PRODUCTIVITY AND TECHNICAL EFFICIENCY OF MAIZE PRODUCTION IN SOME SELECTED AREAS OF MUNSHIGANJ DISTRICT IN BANGLADESH

HUMAYRA HABIB

DEPARTMENT OF AGRICULTURAL ECONOMICS

SHER-E-BANGLA AGRICULTURAL UNIVERSITY

DHAKA-1207

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BY
HUMAYRA HABIB
REGISTRATION NO: 15-06853
Email: obontyhumayra@gmail.com; Contact number:01980396679

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APPROVED BY:

Dr. Ripon Kumar Mondal
Associate Professor
Dept. of Agricultural Economics
Sher-e-Bangla Agricultural University
Supervisor

Dr. Bazlul Ameen Ahmad Mustafi
Former Director (Admin), BRRI
Co-Supervisor

Dr. Monoj Kumar Majumder
Associate Professor & Chairman
Examination Committee
Dept. of Agricultural Economics
Sher-e-Bangla Agricultural University, Dhaka-1207

DEDICATED TO
MY BELOVED
PARENTS

ABSTRACT

The significance of maize production has been steadily increasing in recent years, primarily due to its wide range of diversified applications. The objective of the present study was to identify the socio-economic characteristics of maize farmers, to measure the productivity and technical efficiency of maize production, and address the challenges faced by maize producing farmers in the study area as well as suggest some policy options to address the problems. To achieve these objectives, a Cobb-Douglas stochastic frontier production function were employed. Primary data was collected from 80 randomly selected farmers of the Sirajdikhan and Sreenagar Upazilas in the Munshiganj district. The results indicated that the coefficients of parameters such as seed cost, hired labor cost, machinery used cost, and chemical fertilizer cost were positive, with seed and machinery used costs being highly significant, and the cost of chemical fertilizer cost significant at the 5 percent level. On the other hand, the coefficients of family labor cost, irrigation cost, and insecticide cost were negative, with the costs of irrigation and insecticide found to be insignificant. The technical inefficiency effect model revealed that factors such as age, education, family size, training, livestock rearing, and membership in social organizations were negative, indicating that they help in reducing the technical inefficiency of maize farmers. In terms of the challenges faced by farmers, the high price of quality seeds, natural disasters, and the high cost of labor were identified as the top three concerns. To address these challenges and enhance maize production, it is recommended to reduce seed costs, enhance farm mechanization and provide adequate extension services.

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Humayra Habib

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ABBREVIATIONS AND ACRONYMS

BARI	Bangladesh Agricultural Research Institute
BB	Bangladesh Bank
BBS	Bangladesh Bureau of Statistic
BDT	Bangladeshi Taka
BER	Bangladesh Economic Review
DAE	Department of Agricultural Extension
FAO	Food and Agriculture Organization
et al.	and others (at elli)
GDP	Gross Domestic Product
ha	Hectare
HIES	Household Income and Expenditure Survey
HYV	High Yielding Variety
kg	Kilogram
LFS	Labour Force Survey (LFS)
Ln	Natural Logarithm
ML	Maximum Likelihood
MoP	Muriate of Potash
M.Ton	Metric Ton
NGO	Non-Government Organization
No.	Number
Tk.	Taka
TSP	Triple Super Phosphate
Govt.	Government
US	United States
$	Dollar
%	Percentage

CHAPTER 1
INTRODUCTION

1.1 Background of the Study

The primary economic foundation of Bangladesh is rooted in agriculture. There is no other option for reducing poverty except to boost the agriculture sector as this sector is so important to the growth of the economy. Since the growth of agriculture is directly related to the provision of food security, an increase in living standards, and the creation of employment opportunities for our population. As per the Bangladesh Economic Review, 2022 (BER, 2022), agriculture encompasses crops, livestock, forestry, and fisheries, making up 11.50 percent of the GDP and engaging approximately 40.60 percent of the workforce. Yet, Bangladesh is recognized as one of the most prone nations in the region to the consequences of climate change and global warming due to its reliance on agriculture. Its unique geographic location, abundance of alluvial plains, low altitude, dense population, and heavy reliance upon resources from nature are the main causes of this. Crop yields are on the rise despite diminishing farmland, meeting the dietary needs of an expanding population, as well as contending with the impacts of climate change and the repercussions of COVID-19. In order to ensure food security, the authorities are tirelessly striving to establish agricultural systems that are productive, secure, and sustainable. In FY 2021–2022, 465.83 lakh metric tonnes (MT) of food grains are expected to be produced overall (BER, 2022). To assist farmers, an allocation of Tk. 150 crore for seed production initiatives and Tk. 9,500 crore for fertilizer subsidies and other agricultural endeavors with the goal of enhancing agricultural production, as per the Bangladesh Economic Review of 2022.As a result, the country is now close to becoming self-sufficient in the production of food grains.

Agriculture has historically played a significant role in Bangladesh. The land is quite fertile, and the climate is ideal, so many different kinds of crops flourish here. The livelihoods of a significant portion of our population hinge on agriculture, either through direct involvement or indirect dependence. The country's Gross Domestic Product (GDP) benefits greatly from agriculture. Earlier, this sector accounted for more than 50% of the GDP. The agricultural industry has exhibited outstanding performance throughout the years. The average annual rate of agricultural growth increased from less than 2% throughout the 1970s to the 1990s to about 3.0% in the 2000s and to 3.5% in the next decade (8th five-year plan). The production of food has been on the rise during the past few years. Cereals made up the majority of the total cropped area, accounting for 77 percent of all cultivated land (Figure 1.1).

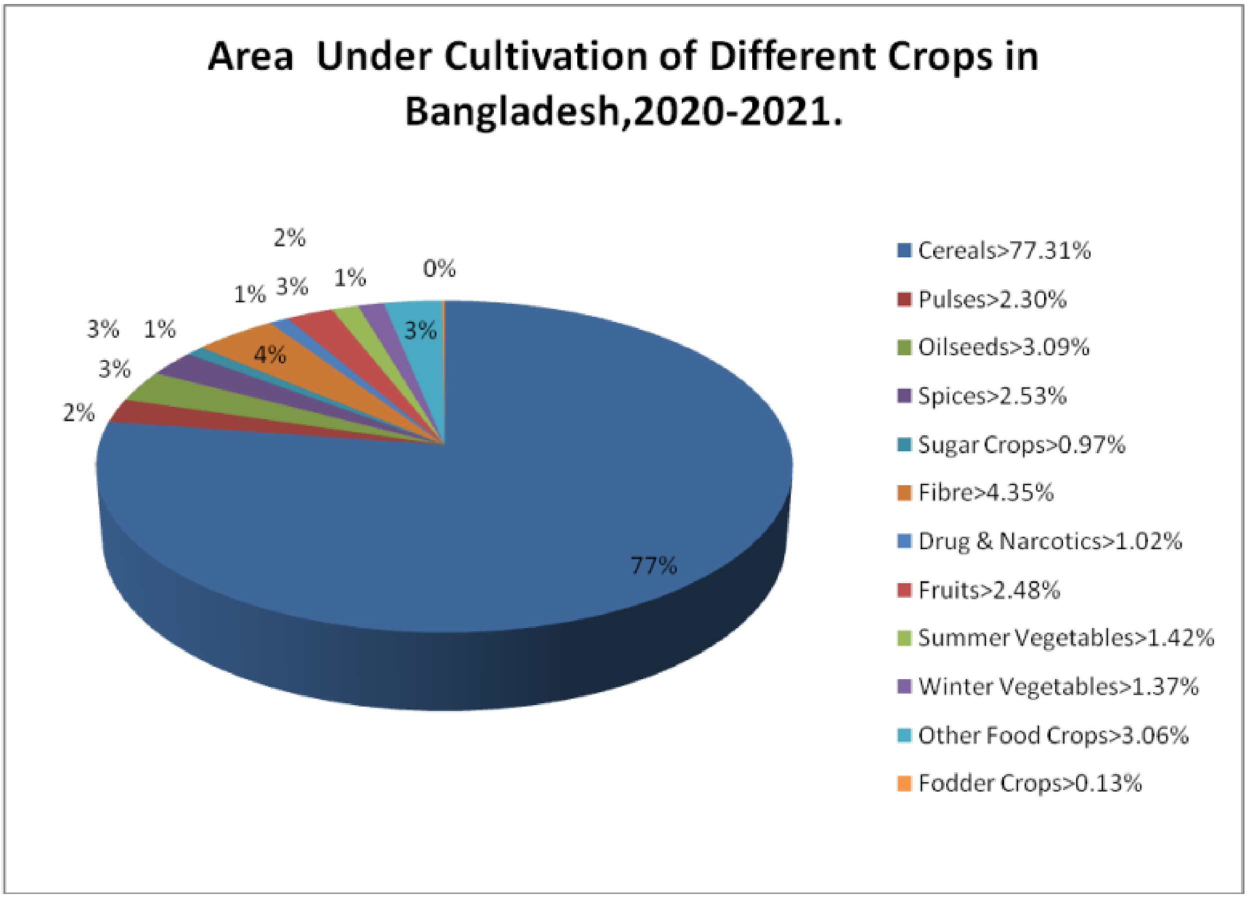


Figure 1.1: Bangladesh's Area Under Different Crop Cultivation, 2020-21

Source: BBS, 2021

In the fiscal year 2020–21, the total production of food grains was projected to be 443.56 million metric tons according to the collective assessment of the Department of Agriculture Extension (DAE, Ministry of Agriculture, and BBS. Among this total, Aus contributed 32.85 million metric tons, Aman 144.38 million metric tons, Boro 198.85 million metric tons, wheat 10.85 million metric tons, and maize 56.63 million metric tons. The overall target for food grain production in the fiscal year 2021–22 is set at 465.83 million metric tons, with Aus contributing 34.84 million metric tons, Aman 150.47 million metric tons, Boro 209.51 million metric tons, wheat 12.26

million metric tons, and maize approximately 58.75 million metric tons. The status of food grain production is shown in Figure 1.2.

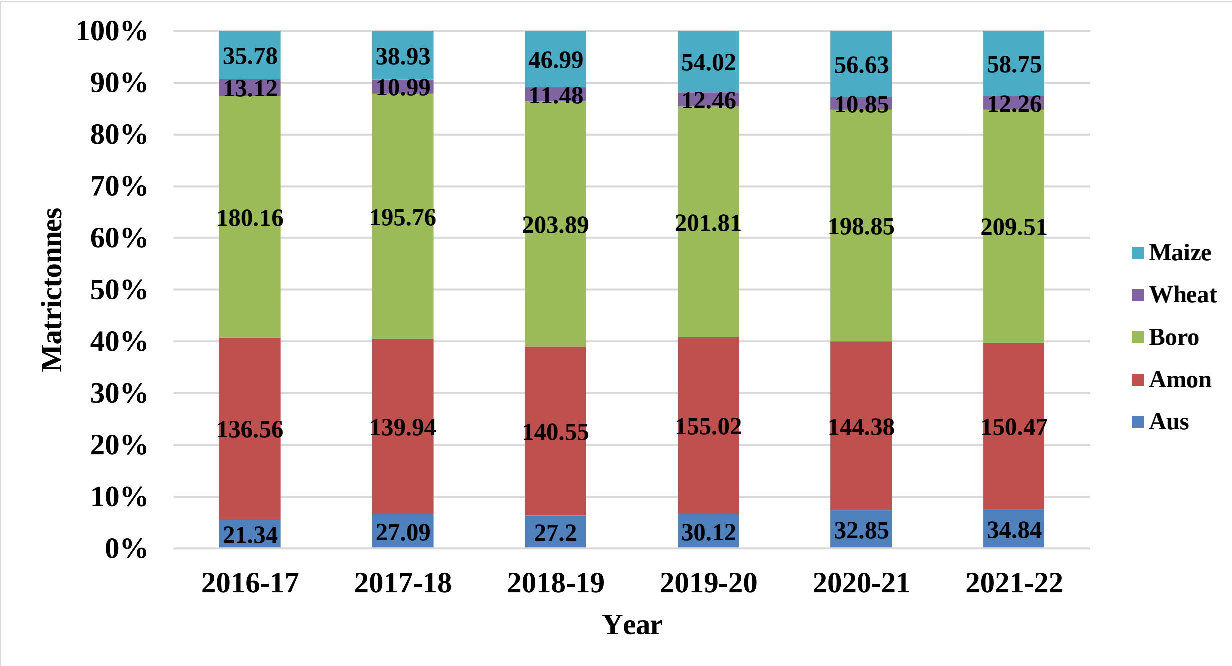


Figure 1.2: Food Grains Production

Source: BER, 2022

Bangladesh ranks as the eighth most populous agricultural nation globally, boasting a total population of 165.16 million. The annual population growth rate and density stand at 1.22 and 1,119, respectively, according to the Bangladesh Bureau of Statistics (BBS) in 2021. Nevertheless, with the onset of industrialization, the population's pursuits diversified across various sectors. Although this transition has resulted in a gradual decline in the significance of the agriculture sector, it remains a crucial and irreplaceable component of the national economy. It is regarded as the most significant sector since it provides a vital means of subsistence for a sizable section of people.

