PROFITABILITY ANALYSIS AND INPUT USE EFFICIENCY OF MAIZE CULTIVATION IN SOME SELECTED AREAS OF CHUADANGA DISTRICT IN BANGLADESH

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This is to certify that thesis entitled ***"PROFITABILITY ANALYSIS AND INPUT USE EFFICIENCY OF MAIZE CULTIVATION IN SOME SELECTED AREAS OF CHUADANGA DISTRICT IN BANGLADESH"*** *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 AGRICULTURAL ECONOMICS,*** *embodies the result of a piece of bona fide research work carried out by* ***RUMANA BISWAS,*** *Registration No.* ***12-05172*** *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 acknowledged.

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THIS THESIS IS
LOVINGLY DEDICATED
TO MY PARENTS

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PROFITABILITY ANALYSIS AND INPUT USE EFFICIENCY OF MAIZE CULTIVATION IN SOME SELECTED AREAS OF CHUADANGA DISTRICT IN BANGLADESH

ABSTRACT

The objectives of this study were to identify the socio-economic characteristics of maize growers; to estimate the cost and return of maize cultivation; to assess the input use efficiency of maize cultivation and to address the problems faced by the farmers and suggest some policy recommendations. The study was conducted in six villages of Alokdia and Karpashdanga union under Chuadanga sadar and Damurhuda upazila of Chuadanga district. Data were collected by using interview schedule from the purposively selected 80 respondents during 1st June to 30th June, 2019. After analyzing the data, total cost of production was Tk. 124495, Tk. 134335 and Tk. 140579 for marginal, small and medium maize production respectively. Per hectare gross return was Tk. 213997, Tk. 204972 and Tk. 197163 for marginal, small and medium maize production, respectively. Per hectare gross margin was Tk. 120478, Tk. 104748 and Tk. 92516 for marginal, small and medium maize production, respectively. Net return was calculated by deducting gross cost from gross return and these were Tk. 89502, Tk. 70637 and Tk. 56584 for marginal, small and medium maize production, respectively. Benefit cost ratio was 1.72, 1.53 and 1.40 for marginal, small and medium maize production, respectively. From Cobb-Douglas production function analysis, it was observed that the coefficients of land preparation cost, irrigation cost, urea and MoP was significant at different level of probability for marginal, small and medium maize production, respectively and the coefficients of human labor, seed and pesticide used was not significant while the coefficients of TSP was negative and significant for marginal, small and medium maize production, respectively. Input use efficiency indicated that all of the resources were under used for maize production except overutilization of human labor and TSP. So there was a positive effect of key factors in the production process of maize cultivation. This study also identified some of the problems associated with maize production. The findings revealed that high price of inputs was the most acute problem followed by lack of technical knowledge and shortage of human labor at the critical stage and declining soil fertility was the last obstacle which stand in the way of maize production in the study area.

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ABBREVIATIONS

BBS	Bangladesh Bureau of Statistics
USDA	United States Department of Agriculture's
FAO	Food and Agriculture Organization
GDP	Gross Domestic Product
BCR	Benefit Cost Ratio
NGO	Non-Governmental Organization
BB	Bangladesh Bank
MoP	Muriate of Potash
HYV	High Yielding Variety
TSP	Triple Super Phosphate
STW	Shallow Tube Well
DTW	Deep Tube Well
SPSS	Statistical Package for Social Science
LUC	Land Used Cost
TVC	Total Variable Cost
NR	Net Return
MFC	Marginal Factor Cost
MVP	Marginal Value Product
MPP	Marginal Physical Product
GM	Geometric Mean
SSC	Secondary School Certificate
HSC	Higher Secondary Certificate

CHAPTER I
INTRODUCTION

CHAPTER I
INTRODUCTION

1.1 Background of the Study:

Bangladesh is the 8th most populous country in the world with a total population of 161 million, population growth rate is 1.36 and its density of population is 1109 persons per Km^2. Bangladesh is first and foremost an agricultural based country restrained by crop production. More than 70 percent of the country's population as well as 45.10 percent of its labor force are directly and indirectly being dependent on agriculture and contributing 14.10 percent to the GDP (BBS, 2019). Bangladesh escalates by and large a sub-tropical monsoon climate. Bangladesh has been reputed for growing large variety of tropical crops particularly rice, wheat, maize, jute, pulses, oilseeds, sugarcane etc. Maize is one of the utmost indispensable cereals crops and it is one of the foremost crops in the world. The fertile soils and subtropical monsoonal climate make Bangladesh much suitable for maize cultivation, although maize is a new crop. Before independence in 1971, maize was rarely cultivated across Bangladesh except in a few tribal areas of the Southeastern Chittagong Hill Tracts. In 2017-18 cropping season, it was planted on about 147996.59 ha of land with national average yields of around 5.7 ton/ha producing well over a million tons of maize grain annually (BBS, 2019).

Maize is cultivating in two seasons, rabi and kharif-I in Bangladesh. Non-water logging soil such as sandy loam or loamy soil is the best for maize cultivation. Optimum temperature for maize cultivation is between 24^0c to 29^0c. Timely sowing is the preconditions for higher yield. Time of sowing and harvesting of maize production are given below:

Season	Sowing time	Harvesting time
Rabi	1st November-1st December	4th March-3rd April
Kharif-I	Mid-March-4th April	Mid June-4th July

Traditionally, rice provides the largest carbohydrate source for most of South Asia's farm families, although with increasing affluence and preferences for fish and poultry protein in diets, maize production has increased from 20.51 to 35.47 Mt in last decade,

with grain sold primarily to the feed industry (FAOSTAT, 2015). Maize adoption has been especially high in Bangladesh, where it was cultivated on approximately 1500 ha in 1984, but area rose rapidly to about 0.20 M ha in 2007–2008 and to 0.36 M ha in 2012–2013, largely through the replacement of pulses, oilseeds and wheat (FAOSTAT, 2015).

1.2 Importance of Maize Production:

Maize is not only highly productive but also nutritious crop used as a human food, feed for poultry and fodder for livestock. Maize is more nutritious than rice in terms of protein, phosphorus and carotene content. Fats and mineral contents are also higher. It is rich in Vitamin B and trace elements.

Maize is extensively used as one of the major ingredients of feed for poultry and fish. Besides this, maize is also used directly for human consumption, in industrially processing foods, industrially non-food products such as starches, acids and alcohols. Maize in Bangladesh is fetching a vital crop in the rice grounded cropping system. Maize industry is a prospective industry and its escalation is also connected with national GDP. It has a substantial implication in nationalized economy. A limited number of socio-economic investigations were conducted on maize cultivation in Bangladesh, which revealed that it is a more profitable crop than rice (Hussain et al., 1995, Fokhrul & Haque, 1995) and mustard (Haque, 1999). Rahman et al. (2014) and Rahman et al. (2012) noted that maize production is not only profitable but the technical and economic efficiency of the maize farmers is much higher than those of rice and wheat farmers. Although Rahman et al. (2012) noted that the gross return is the main driver of choosing winter maize production in Bangladesh, it is not known whether maize production is internationally competitive or not. Conventionally maize was imported to Bangladesh which drained valuable foreign currency reserves to pay for import. Therefore, if maize is globally competitive, then an increase in the production of maize can fruitfully substitute its import and save foreign currency. The land of Bangladesh is also suitable for maize production. In fact, the Fifth Five Year Plan (1997–2002) emphasized set specific objectives to attain self-sufficiency in food-grain production and increased production of other nutritional crops and earmarked 8.9% of the total agricultural allocation to promote crop diversification. Subsequently,

the Poverty Reduction Strategy Paper (2005) and the Sixth Five Year Plan (2011–2015) also emphasized crop diversification. According to seventh five year plan (2016-2020) agricultural growth is expected to rise only moderately to 3.5% in 2020 as its major component, cereal and commercial crops, appears to have reached a plateau of 1.4% growth for several years.

1.3 Statement of the Problem

Maize has an abundant panorama in Bangladesh. The most important livelihood of the people of Bangladesh is associated with Agriculture. Farmers of this country at the outset produce crops what satisfies family life wants then they exemplify interest on production of cash crop such as cotton, jute, tea, maize, coffee, and so on are mostly expected in dealing demand of home market and sell abroad in foreign currency in support of developing countries. Maize is one of the utmost essential cereals crops and it is one of the foremost crops in the world. It is not only highly productive but also nutritious crop used as a human food, feed for poultry and fodder for livestock. Maize has a substantial implication in nationalized economy. Small hard work has been completed to study the economics of the maize production. By the way cost of production and profitability determination should be premeditated. This study will be intended at determining causes of variation and aspect of success among farms growing maize; it is indispensable both for the farmers and planners to carry out a program considered for eliciting agricultural production. Updating knowledge on profitability of maize is one rationalization of this study. It is essential to evaluate substitute profitability of this investment in terms of land and other resources keen to maize farming. This research possibly will endow with a number of detailed benefits to the individual farmers for efficient operation and management of the farm and also to the research personnel for supplementary studies of related natural history and to the planners and policy makers who provide the farmers centrally for macro-level strategy assessment.

1.4 Key Research Questions

1. Is maize a profitable crop at farm level?
2. Are the farmers using inputs efficiently in maize cultivation?
3. To what extent the farmers faced problems to cultivate it?

1.5 Justification of the Study

Bangladesh is one of the high populous countries in the world. For this it is essential for Bangladesh to diversify crops for increasing population to ensure food security. Maize has a great prospect in Bangladesh. It is one of the most important and fastest expanding cereal in our country. The area under maize cultivation is increased also. Greater portion of people are dependent on agriculture. Therefore, it is indispensable for Bangladesh to diversify crops for ensuring food security. But, farmers of Bangladesh are not conscious of the benefit of maize production. They also afraid to invest in maize cultivation owing to lack of information on maize production and marketing policy. Rabi maize covered 99.9% of total maize production in Chuadanga district in 2016-17 (BBS, 2018) So, there had great research opportunity on profitability analysis and input use efficiency of maize cultivation in Chuadanga district. Again, the principal consumption of maize is in the form of feed for poultry although some dairy farms use maize as feed grains and its plants as green fodder for the cattle. Demand for maize in the country is growing and is expected to increase further with the establishment of new poultry, dairy and fish farms. Like other crop growers, maize farmers are also not very aware about the input use efficiency of maize cultivation. The rural farmers are often suffer from risk and uncertainty. It is expected from this study to provide valuable information and useful for formulating appropriate policy for widespread cultivation of maize.

1.6 Objectives of the Study

1. To identify the socio-economic characteristics of maize growers;
2. To estimate the cost and return of maize cultivation;
3. To assess the input use efficiency of maize cultivation; and
4. To address the problems faced by the farmers and suggest some policy recommendations.

1.7 Production of Maize:

Maize (*zea mays*) is the utmost extensively grown cereal crop in the world. Maize is an industrially significant money-making crop. In the middle of the world's cereal crops, maize ranks second to wheat in production. Nonetheless, amongst the developing countries maize rank first in Latin America and Africa but third after rice and wheat in Asia (Dowswell et al., 1996). As the demand for maize crop has been

shifting increasingly in the world, particularly in the developing countries, its requirement will also increase from 282 million tons in 1995 to 504 million tons in 2020 (Pingali and Pandey, 2000). According to a recent US Department of Agriculture's (USDA) report, farmers in Bangladesh earn over $2,275 by investing $1,421 for every hectare of maize. Boro fetches them $1,081 against an investment of $1,319, a loss-making project, it claimed. And comparing to maize, growing wheat is less profitable too. Farmers can earn a little over US $823 from per hectare of wheat farming with an investment of US $663, stated the USDA report "Bangladesh: Grain and Feed Annual 2016". "The gross margin from maize sales, per hectare, is 2.4 times greater than that of wheat or rice. Maize also has fewer pest and disease problems," said a report of the UN Food and Agriculture Organization (FAO) (Masudul et al., 2017)

Maize is the third grain crop in Bangladesh. It can be grown in all the three seasons of the year. Among different districts, Dinajpur, Chuadanga, Takurgaon, Lalmonirhat, Rajshahi, Kushtia, Rangpur and Bogra are noted to be more progressive in maize production with higher rates of growth. Highest production of maize occurred in Rangpur division (1378913 M. ton) and Khulna division is in 2nd position (719184 M. ton). Maize production in Khulna division is around 24% of total country's production (2686832 M. ton) in which Chuadanga district alone covered 66% (474828 M. ton) of total production of Khulna division. Winter maize (rabi maize) is found to be predominant with a share of 89% of the country's total maize production (BBS, 2019).

