	No.	**%**	**No.**	**%**	**No.**	**%**
Illiterate	32	36.36	56	63.63	88	17.39
1-5 years of schooling	155	54.01	132	45.99	287	56.72
6-10 years of schooling	41	68.33	19	31.66	60	11.86
11-12 years of schooling	38	76	12	24	50	9.88
Above 12 years of schooling	15	71.42	6	28.57	21	4.15
Total	281	100	225	100	506	100

TableA 6.2 Descriptive statistics of Inefficiency model

Item	Value
Mean	0.680007772
Standard Error	0.015011206
Median	0.7185485
Mode	0.6277102
Standard Deviation	0.163063432
Sample Variance	0.026589683
Kurtosis	0.876889871
Skewness	-1.178787157
Range	0.7573451
Minimum	0.1565266
Maximum	0.9138717
Sum	80.2409171
Count	118