According to the sectoral distribution as of right now, services make up 51.44 percent, industry makes up 37.07 percent, and agriculture makes up 11.50 percent (Figure 1.3). In contrast, the corresponding percentages were 12.09 percent, 36.01 percent, and 51.92 percent during the preceding fiscal year.

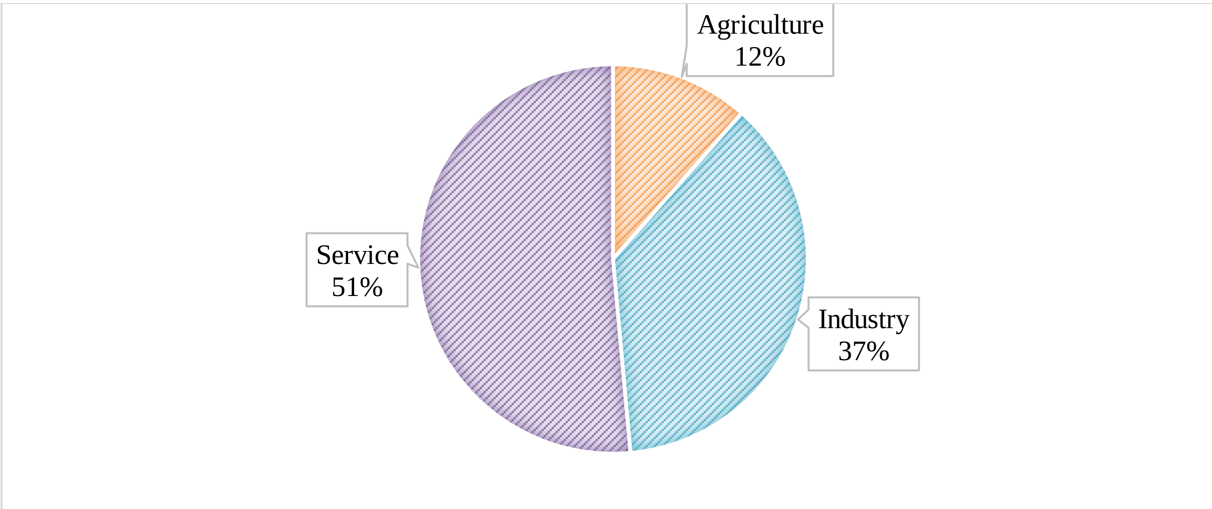
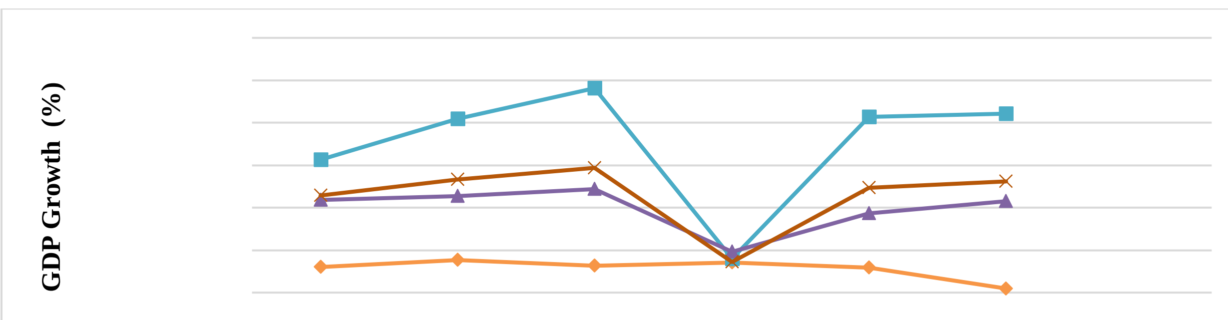


Figure 1.3: Sectorial Share of Country`s GDP in 2021

Source: BER, 2022

The GDP growth stood at 6.94 percent in FY2020-21, which were 3.61 percent, 7.88 percent, 7.32 percent, 6.59 percent in fiscal year 2019-20, 2018-19, 2017-18, 2013-14 and 2016-17 respectively. The broad sectoral growth of GDP has been shown in Figure 1.4.



	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22*
Agriculture	**3.2**	**3.54**	**3.26**	**3.42**	**3.17**	**2.2**
Industry	**8.27**	**10.2**	**11.63**	**3.61**	**10.29**	**10.44**
Service	**6.37**	**6.55**	**6.88**	**3.93**	**5.73**	**6.31**
GDP	**6.59**	**7.32**	**7.88**	**3.45**	**6.94**	**7.25**

Year

Agriculture **Industry** **Service** **GDP**

*Provisional

Figure 1.4: Broad Sectoral GDP Growth at Constant Prices

Source: BER, 2022

The main driver of Bangladesh's economy after independence was the agricultural sector. Agriculture is vital for contributing to GDP. But its contribution has reduced, going from 13.07 percent in fiscal year 2017-18 to 11.50 percent in fiscal year 2021-22. Figure 1.5 illustrates the declining pattern of the agricultural sector's contribution to the GDP at current prices, with the base year being 2015-16.

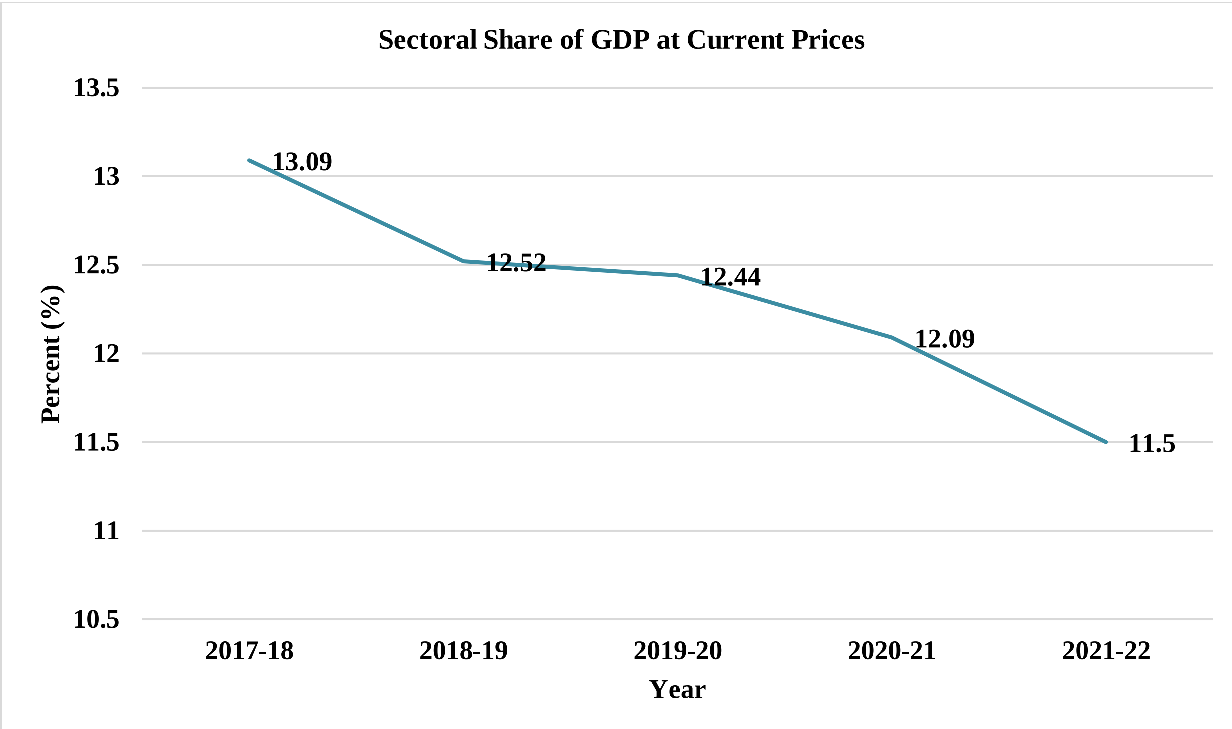


Figure 1.5: The Impact of the Agricultural Sector on the Gross Domestic Product (GDP) of the Nation

Source: BBS, 2021

This agricultural sector has remained resilient in terms of productivity and profitability despite the ever-increasing population, exacerbated by the impact of the pandemic and climate change. Fishing, raising livestock, and forestry, however, became significant sources of income. Moreover, the forestry subsector witnessed an average growth rate of 6.1% in the initial four years of the 7th Plan, contrasting with the average growth rate of 4.58 percent recorded during the 6th plan period from FY2011 to FY2015. Crops, constituting over half of the agricultural GDP, demonstrated an annual expansion at an average rate of 1.7%. The fisheries subsector exhibited strong performance, consistently maintaining an annual growth rate exceeding 6% (Table 1.1).

Table 1.1: Performance in the Growth of Agriculture Sub-Sectors

	2014-15	2015-16	2016-17	2017-18	2018-19
	Growth(%)				
Agriculture	3.33	2.79	2.97	4.19	3.92
A. Agriculture & Forestry	2.45	1.79	1.96	3.47	3.15
i)Crops & Horticulture	1.83	0.88	0.96	3.06	1.96
ii)Animal Farming	3.08	5.12	5.6	5.51	8.34
iii)Forest & Related Services	6.38	6.11	6.23	6.37	6.21
	GDP (%)				
Agriculture (A+B)	16	15.35	14.74	14.23	13.65
A. Agriculture & Forestry	12.32	11.7	11.12	10.67	10.15
i)Crops & Horticulture	8.87	8.35	7.86	7.51	7.06
ii)Animal Farming	1.73	1.66	1.6	1.53	1.47
iii)Forest & Related Services	1.72	1.69	1.66	1.62	1.62
B. Fisheries	3.69	3.65	3.61	3.56	3.49

Source: GED, 2020

The Labour Force Survey (LFS), carried out by the Bangladesh Bureau of Statistics (BBS), serves as a valuable tool for assessing the overall employment landscape in the country. According to the latest study in FY 2016-17, the economically active population over the age of 15 stands at 6.35 crore (63.5 million). Out of this total, approximately 4.35 crore (43.5 million) are men, while women account for 2 crores (20 million) of the workforce.

Within the workforce, a substantial number of individuals, around 6.08 crore (60.8 million), are engaged in various occupations. Notably, the agriculture sector continues to play a significant role, employing 40.6% of the workforce. To better understand the employment trends in the agricultural industry, Figure 1.6 illustrates the declining trend of employed individuals over the age of 15 within this sector. The data presented in the figure is derived from the Labour Force Surveys conducted in different years, namely 2005-06, 2010, 2013, 2015-16, and 2016-17. This visual representation provides insights into the changing dynamics of employment in agriculture over time.

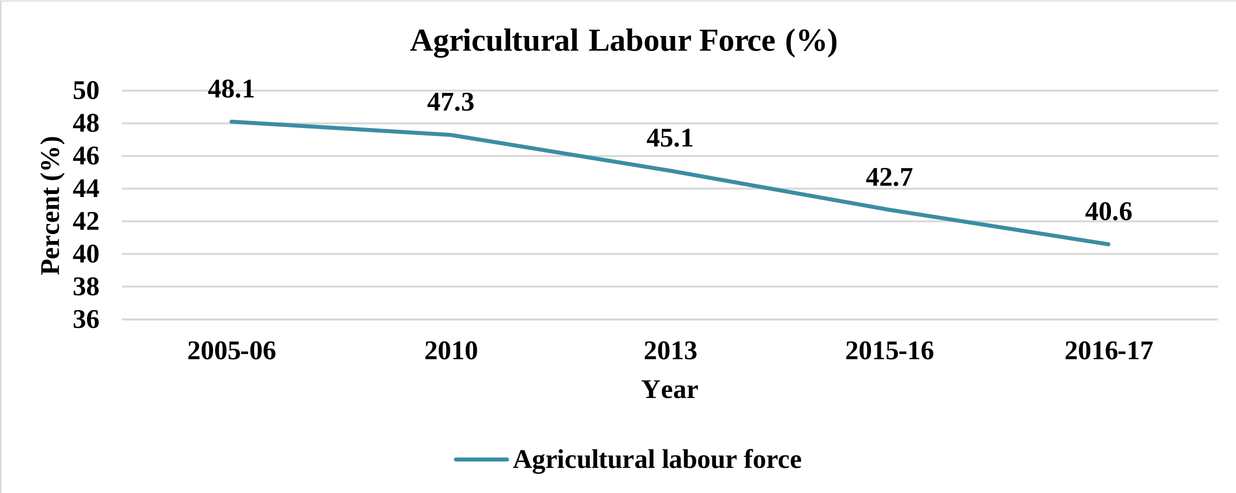


Figure 1.6: Trend of Agricultural Labour Force in Bangladesh

Source: BBS, 2021

1.2 Bangladesh's Current Maize Production Situation

A cereal crop of maize was introduced in Bangladesh to replace rice and wheat as a source of food for people as well as for livestock and poultry. In Bangladesh, maize yields have recently grown astronomically. In terms of yield, maize has surpassed both wheat (2.60 t/ha) and boro rice (3.90 t/ha) to claim the top spot among cereals (BBS, 2020). Early in the 1990s, maize cultivation began for commercial purposes; since then, it has flourished and grown to be a significant cash crop. The annual requirement for maize in Bangladesh presently exceeds two million tons, whereas the yearly production stands at approximately 4,700 thousand tons (BBS, 2021). Huge sums of money are spent on importing maize seeds and products in order to meet the demand. In Bangladesh, maize will increasingly be consumed as food for humans, animal feed, and poultry feed across all market sectors. Moreover, maize has a promising future in Bangladesh because the country's average annual weather has benefited maize cultivation. In Bangladesh, maize can grow well in every environment due to its extensive genetic diversity. In Bangladesh, it often grows year-round and exhibits potential productivity.