Table 1.1. Division wise area and production of rabi maize in Bangladesh

Division	2014-15		2015-16		2016-17	
	Area (ha)	Production (M. ton)	Area (ha)	Production (M. ton)	Area (ha)	Production (M. ton)
Barishal	670	2933	694	2937	895	3267
Chittagong	8260	426261	8275	43448	15149	77418
Dhaka	23571	164071	28672	208518	24341	169337
Khulna	67389	579888	66541	602042	76925	719184
Mymensingh	5784	42091	7896	70720	8180	79770
Rajshahi	29905	174610	27857	181174	34297	258853
Rangpur	138179	997329	150831	1123128	170955	1378913
Sylhet	12	75	16	101	21	90
Bangladesh	267987	1961527	282886	2161348	330763	2686832

Source: BBS, 2019

Table 1.2. Major maize growing district in Bangladesh

District	Area (ha)	Production (M. Ton)
Comilla	8991	38589
Manikgonj	19978	126457
Chuadanga	49263	474828
Bogra	7170	43592
Dinajpur	67864	530717
Lalmonirhat	27153	191225
Rangpur	22880	161567
Thakurgoan	36946	269319

Source: BBS, 2019

In 2016-17 total cereal (rice, wheat & maize) production was 38.14 million Ton, while total maize production was only 3.03 million Ton. Maize is covered 8% of total cereal production in Bangladesh. In 2017-18 the production of maize is estimated by 3.29 million Ton (BBS, 2019).

Table 1.3. Production of major crops in Bangladesh

Production of Major Crops						
Major Crops	2015-16		2016-17		2017-18	
	Area ('000, ha)	Production (million tons)	Area ('000, ha)	Production (million tons)	Area ('000, ha)	Production (million tons)
Aus	1019	2.288	942	2.134	1076	2.710
Aman	5593	13.484	5586	13.656	5682	13.993
Boro	4775	18.938	4478	18.014	4861	19.576
Wheat	445	1.348	415	1.311	351	1.099
Major cereals	11831	36.058	11421	35.115	11970	37.377
Maize	335	2.445	390	3.026	401	3.288
Jute	678	7.559	738	8.247	758	8.895

Source: BBS, 2019

Since 2015 to 2018, maize production showed progressive growth compared to other cereals. Compared to 2010-2011, maize production almost doubled in 2015-2016. It indicated steady growth. It indicates that maize production is increased over the years.

Table 1.4. Trend of maize production in Bangladesh

Year	Area ('000' ha)	Production ('000' M. tons)
2009-10	152	887
2010-11	165	1018
2011-12	197	1298
2012-13	235	1548
2013-14	307	2124
2014-15	325	2272
2015-16	335	2446
2016-17	390	3026
2017-18	401	3288

Source: BBS, 2019

Total maize production in Chuadanga district was 474828 M. Tons in 2016-17. Out of this, the area under kharif maize cultivation was 108 thousand hectares with a total production of 303 M. Tons and rabi maize was cultivated in 49155 thousand hectares with total production of 474525 M. Tons during 2016-17 (BBS, 2018). So, rabi maize covered 99.9% of total maize production in Chuadanga district. In 2016-17 total maize production in Bangladesh was 3025392 (M. Ton) and Chuadanga district covered around 16% of total maize production (BBS, 2018).

Table 1.5. Percentage distribution of maize producing area & production by farming time in Chuadanga district

Farming time	Chuadanga				National level	
	Area ('000, ha)	%	Production ('000, M. tons)	%	Area ('000, ha)	Production ('000, M. tons)
Rabi	49155	14.9	474525	17.7	330763	2686832
Kharif	108	0.2	303	0.9	59115	338560
Total	49263	12.63	474828	15.7	389878	3025392

Source: BBS, 2018

Moreover, area under maize is more than 2.2% of total cultivated areas in Bangladesh (BBS, 2018). Some studies (Uddin et al., 2008 & Ferdausi et al., 2014) showed that farmers could not obtain higher yield due to some constraints that need to be solved

urgently for the interest of farmers as well as for the country. Although maize is one of the major grain crop of Bangladesh, but its production technologies has not been standardized from the scientific and economic point of view. The nature of sensitivity of the maize farmers to changes in input and output prices is not known. This information is important because Bangladeshi farmers not only need to be more efficient in their production activities, but also to be responsive to market indicators, so that the scarce resources are utilized efficiently to increase productivity as well as profitability in order to ensure supply to the urban market (Rahman, 2003) and increase farmers' welfare. Furthermore, the government of Bangladesh is seeking to diversify its agricultural sector to other cereals than rice (i.e., wheat and maize) as well as non cereals (e.g., potatoes, vegetables and spices, etc.). The present study on the profitability analysis and input use efficiency of maize will be helpful for formulating appropriate policy for improving maize cultivation in Bangladesh.

1.8 Outline of the study:

There are eight chapters in this study. Chapter 1 presents the introduction of the study. After this introduction, relevant review of literature is discussed in Chapter 2. Chapter 3 consists with methodology of the study. A short description of the socioeconomic characteristics of the sample farmers are given in Chapter 4. Chapter 5 represents profitability of maize production. Input use efficiency of maize cultivation is shown in Chapter 6. Chapter 7 presents the problems of maize growing farmers. At last, summary, conclusion and recommendations are shown in Chapter 8.

CHAPTER II
REVIEW OF LITERATURE

CHAPTER II
REVIEW OF LITERATURE

Review of literature is important to know the knowledge and information which are related to the proposed study. This knowledge and information are helpful to give a guideline for designing the future research problem and validating the existing findings. Review of some research works relevant to the present studies, which have been conducted in the past, are discussed below:

Islam (2006) conducted a study on impact of maize production on income and livelihood of farmers in a selected area of Lalmonirhat district. He reported that maize production has brought positive changes in different aspects of livelihood such as capital, food intake, etc. The study revealed that positive change in income took place due to maize production. He also reported average annual income increase for maize growers was 63 percent while it was 37 percent for non-maize growers. The study suggested encouraging production of maize, irrigation facilities needed to be extended and provided post-harvest low cost technologies.

Shohag (2006) conducted a study on production and marketing of maize in a selected area of Gaibandha district. The study revealed that the rate of changes of area, production and yield of maize increased dramatically for the increasing of potential demand in the various sector. Gross margin and net return were also calculated at Tk. 36425 and Tk. 29591 respectively. He also recommended the availability of input at reasonable prices, supply of credit at low interest, supply of adequate fertilizer in the production period, supply of good quality seed, increases in market demand, improvement of storage and market facilities, availability of post-harvest technology and pesticides are important measures which can encourage maize production.

Ahmed and Jahan (2007) conducted an experiment on maize/pea intercropping during rabi season to find out suitable planting system for higher productivity and economic return. Results revealed that pea grown as intercrop with maize is more profitable than sole maize. The result also suggested that 4 rows of BARI motorshuti-1 intercropped with maize is the most suitable intercrop combination for higher economic benefit.

Hasan (2008) completed a study on economic efficiency and constraints of maize production in the northern region of Bangladesh. He reported that all the farmers used hybrid seeds for maize cultivation with an average yield of 6.27 tonne per hectare, which is higher in Dinajpur (6.35 tonne per hectare) compared to Panchagarh district (6.18 tonne per hectare). The returns to scale of the selected inputs were 0.72 and 0.68 for Dinajpur and Panchagarh respectively. The technical efficiency was found on an average 0.84 at Dinajpur and 0.80 at Panchagarh. It was also found that, farmers in the study area had scope to increase maize productivity by attaining full efficiency through reallocating the resources. Economic analysis of maize production and maize-based cropping pattern in comparison to Boro rice and Boro-based cropping pattern indicates the high profitability of maize production system than that of Boro rice.

Uddin et al. (2008) conducted an economic study on maize production under different farm size groups in a selected area of Bangladesh. He determined the profitability, productivity and resource use efficiency under different farm size groups. This study showed that per hectare average net returns of maize were estimated at Tk. 31583, Tk. 47823, and Tk. 41648 for small, medium and large farmers respectively. The study revealed that selected explanatory variables had impacts on maize production of all categories of farmers. The findings of the study revealed that medium farmers earned higher profit than those of small and large farmers. Finally, some recommendations were made for the development of maize production in Bangladesh.

Haque (2009) conducted a comparative economic study of hybrid maize Uttaran and 900 M cultivation in an area of Sherpur Upazilla in Bogra district. The major findings of the study revealed that per hectare average total costs were Tk. 39035.49 and Tk. 42,807.92 for Uttaran and 900 M maize growers, respectively. Per hectare average net returns from Uttaran and 900 M maize were Tk. 48,911.40 and Tk. 55,906.09 respectively. The study revealed that, 900 M maize growers earned relatively higher per hectare profits than the Uttaran maize growers.

Alam et al. (2010) conducted a study on economics of hybrid maize production in some selected areas of Bangladesh. The present study is an attempt to assess the existing agronomic practices of hybrid maize cultivation, its profitability, constraints,

and factors affecting hybrid maize production. The majority of the total farmers sowed seeds during the first week of December. The average seed rate was found to be 20.94 kg per hectare. About 16 varieties were found to cultivate by farmers, of which majority farmers used NK-40 followed by Pacific-II. All kinds of fertilizer used by the farmers were below the optimum level of recommendation. About 33 and 28 percent of the total variable cost was for human labor and chemical fertilizer, respectively. The average yield of hybrid maize was found higher than the national average. The average gross margin was observed to be Tk. 28456 on total variable cost basis. The cost per kilogram of maize cultivation was Tk. 4.12 and return from one kilogram of maize production was Tk. 7.80. It is found that the coefficient of human labor, land preparation, irrigation, urea and borax have significantly impact on gross return. Timely non-availability of seeds, high price of fertilizer, and low price of yield were the major problems for hybrid maize production. Farmers cultivated hybrid maize because of higher yield, higher income, and easy growing.

Alam et al. (2010) conducted a survey on four major maize growing areas namely Chuadanga, Dinajpur, Bogra and Lalmonirhat during 2006/07 to know profitability of maize production in Bangladesh. A pre-designed interview schedule was used for collecting data from 200 randomly selected maize growers, where each location contained 50 farmers. The average yield was found to be 8.00t/ha. The average costs of maize production were Tk. 44197, Tk. 33195 and Tk. 24441 per hectare on total cost, variable cost and cash cost basis, respectively and gross return was Tk. 69773 per hectare. The gross margin was Tk. 36578/ha on total variable cost (TVC) and Tk. 45332/ha on cash cost basis. The net return was observed to be Tk. 25575 per hectare. Benefit-cost ratios were calculated as 1.58, 2.10 and 2.85 on total cost, variable cost and cash cost basis respectively. As a result, maize cultivation was highly profitable. Lack of capital and high price of TSP were the main constraints to its higher production.

Paul (2011) carried out a study on Lalmonirhat district of northern region of Bangladesh, maize producing area to have an idea of productivity of maize. He found that per hectare gross return of small, medium and large were calculated at Tk. 85100, Tk. 97280 and Tk. 112853 respectively. The undiscounted BCR came out to be 2.04, 1.70 and 1.88 respectively. The result revealed that maize production was profitable

on that area where per hectare average net returns of all farmers was Tk. 45459 and BCR was 1.86.

Hossain, K. (2013) has been undertaken this study considering the increasing demand for maize as feed for livestock and poultry in recent years. The study was conducted in some selected areas namely Nulsundha, kajolgram and rupsha from pingna union of Sarishabari Upazilla of Jamalpur district to estimate profitability, productivity, factors affecting profitability, problems and constraints of maize farmers by using stratified random sampling method. To achieve the objectives of the study, descriptive statistic, Benefit cost ratio (BCR) and cobb-Douglas production functional model had been used. On this be trained, large farmers gain more net return (Tk. 65033), which is more than small, medium farmers that have been Tk. 54697 and Tk. 44488, respectively. The small, medium and large farmers undiscounted BCR used to be 1.77, 1.88 and 2.02 respectively. The study revealed that the fundamental constraints of maize farming within the study field were lack of quality seeds, high rate of inputs and high transportation cost. Regardless of the all constraints, there is a great prospect in maize farming within the study area as a lucrative enterprise.

Sadiq et al. (2013) conducted a study on Profitability and Production Efficiency of Small-Scale Maize Production in Niger State, Nigeria and found that the costs and returns analysis indicated that maize production was profitable with an average net farm income of N48, 109.00/hectare, and a gross ratio of 0.39; a production efficiency index (2.50) per farmer further adjudged the profitability of the enterprise, that is, the returns cover the cost of production almost three times.

Ferdausi et al. (2014) conducted a study on an economic study on maize production in some selected areas of Bogura district and found that cost and return analysis reveal that maize is a profitable crop for all categories of farmers. On an average per hectare total cost of maize production was estimated at Tk. 46278 for all farmers and Tk. 41263, 53554 and 48715 for small, medium and large farmers, respectively. Again, gross margins from maize production were estimated at Tk. 67592, 64694 and 74089 for small, medium and large farmers, respectively. However, net returns for the farm size groups of small, medium and large were calculated at Tk. 57823, 53895 and 64138 per hectare, respectively. BCR was the highest (2.40) for the small farmers

followed by medium (2.01) and large (2.32) farmers, respectively. Cobb-Douglas production function analysis indicated that out of nine variables, the effects of using seed, manure, fertilizer, irrigation and insecticide had significant impact on gross return from maize production for all farmers. Efficiency analysis indicated that most of the farmers inefficiently used their inputs. The findings of the study revealed that large farmers earned higher profit than those of small and medium farmers.

Rahman (2014) conducted a study on exploring the potential of maize expansion by examining its profitability and economic efficiency using a survey data of 300 farmers from three regions. Maize ranks first in terms of yield (7.98 t/ha) and return (BCR=1.63) as compared with rice and wheat. The economic efficiency of maize production is also estimated at a high 87%, although a substantial 15% [(100-87)/87)] cost reduction is still possible while maintaining current output level by eliminating technical and allocative inefficiency. Education positively contributes towards increasing efficiency while large farmers are relatively inefficient. Geography does matter. Efficiency is lower in Bogra region as compared with Dinajpur and Kushtia. Policy implications include investment in education, setting up appropriate price policies to stabilize prices and facilitation of the input markets for timely delivery of required inputs.

Dhakal et al. (2015) conducted a study on productivity and profitability of maize-pumpkin mix cropping in Chitwan, Nepal and found that the benefit cost ratio (1.58) indicates that maize-pumpkin mix cropping was profitable with productivity of 2.83 ton per ha on maize main product equivalent basis. The magnitude of regression coefficients of maize-pumpkin mix cropping implied that expenditure on seed and fertilizer and irrigation had significant positive effect on gross return with estimated decreasing return to scale (0.85). According to estimated allocative efficiency indices, it is suggested to increase expenditure on seed and fertilizer cum irrigation by about 90% and 55% respectively.

Rahman (2016) conducted an economic study on maize production under different farm size groups in some selected areas of Thakurgoan district in Bangladesh. He found that maize production is a profitable business. The study showed that per acre net returns of maize were calculated at Tk. 23259.61, Tk. 25380.21 and Tk. 27944.97

for small, medium and large farmers respectively. Average net return for all classes of farmers was Tk. 24173.47. The study revealed large farmers obtained the highest gross return per acre. The Cobb-Douglas production functions was used for this study to measure the individual effect of input use on maize production. The effect of using human labor, urea cost, gypsum cost, seed cost and tillage cost were significant and indicated positive effects on maize production. Finally, identified some problems faced by the maize farmers as lack of capital, high input cost, lack of quality seeds etc. and suggest some recommendations to improve the present production situation.

Masudul et al. (2017) conducted a study on farmer's profitability of maize cultivation at Rangpur district in the socio-economic context of Bangladesh: An empirical analysis and found that per acre cost of maize cultivation of Small, Medium and large farmers are exposed. Total variable cost include total cost was the summation of total variable cost and total fixed cost. Total cost was highest for large farmers (TK. 1324536.) followed by medium farmers (TK.1134342) and small farmers (TK.363813.6). Productivity is highest for large farmer (549.6+274.8= 824.4mon) followed by Medium farmer (470.64+235.32= 705.96mon) and small farmer (150.96+75.48= 226.44mon). Profitability is also highest for large Farmers (TK. 397086) followed by medium farmer (TK. 329448) and small Farmer (TK. 105672). Because most of the large farmer has more land as well as more output.

Conclusion:

In the earlier discussion, it is clear that, many studies conducted on maize production as a whole but a little research conducted on profitability along with input use efficiency of maize cultivation in Bangladesh. Therefore, the present study undertaken to determine the profitability and input use efficiency of maize cultivation in selected areas. Put differently, this is a new and precursor study on maize cultivation on the basis of farm size in the context of Chuadanga district in Bangladesh. This study is, therefore, expected to generate some valuable information which facilitate farmers' and policy makers' decision making on economics of maize cultivation.

CHAPTER III
METHODOLOGY OF THE STUDY

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Methodology is a fundamental part of any research. Appropriate methodology plays main position for conducting a research. Use of improper methodology very generally results in inaccurate outcome. The credibility of survey research rely on the correct methodology. Right methodology will depend on nature, scope, objectives, availability of literature, substances and time. Survey method has been used in the present study because it is assumed to have some advantages over the other methods. This method enables less time requirement, less cost, the result accomplished has wider applicability as well as the method is usually more magnificent. However, survey method has also some drawbacks.

This chapter discusses about the selection of the study area, period of study, sampling technique and sample size, preparation of the survey schedule and data processing and analysis.

3.1 Selection of the Study Area

Chuadanga district was selected purposively as a study area because this district is one of the leading maize producing area of Bangladesh. Chuadanga Sadar Upazila and Damurhuda Upazila was selected purposively from Chuadanga District as the study area. One union was selected from each upazilla. A preliminary survey was conducted in three villages from each union. After preliminary visit six village's namely Karpashdanga, Aramdanga and Shubolpur from Karpashdanga union and Pirpur, Monirampur and Rajapur from Alokdia union were selected purposively as a locale of the study. Most of the farmers in these areas used to produce high yielding varieties of maize and sell their product to different middlemen.

The main criteria behind the selection of the upazila were as follows:

- The selected upazila was a good maize producing area.
- The researcher is familiar with the language, living, beliefs, and other socio-economic characteristics of the villages of this upazila and
- Previously such type of study was not conducted in this area.

3.2 Selection of the sample and sampling techniques

A purposive sampling technique was applied for the study. It was not possible to conduct a farm business survey overlaying all farms. Here, sampling is taken for sample farms to cut down cost in terms of time and resources for the study. In total 80 farmers were selected for the study. Among the 80 farmers, 10 from Pirpur village, 15 from Monirampur village, 15 from Rajapur village, 10 from Karpashdanga village, 15 from Aramdanga village and 15 from Subolpur village respectively. Farm size was arbitrarily classified on the basis of their land where they produce maize and other crops. Farmers having 0.02-0.20 hectare lands were considered as marginal farmers, 0.21-1.0 hectare as small farmers while those having 1.01 hectare and above lands as medium farmers (DAE, 1999).

Table 3.1 Distribution of sample farmers in the study area:

Upazila	Union	Villages	Maize Cultivars
Chuadanga Sadar	Alokdia	Pirpur	10
		Monirampur	15
		Rajapur	15
Damurhuda	Karpashdanga	Karpashdanga	10
		Aramdanga	15
		Subolpur	15
Total			**80**

3.3 Period of Data Collection

Primary data are needed for this study and researcher herself was collected necessary data by interviewing the selected farmers. Data was collected by using a structured questionnaire during 1st June to 30th June, 2019. Data was collected in that time because maize was harvest in April and the post-harvest management and selling were done during April to May. Since the farmers of Bangladesh do not usually maintain records and accounts of their farm operations, they gave information rely on their memory.

That's why, it is beneficial to collect information from respondents as early as possible after selling the maize.

3.4 Data Collecting Instruments

Both technical and socio-economic data were needed for this research.

The measures taken were:

- Built-in-check in the interview schedule;
- Field checking and
- Independent re-interviewing of the respondents.

3.5 Preparation of the Survey Schedule

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

i. Identification of the farmer;
ii. Family size and composition, use of family labor, Land holding pattern and the occupation of the sample farmers;
iii. Input and output related information of maize cultivation at farm level;
iv. Cost of human labor and material inputs for maize production;
v. Problems of maize farmers;
vi. Suggestions according to the problems faced by the maize farmers.

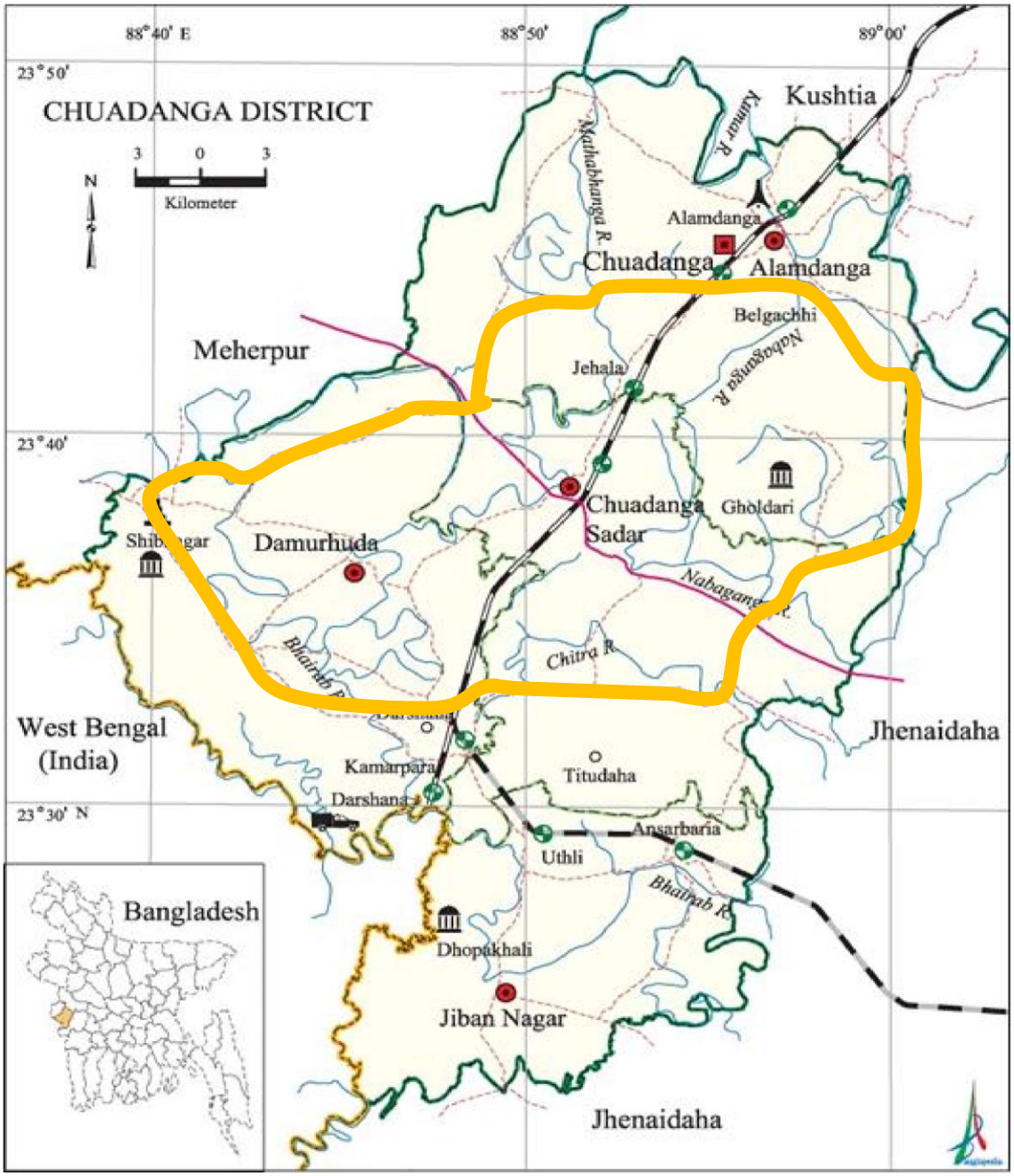

Figure 3.1 Map of Chuadanga District showing Chuadanga sadar and Damurhuda upazila

3.6 Collection of Data

A farm management study usually involves collection of information from individual farmers. There are various methods of collecting information from the farmers. For the present study Farm survey method was adopted for collecting data.

There are three main methods through which farm survey data can be gathered (Dillion and Hardaker, 1993). These are

1) Direct observation
2) Interviewing respondents.
3) Records kept by the respondents.

To satisfy the objectives of the study, necessary data were collected by visiting each farm personally and by interviewing them with the help of a pretested interview schedule. Usually most of the respondent does not keep records of their activities. Hence it is very difficult to collect actual data and the researcher has to rely on the memory of the respondent. Before going to an actual interview, a brief introduction of the aims and objectives of the study was given to each respondent. It was narrated to the farmers that the study was purely academic. Farmers also stated the usefulness of the study in their farm business context. The question was asked systematically in a very simple manner and the information was recorded on the interview schedule. When each interview was over the interview schedule was checked and verified to be sure that information to each of the items had been properly recorded. In order to minimize errors, data were collected in local units. These were subsequently converted into appropriate standard unit.