The acreage dedicated to maize cultivation has risen from 1,100,000 acres in 2018-19 to 1,186,000 acres in 2020-21. A noticeable upward trend is also observed in the yield rate, which increased from 3,245 kg/acre in 2018-19 to 3,471 kg/acre in 2020-21. The total maize production volume reached 4,116,000 metric tons in 2020-21 (Table 1.2 and 1.3).

Table 1.2: Production Area, Yield Rate and Maize Production from 2018-19 to 2020-21, Bangladesh

Crop	2018-19			2019-20			2020-21		
	Area '000' Acres	Per acre Yield (Kg)	Production '000' M. Tons	Area '000' Acres	Per acre Yield (Kg)	Production '000' M. Tons	Area '000' Acres	Per Acre Yield (Kg)	Production '000' M. Tons
Maize	1100	3245	3569	1168	3438	4016	1186	3471	4116

Source: BBS, 2021

Table 1.3: Indicators for Maize Cultivation Area and Production (Base Year: 1984-85 = 100), Bangladesh

Crop	Area (Acres)					Production (M. Tons)				
	2016- 17	2017- 18	2018- 19	2019- 20	2020- 21	2016- 17	2017- 18	2018- 19	2019- 20	2020-21
Maize	10332	10617	11806	12505	12720	92520	100554	109154	122792	125885

Source: BBS, 2021

The combined production area for Kharif and Rabi maize in the Munshiganj district during 2020-21 was 31,582.12 acres and 10,394 acres, respectively. In Bangladesh as a whole, the total production area for Kharif maize was 206,440.73 acres, and for Rabi maize, it was 979,210.77 acres during the same period. The overall production was 23219.15M. Ton for kharif maize and 1932.64M. Ton for rabi maize in Munshiganj district in the same year (Table 1.4 and 1.5). From 2018-19 to 2020-21, total production of kharif maize was increased from 30005M.Ton to 71260.88M. Ton as well as total production of rabi maize was also increased from 24869M. Ton to 28389.90M. Ton in Dhaka division (Table 1.4 and 1.5).

Table: 1.4: The Kharif Maize Production Area and Yield from 2018–19 to 2020–21

District/Division	2018-19		2019-20		2020-21	
	Area (acre)	Production (MT)	Area (acre)	Production (MT)	Area (acre)	Production (MT)
Dhaka Division	18257	30005	25770	55913	31582.12	71260.88
Munshiganj	5644	2274	9621	20748	10584	23219.15
Bangladesh	177008	449466	192426	487277	206440.73	552764.08

Source: BBS, 2021

Table: 1.5: The Rabi Maize Production Area and Yield from 2018–19 to 2020–21

District/Division	2018-19		2019-20		2020-21	
	Area (acre)	Production (MT)	Area (acre)	Production (MT)	Area (acre)	Production (MT)
Dhaka Division	10605	24869	10659	30465	10394	28389.90
Munshiganj	515	1343	721	1932	721.01	1932.64
Bangladesh	922876	3119855	973167.80	3528029.08	979210.77	3563674.38

Source: BBS, 2021

The combined cultivation area for Kharif maize and Rabi maize in Munshiganj district in 2020-21 amounted to 11,305.01 acres, with a total production of 25,121.79 metric tons (Table 1.6).

Table 1.6: Production Area and Maize Production (Rabi & Kharif) in Munshiganj District

District/Division	2018-19		2019-20		2020-21	
	Area (acre)	Production (MT)	Area (acre)	Production (MT)	Area (acre)	Production (MT)
Dhaka Division	11432	26711	11749	33201	16502	44431.9
Munshiganj	6159	3617	10342	22680	11305.01	25151.79
Bangladesh	1099884	3569321	1165594	4015306	1185651.50	4116438.46

Source: BBS, 2021

1.3 Nutritional and Therapeutic Benefits of Maize

Maize possesses considerable nutritional attributes, with 100 grams of mature maize seeds containing 9.42 grams of protein, 74.26 grams of carbohydrates, 0.64 grams of sugar, 7.3 grams of dietary fiber, and providing 365 kcal of energy (Wikifarmer, 2022). In addition to improving bone and kidney health, maize lowers stomach acidity, controls heart rate, and avoids constipation. Additionally, it aids in reducing LDL cholesterol, offering protection against cardiac diseases, diabetes, and hypertension. Consequently, maize offers a multitude of health advantages, contributing to addressing malnutrition within the population of the country.

1.4 Uses of Maize

i. Human Food:

Maize, a significant source of starch, is widely utilized in various forms. Maize flour plays a vital role in both domestic cooking and the manufacturing of processed food items. Additionally, it serves as a primary source for producing corn oil, corn flakes, and popcorn, enhancing flavor and providing versatility in culinary applications.

ii. Animal feed:

It's commonly acknowledged that maize reigns supreme among feed ingredients. It is a major energy supplement that can make up to 30% of an animal's diet in protein, 60% in energy, and 90% in starch (Dado, 1999). The utilization of maize in livestock feeding takes various forms. As a cereal crop, dried out seeds are utilized immediately for livestock nutrition. Through this procedure, the plant's leftover components, referred to as maize stover, can be used again as a soil supplement, or livestock feed.

iii. Industrial products:

Maize serves a diverse range of industrial purposes. One notable application is the production of industrial alcohol. Additionally, maize stalks find utility in the manufacturing of rayon, plastic, paper, and wallboards, showcasing the versatility of this crop in various industries.

1.5 Global Maize Production

The major portion of the worldwide maize cultivation area is situated in the Americas and Asia, each accounting for over a third, while Africa constitutes a fifth, and Europe contributes a tenth (Figure 1.7).

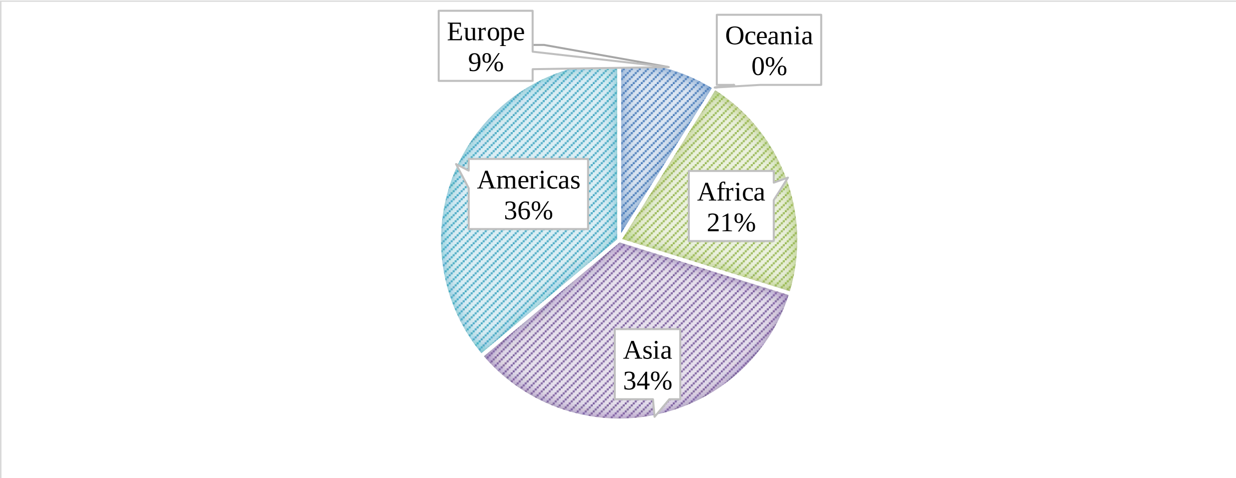


Figure 1.7: Area Share of Maize Production in Different Regions of the World

Source: FAO, 2021

Maize exhibits significant variations in yield across different regions. Approximately half of the world's maize production is contributed by the Americas (TE2019), with Asia following closely at one-third (32%). The remaining production is primarily shared by Europe (11%) and Africa (7.4%-Figure 1.8).

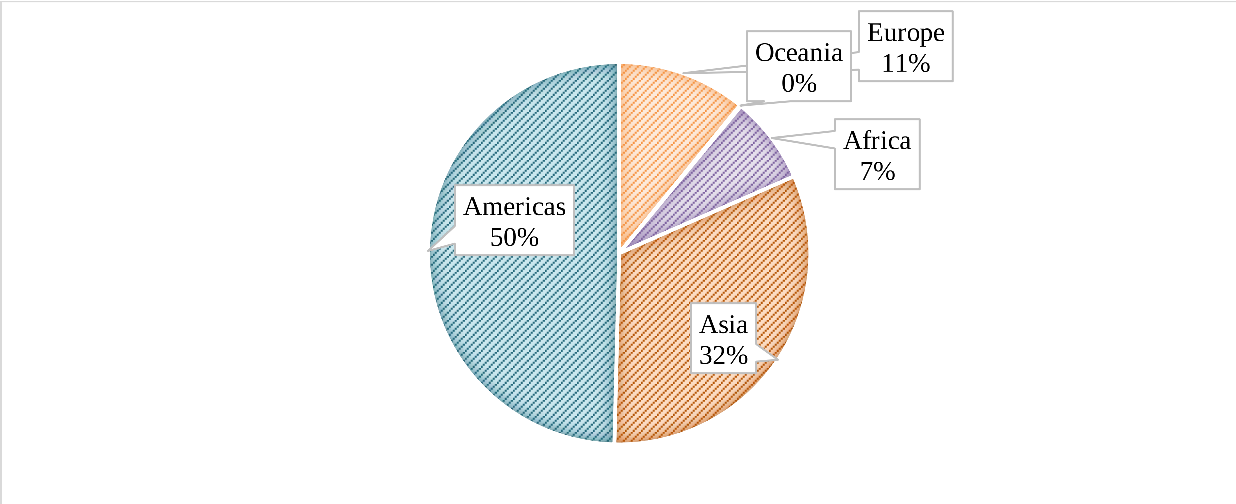


Figure 1.8: Production Share of Maize Production in Different Region of the World

Source: FAO, 2021

Maize is extensively traded on a global scale, with 15% of the world's maize production being exported, marking an increase from 11% a decade earlier (Awika, 2011). Real maize prices have witnessed a 31% increase over the past few decades, rising from US$127/ton in 1994 to US$167/ton in 2020 (see Figure 1.9). The peak annual maize prices during this period were recorded in 2012 at US$271/ton, following an earlier high in 2008 (US$217), which was linked to the global food crisis. The fluctuations in maize prices over the last decade closely align with the pattern observed for urea fertilizer (refer to Figure 1.9), although real urea prices have doubled over the last 25 years, escalating from US$116/ton in 1995 to US$241 in 2020. While the primary global staples experienced somewhat similar price trends during this period, maize maintained the lowest real prices. It is noteworthy that these price dynamics over the last 25 years diverge from the preceding half-century trend of declining real prices for maize (and wheat) from 1950 to 2001 (Wright, 2011).