In order to obtain reliable data the researcher initially visited for several times to introduces herself with the people of the study areas during the season. Secondary information sources makes the present study additional value. Secondary data were collected through literature and different publications from Bangladesh Bureau of Statistics, Ministry of Finance and Bangladesh Bank (BB) etc.

3.7 Editing and Tabulation of Data

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

3.8 Procedure for computation of costs

The farmers producing maize had to incur cost for different inputs used in the production process. The input items were valued at the prevailing market price and sometime at government price in the area during survey period, or at the priced at which farmers bought. Sometimes, the farmers purchased hired labor, seed, fertilizer, manure and pesticide from the market and it was easy to pricing these items. But, farmers did not pay cash for some input such as family labor. So it was very difficult to calculate the cost of production of these inputs. In this case opportunity cost principle was used. In calculating the production cost, the following components of cost were considered in this study area:

- Human labor
- Land preparation/Mechanical power cost
- Seed
- Manure
- Fertilizer
- Irrigation
- Pesticides cost
- Interest on operating capital and
- Land use

3.8.1 Cost of human labor

Human labor cost was one of the most important and largest cost items of maize production in the study area. It is required for different farm operations like land preparation, weeding, application of fertilizer and insecticide, harvesting and carrying

etc. Mainly two types of human labor used in the study area; such as family labor and hired labor. Family labor includes the operator himself, the adult male and female as well as children of a farmer's family and the permanently hired labor. To determine the costs of unpaid family labor, the opportunity cost concept was used. In this study the opportunity cost of family labor was assumed to be market wage rate, i.e., the wage rate that the farmers actually paid to the hired labor. The labor that was appointed permanently was considered as a family labor in this study. In computing the cost of hired labor, actual wages were paid and charged in case where the hired labors were provided with meals; the money value of such payment was added to the cash paid. The labor has been measured in a man-day unit, which usually consisted of 8 hours a day.

In producing maize human labor were used for the following operations:

- Land preparation/ploughing/laddering
- Fertilizing, weeding and irrigation
- Pest control
- Harvesting, storing and marketing

3.8.2 Cost of land preparation

Human labor and mechanical power were jointly used for land preparation. land preparation cost was the summation of hired draft power and human labor. Hired power tiller and laddering cost were calculated by the prevailing market prices that were actually paid by the farmers.

3.8.3 Cost of seeds

The costs of seed were calculated at the actual price paid by the farmers. It may be marked here that there was a variation in the cost of per kilogram (kg.) seed in the study area.

3.8.4 Cost of manure

Manure may be used through purchased. The value of purchased manure was calculated at the prevailing market price.

3.8.5 Cost of fertilizer

It is very important for maize cultivation to use the fertilizer in recommended dose. In the study area, farmers used mainly three types of chemical fertilizer i.e., Urea, TSP (Triple Super Phosphate), MoP (Muriate of Potash) for growing maize cultivation. Fertilizer cost was calculated according to the actual price paid by the farmers.

3.8.6 Cost of pesticide

Most of the sample farmers used Vittaku, Furadan, Sunforan, Rijent, Dithane M-45, Thiovit 80wp and Rovral 50wp for maize. The cost of these pesticides was calculated by the prices paid by farmers.

3.8.7 Cost of irrigation

The cost of irrigation included the rental charge of machine plus the costs of fuel. Someone rent/borrow only water from the shallow tube well (STW) owners by paying some charge.

3.8.8 Interest on operating capital

Interest cost was compute at the rate of 10% per annum. It was assumed that if farmers would take loans from a bank, they would have to pay interest at the above mentioned rate. Since all expenses were not incurred it the beginning of the production process, rather they were spent throughout the whole production period. Interest on operating capital was calculated by using the following standard formula (Miah, 1992).

Interest on Operating Capital (IOC) = Alit

Where,

Al= Total investment /2,

t = Total time period of a cycle

i= Rate of interest

This actually represented the average operating costs over the period because all costs were not incurred at the beginning or at any fixed time. The cost was charged for a period of 6 months at the rate of Tk. 10 per annum.

3.8.9 Land use cost

The price of land was different for different plots depending upon location and topography of the soil. The cost of land used was estimated by the cash rental value of land. In calculating land use cost, average rental value of land per hectare for a particular year. In computing rental value of land of the land used cost (LUC), it was calculated according to farmer's statement.

3.9 Analytical Techniques

Both tabular and statistical tools was used for analyzing the data. Tabular tools will be used for calculating profitability, average, percentage, total etc. For multiple regression analysis, Cobb-Douglas production function was also used to estimate the effects of key variables (Dillion and Hardaker, 1993). Because in Cobb-Douglas production function, the regression co-efficient directly shows production elasticity and as all the sum of the production elasticities indicate whether the production process as an increasing, constant, or decreasing returns to scale.

The Cobb-Douglas production frontier model was used for estimating profitability of maize production in the study areas and the model is given below:

$$Y= aX_1^{b1}\ aX_2^{b2}\ aX_3^{b3}\ aX_4^{b4}\ aX_5^{b5}\ aX_6^{b6}\ aX_7^{b7} aX_8^{b8} e^{ui}$$

To identify the factors affecting the gross return on maize production, the Cobb-Douglas production function has used:

$$\ln Y=\ln a+b_1\ln X_1+b_2\ln X_2+b_3\ln X_3+b_4\ln X_4+b_5\ln X_5+b_6\ln X_6+b_7\ln X_7+b_8\ln X_8+\ldots.+b_n\ln X_n + u_i$$

Where,

ln = Natural logaritham;

Y= Yield (kg/ha);

X_1 = Cost of land preparation (Tk/ha);

X_2= No. of human labor (man days/ha);

X_3= Quantity of seed (kg/ha);

X_4 = Cost of irrigation (Tk/ha);

X_5 = Quantity of urea (kg/ha);

X_6 = Quantity of TSP (kg/ha);

X_7 = Quantity of MoP (kg/ha);

X_8 = Cost of pesticide (Tk/ha) ;

a = Constant or intercept term;

b1, b2, b3, b4, b5, b6, b7, b8 = production coefficient of the respective input variable to be estimated; and

u_i = error term

3.10 Profitability Analysis

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

3.10.1 Calculation of Gross Return

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

Gross Return = Quantity of the product * Average price of the product

3.10.2 Calculation of Gross Margin

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

That is, Gross margin = Gross return – Total Variable cost.

3.10.3 Calculation of Net Return

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

Net return = Gross return – Total cost.

The following conventional profit equation was applied to examine farmer's profitability level of maize producing farms in the study areas.

$$\text{Net profit, } \pi = \Sigma PmQm + \Sigma PfQf - \Sigma (Pxi\ Xi) - TFC.$$

Where,

π = Net profit/Net return from maize cultivation (Tk. /ha);

Pm = Per unit price of maize (Tk. /kg);

Qm = Total quantity of the maize cultivation (kg/ha);

Pf = Per unit price of other relevant maize (Tk./kg);

Qf = Total quantity of other relevant maize (kg/ha);

Pxi = Per unit price of i-th inputs (Tk.);

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

TFC = Total fixed cost (Tk.) and

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

3.10.4 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 gross return to total cost per hectare.

$$BCR = \frac{\text{Gross Return}}{\text{Total Cost}}$$

3.11 Measurement of Input Use Efficiency

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

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

$$\text{That is, } \frac{MVP}{MFC} = r$$

Where,

r = Efficiency ratio,

MVP = value of change in output resulting from a unit change in variable input (BDT) MFC = price paid for the unit of variable input (BDT)

Under this method, the decision rules are that, when: r >1, the level of resource use is below the optimum level, implying under-utilization of resources. Increasing the rate of use of that resource will help increase productivity. r <1, the level of resources use is above the optimum level, implying over utilization of resources. Reducing the rate of use of that resource will help improve productivity. r = 1, the level of resource use is at optimum implying efficient resource utilization.

The most reliable, perhaps the most useful estimate of MVP is obtained by taking all input resources (Xi) and gross return (Y) at their geometric means (Dhawan and Bansal, 1977). All the variables of the fitted model were calculated in monetary value. As a result the slope co-efficient of those independent variables in the model represent the MVPs, which were estimated by multiplying the production co-efficient of given resources with the ratio of geometric mean (GM) of gross return to the geometric mean (GM) of the given resources, that is,

$$MVP\ (Xi) = \beta_i \frac{\bar{Y}\ (GM)}{\ddot{X}i\ (GM)}$$

Where, $\bar{Y}$ (GM) = Geometric mean of gross return (BDT)

$\ddot{X}i$ (GM) = Geometric mean of different independent variables (BDT)

β_i = Co-efficient of parameter i = 1, 2,……..n

3.12 Problems Faced in Collecting Data

The researcher had to face following problems in the field during the collection of data.

- The farmers did not keep records of their farming activities. Therefore, the researcher had to depend upon their memory. It was difficult to get information from memory.

- Most of the farmers in the study area thought that the investigator was a government officer. So, they initially hesitated to answer the questions relating to their income and expenditure. Some were afraid of imposition of new taxes.

- Sometimes, the farmers were not available at their home because they remained busy with outside work. That is why sometimes more than two visits were required to get information from them.

3.13 Limitations of the study

- One of the key limitations of the current study is that, the researcher had to depend on the memory of the farmers for data collection. Because, the sample farmers did not keep records of their farm business. That's why, the possibility of errors cannot be fully ruled out.

- The study was completed in a limited area of Chuadanga district taking into account limited number of samples due to limitations of resources and time. So, the findings of the study are not out of question and it is not applicable for all maize growing farmers.

CHAPTER IV

SOCIOECONOMIC CHARACTERISTICS OF THE MAIZE FARMERS

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In this chapter the findings of this study have been discussed in relation to the present findings and also to those found in other studies. It was not possible to gather all the information concerning the socioeconomic characteristics of the farmers affect their production pattern. In order to get an entire picture of maize production, it is necessary to know the socioeconomic characteristics of maize growing farmers. Socioeconomic characteristics affect the maize growing farmer's production pattern and technology use. Seven characteristics of the farmers were selected for this research. The characteristics include: age, education, occupation, family size, farm size, land under maize cultivation and annual family income. However, for ready reference, separate tables are provided while presenting categorizations, discussing and /or interpreting results concerning each of the characteristics in this chapter.

4.1 Age

Age of the farmers ranged from 22 to 74 years and the average being 47.03 years. On the basis of age, the farmers were classified into three categories: "young" (22-35), "middle aged" (36-50) and "old" (above 50). The distribution of the farmers accordin to their age is shown in Figure 4.1.

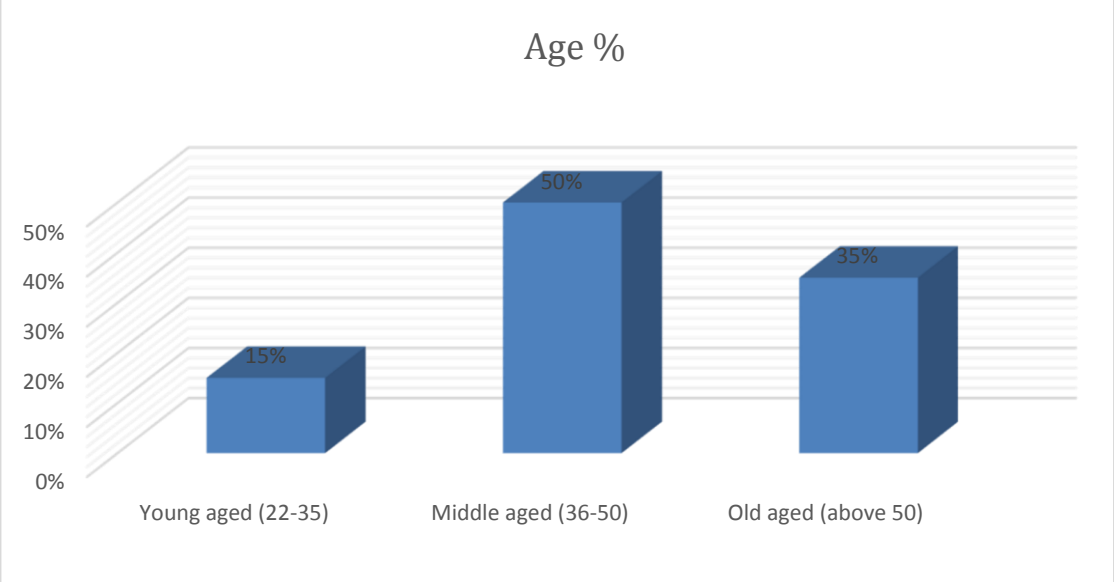

Figure 4.1 Distribution of the farmers according to their age

Source: Field Survey, 2019

Figure 4.1 showed that the highest proportion 50 percent of the maize farmers fell in the "middle aged" category, while 35 percent of them fell in the "old" category and 15 percent in the "young aged" category. The findings indicate that a large proportion of the farmers were middle to old age.

4.2 Education:

The education scores of the farmers ranged from 0 to 16 and the average was 5.08. On the basis of their educational scores, the farmers in maize cultivation were classified into four categories, namely "illiterate (0-0.5), primary (1-5), S.S.C. (6-10), H.S.C (11-12) and higher education (above 12). The distribution of the farmers according to their education is shown in Figure 4.2.

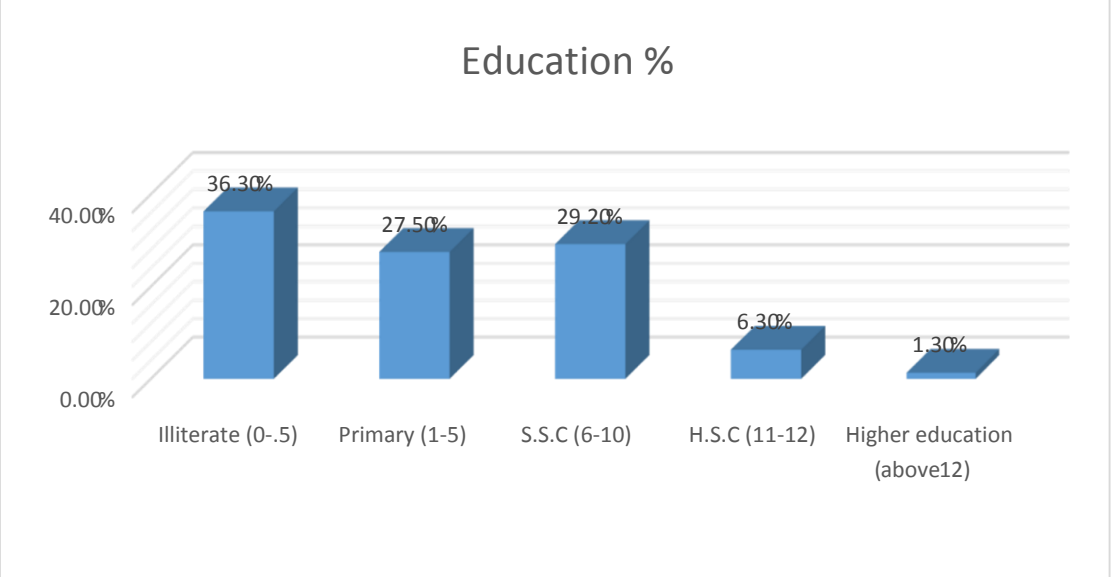

Figure 4.2 Distribution of the farmers according to their education
Source: Field Survey, 2019

Figure 4.2 indicated that the majority (36.30 percent) of the farmers had illiterate compared to 29.20 percent of them having S.S.C level education. About 27.50 percent of the farmers were primary level of education, while 6.30 percent had H.SC level of education. Only 1.30 percent of the farmers were higher level of education. The findings indicate that a large proportion of the farmers are illiterate to primary level of education.

4.3 Occupation

Occupation scores of the farmers ranged from 1 to 2. On the basis of their occupation, the respondents were classified into two categories namely, agriculture and non-agriculture. The scale used for computing the occupation score of a respondent is given Figure 4.3.

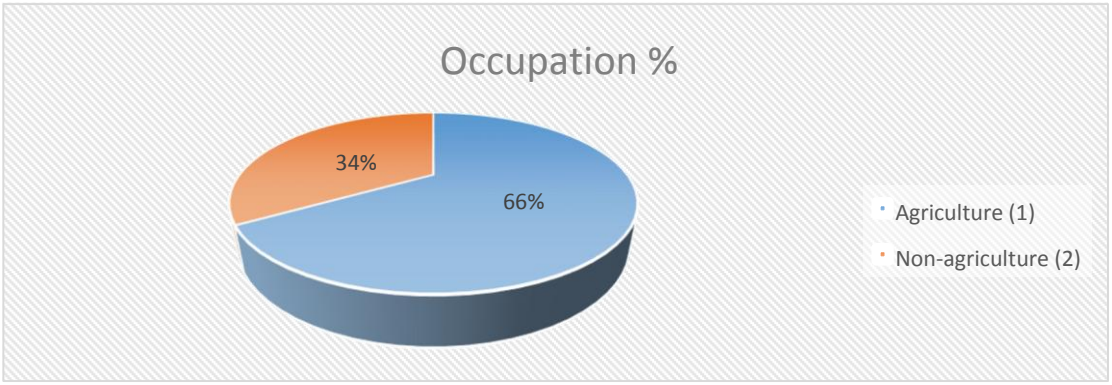

Figure 4.3 Distribution of the farmers according to their occupation
Source: Field Survey, 2019

Data contained in the Figure 4.3 indicated that the highest proportion (66.0%) of the respondents had agriculture and (34%) had had non-agriculture, respectively.

4.4 Family size

The family size of the farmers ranged from 2 to 11 members and the average was 5.51. On the basis of their family size the farmers were classified into the following three categories: "small family" (2-4), "medium family" (5-7) and "large family" (above 7). Figure 4.4 contains the distribution of the farmers according to their family size.

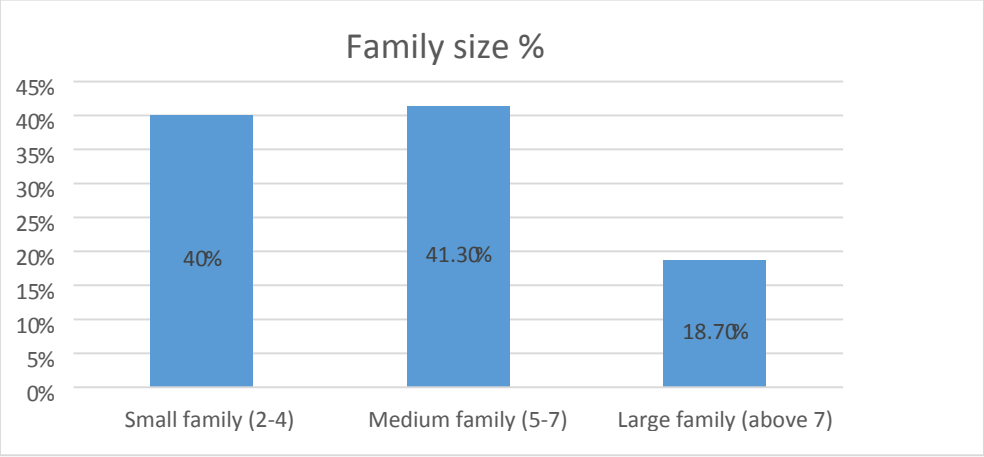

Figure 4.4 Distribution of the farmers according to their family size
Source: Field Survey, 2019

Figure 4.4 showed that the majority of the 41.30 percent of the maize farmers had "medium family" of 5-7 members compared to 40 percent of them having "small family" of 2-4 members. The proportion of "large family" was 18.70 percent (Figure 4.4).

4.5 Farm size

Farm size of the respondents varied from 0.15 to 2.98 hectare. The average farm size was 0.94 decimal with a standard deviation of 0.60. The respondents were classified into the following three categories based on their farm size: "marginal land" (0.02-0.20 ha)", small land" (0.21-1 ha) and "medium land" (1.01-3 ha) (DAE, 1999). The distribution of the farmers according to their land under maize cultivation is shown in Figure 4.5.

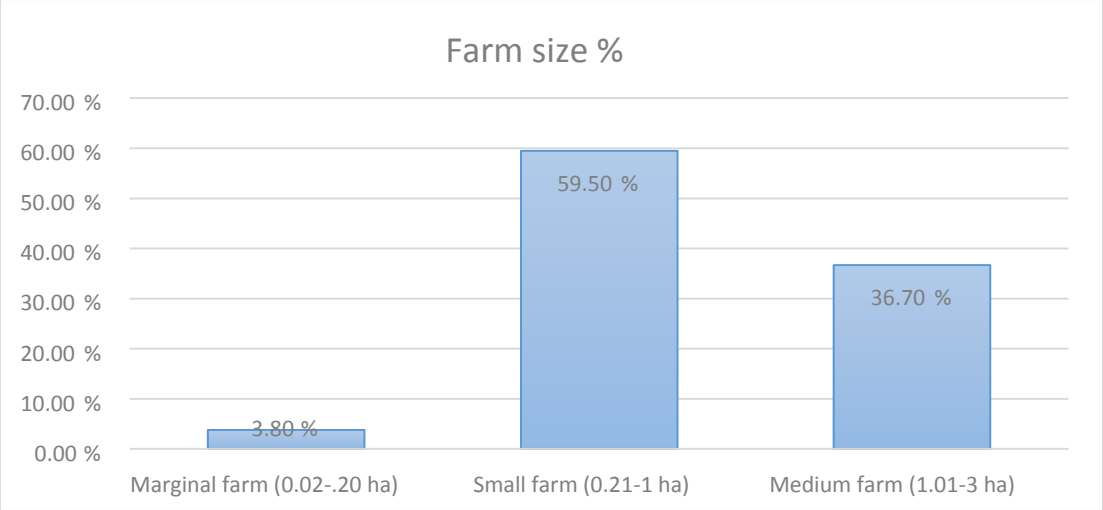

Figure 4.5 Distribution of the farmers according to their farm size
Source: Field Survey, 2019

Figure 4.5 indicated that more than half (59.50 percent) of the farmers possessed small farm size compared to 36.70 percent of them having medium farm size and 3.80 percent of the farmers having marginal farm size.

4.6 Land under maize cultivation

Land under maize cultivation of the respondents varied from 0.05 to 1.23 hectare and the average farm size was 0.29 hectare. The respondents were classified into the following three categories based on their land under maize cultivation: "marginal and" (0.02-0.20 ha)", small land" (0.21-1 ha) and "medium land" (1.01-3 ha), (DAE, 1999).

The distribution of the farmers according to their land under maize cultivation is shown in Figure 4.6.

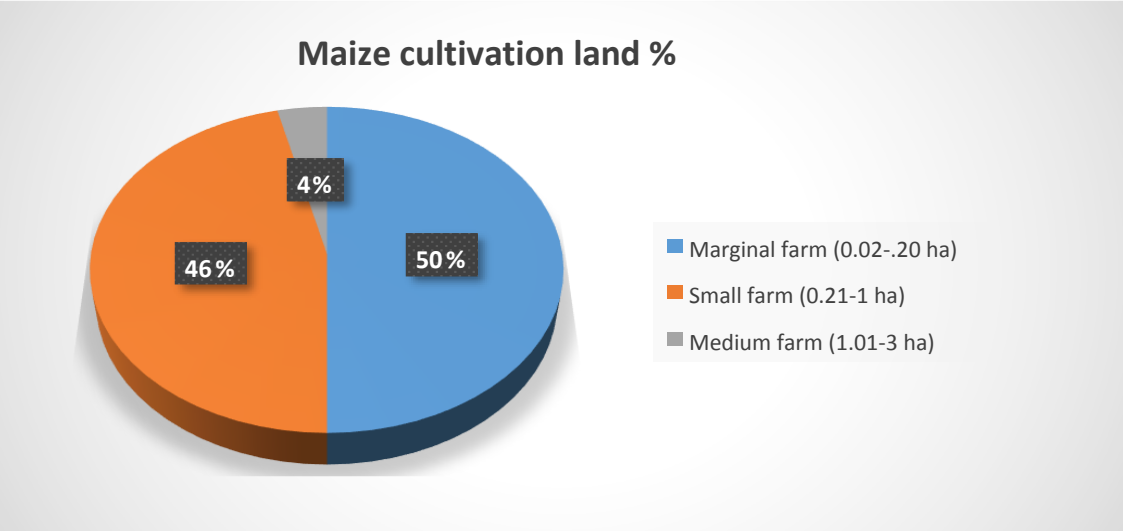

Figure 4.6 Distribution of the farmers according to maize cultivation land
Source: Field Survey, 2019

Figure 4.6 indicated that about half (50 percent) of the farmers possessed marginal land under maize cultivation compared to 46 percent of them having small land and only 4 percent medium land under maize cultivation.