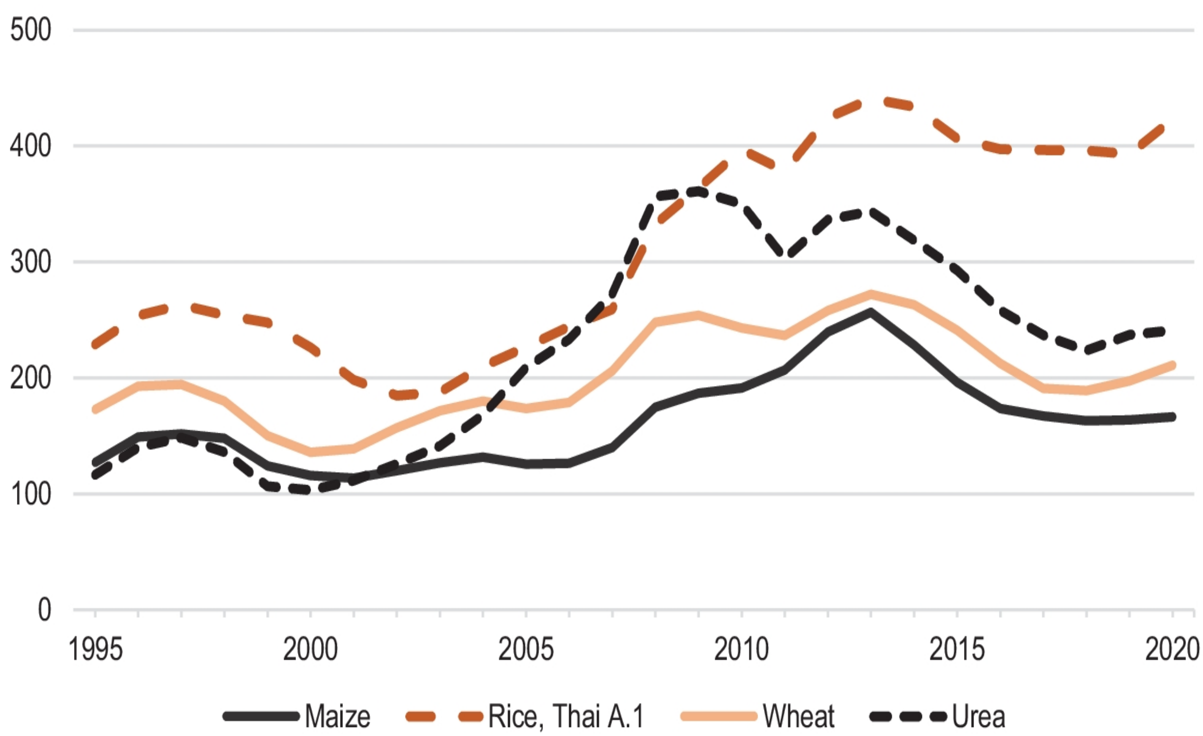


Figure 1.9: Cereal and Urea Prices (Real US$/ton, 1995-2020), Global

Source: World Bank, 2021

1.6 Justification of the Study

To assess whether maize farmers were optimizing their production capabilities and, if not, to identify strategies for enhancing their productivity. The purpose of this research is to aid in the discovery of tactics that would encourage improvements in maize productivity and overall production. The researcher, maize growers, government policy makers, utterly the development of policy recommendations to address the limits will all greatly benefit from this work. Finding areas of inefficiency in maize production enables growers to make the most of the limited resources available in the area by making optimal use of their inputs. To get the most output, farmers must utilize resources wisely. In other words, if maize farmers can boost output while using the same input levels and manage resources effectively at the farm level, this would have a significant impact on holistic national progress.

The findings of this research will also assist lawmakers in developing interventions that are specifically targeted to the needs and limitations of maize producers. Also, it was shown that maize productivity in farmer fields frequently falls short of what is attainable with better management. Gaining a comprehensive understanding will enable us to identify enhancements in maize farmer fields and assess the degree to which higher expenses might be warranted in order to boost yields or lower yield damage.

Several researches work (Karim et al., 2010; Khandoker et al., 2018; Rahman et al., 2016; Uddin et al., 2010) have indicated that maize farming is a lucrative venture. Nevertheless, to my knowledge, there is a gap in studies focusing on the productivity and technical efficiency of maize-producing farmers specifically in the Munshiganj district. Hence, this current study aims to explore the technical efficiency and productivity of maize-producing farmers in the Munshiganj district, Bangladesh.

By taking these things into account, the research will be beneficial for appropriate planning and policy making, as well as for the efficient operation and management of farms on a personal level, for planners and farm owners alike. The study may aid in the knowledge of the extension personnel regarding various problems associated with maize production, enabling them to counsel farmers on how to address those problems.

1.7 Objectives of the Study

1.7.1 Overall Objective:

Measuring the productivity and technical efficiency of maize production was the study's main goal. However, there are some specific objectives which the study considered to address the broad objective.

1.7.2 Specific Objectives:

The subsequent specific goals were devised to provide clear guidance for the study:

1. To identify the socio-economic profile of maize farmers;
2. To measure the productivity of maize production;
3. To estimate the technical efficiency of maize production;
4. To identify the problems facing by maize farmers and suggest policy options to solve these problems.

1.8 Organization of the Study

This thesis is composed of eleven chapters arranged in the following order. Chapter 1 introduces the study, while Chapter 2 offers a review of the literature. The methodology of the relevant study is outlined in Chapter 3, followed by a concise description of the study area in Chapter 4. The socio-demographic profile of maize farmers is discussed in Chapter 5, and Chapter 6 delves into the productivity and technical efficiency of maize farmers. Constraints to maize cultivation are detailed in Chapter 7. Ultimately, Chapter 8 provides a summary, conclusion, and recommendations for enhancing maize productivity in Bangladesh.

1.9 Concluding Remark

Bangladesh's economy is primarily being grown by agriculture. The most significant contributor to agriculture, total GDP, and hence indirectly to the expansion and growth of the entire economy is the sector of crops. However, following rice and wheat, maize stands as the third cereal crop raised by farmers in Bangladesh. It is usually believed that farmers produce maize crops inefficiently. Hence, the current investigation aims to assess the productivity and technical efficiency of farmers engaged in maize cultivation. Consequently, the findings of this study can offer valuable insights to relevant authorities, contributing to the enhancement of maize production and potentially reducing the reliance on rice as the primary staple in the Bangladeshi diet. The subsequent Chapter 2 will delve into the literature review.

CHAPTER 2
REVIEW OF LITERATURE

Reviewing several related studies in relation to the current study is the primary goal of this chapter. The productivity and technical efficiency of maize farms in Bangladesh have received limited attention in previous studies. Moreover, some of these studies may not directly align with the current focus, yet their findings, analytical approaches, and recommendations significantly influence the subject at hand. The ensuing discussion entails an examination of recent research topics relevant to the present study.

Ali et al. (2009) conducted a study on the status and research needs of Maize-rice cropping systems in Bangladesh. The research revealed that crossbred maize, emerging as a valuable grain crop, was cultivated in extensive M-R cultivation method and demonstrated some of the greatest mean crop yields (5.7 tha-1) in Asia. The study anticipated a continuous growth rate of approximately 15% annually for the expansion of hybrid maize in the near future. The prevailing crop system is centered around maize-T. Aman rice, with ongoing diversification into various crops, like potato. Maize-rice cultivation methods in Bangladesh are on the rise, and the country boasts some of the highest maize yields in Asia, averaging around 5.7 tha-1.

Ameda et al. (2021) employed cross-sectional data gathered from 150 households through the multistage sampling technique to assess the present levels of technical efficiency among maize farmers in the Gurage zone of Meskanworeda. The study discovered that there is inefficiency in the system used to produce maize with an average technical efficiency of 49% for the combined sample. The results indicated a positive and statistically significant correlation between technical efficiency and factors such as seed usage and contact with extension agents, both at a significance level of less than 1%. Technical efficiency was significantly correlated, significant at 5%, with education and good soil. Technical efficiency was positively correlated and significant at 10% with respect to gender and family size. At the 1% level, the variance parameters gamma (γ) and sigma ($\delta 2$) are both significant, according to the outcomes of the stochastic frontier production function. The study suggested that enhancing technical efficiency in farm production among farmers could be achieved by optimizing the utilization of available resources.

Asante et al. (2019) investigated the productivity performance and influencing factors of maize farmers in three agroecological zones (Forest, Transition, and Guinea Savanna) in Ghana. The selection of 453 maize farmers was carried out using a multi-stage sampling technique. A meta-frontier model was used to assess average technical efficiencies and identify maize productivity gaps across diverse agroecological zones. The findings indicated that the production of maize is significantly influenced by factors such as land, labor, and fertilizer. Furthermore, farmers' managerial effectiveness was influenced by factors such as access to credit and participation in farmer-based organizations across various agroecological zones. The most important factor in the production of maize in the Guinea Savanna zone was seed, which was followed by labour and fertiliser, with corresponding elasticities of 0.42, 0.27, and 0.20. In the Transition zone, the variables with the highest degrees of influence were seed, labour, and fertilizer, with corresponding elasticities of 0.33, 0.26, and 0.25. Similar circumstances were observed in the Forest zone, where labour, fertiliser, and seed were the main factors influencing maize production.

Belete (2020) explored the technical efficiency of maize production among farmers and the factors contributing to its variation. The study used a simple random sampling technique to collect cross-sectional data from 234 farm households. Employing a one-step stochastic frontier model estimated through the maximum-likelihood method, the research evaluated farmers' technical efficiency and pinpointed factors influencing maize yield per hectare. The calculated technical efficiency for farmers engaged in maize production was 69.03%, indicating that 69.23% of maize-producing farmers operate within a technical efficiency score range of (0.5–0.75) in both districts. The outcomes obtained through maximum-likelihood analysis indicated that the technical inefficiency of farmers was significantly influenced by variables such as the gender and age of the household head, farm earnings, credit availability, size of the working labor, land ownership, availability of developed seed, and the livestock quantity.

Bekele et al. (2009) carried out research on how farm size influences the efficiency of wheat production in the Moretna-Jirru district in central Ethiopia. A total of 198 farmers were chosen at random, of which 95 households were categorized as belonging to a large farm size (group) and the remaining 103 as belonging to a small farm size (group). Six input categories and eight inefficiency effects were used in a two-stage sampling technique to analyze the production function and explain differences in efficiency amongst farm households. Large farmers are technically more efficient than small farmers, according to the findings of the stochastic frontier production function derived in this study. With a mean technical efficiency estimated to be 0.84, the technical efficiencies of large farms range from 0.70 to 0.97. Technical efficiencies for small farms range from 0.63 to 0.94, with 0.76 found to be the mean value. The findings showed that there is a statistically significant difference between the mean technical efficiency of the large farm group and that of the small farm group. Technical efficiency differences were primarily caused by large farms allocating more land to newly released wheat varieties and by large farms using more traction and fertilizer per hectare than small farms.

Bempomaa and Acuah (2014) utilized a single-stage modeling stochastic frontier approach to assess maize farmers' effectiveness in the Ejura-Sekyedumase District of Ghana. Their findings revealed that land, labor, and fertilizer positively influenced output, while agrochemicals and seeds had negative impacts. On average, farmers exhibited 67 % technical efficiency, signifying that 33% of maize output potential remained unrealized. The return to scale, indicating farmers' productivity, was determined to be 1.22.

Bhatt and Bhat (2014) examined the technical efficiency and the correlation between farm size and productivity efficiency. They utilized field survey data from 461 farmers in the Pulwama district of Jammu & Kashmir, India, to assess technical efficiency through Non-parametric Data Envelopment Analysis. The average technical efficiency was calculated to be 48%, indicating that the majority of farms were operating at low levels of technical efficiency. There was also substantial variance in technological efficiency across agricultural categories. The connection between farm size and productivity efficiency was demonstrated to be non-linear, initially decreasing and then rising with size. Larger farms exhibited higher net farm income per acre and demonstrated greater technical efficiency when compared to other smaller farm size groups. Using the Two-limit Tobit Regression Model, the study further characterised the institutional, socioeconomic, and farm determinants of technical efficiency. The findings showed that the main factors influencing the differences in technical efficiency between farm sizes are Job, Farm Knowledge, Family Size, Farming dimension, Associations, and Seed kind.

Fatima et al. (2015) studied on the effect of farm size on the productivity and technical efficiency of Pakistan's three main food crops, including maize, wheat, and rice, from 1948 to 2011. It employs the Data Envelopment Analysis (DEA) method. According to the study's findings, the production of wheat was 88% inefficient. The maize crop efficiency result showed a 9% overutilization of farm size. For frontiers with variable and constant returns to scale, the mean technical efficiency of the rice crop is 0.91 and 0.62, respectively. The findings showed that adopting contemporary farming techniques is now more important than expanding the area planted to food crops. Farmers must also adopt new agricultural technologies and develop new markets.

Ferdausi et al. (2014) undertook a research project to assess the profitability and resource utilization efficiency across various farm size categories in maize production. The study randomly selected 65 farmers from five villages in the Bogra district, consisting of 30 small farmers, 30 medium-sized farmers, and 5 large farmers. The average cost of maize production per hectare for all farmers was Tk 46,278. Specifically, small, medium, and large farmers incurred Tk 41,263, Tk 53,554, and Tk 48,715, respectively. Gross margins from maize output were estimated at Tk 67,592, Tk 64,694, and Tk 74,089 for small, medium, and large farmers, respectively. Net returns per hectare for these farm size groups were Tk 57,823, Tk 53,895, and Tk 64,138, respectively. Small farmers achieved the highest Benefit-Cost Ratio (BCR) at 2.40, followed by medium-sized farmers at 2.01, and large farmers at 2.32. However, efficiency analyses revealed that most farmers utilized their inputs inefficiently.