4.7 Annual family income

Annual family income of the respondents varied from 50 to 350 thousand Tk. The respondents were classified into the following three categories based on their income: (less than 150 thousand)", (151-250 thousand) and (above 250). The distribution of the farmers according to their annual family income is shown in Figure 4.7.

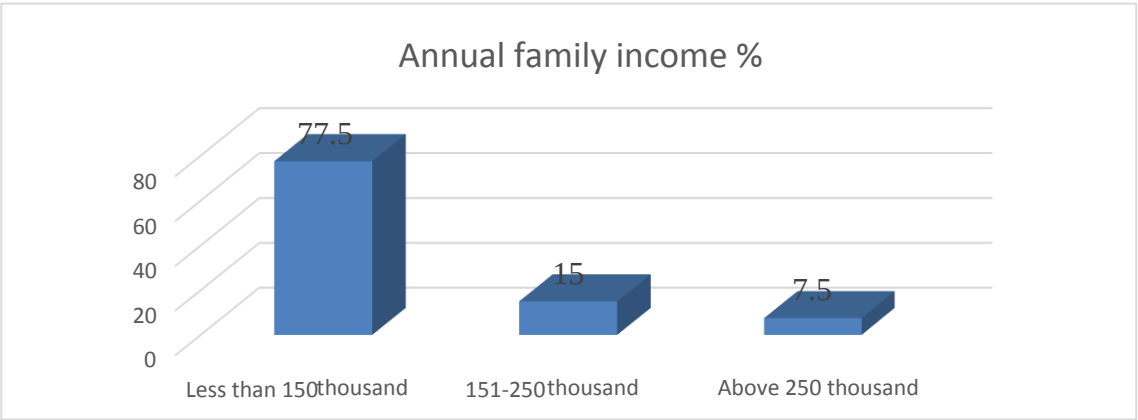

Figure 4.7 Distribution of the farmers according to their annual family income
Source: Field Survey, 2019

Figure 4.7 indicated that majority of the farmers (77.5 percent) had less than 150 thousand income which was less than the national per capita income ($1909) compared to 15 percent of them having 151-250 thousand income and only 7.5 percent of the farmers had above 250 thousand annual family income.

4.8 Conclusion

From the above discussion it can be narrated that this study shows the numbers of small farmers are higher than marginal and medium farmers. Marginal farmers are cultivating more land under maize cultivation than small and medium farmers. The study also compared many perspectives of the socio economic characteristics of the sample farmers those were also discussed in this chapter.

CHAPTER V

PROFITABILITY OF MAIZE PRODUCTION

CHAPTER V
PROFITABILITY OF MAIZE PRODUCTION

5.1 Introduction

This chapter is designed to analyze and compare the per hectare profitability of maize production of the farmers. The related cost items include fertilizer cost, seed cost, animal and power tiller cost, manure cost, insecticide cost, irrigation cost, labor cost, land rental value and land preparation cost. The average gross return and average net return are estimated in this chapter. The Benefit cost ratio (BCR) is also estimated for determining the profitability of the farmers.

5.2 Pattern of input use for maize cultivation

Farmers in the study areas used various inputs for maize cultivation. Farmers used per hectare on an average family labor was 33 man-days and hired labor was 126 man-days. On an average, they sowed 24.5 kg seed per hectare of farms. They applied at the rate of urea 389 kg/ha, TSP 223 kg/ha and MoP 105 kg/ha for maize production. It was observed that among the chemical fertilizer, farmers used highest amount urea for the farms. In the study areas, farmers also applied gypsum (37 kg/ha), zinc (7) and manure 1150 kg/ha for maize cultivation.

Table 5.1 Level of input use per hectare of maize cultivation

Particulars	**Farms**				
	Marginal	**Small**	**Medium**	**All farms**	**Price Tk./unit**
Human labor (man-day)					
Family	**27**	**34**	**38**	**33**	**400**
Hired	120	125	132	126	400
Seed (kg)	21	25	27	24.5	250
Urea (kg)	402	395	369	389	16
TSP (kg)	208	220	242	223	27
MoP (kg)	90	110	115	105	30
Manure (kg)	1200	1300	950	1150	3
Gypsum (kg)	35	39	37	37	36
Zinc (kg)	4	7	9	7	200

Source: Field Survey, 2019

5.3 Profitability of maize production

To determine the profitability and compare it among the maize production farmers the following costs and returns items were calculated.

5.3.1 Estimation of Costs

Costs are the expenses incurred in organizing and carrying out the production process. In the production process farmers used two categories of cost, variable cost and fixed cost. The variable costs of maize production include the cost of seed, hired labor, animal and power tiller cost for land preparation, fertilizer, manure, irrigation and pesticide. In this study the fixed costs include interest on operating capital, land lease value and family labor. Farmers used both home supplied and purchased inputs. The costs of purchased inputs were estimated on the basis of the actual payments made by the farmers and for home supplied inputs, opportunity cost principle was applied to determine their value.

5.3.1.1 Cost of Human Labor

For maize production human labor is the most important inputs. It was required for different operations like land preparation, weeding, fertilizing, using pesticide, harvesting, carrying, threshing, drying, storing, etc. In this study, human labor was measured in man-days. One man-day was equivalent to 8 hours work of an adult man. For women and children, man equivalent day was estimated. This was computed by converting all women and children day into man equivalent day according to the following ratio. 1 man –day = 1.5 woman day = 2 child day.

The per hectare human labor cost of maize is shown in table 5.2. The per hectare human labor costs were Tk. 48000, Tk. 50000 and Tk. 52800 for marginal, small and medium farmers respectively and their percentages of total cost of production was 38.56, 37.22 and 37.56 percent respectively.

5.3.1.2 Cost of Land Preparation

In the study area, power tiller was mainly used for land preparation. Power tiller was used on contact basis. In the study area farmers used purchase power tiller and animal labor for leveling their land. By adding power tiller cost and animal labor cost total cost of land preparation was found. Table 5.2 indicates that per hectare animal labor and power tiller cost for maize production were Tk. 8344, Tk. 9520 and Tk. 9825 for

marginal, small and medium farmers respectively and their percentages of total cost of production was 6.70, 7.09 and 6.99 percent respectively (Table 5.2).

5.3.1.3 Cost of Seed

In the study area, farmers used mainly purchased seed. Seeds used by the farmers in the study area were Pionear V-92, Balaji, Boloban, 63-Kaveri, Chhokkavutta, etc. The costs of purchased seed were calculated on the basis of actual prices paid by the farmers in the study area. Per hectare costs of seeds of maize production were Tk. 5250, Tk. 6250 and Tk. 6750 for marginal, small and medium farmers respectively and their percentages of total cost of production was 4.22, 4.65 and 4.80 percent respectively (Table 5.2).

5.3.1.4 Cost of Fertilizer

In the study area farmers used five types of chemical fertilizer namely, Urea, Triple Supper Phosphate (TSP), Muriate of Potash (MoP), Gypsum and Zinc Sulphate (Znso4). These chemical fertilizers were charged at the rate of price paid by the farmers. Per hectare costs of Urea was Tk. 6432, 6320 and 5904 for the marginal, small and medium farmers respectively and their percentages of total cost of production was 5.17, 4.70 and 4.19 percent respectively.

Per hectare costs of TSP was Tk. 5616, 5940 and 6534 for the marginal, small and medium farmers respectively and their percentages of total cost of production was 4.51, 4.42 and 4.65 percent respectively.

Per hectare costs of MP was Tk. 2700, 3300 and 3450 for the marginal, small and medium farmers respectively and their percentages of total cost of production was 2.17, 2.46 and 2.45 percent respectively.

Per hectare costs of Zinc Sulphate were Tk. 800, 1400 and 1800 for the marginal, small and medium farmers respectively and their percentages of total cost of production was 0.64, 1.04 and 1.28 percent respectively.

Per hectare costs of gypsum were Tk. 1260, 1404 and 1332 for the marginal, small and medium farmers respectively and their percentages of total cost of production was 1.01, 1.05 and 0.95 percent respectively.

Using various kinds of fertilizer plays an important role for maize cultivation. In the study area farmers used Urea, TSP, MoP, Zinc Sulphate and Gypsum for maize cultivation. Per hectare costs of fertilizers were Tk. 16808, Tk. 18364 and Tk. 19020 for marginal, small and medium farmers respectively (Table 5.2). It is clear to see that the fertilization cost of medium farmer is higher than marginal and small farmers.

5.3.1.5 Cost of Manure

Per hectare cost of manure for marginal, small and medium farmers were Tk. 3600, 3900 and 2850, respectively and their percentages of total cost of production was 2.89, 2.90 and 2.03 percent respectively (Table 5.2). Manure cost is higher for small farmer than marginal and medium farmer. Most of the small farmer are fully involved in their farm business. Because of dearth of cash they are not always capable to purchase fertilizer. Fertilizer dealers sometime provide fertilizer to the farmer. in that case the farmer are obligated to sell their production in that particular fertilizer seller below the actual market price. Family labor are also involved to manage small farms. Therefore, small farmers have more interest for the application of manure in their farm. That's why, their manure cost is also higher.

5.3.1.6 Cost of Irrigation

Maize production needs a huge amount of water. In the study area, farmers had to depend on shallow tube well (STW) and deep tube-well (DTW). These tube-wells were diesel operated and/or electricity operated. The cost of irrigation water was charged at fixed rate for per unit area of irrigated land .All irrigation water charges were paid in cash. Per hectare costs of irrigation cost were Tk. 8712 Tk. 8940 and Tk. 9845 for marginal, small and medium farmers respectively and their percentages of total cost of production was 6.99, 6.66 and 7.00 percent respectively (Table 5.2).

5.3.1.7 Cost of Pesticides

The pesticides used by the farmers in the study area were Vittaku, Sunforan, Rijent, Dithane M-45, Thiovit 80wp and Rovral 50wp, etc. Table 5.2 reveals that per hector cost of pesticides were Tk. 2805, Tk. 3250 and Tk. 3557 for marginal, small and medium farmers respectively and their percentages of total cost of production was 2.25, 2.42 and 2.53 percent respectively (Table 5.2).

Table 5.2 Per hectare costs of maize cultivation

Particulars	Marginal		Small		Medium		All farms
	(Tk/ha)	%	(Tk/ha)	%	(Tk/ha)	%	**(Tk/ha)**
Hired labor	48000	38.56	50000	37.22	52800	37.56	50400
Land preparation	8344	6.70	9520	7.09	9825	6.99	9229
Seed	5250	4.22	6250	4.65	6750	4.80	6125
Urea	6432	5.17	6320	4.70	5904	4.19	6224
TSP	5616	4.51	5940	4.42	6534	4.65	6021
MoP	2700	2.17	3300	2.46	3450	2.45	3150
Zinc sulphate	800	0.64	1400	1.04	1800	1.28	1400
Gypsum	1260	1.01	1404	1.05	1332	0.95	1332
Manure	3600	2.89	3900	2.90	2850	2.03	3450
Irrigation	8712	6.99	8940	6.66	9845	7.00	9165
Pesticide	2805	2.25	3250	2.42	3557	2.53	3204
A. Total variable cost	**93519**	75.12	**100224**	74.61	**104647**	74.44	**99700**
Land use cost	15500	12.45	15500	11.54	15500	11.03	15500
Family labor	10800	8.67	13600	10.12	15200	10.81	13200
Interest on operating capital	4676	3.76	5011	3.73	5232	3.72	4985
B. Fixed Costs	**30976**	24.88	**34111**	25.39	**35932**	25.56	**33685**
Total cost (A+B)	**124495**	**100**	**134335**	**100**	**140579**	**100**	**133385**

Source: Field Survey, 2019

5.3.2 Total Variable Cost

In the study area, the total variable costs varied from year to year. It was observed that the total per hectare variable cost for maize cultivation Tk. 93519, Tk. 100224 and Tk. 104647 for marginal, small and medium farmers respectively and their percentages of total cost of production was 76.56, 72.72 and 71.70 percent respectively (Table 5.2).

5.3.3 Fixed Costs

5.3.4 Land use cost

The farmers used the land as per conditions of leasing arrangement. The term leasing cost means the cost which was required for maize farmers to take land lease which would be used for maize production to a particular period of time. Leasing cost varies from one place to another depending on the location, soil fertility, topography of the soil and distance from the sources of water etc. Leasing cost was the single highest cost item in the study areas. The value of own land was calculated as opportunity cost concept. Land use cost for maize production was estimated at the prevailing rental

value per hectare in the study area. The rental value of per hectare land was estimated at Tk. 15500, Tk. 15500 and Tk. 15500 for marginal, small and medium farmers and their percentages of total cost of production was 12.45, 11.54 and 11.03 percent (Table 5.2).

5.3.5 Family labor

In the study area, it was estimated that per hectare family labor cost for maize cultivation were Tk. 10800, Tk. 13600 and Tk. 15200 for marginal, small and medium farmers and their percentages of total cost of production was 8.67, 10.12 and 10.81 percent (Table 5.2). The family labor cost of medium farmer is higher than marginal and small farmer. The farm size of marginal farmers are smaller than small and medium farmers. Again, most of the marginal farmers are day laborers and possessed on other off farm activities. Thereat, they are less interested to fully involved their family labor in the maize cultivation.

5.3.6 Interest on Operating Capital

It is evident from table 5.2 that interest on operating capital per hectare was Tk. 4676, 5011 and 5232 for marginal, small and medium farmers which covered 3.76, 3.73 and 3.72 percent of the total cost.

5.3.7 Total Fixed Cost

In the study area, it was estimated that per hectare total fixed cost for maize cultivation was Tk. 30976, 34111 and 35932 for marginal, small and medium farmers which comprised of 23.44, 27.28 and 28.30 percent of total cost.

5.4 Total Cost

The total costs were calculated by adding up total variable cost and total fixed cost. In the study per hectare total cost of maize cultivation were calculated at Tk. 124495, Tk. 134335 and Tk. 140579 for marginal, small and medium farmers (Table 5.2). It was found that highest and lowest costs per hectare were appeared in medium and marginal farms respectively.

5.5 Return of Maize Production

5.5.1 Gross Return

Per hectare gross return of maize production under marginal, small and medium farms are shown in Table 5.3. Gross return per hectare consisted of the value of main product. Per hectare return was calculated by multiplying the total amount of products by their respective average market price. The average market price of maize was Tk. 19 per kg. Per hectare gross return of maize cultivation under marginal, small and medium farms were Tk. 213997, Tk. 204972 and Tk. 197163 respectively which indicates that per hectare gross return of marginal farms were higher than small and medium farms (Table 5.3).

5.5.2 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. 120478, Tk. 104748 and Tk. 92516 per hectare for marginal, small and medium maize farm respectively (Table 5.3).

5.5.3 Net 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 were estimated as Tk. 89502, Tk. 70637 and Tk. 56584 for marginal, small and medium maize farm per hectare (Table 5.3). As, the farm size of marginal farmer is very small, the farmer handle the farm by themselves. That's why their production is higher and cost is also lower than small and medium farmers. As a result, their net return is higher than small and medium farmers.

Table 5.3: Per Hectare Cost and Return of Maize Production

Particulars	**Marginal farm**	**Small farm**	**Medium farm**	**All farm**
Total Production (kg/ha)	11263	10788	10377	10809
Price of maize (Tk./kg)	19	19	19	19
Gross Return (Tk./ha)	213997	204972	197163	205371
Total variable cost (Tk./ha)	93519	100224	104647	99700
Gross Margin (Tk./ha)	120478	104748	92516	105671
Total cost (Tk./ha)	124495	134335	140579	133385
Net Return (Tk./ha)	89502	70637	56584	71986
BCR (Total cost basis)	1.72	1.53	1.40	1.53
BCR (Total variable cost basis)	2.29	2.04	1.88	2.06

Source: Field Survey, 2019

5.5.4 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 1.72, 1.53 and 1.40 for marginal, small and medium maize farm respectively which implies that one taka investment in maize production generated Tk. 1.72, 1.53 and 1.40 respectively (Table 5.3). From the above calculation it was found that maize production is profitable in the study area but there is a difference in profitability among individual farm groups. It can be seen from table 5.3 that marginal farmers are making the highest amount of profit while the medium farmers are earning the lowest amount of profit from their maize production.

5.6 Concluding Remarks

From the above discussion it can be concluded here that maize production is a profitable business for farmers in the study area.

CHAPTER VI
INPUT USE EFFICIENCY OF MAIZE CULTIVATION

CHAPTER VI

INPUT USE EFFICIENCY OF MAIZE CULTIVATION

6.1 Introduction

This chapter is designed to estimate and compare the relative economic potential of maize production in tabular form. The main focus of the present chapter is to estimate the contribution of the individual key variables to the production process of maize.

6.2 Factors Affecting Production of Maize

For producing maize production different kinds of inputs, such as human labor, land preparation, seed, fertilizer, irrigation and insecticides were employed which were considered as a priori explanatory variables responsible for variation in maize production. Multiple regression analysis was employed to understand the possible relationships between the production of maize and the inputs used.

6.3 Method of Estimation

For determining the effect of variable inputs to the maize production, Cobb-Douglas production function was chosen on the basis of best fit and significance result on output. (Dillion & Hardaker, 1993). Moreover, use of Cobb-Douglas production function enables one to obtain the returns to scale directly. This model is also popular in applied work. The functional form of the multiple regression equation is as follows.

$Y= aX_1^{b1}\ aX_2^{b2}\ aX_3^{b3}\ aX_4^{b4}\ aX_5^{b5}\ aX_6^{b6}\ aX_7^{b7} aX_8^{b8} e^{ui}$

This equation may be alternatively expressed as:

$\ln Y= \ln a + b_1 \ln X_1 + b_2 \ln X_2 + b_3 \ln X_3 + b_4 \ln X_4 + b_5 \ln X_5 + b_6 \ln X_6 + b_7 \ln X_7 + b_8 \ln X_8 + u_i$

Where,

Y = Yield (kg /ha);

a = Intercept;

X_1 = Cost of land preparation (Tk. /ha) ;

X_2=No. of human labor (man days/ha) ;

X_3 = Quantity of seed (Kg/ha) ;

X_4= Cost of irrigation (Tk. /ha) ;

X_5= Quantity of urea (Kg /ha) ;

X_6= Quantity of TSP (Kg /ha) ;

X_7= Quantity of MoP (Kg /ha) ;

X_8= Cost of pesticide (Tk. /ha) ;

b_1,b_2……b_8=Coefficient of relevant variables;

u_i=Disturbance term;

ln=Natural logarithm;

This equation is individually applicable for maize production farmers because the same set of inputs as indicated in the model were used.

6.4 Interpretation of Results

Interpretation of the estimated co-efficient and related statistics of Cobb-Douglas production function of the farms which maize production have been shown in Table 6.1. The following features were noted.

- Cobb-Douglas production function fitted well for maize production farms as indicated by F-values and R^2.
- The relative contribution of individual key variables affecting productivity of maize production farmers can be seen from the estimates of regression equation. The results showed that most of the co-efficient had expected sign. However, the explanatory variables like land preparation (X_1), irrigation (X_4), urea (X_5), TSP (X_6) and MoP (X_7) were found to have significant effect on production in maize farms, but human labor (X_2), seed (X_3) and pesticide (X_8) was found to have insignificant effect on production of maize.

6.4.1 Maize Production

Land preparation (X_1):

It is evident from Table 6.1 that the coefficient of land preparation cost was 0.425 which was significant at 1 percent level. That means, 1 percent in cost of this input keeping other factors constant would result in an increase of yield by 0.425 per cent.

Human labor (X_2):

The co-efficient for human labor was 0.061 and was insignificant .

Seed (X_3):

The estimated co-efficient of seed was 0.116 which was insignificant.

Irrigation (X_4):

The co-efficient of this variable was 0.305 and significant at 1 percent level. This suggests that holding other factors constant an additional spending of 1 percent on irrigation water would enable the farmers to increase the yield by earn 0.305 percent.

Urea (X_5):

The estimated value of the co-efficient of urea fertilizer was 0.175 and was significant at 5 per cent level which indicates that 1 percent increase in urea keeping other factors constant, would increase the yield by 0.175 percent.

TSP (X_6):

The estimated value of the co-efficient of TSP fertilizer was -0.076 for maize farmer. The co-efficient of TSP was negative and significant at 1 percent level .It can be said that 1 percent increase in TSP keeping other factors constant, would decrease the yield by 0.076 percent. For farmers, it also can be stated that use of additional TSP would harm the output.

MoP (X_7):

The estimated value of the co-efficient of MoP fertilizer was 0.131 and was significant at 5 percent level indicates that 1 percent increase in MoP fertilizer keeping other factors constant, would increase the yield by 0.131 percent.

Pesticide (X_8):

The co-efficient of the variable was 0.027 and insignificant.

Table 6.1 Estimated Values of Coefficients and Related Statistics of Cobb-Douglas Production Function

Explanatory variables	Coefficient	Standard error	p- value
Intercept	2.908	.298	0.000
Cost of land preparation (X_1)	.425	.104	.000***
human labor (X_2)	.061	.062	.323
seed (X_3)	.116	.104	.196
Cost of irrigation (X_4)	.305	.118	.007***
urea (X_5)	.175	.081	.048*
TSP (X_6)	-.076	.049	.000***
MoP (X_7)	.131	.062	.044*
Cost of pesticide (X_8)	.027	.053	.652
R^2	0.852		
Adjusted R^2	0. 846		
Return to scale	1.164		
F-value	175.495***		

Source: Field Survey, 2019

Note: *** Significant at 1 percent level; * Significant at 5 percent level and NS: Not Significant

Value of R^2:

The co-efficient of multiple determinations, R^2 was 0. 852 for owner farmer which indicates that about 85 percent of the total variation in return of maize production is explained by the variables included in the model. In other words the excluded variables accounted for 15 percent of the total variation in return of maize.

F-Value:

The F-value of the equation was highly significant and it implies that the included variables are important for explaining the variation in returns of maize production.

Returns to Scale

The summation of all the production coefficients indicates returns to scale. For maize production in farmers the summation of the coefficients was 1.164. This indicated that the production function showed increasing returns to scale.

6.5 Input Use Efficiency in Maize Production

In order to identify the status of resource use efficiency, it was considered that a ratio equal to unity indicated the optimum use of that factor, a ratio more than unity indicated that the yield could be increased by using more of the resources. A value of less than unity indicated the unprofitable level of resource use, which should be decreased to minimize the losses because farmers over used this variable. The negative value of MVP indicates the indiscriminate and inefficient use of resource (Dhawan and Bansal, 1977).

The ratio of MVP and MFC of land preparation (9.44) for maize production was positive and more than one, which indicated that in the study area land preparation was under used (Table 6.2). So, farmers should increase the optimum use of land preparation to attain efficiency considerably.

Table 6.2 showed that the ratio of MVP and MFC of human labor (0.32) for maize cultivation was positive and less than one, which indicated that in the study area human labor for maize cultivation was over-utilization. So, farmers should decrease the use of human labor to attain efficiency level.

The ratio of MVP and MFC of seed was found to be 2.11 for maize cultivation was positive and more than one, which indicated that in the study area use of seed for maize production was under-utilization (Table 6.2). So, farmers should increase the use of seed for maize production to attain efficiency considerably.

Table 6.2 revealed that the ratios of MVP and MFC of irrigation used for maize cultivation was positive and more than one (4.41), which indicated that irrigation application was underutilized. So, farmers should increase the use of irrigation to attain efficiency in maize cultivation.

It was evident from the table 6.2 that the ratio of MVP and MFC of urea (4.97) for maize cultivation was positive and more than one, which indicated that in the study

area use of urea for maize cultivation was under used. So, farmers should increase the use of urea to attain efficiency in maize cultivation.

Table 6.2 Estimated Input Use Efficiency in Maize Production

Variable	Geometric mean (GM)	$\bar{Y} = (GM)/\ddot{x}_i$ (GM)	Co-efficient	MVP (Xi)	r=MVP/MFC	Decision rule
Yield (Y)	40710.07					
Cost of land preparation (X_1)	1831.93	22.22	.425	9.44	9.44	Under-utilization
Human labor (X_2)	7686.39	5.29	.061	0.32	0.32	Over-utilization
Seed (X_3)	2239.44	18.17	.116	2.11	2.11	Under-utilization
Cost of Irrigation (X_4)	2818.74	14.15	.305	4.41	4.41	Under-utilization
Urea (X_5)	1434.60	28.38	.175	4.97	4.97	Under-utilization
TSP (X_6)	1043.37	39.02	-.076	-2.96	-2.96	Over-utilization
MoP (X_7)	660.07	61.68	.131	8.08	8.08	Under-utilization
Cost of Pesticide (X_8)	471.59	86.33	.027	2.33	2.33	Under-utilization

Source: Field survey, 2019.

The ratio of MVP and MFC of TSP (-2.96) for maize cultivation was negative and less than one, which indicated that in the study areas use of TSP for maize cultivation was over used (Table 6.2). So, farmers should decrease the use of TSP to attain efficiency considerably.