Guha et al. (2020) investigated farm-level cost inefficiency in maize farming and its causes in a variety of Sikkim agroclimatic zones in their 2020 study. They used a multistage sampling technique to gather primary data from 200 farm households. Data envelopment analysis and stochastic frontier analysis were both used in the study to quantify inefficiency in various agroclimatic zones. The study estimated the stochastic frontier cost function and looked at the impact of outside factors on farm-level cost inefficiency using the Cobb-Douglas cost function for maize output. The findings of this study indicated that, on average, farmers experienced costs ranging from 8% to 72% above the minimum cost set by the best practice frontier. Moreover, cost inefficiency was more pronounced among farmers in the temperate agro-climatic region. Farmland's isolation from input markets seemed to be a direct cause of this increased inefficiency.

The outcomes showed that cultivating rented plots and gaining more years of farming experience reduced cost inefficiencies.

Hasan (2014) conducted research on the limitations and economic effectiveness of maize production in Bangladesh's northern region. The study's objective was to compare maize production to Boro rice production in terms of costs, returns, and economic efficiency. 100 farmers were chosen at random, and all of them utilised hybrid seeds to grow maize, with an average output of 6.27 tonnes per hectare, greater in Dinajpur (6.35 tonnes per hectare) than in Panchagarh district (6.18 tonnes per hectare). Between 1987–1988 to 2005–2006, there has been a comparatively high growth rate in the area, production, and yield of maize due to the introduction of composite and hybrid varieties during this time.

John et al. (2013) assessed the technical efficiency and factors influencing of maize farmers in the Eastern Region of Ghana. A multi-stage random sampling technique was employed to select 226 maize farmers for the research, representing the four primary geographic zones in the region. The study's findings showed that the elasticities of mean output for agrochemicals, hired labor, and other inputs were positive while they were negative for seed, fertilizer, and family labor. On average, the maize farms showed diminishing returns to scale, according to the computed return to scale. Technical efficiency was influenced by the combined effect of operational and farm-specific factors, however some of the individual effects were not statistically significant. Considering the existing technology and input levels, the farmers' mean technical efficiency was calculated at 51%. This implies that there is a potential for short-term enhancement in maize production within the region by improving farmers' technical efficiency by 49%, incorporating the best practices observed in top-performing maize farmers. According to the findings of the resource use efficiency study, maize farmers in the area overused family labor, family seed, and fertilizer while underutilizing hired labor and agrochemicals.

Karim et al. (2010) evaluated the economics of producing hybrid maize in a few chosen Bangladeshi regions. The study randomly selected 120 farmers from each of the four districts: Rangpur, Dinajpur, Bogra, and Kushtia. The research utilized the Cobb-Douglas production model and revealed that the mean seed rate per hectare amounted to 20.94 kg. Maize cultivation cost Tk.

4.12 per kilogram. The calculated profit for producing one kilogram of maize was Tk 7.80, with an average grain cost of Tk 7.60 per kilogram. The study determined that the mean gross margin was Tk. 28456.A benefit cost ratio of Tk. 1.89 was found. It stated that the farmer will receive Tk. 1.89 for every Taka invested. It was discovered that the coefficients of urea, borax, irrigation, human labour, and land preparation all had an important effect on the overall return.

Moniruzzaman et al. (2009) conducted the study on Agro-economic analysis of maize cultivation in Bangladesh. In order to determine the profitability of maize cultivation, Chuadanga, Dinajpur, Bogra, and Lalmonirhat—four major maize-growing regions—were visited. Sixty-one percent of the country's total maize areas were represented by the four districts that were chosen. Among 200 maize growers randomly selected, the mean production and costs were determined to be 8.00 Tk/ha and Tk 44197 per hectare. The calculated gross margin, net return, and benefit-cost ratios were 36578/ha, 25575 Tk/ha, and 1.58, respectively.The analysis revealed that maize cultivation is more profitable.

Musaba et al. (2014) investigated the technical efficiency of smallholder maize farmers in Zambia. A survey was conducted among 100 randomly selected smallholder maize farmers in the Masaiti district of Zambia, utilizing a structured questionnaire for data collection. The gathered information underwent analysis through descriptive statistics and the stochastic frontier production function method. The results from the computed stochastic frontier Cobb-Douglas production function highlighted fertilizer usage and the size of the maize land as the primary variables influencing maize productivity. Technical efficiency at the farm level varied from 52.2 to 93.2 percent, with a mean of 79.5 percent. According to their study, smallholder farmers in the study area might potentially boost their maize yield by 20.4% by using current technology effectively. According to the inefficiency model's findings, factors that significantly increase efficiency include farm size, membership and farmer age. Technical efficiency was negatively impacted by the types of seeds utilized, rotation techniques, and farmer education. He solely looked at smallholder maize producers' technical efficiency. For a better understanding, the profitability could also be evaluated and the same approach could be used to medium- to large-scale farmers.

Ndlovu et al. (2014) assessed the productivity and efficiency of maize production within the framework of conservation agriculture (CA). The study utilized a three-year (2008-2010) panel sample of smallholder farming households from 15 rural areas in Zimbabwe. Estimated maize production functions and derived technical change under CA and conventional farming using a fixed effects model. To compare the technical efficiency and productivity of CA and conventional farming, a joint stochastic production frontier was once more estimated. The efficiency analysis' findings revealed that farmers in CA produce 39% more than they do in traditional farming, despite the fact that both technologies' technical efficiency levels are basically equal. The results showed that CA methods significantly increased yield and significantly increased the amount of food produced.

Ngango et al. (2022) examined the relationship between farm size and technical efficiency for maize production in Rwanda. 351 household farmers were randomly chosen as part of this study's representative sample from among three districts in Rwanda's Eastern Province: Bugesera, Kirehe, and Nyagatare. Multistage sampling was used to take this sample. Using a stochastic frontier method with zero inefficiency to estimate both efficiency and inefficiency in the sample under study. The mean technical efficiency for maize farms in the entire sample was 0.64, suggesting that enhancing maize output by approximately 36% is possible without augmenting the ratio of utilized farm inputs. The research results revealed a favorable correlation between farm size and technical efficiencies in Rwanda's maize cultivation.

Rahman et al. (2013) assessed the Technical Efficiency of Maize Cultivation in a specific region of Bangladesh, focusing on the Natore district. For data collection, a total of 60 maize farmers from three villages were randomly selected, with 20 farmers chosen from each village. The productivity and resource use efficiency of maize production were examined using the Cobb-Douglas stochastic frontier production function. According to the study, producing maize was profitable since the BCR (benefit cost ratio) and net return were, respectively, 1.54 and Tk. 28340. The technological efficiency of maize farmers was remarkably high (96.90%), indicating their superior productivity in growing the crop. This meant that the cost of production could only be raised by a mean of 3% per farm.

Rahman et al. (2014) examined the economic viability and efficiency of expanding maize cultivation using survey data from 300 farmers across three regions. Maize, in comparison to rice and wheat, exhibited the highest yield at 7.98 t/ha and the greatest return, with a benefit-cost ratio (BCR) of 1.63. Although a significant 15% [(100-87)/87%] cost reduction is still feasible while maintaining present output levels by eliminating technical and allocative inefficiency, maize production is also predicted to be economically efficient at a high 87%.

Roy et al. (2017) examined the increasing trend of maize cultivation in the Rangpur district of Bangladesh, focusing on evidence from Gangachara Upazila.The goal of the study was to determine why maize farming is becoming more and more common in Rangpur District's Gangachara upazila (Sub-district). Data were gathered from 110 farmers who have been actively engaged in maize production for at least ten years using a three-stage cluster sampling procedure. Both the Potato-Maize-Aman and Maize-Aus6-Aman crop patterns were identified, although the Potato-Maize-Aman crop was more widely grown. The B-C ratios for the cultivation of maize, boro rice, and tobacco were 1.40, 0.68, and 0.75 respectively. If maize costs Tk. 1 to produce, it will bring in Tk. 1.40 from the market, generating a Tk. 0.40 return on an initial investment of Tk. 1.

Sampa, A. Y. (2018) conducted an analysis of the technical efficiency and profitability of maize production in six villages located in the Manikganj and Rajshahi districts. Primary data was gathered from 131 farmers using random sampling. The study's key findings indicated that maize production is a lucrative venture, with a total cost of production amounting to Tk. 107012.19 per hectare. The gross returns and gross margin per hectare were Tk. 151323.72 and Tk. 69003.91, respectively, while the net returns amounted to Tk. 44311.53 per hectare. The maize yield per hectare was observed to be 8563.421 kg, and the Benefit-Cost Ratio (BCR) was calculated at 1.41. To assess the technical efficiency of maize farmers, the Cobb-Douglas stochastic frontier production function was employed. The parameter coefficients, such as those for cost of land preparation, seed as well as irrigation, exhibited positive values, with seed and irrigation being highly significant and land preparation cost significant at the 5 percent level. The experience, services for extension, and the number of acres owned all had a negative value in the technical inefficiency effect model, demonstrating their contribution to lowering technical inefficiency among maize farmers. The variance in the stochastic frontier model was found to be correlated with a parameter γ of 0.9531, implying a significant contribution of inefficiency effects to the level and variability of output produced by maize farms.

Seyoum et al. (1998) estimated the technical efficiency of two groups of maize producers in eastern Ethiopia—one consisting of farmers engaged in the Sasakawa-Global 2000 initiative and the other composed of farmers not participating in this project. In this research, stochastic frontier production functions were utilized, and it was assumed that the technical inefficiency impacts depended on the farmers' ages, levels of education, and the amount of time extension advisors spent aiding them in their agricultural production operations. The SO 2000 project's expected technical efficiencies for the farmers range from 0.748 to 0.990, with the mean predicted to be 0.937. The technical efficiencies for the farmers outside of the project ranged from 0.557 to 0.965, with a mean assessed to be 0.794. The findings showed that, in relation to their particular technologies, farmers inside the SG 2000 project were more technically efficient than farmers outside the initiative. Farmers participating in the SG 2000 project exhibited a significantly higher average frontier output of maize compared to those not involved in the initiative.

Sheng et al. (2019) investigated the correlation between farm size and productivity, along with its underlying factors, for maize producers in Northern China since 2003. They employed a farm fixed-effect model with an instrumental variable. Analyzing farm-level panel data spanning from 2003 to 2013, the study revealed a mild U-shaped relationship between maize yield and cropping area, deviating from the apparent inverse U-shaped curve. The findings indicated that a reverse association between farm size and productivity prevails, especially among smaller farms. Additional investigations suggested that the choice of input by farmers, whether it be labor or capital, played a role in mitigating the non-linear relationship between farm size and productivity. The use of capital was more likely to influence the farm size–productivity dynamic on a larger scale. These results suggested that providing subsidies for farmers to lease land without concurrently improving their equipment could lead to a misallocation of resources, favoring larger farms employing less-efficient labor-intensive technologies.

Uddin et al. (2017) employed a stochastic frontier approach to assess the efficiency of maize production in Bangladesh. Primary data was gathered from 120 maize farmers in the Thakurgaon district, known for its high maize cultivation density. The Translog Stochastic Frontier production function was utilized to measure the technical efficiency of maize harvesting during the Rabi and Kharif seasons. The study revealed that maize production in Thakurgaon was not technically efficient. However, with existing technology, productivity could potentially increase by 12.5% and 8% during the Rabi and Kharif seasons, respectively. The mean technical efficiency for the Rabi season was determined to be 87.5%, while for Kharif season maize, it was 92%. Fertilizer and irrigation positively influenced the Rabi season, whereas farm size had a negative impact. Once more, the production of maize during the Kharif season is positively impacted by farm size and negatively impacted by irrigation.

Wongnaa (2016) investigated the economic efficiency and productivity of maize farmers to explore the factors contributing to the low productivity of maize in Ghana. This study collected cross-sectional data using a multi-stage sampling technique via 576 maize farmers in eight districts spread across four agroecological zones in Ghana. A stochastic frontier production function and a multinomial logit model were used to analysis the data along with derive the findings. Higher levels of education, availability of credit, training, connections with extension agents, affiliation to a group, and a ready market were all found to be associated with a greater uptake of modern technology that boosts maize productivity. Maize output showed a positive correlation with inputs such as fertilizer, insecticides, manure, herbicide, seed, and land. Technical efficiency scores for maize producers in the northern savannah, transitional, forest, and coastal savannah zones were determined as 61.2 percent, 70.2 percent, 49.9 percent, and 66 percent, respectively. The most cost-effective region for maize cultivation was found to be the transitional belt in Ghana. Overall mean scale efficiencies for maize farmers in the northern savannah, transitional, forest, and coastal savannah zones were 85.7 percent, 90.9 percent, 88.6 percent, and 85.5 percent, respectively.

Specific Research Gap

In light of the increasing land scarcity due to population growth, there is a notable academic and policy interest in evaluating the role of productivity and technical efficiency in agricultural crop production. It is crucial to understand whether maize producers exhibit uniform or varying levels of technical efficiency in maize production. While several studies (Hasan, 2014; Rahman et al., 2014) have explored the impact of maize production in different contexts, to the best of my knowledge, no studies have specifically examined the productivity and technical efficiency of maize-producing farmers in the Munshiganj district. Given that the productivity and technical efficiency of farm production are significantly influenced by various managerial and resource constraints, it is imperative to identify disparities in the productivity and technical efficiency of maize production. Consequently, this study aims to investigate the technical efficiency and productivity of maize-producing farmers in the Munshiganj district in Bangladesh. The findings from this study can offer valuable insights to policymakers, aiding in a better understanding of the current agricultural landscape and facilitating effective policy interventions to enhance efficient maize production and overall agricultural development.

CHAPTER 3
METHODOLOGY

3.1 Introduction

The research methodology acts as a framework that describes the steps a researcher will take to carry out their study and offers a methodical and rational way to approach the issue at hand. It generates results that are supported by science and ensures the validity of the research. A strong research methodology delivers researchers with a clear road map for their investigation. cautiously selecting methods that complement the aim of the study is crucial for researchers when creating procedures and methods for conducting research. In order to answer the research questions, the current section seeks to clarify the subject location, design of the study, and the gathering and analyzing of data procedure. The aim of the study determines which approach to gathering data is best; in this case, primary data are used, and the farm survey approach is employed. The survey approach is preferred due to its benefits; however, it is constrained by the recollection of the respondents. Survey schedules were carefully designed to guarantee thorough examination of all necessary opinions through in-depth questioning in order to tackle this limitation.

3.2 Sampling Frame

Regarding the study's goals, the farm management research requires some fundamental data. The areas where maize growing was intensive were specifically chosen for the sampling frame for the current investigation. Two upazilas in the Munshiganj district, Sirajdikhan and Sreenagar, were the focus of the study due to their elevated levels of maize growing crops. The following criteria were used for choosing these study areas:

1. The study areas have a substantial population of maize growers, and maize production thrives, with farmers dedicating a significant portion of their land to maize production.
2. These villages shared common attributes such as topography, soil composition, and climatic conditions conducive to maize cultivation.
3. These villages benefit from convenient accessibility and well-established communication facilities.

4. The researcher was acquainted with the local language and the socio-economic traits of farmers in the chosen villages. Anticipated high cooperation from respondents suggested a likelihood of obtaining a reasonably accurate dataset.
5. The purpose was to carry out a socioeconomic investigation in these specified study areas

3.2.1 Sample Size

Both a low sampling error as well as a low standard error are necessary for an excellent survey sample. If someone has unlimited resources, they can get this. However, tradeoffs must be made in the sample size selection process due to limitations including money, time, and data management. As sample size increases, so do reliability, inaccuracy, alongside the level of confidence that the results accurately reflect the features of the general population as a whole. However, when time and money constraints become unavoidable, the researcher has to choose a decision between the best and acceptable degrees of accuracy, dependability, and assurance. It is generally accepted that a sample size of at least 60 is necessary to generate a sufficient degree of assurance for making choices in a population that is larger. (Daplyn and Poate, 1993). Samples were chosen from pre-designated areas and included 80 farmers who produced maize, 40 of whom were from Sirajdikhan Upazila and 40 from Sreenagar Upazila.

3.2.2 Sample Selection Procedure

The researcher wants to prevent bias in the sample selection process in order to attain precision within the estimations, which is to have a small standard error. To minimize bias in sample selection, employing a straightforward random sampling method is the most effective approach. This method ensures that every element within the overall population has an equal probability of being selected (Scheaffer, 1979). To improve the accuracy of the sampling process, one can either expand the sample size or apply different limitations and adjustments to the basic random sampling method. Deliberate random sampling was employed in this research in order to reduce time and expense while achieving the key goals.

To choose the sample, a multistage purposive approach was applied. To illustrate, during the initial phase two Upazila namely Sirajdikhan and Sreenagar Upazila have been selected purposively considering the convenience of data collection of the researcher. In the second step, researcher selected two Union from Sirajdikhan Upazila namely Ichhapur Union and Kola Union and two Union from Sreenagar Upazila namely Birtara Union and Tantar Union as the concentration of farmers growing maize in the research regions.

Table: 3.1 Sampling Distribution

Crop	District	Upazila	Union	Village	Sample size
Maize	Munshiganj	Sirajdikhan	Ichhapur	Kusumpur	20
			Kola	Jibsara	20
		Sreenagar	Birtara	Majidpur	20
			Tantar	Singpara	20
Total					80

Source: Field Survey, 2022

In the third step, researcher herself communicated with Upazila Krishi Officer and Block Supervisor with a view to selecting maize concentrated villages. Thereafter, four villages namely Kusumpur (Ichhapur Union), Jibsara (Kola Union), Majidpur (Birtata Union), Singpara (Tantar Union) were selected purposely in order to collect data. Finally, twenty (20) sample from each village has been selected using random sampling.

3.3 Data Collection Procedure

Primary data was obtained by means of surveys that were administered to maize producers within specific regions. The information gathered from the fieldwork included prices, labour and input usage, prices, and natural and socioeconomic constraints related to maize production practices. The methodology included interviews with knowledgeable maize producers, a field survey, and a detailed review of earlier research. In order to assess the current management strategies and input usage of maize producers during this phase, researchers also participated in direct observation.

3.3.1 Design of Questionnaire

A survey tool, such as a questionnaire, proves to be a valuable evaluation tool, allowing for the inclusion of multifaceted questions to gather data. However, a questionnaire lacking a certain objective is likely to overlook important issues, leading to the unnecessary expenditure of time for both enumerators and respondents as they engage in answering questions that lack relevance. To the best of our ability, all of these issues were taken into consideration when creating the survey questionnaire. Since creating the survey schedule is crucial to the success of the survey, a sample schedule was prepared for pre-testing in order to assess the questions' applicability and the farmers' level of response. The questionnaire was given to my supervisor once any necessary corrections, modifications, and adjustments had been made. The questionnaire was eventually completed and approved. Following the completion of the questionnaire, a personal, in-person interview was carried out.

In this research, the questionnaires were crafted with the following sections-

i. Broad information about the farmers taking part;
ii. Household structure of the selected farmers;
iii. Employment and educational background of the surveyed farmers;
iv. Yearly income from main and subsidiaries occupation;
v. Information about farm size;
vi. Production cost of maize including human labour use, machinery inputs and material inputs;
vii. Quantity of maize yield and the selling price of the produced output;
viii. Farmer's age and duration of experience in agriculture;
ix. Training and loan facility for maize production;
x. Maize farming experience and access to extension service;
xi. Challenges encountered by farmers in maize production.

Although the questions on the questionnaires were written in English, the respondents were asked the questions in their native tongues.

3.3.2 Data Collection Techniques

Field surveys were used to get primary data, while publications (such as BBS, DAE and BER) and statistics bulletins were used to gather secondary data. Farmers didn't keep records of their farming operations, so data was acquired using a range of methods that depend on remembering for basic information such as labour costs, compensation, and input expenses.

3.3.2.1 Primary Data Collection

Since farming is a seasonal industry, a comprehensive farm operations survey should encompass the entire cropping year. In particular, the investigator has to determine the degree to which the data for a given year represents average or typical conditions for crop yields, yearly production, and pricing. Primary producers provided the initial data that was gathered. Farmers' fields were also visited in order to obtain comprehensive knowledge, observations, as well as perspectives of the study area.

3.3.2.2 Secondary Data Collection

A wide range of research sources, such as articles, thesis papers, and other statistical documents, were used to collect secondary data. The following documents served as the source of the research materials:

- The Agricultural Statistics Yearbook
- The Economic Reviews of Bangladesh
- Bangladesh Statistical Yearbook
- The articles, books, and publications, both national and international
- Sher-e-Bangla Agricultural University's master's thesis
- Using the Internet or websites

3.4 Period of Data Collection

As maize can be cultivated all year in Bangladesh, it can be inserted between the main farming seasons without having an adverse effect on the primary crops. Within 50 days of planting, it can be harvested as fodder; in 60–80 days, it can be collected as green cobs; and in 100–130 days, it can be harvested as grain. Maize can be planted in Bangladesh in the Rabi and Kharif I cropping seasons. Depending on the kind of land, the weather, and other factors, farmers normally plant maize in November and February or March. In the Rabi season, harvesting takes place five to six months later, and in the Kharif I season, it happens three to four months later. The researcher, with the help of an agricultural extension officer and a block supervisor, gathered the data for the present study from November to December 2022, during the Rabi season.

3.5 Processing, Editing and Tabulation of Data

To ensure consistency and accuracy, the gathered data were examined and verified. Editing and coding procedures were undertaken before inputting the data into the computer. To mitigate the risk of inaccuracies, a meticulous analysis and summarization of all the data were conducted. The data were usually presented in tabular format, given its widespread use, straightforward calculations, and ease of comprehension. Using the relevant tools STATA and Microsoft Excel, data analysis was completed.

3.6 Analytical Techniques

The study's goals were pursued through the analysis of the data. In the current investigation, several analytical techniques were used. The tabular technique was extensively employed for a significant portion of data examination. This approach is favored for it's innate capacity to offer a precise representation of the farm economy. To assess data and delineate the socioeconomic aspects of maize growers, as well as input utilization, expenditures, and maize production returns, relatively straightforward statistical methods like percentages and arithmetic mean were applied. According to the rules of production function theory, the degree of technical efficiency was determined in this work using a stochastic frontier production function of the Cobb-Douglas type.

3.6.1 Technical Efficiency Analysis

Technical efficiency represents just one facet of overall production efficiency. The ability to minimize waste by generating a consistent level of output with a specific quantity of inputs or by employing minimal input to achieve a particular output level is termed the technical efficiency component. Debreu (1951) and Farrel (1957) were the initial researchers to introduce an evaluation of technical efficiency to a broader audience. According to Farrel (1957), a technical efficiency measurement can be achieved by counting the number of inputs and outputs without taking their pricing into account. Achieving technical efficiency is essential for achieving economic efficiency, given that technical efficiency is a constituent of overall economic effectiveness.

3.6.1.1 The Stochastic Frontier Model

The stochastic frontier model stands out as the most renowned and robust technique, both theoretically and empirically, for assessing efficiency. In that it adds a symmetric error term to the model in addition to the one-sided error component, it represents an enhancement compared to the conventional average production function and various deterministic frontiers. As a result, the frontier is free to fluctuate among farms and reflects the effects of measurement inaccuracies, additional statistical noise, and unanticipated factors that are outside the firm's authority. A single component illustrates the effects of inefficiency with respect to the stochastic frontier. The "composite error" model, first proposed by Aigner, Lovell, and Schmidt (1977), is another name for the stochastic frontier model. Later, Jondrowet al. (1982) expanded and developed it. The concept of a determined frontier applicable to all farms overlooks the genuine possibility that a farm's performance may be impacted by factors within its control as well as those entirely beyond its control (such as machinery issues, adverse weather conditions, input supply disruptions, etc.). On the other hand, stochastic frontiers consider all variables during model estimation, thereby distinguishing between firm-specific efficiency and random error effects. Consequently, both efficiency measurements and calculated parameters remain unbiased.

3.6.1.2 Specification of the Stochastic Frontier Function

To determine the degree of technical efficiency, we have defined the Cobb-Douglas Stochastic Frontier Production Function specification. The following is the stochastic frontier's functional form:

$$Y = \beta_0 X_1 \beta_1 X_2 \beta_2 \ldots\ldots\ldots X_7 \beta_7 e^{V_i - U_i} \qquad (3.1)$$

The function above is expressed in a double-logarithmic linearized form:

$$\ln Y = \ln \beta_0 + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + \beta_4 \ln X_4 + \beta_5 \ln X_5 + \beta_6 \ln X_6 + \beta_7 \ln X_7 + V_i - U_i \qquad (3.2)$$

Where,

Y = Revenue (Tk/ha)

X_1= Seed cost (Tk/ha)

X_2= Family labor cost (Tk/ha)

X_3= Hired labor cost (Tk/ha)

X_4= Machinery used cost (Tk/ha)

X_5 = Chemical fertilizer cost (Tk/ha)

X_6 = Irrigation cost (Tk/ha)

X_7= Insecticide cost (Tk/ha)

The formulation of the effects of technical inefficiency in the stochastic production frontier equation is specified by

$$U_i = \delta_0 + \delta_1 Z_1 + \delta_2 Z_2 + \delta_3 Z_3 + \delta_4 Z_4 + \delta_5 Z_5 + \delta_6 Z_6 + \delta_7 Z_7 + \delta_8 Z_8 + W_i \qquad (3.3)$$

Where,

$Z_1 \ldots\ldots Z_7$ are independent variables.