It was evident from the table 6.2 that the ratio of MVP and MFC of MoP (8.08) for maize cultivation was positive and more than one, which indicated that in the study area use of MoP for maize cultivation was under used. So, farmers should increase the use of MoP to attain efficiency in maize cultivation.

It was evident from the table 6.2 that the ratio of MVP and MFC of pesticide (2.33) for maize cultivation was positive and more than one, which indicated that in the study area use of pesticide for maize cultivation was under used. So, farmers should increase the use of pesticide to attain efficiency in maize cultivation.

6.6 Concluding Remarks

It is evident from the Cobb-Douglas production function model, which the included key variables had significant and positive effect on maize production except the positive and insignificant effect of human labor, seed and pesticide. Resource use efficiency indicated that all of the resources were under-utilization for maize production except over- utilization of human labor and TSP. So there is a positive effect of key factors in the production process of maize production.

CHAPTER VII
PROBLEMS OF MAIZE CULTIVATION

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PROBLEMS OF MAIZE CULTIVATION

7.1 Introduction

The maize growers were found to face different problems were non-available of good quality seed, low yield and unstable price, land unsuitability, attack by insects and diseases, high price of pesticide and fertilizer, lack of capital. Shortage of hired labor at the harvesting period, irregular extension contact and drought. The nature and extent of these problems are discussed below:

7.2 Problems of maize cultivation

• High price of inputs:

Based on farmers' opinion, another top ranking constraint was high price and spot scarcity of fertilizers. Majority (26.25%) of the farmers mentioned that they faced the problem of high price and spot scarcity of one or more of the chemical fertilizers in maize growing season. Such problem led some of the farmers to apply less amount of some of the fertilizers which further aggravated the imbalanced use of chemical fertilizers. This problem was ranked 1st for maize growers (Table 7.1).

• Lack of technical knowledge

It was observed that 15 percent of maize growers in the study areas had lack of technical knowledge for the cultivation of the maize (Table 7.1). This problem ranked 2nd for maize farmers.

• Shortage of human labor at the critical stage:

Shortage of human labor at the critical stage is a seasonal problem and generally occurs in peak period of maize production. Shortage of human labor hampered different intercultural management and delayed harvesting which ultimately reduced yield. About 48 percent of maize growers faced the problem of shortage of human labor. This problem ranked 3rd for maize cultivation.

• Lack of sufficient fund

Farmers in our country especially the small farmers cannot save much from their crops for investing in the succeeding crops. On the other hand, agricultural credit from formal sources is very much limited and farmers often cannot afford it for various reasons. About 11.25 percent of the maize growing farmers mentioned that they had dearth of cash for maize cultivation (Table 7.1) and ranked 4th problem.

• Lack of good quality seed:

Though all the farmers were found to produce high yielding varieties of maize, 10 percent of them mentioned that they had lacking of good quality seed and this constraint ranked 8th among the constraints (Table 7.1). Most of the own preserved seeds and the seeds collected from local markets or neighbors were not good quality seeds as their germination was poor.

• Low yield and unstable price:

The problem of low price and unstable price was noticed by 7.5 percent of maize growers in the study areas (Table 7.1). It was a severe problem for maize production and ranked 6th among the problems.

• Lack of suitable land:

It was observed that 6.25 percent of maize growers in the study areas had lacking of suitable land for the cultivation of the maize (Table 7.1). This problem ranked 7th for maize farmers.

• Disease infestation:

Diseases was one of the most severe constrains to produce maize. About 5 percent of maize producers, reported that they were facing this problem (Table 7.1). This problem ranked 8th for the maize cultivar.

Table 7.1 Problems of maize production

Problems	Farmers	Responded (%)	Rank
High price of inputs	21	26	1st
Lack of technical knowledge	12	15	2nd
Shortage of human labor at the critical stage	10	13	3rd
Lack of sufficient fund	9	11	4th
Lack of good quality seed	8	10	5th
Low yield and unstable price	6	8	6th
Lack of suitable land	5	6	7th
Disease infestation	4	5	8th
Declining soil fertility	3	4	9th
Others problems	2	2	10th
Total	80	100	

Source: Field Survey, 2019

- **Declining soil fertility:**

Farmers in the study areas were concerned about the declining soil fertility. About 3.75 percent of the respondents mentioned that declining soil fertility hampered maize production. Reports are already available that fertility of our soils has deteriorated over the years and the productivity of some crops have either stagnated or declined. Declining of soil fertility is further aggravated due to deficiency of more and more micronutrients in the soil. Farmers also mentioned that they got less yield from same amount of fertilizers than before due to declining soil fertility.

- **Other problems:**

The maize growers in the study areas faced some other problems like drought, storage problem, low price at harvesting period, irregular extension service etc. About 2.5 percent of the sample farmers faced the above mentioned problems.

CHAPTER VIII
SUMMARY, CONCLUSION AND RECOMMENDATION

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SUMMARY, CONCLUSION AND RECOMMENDATION

This chapter narrates the summary of the earlier chapters. On the basis of empirical outcomes, conclusion has been made. It also concentrate on the policy recommendations, limitations on the study for development of maize production in the study area.

8.1 Summary:

Traditionally, rice provides the largest carbohydrate source for most of South Asia's farm families, although with increasing affluence and preferences for fish and poultry protein in diets, maize production has increased from 20.51 to 35.47 Mt in last decade, with grain sold primarily to the feed industry. Maize adoption has been especially high in Bangladesh, where it was cultivated on approximately 1500 ha in 1984, but area rose rapidly to about 0.20 M ha in 2007–2008 and to 0.36 M ha in 2012–2013, largely through the replacement of pulses, oilseeds and wheat.

High profitability of maize cultivation continued to incentivize the farmers to produce more maize. Production of maize rose significantly, registering a 23.7 per cent growth (BBS, 2017).

In order to find out the problems, potentials and possibilities of continuation in the average and production of maize, the present study is driven to examine the profitability and input use efficiency in some selected area of Chuadanga district.

The following are the specific objectives:

1. To identify the socio-economic characteristics of maize growers;
2. To estimate the cost and return of maize cultivation;
3. To assess the input use efficiency of maize cultivation; and
4. To address the problems faced by the farmers and suggest some policy recommendations.

The study is principally based on primary data, which were collected by the researcher herself through direct interviewing the sample farmers. In order to attain the objectives, survey was driven in six villages namely Karpashdanga, Aramdanga, Subolpur, Pirpur, Monirampur and Rajapur. Primary data were collected from 80 farmers. A purposive random sampling was followed. Simple statistical technique and Cobb-Douglas production function were used to process and analyzed the data to attain the objectives of the study.

The general socio-economic characteristics of the sample farmers such as farmers' age and education, occupation, family size, farm size, land under maize cultivation were calculated. The highest proportion of maize growers (50%) were in the age 'group of 36-50 followed by age group above 50 years (35%) and up to 35 years (15%). According to the field survey, it was found that 36.30% farmers were illiterate, 27.50 percent had primary level education and 29.20 percent had S.S.C level education while 6.30 percent had H.SC level of education. Only 1.30 percent of the farmers were higher level of education. The highest proportion (66.0%) of the respondents had agriculture and (34%) had had non-agriculture, respectively. The majority of the 41.30 percent of the maize farmers had "medium family" of 5-7 members compared to 40 percent of them having "small family" of 2-4 members. The proportion of "medium family" was 18.70 percent. More than half (59.50 percent) of the farmers possessed small farm size compared to 36.70 percent of them having medium farm size and 3.80 percent of the farmers having medium farm size. Half (50 percent) of the farmers possessed marginal land under maize cultivation compared to 46 percent of them having small land and only 4 percent medium land under maize cultivation. Majority of the farmers (77.5 percent) of the farmer’s had less than 150 thousand income compared to 15 percent of them having 151-250 thousand income and only 7.5 percent of the farmers had above 250 thousand annual family income.

Profitability depends on the costs involved in production and returns from its product and by-product. In calculating cost, both cash cost and non-cash cost were considered. The cost items were cost of human labor, mechanical power, seed, manure, fertilizer, pesticide, irrigation, land rent and interest on operating capital. The variable costs were estimated at Tk. 93519, Tk. 100224 and Tk. 104647 for marginal, small and medium group of farmers for maize production, respectively. Total fixed costs were estimated at Tk. 30976, Tk. 34111 and Tk. 35932 for marginal, small and medium

maize production, respectively. Thus, the total cost of production was Tk. 124495, Tk. 134335 and Tk. 140579 for marginal, small and medium maize production respectively.

Per hectare gross return was Tk. 213997, Tk. 204972 and Tk. 197163 for marginal, small and medium maize production, respectively. Per hectare gross margin was Tk. 120478, Tk. 104748 and Tk. 92516 for marginal, small and medium maize production, respectively. Net return was calculated by deducting gross cost from gross return and these were Tk. 89502, Tk. 70637 and Tk. 56584 for marginal, small and medium maize production, respectively. Benefit cost ratio was 1.72, 1.53 and 1.40 for marginal, small and medium maize production, respectively.

From Cobb-Douglas production cost function cost analysis, it was observed that the coefficients of land preparation cost, irrigation cost, urea and MoP was significant at different level of probability for marginal, small and medium maize production, respectively and the coefficients of human labor, seed and pesticide used was not significant while the coefficients of TSP was negative and significant for marginal, small and medium maize farms, respectively.

Finally, it was observed that most of the MVPs of inputs were positive or more than one which indicate that more profit can be obtained by increasing most of the input included in production function. Input use efficiency indicated that all of the resources were under used for maize production except overutilization of human labor and TSP. So there was a positive effect of key factors in the production process of maize cultivation. This study also identified some of the problems associated with maize production. The findings revealed that lack of good quality seed, low yield and unstable price, lack of suitable land, disease infestation, high price of inputs, lack of sufficient fund, shortage of human labor at the critical stage, declining soil fertility etc. were the major obstacle which stand in the way of maize production in the study area.

8.2 Conclusion

The study showed that maize production is profitable in the study area. Marginal farmers received higher profit than small and medium farmers. Although maize production was profitable as others crop cultivation, but the farmers were not so much

interested to grow a huge bulk of maize continuously, because of fluctuating market price of the maize. Therefore, there is a need to ensure a reasonable market price of maize at the harvesting period and that should be stable. Moreover, the government should take necessary steps to overcome these constraints and to expand the production of maize in different areas of Bangladesh.

8. 3 Recommendations

The following recommendations are drawn on the basis of findings of the study to the policy makers and researchers in order to adopt all sort of potential measures to improve the present situation of maize production:

1. Most of the farmers of the study area cultivated maize for commercial basis. As the present study stated that maize production is profitable. Therefore, the maize growing farmers should be made conscious or created awareness regarding profitability level of maize. As there is limited scope for horizontal expansion of maize area, so attention should be given to the vertical improvement office output at the same time concerted efforts of the researchers should be develop new high yielding short during varieties responsive to high input and feasible management practices.

2. Most of the farmers did not have knowledge about appropriate utilization of inputs for maize production which might have fostered a positive contribution to yield. None of the farmers appeared to have optimum allocation of the inputs for producing maize and there appeared to be substantial scope for reallocation of inputs to cultivate each variety by each of the farmers' categories. Farmers were found to have used both insufficient amount of inputs precisely seed, farm yard manure and chemical fertilizers. Excess or insufficiency of an element reduces the effectiveness of the other elements and consequently reduces the yield. Therefore, farmers should be encouraged to use balanced dose of fertilizers and allocate their resources optimally and timely for increasing maize yield by maintaining soil health.

3.The average technical efficiency of maize production in Bangladesh is 85. This indicates a good potential for increasing maize output by 15 percent with the existing technology and levels of inputs for maize. Therefore, DAE, BRRI and other concerned organizations should be focused on the scope in order to increase the tempo of production of maize.

4. Lower price of maize was observed at the harvesting period in the study areas. Reasonable steady market price of maize should be ensured by the concerned authority at the harvesting period so that the maize growers would get their expected return from maize. Government should take necessary steps to explore the possibility of export of the maize in different countries. In this case, government should purchase maize from the farmers at the harvesting period and export to the recipient countries as per their demand.

5. Special incentive should be given to the maize growers such as credit, maize insurance etc. so that they would bear production cost. Attempt should be taken to minimize risk and uncertainty that might appear at any adverse circumstances.

6. A constant paucity of fertilizer along with its exorbitant price affected the desired level of application in the maize field. In this regard concerned authority should take necessary steps in order to supply desired amount of fertilizer to the farmers in time with fair price.

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