The expression can be formulated as:

$$\begin{aligned} U_i = {} & \delta_0 + \delta_1 \text{Age} + \delta_2 \text{Education} + \delta_3 \text{Family size} + \delta_4 \text{Farm size} + \delta_5 \text{Training} \\ & + \delta_6 \text{ Extension service} + \delta_7 \text{Livestock} + \delta_8 \text{Membership} + W_i \qquad (3.4) \end{aligned}$$

Table 3.2 Definitions of Different Variables

Variable	Definitions	Expected Sign with Productivity
Seed cost (Tk/ha)	The cost of using seed during maize production per hectare.	Positive (+)
Family labor cost (Tk/ha)	The cost of involving family labor during maize production. It is calculated on hours work basis and child is consider on 1.5= 1 adult	Positive (+)/Negative(-)
Hired labor cost (Tk/ha)	The expenses associated with involving hired labor during maize production. Actual market price is considered.	Positive (+)/Negative(-)
Machinery used cost (Tk/ha)	The expenses associated with using machinery during maize production. Actual cost is considered.	Positive (+)
Chemical fertilizer cost (Tk/ha)	The expenses associated with using fertilizer during maize production. Actual cost is considered.	Positive (+)
Irrigation cost (Tk/ha)	The expenses associated with irrigation during maize production. Actual cost is considered.	Positive (+)
Insecticide cost (Tk/ha)	The expenses associated with using insecticide during maize production. Actual cost is considered.	Positive (+)
Age	The age of the respondent in completed year.	Positive (+)/Negative(-)
Education	The educational duration of the farmers.	Positive (+)/Negative(-)
Family size	The total count of family members residing within a single household.	Positive (+)/Negative(-)
Farm size	Total farm size in hectares.	Positive (+)/Negative(-)
Training	A binary variable that assumes a value of 1 when respondents have received agricultural training and 0 otherwise.	Positive (+)/Negative(-)
Extension service	Number of times respondents get extension service.	Positive (+)/Negative(-)
Livestock	A binary variable that assumes a value of 1 when respondents have livestock and 0 otherwise.	Positive (+)/Negative(-)
Membership	A binary variable that assumes a value of 1 when respondents have any societal membership and 0 otherwise.	Positive (+)/Negative(-)

3.7 Concluding Remark

A total of 80 (40 from Sirajdikhan Upazila and 40 from Sreenagar Upazila) maize farmers were selected as samples. through field survey and direct interview method Primary data has been collected from maize producers. The secondary data were gathered from diverse research documents, including thesis papers, articles, and other statistical papers. Raw data underwent editing, coding, and entry into a computer using Microsoft Excel. Descriptive analysis was conducted using STATA and presented in both tabular and graphical formats. To estimate the level of technical efficiency, the Cobb-Douglas Stochastic Frontier Production Function was employed. However, a brief overview of the descriptive features of the study area is provided in the following chapter.

CHAPTER 4
DESCRIPTION OF THE STUDY AREA

4.1 Introduction

Any study must have a thorough understanding of the physical characteristics of the research area because it provides a broad overview of the agricultural situation. The features of the research area have been succinctly summarized in this section. Understanding and interpreting the analysis's findings—which include information on potential development sites, agricultural practises, and the area's potential—requires acquaintance with the subject matter. The location, size, population, average monthly temperature, rainfall, agriculture, vocations, cropping trends, interaction, as well as infrastructure of the research area are all covered in detail in this chapter. Furthermore, any crop's development depends critically on an understanding of the geography and climate of the studied areas.

4.2 Location

The district of Munshiganj is located in the centre of Bangladesh. It belongs to the Division of Dhaka. It can be found at 23° 27′ 36″ N and 90° 32′ 24″ E. The Munshiganj District is 954.96 sq km in size and is bordered to the north by the districts of Dhaka and Narayanganj, to the south by the districts of Madaripur and Shariatpur, to the east by the districts of Comilla and Chandpur, and to the west by the districts of Dhaka and Faridpur. The Padma, Meghna, Dhaleshwari, Ichamati, and Shitalakshya are the principal rivers in this area. The chosen sample of farmers resides in five villages: Birtara, Singpara, Mjidpur in the Sreenagar upazila, and Kola, Kusumpur in the Sirajdikhan area, respectively.

4.3 Climate, Temperature and Rainfall

The district has a tropical climate with yearly temperatures that are largely constant. The average minimum and maximum temperatures in the winter range from 12.1°C to 25.8°C. The average summertime high and low temperature ranges from 34.6°C to 25.6°C. November through the end of February is the dry winter season, and mid-March to mid-June is the summer season. Strong rains usually fall in July and August.The level of humidity is around 70 percent in January and around 84 percent in July. (**Source:** BBS, 2013)

4.4 Description of the Study Area

4.4.1 Sreenagar Upazila

The geographical expanse of Sreenagar Upazila spans 202.98 square kilometers, situated between 23°27' and 23°38' north latitudes and 90°10' and 90°22' east longitudes. Its borders converge with those of Sirajdikhan and Nawabganj (Dhaka) Upazilas to the north, while to the south, it shares boundaries with Lohajang and Shibchar Upazilas. In the eastern direction, Sreenagar Upazila is contiguous with Sirajdikhan along with Lohajang, and to the west, it is demarcated by Nawabganj and Doha Upazilas.

The total population of Sreenagar Upazila is 228,771, with 114,878 males and 113,893 females. The population density is 1,127 per sq. km. The overall literacy rate is 52.6%, with rates of 54.1% for males and 52.2% for females. In Sreenagar Upazila, the primary sources of income exhibit a diversified landscape, with agriculture constituting 36.12% of the total, followed by non-agricultural labor at 2.47%, industry at 1.99%, commerce at 23.60%, transport and communication at 2.97%, service at 12.83%, construction at 3.01%, and supplementary contributions from remittance at 6.96% as well as other miscellaneous sources accounting for 9.84%. Moreover, the distribution of land ownership further delineates the socioeconomic fabric, revealing that 42.25% are landowners while 57.75% are categorized as landless. The intricate pattern of agricultural land ownership unveils a dichotomy between urban and rural areas, with urban landowners constituting 24.25% and rural landowners representing 43.10% of the total landscape (**Source:** Banglapedia,2019)

Sreenagar Upazila's location is depicted on Map 4.1.

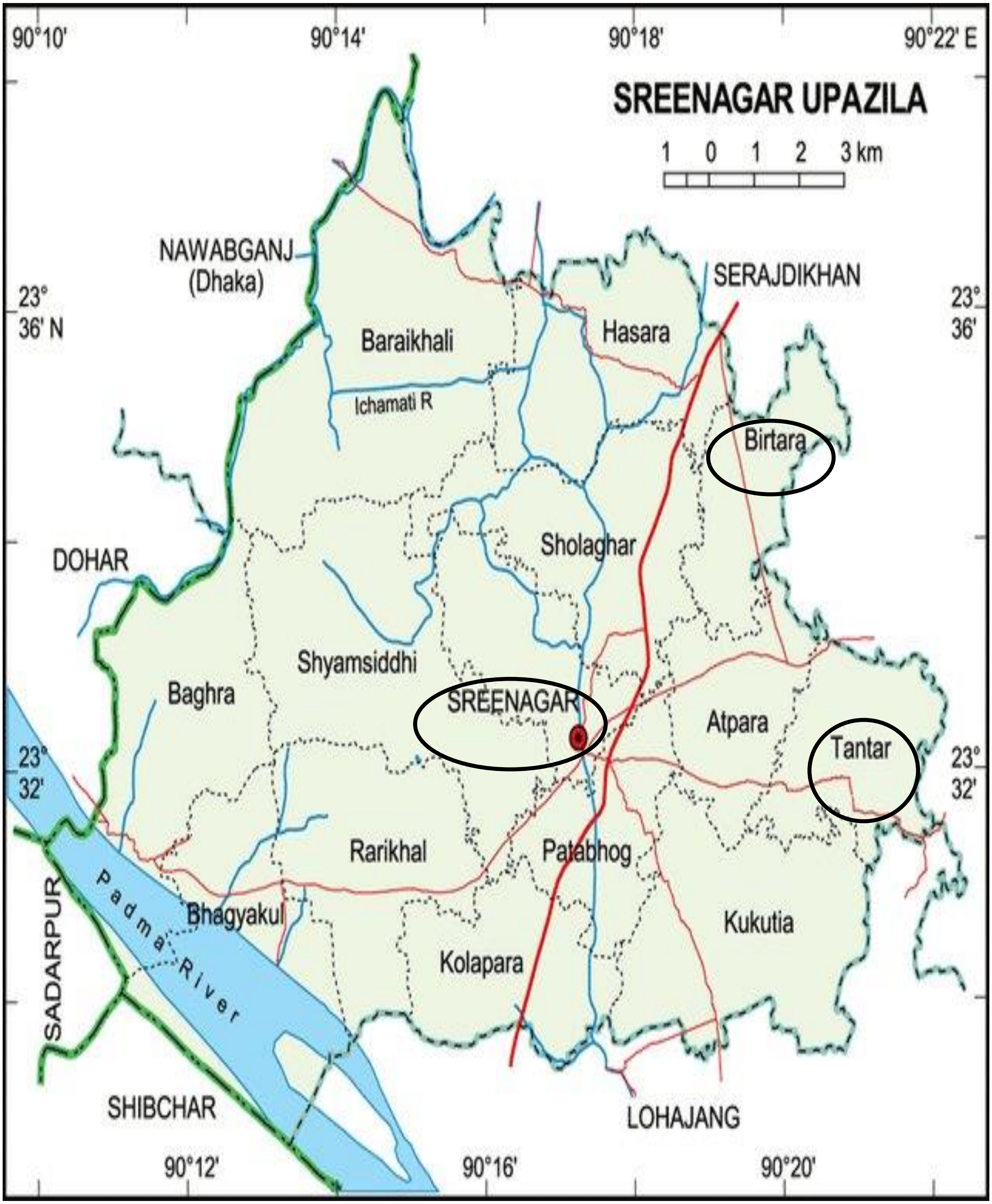


Figure 4.1: Map of Sreenagar Upazila

Source: Banglapedia,2019

4.4.2 Sirajdikhan Upazila

Encompassing a geographical expanse of 180.19 square kilometers, Sirajdikhan Upazila occupies a strategic position between 23°30' and 23°40' north latitudes and 90°15' and 90°27' east longitudes. Its borders are demarcated by Keraniganj Upazila to the north, while to the south, it is flanked by the neighboring Upazilas of Lohajang and Sreenagar. In the eastern direction, the boundaries are shared with Tongibari and Narayanganj Saddar Upazilas, and to the west, Sirajdikhan Upazila is delineated by the proximity of Sreenagar and Nawabganj Upazilas. This spatial arrangement highlights the interconnectedness and geographical context of Sirajdikhan Upazila within its surrounding administrative divisions.

Sirajdikhan has a total inhabitant of 241,804 people, 120,342 women and 121,462 men. There are 1,341 people per square kilometre. The national average rate of literacy is 47.7%, with 50.3% of men and 45.1% of women literate. Constituting the predominant sources of revenue in Sirajdikhan, agriculture commands a significant share at 40.91%, followed by non-agricultural labor at 2.37%, industry at 2.26%, commerce at 18.08%, communication and transportation at 3.11%, service at 9.08%, development at 3.09%, religious service at 0.19%, rent and remittance at 10.69%, and a diverse array of other sources.55.38% of people do not own any land, while 44.62% of people do. Ownership of agricultural land is split between urban areas (21.79%) and rural areas (44.95%). Potato, paddy, jute, and sesame are the principal crops grown; sugarcane, kalai, lentil, khesari, pea, and linseed are practically extinct crops. Mainly grown fruits include mangos, bananas, and jackfruit. (**Source:** Banglapedia,2019)

The positioning of Sirajdikhan Upazila is depicted on Map 4.2.

4.5 Concluding Remark

Within above discussion, the study area's features have been briefly summarized. In pursuit of the study's objectives, the study delved into the discussion of the selected area's location, size, population, monthly average temperature, rainfall, and agricultural amenities. However, the socioeconomic features of the study area will be detailed in the subsequent Chapter 5.

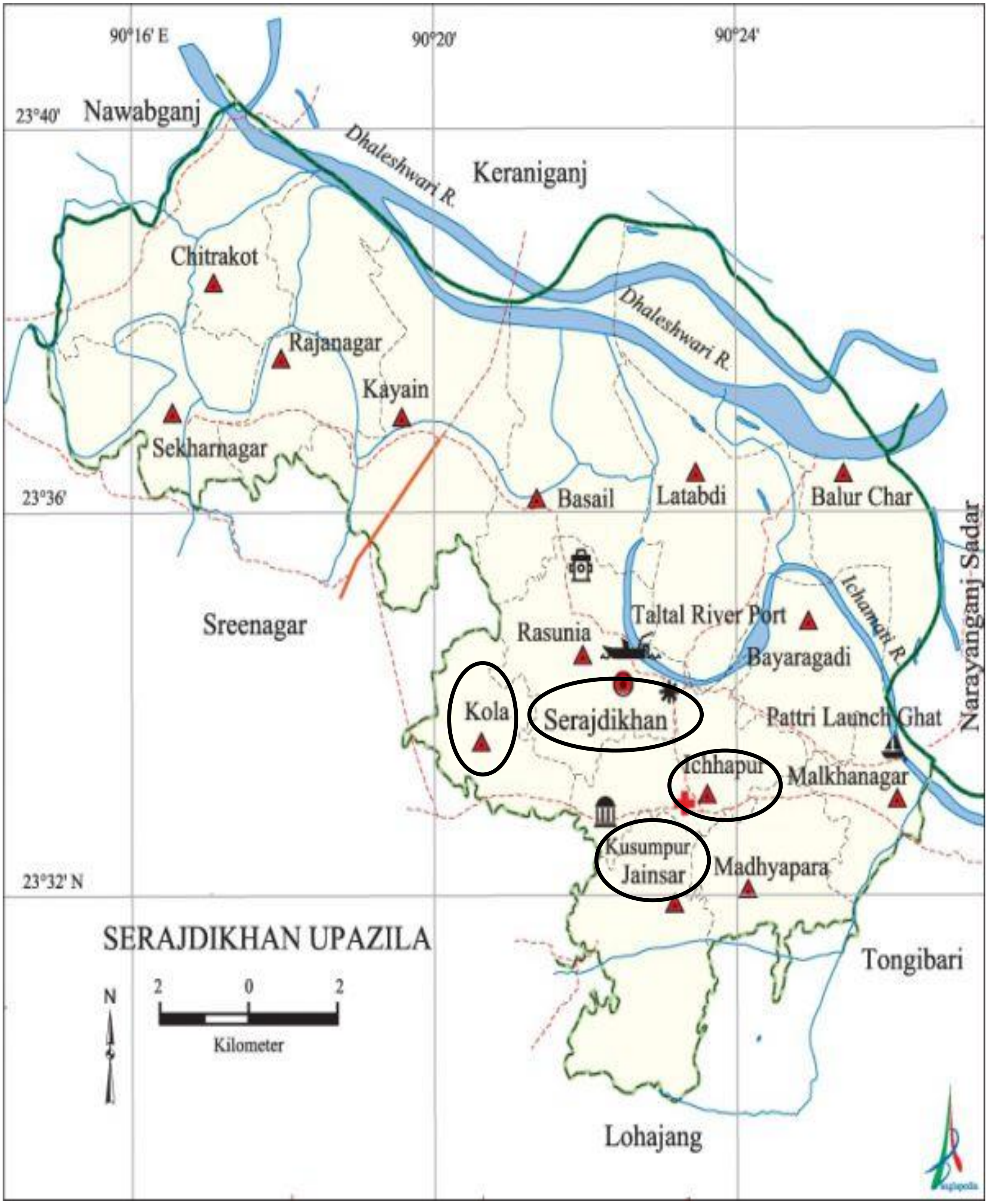


Figure 4.2: Map of Sirajdikhan Upazila

Source: Banglapedia,2019

CHAPTER 5

SOCIO-ECONOMIC PROFILE OF SAMPLE FARMERS

5.1 Introduction

The objective of this chapter is to provide a succinct overview of the socioeconomic traits of the farmers that produce maize. Several factors connected to the farmers' standard of living, their socioeconomic surroundings, and the type and degree of their participation in national development activities can be considered when examining the socioeconomic features of farmers from various angles. Because of limitations in time and resources, obtaining comprehensive data on the socioeconomic attributes of the sampled farmers was not feasible. Understanding the socioeconomic status of the sampled farmers is vital for research planning, given the intricate and interrelated characteristics that shape an individual and significantly influence the development of their behavior and personality. Due to the variety of socioeconomic factors, people vary from one another. A few socioeconomic traits have, however, been discussed for the sake of the current research.

5.2 Distribution of the Respondents Based on Age

With the exception of age, which was classified using guidelines provided by the Ministry of Youth and Sports, Government of the People's Republic of Bangladesh, all factors were classed according to their possible scores. In the study area, respondents were 45.96 years old on average. Table 5.1 displayed the minimum and maximum age by a respondent in the study area were observed to be 21 years and 75 years respectively.

Table 5.1: Distribution of the Respondents Based on Age in the Study Area

Category of age	Number of the respondents	Percentage of the respondents
Young aged (17-35 years)	21	26.25
Middle aged (36-50 years)	29	36.25
Old aged (above 50 years)	30	37.50
Mean	45.96	
Min	21	
Max	75	

Source: Field Survey,2022

80 farmers were selected as a representative sample, and of those, 26.25 percent were under the ages of 17 and 35, 36.25 percent were under the ages of 36 and 50, and 37.50 percent were over the age of 50. Figure 5.1 displayed the age-based distribution of the maize farmers.

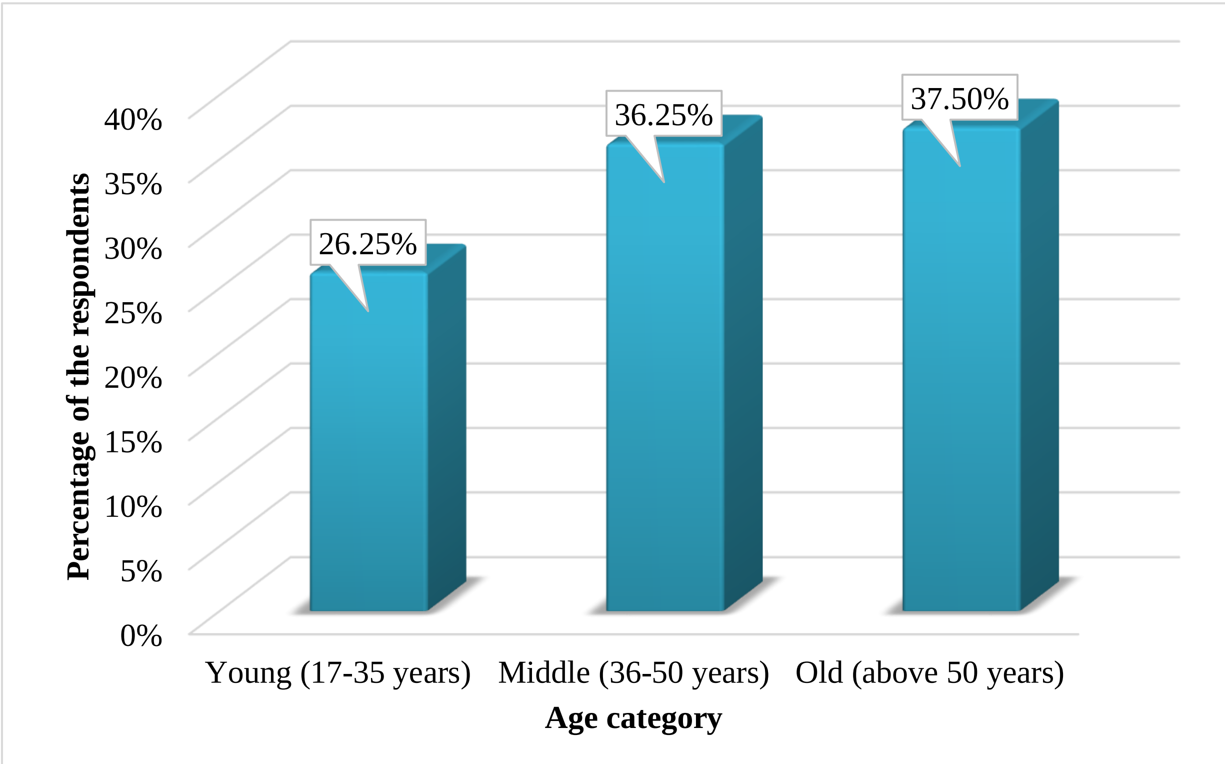


Figure 5.1: Age Distribution of the Maize Farmers in the Study Area
Note: Age has been categorized based on the (MoYS, 2012)

5.3 Distribution of the Respondents Based on Educational Status

Education serves as an indicator of the socioeconomic advancement of a community. It plays a pivotal role in diminishing poverty and inequality, promoting better health, and facilitating the application of knowledge. Individuals with higher levels of education have access to more valuable information about food and livelihood systems. Moreover, elevated levels of income, intertwined with increased earnings, are often associated with higher educational attainment.

According to Bangladesh Bureau of Educational Information and Statistics (BANBEIS), 2021, respondent's educational status was divided into four groups: Illiterate (respondents who have no education), Primary education (respondents who have completed schooling 1-5), Secondary education (respondents who have completed schooling 6-10), Higher secondary and above (respondents who have completed schooling above 11).The respondents' average level of education in the subject area was class 5.Table 5.2 displayed the minimum and maximum educational level by the respondents and the category of educational level in the subject area.

Table 5.2: Respondents' Level of Education in the Subject Area

Category of educational level	Number of the respondents	Percentage of the respondents
Illiterate	2	2.50
Primary education	43	53.75
Secondary education	31	38.75
Higher secondary and above	4	5.00
Mean	5	
Min	0	
Max	15	

Source: Field survey, 2022

Note: Education category has been adopted from the (BANBEIS,2021)

According to the data presented in Figure 5.2, it can be observed that the education level of the study population is quite diverse. Out of the entire population, 2.50 percent reported having no education at all. This suggests that a small portion of the sample had not received any formal education.

Conversely, a notable proportion of the participants, constituting 53.75 percent, had received education ranging from grades 1 to 5, categorized as primary education. This indicates that a majority of the sample population had received a basic level of education.

Additionally, 38.75 percent of the respondents had completed schooling from grades 6 to 10, which falls under the category of secondary education. Furthermore, only 5.00 percent of the participant completed higher secondary education (grades 11-12) or had received education beyond the secondary level (grades 13-17). This suggests that a relatively small percentage of the sample population had pursued education beyond the secondary level.

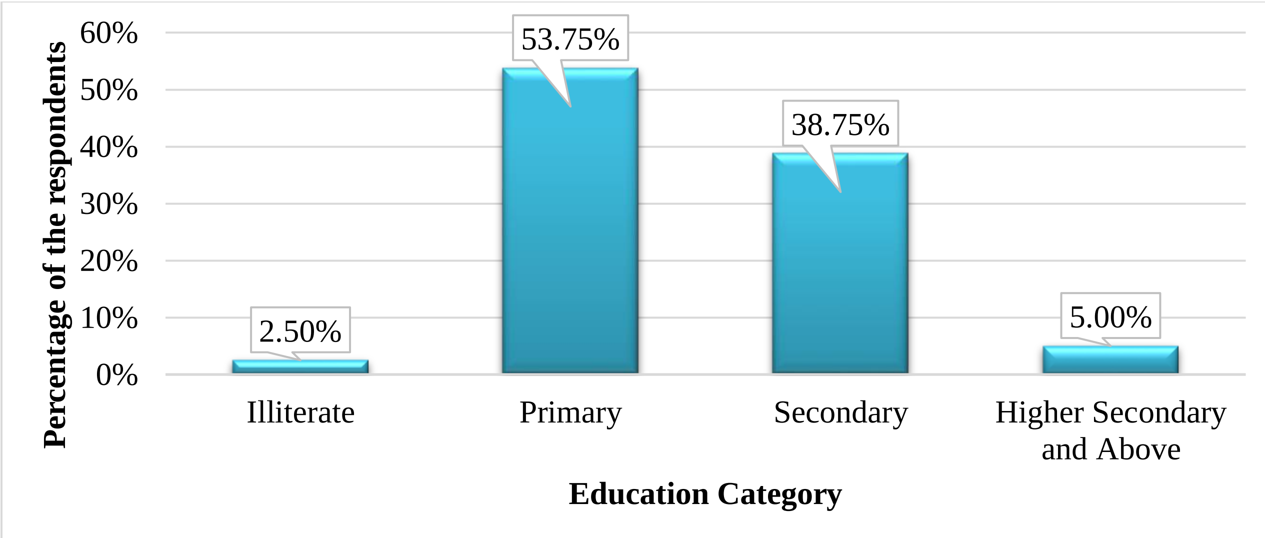


Figure 5.2: Respondents' Level of Education in the Subject Area

Note: Education category has been adopted from the (BANBEIS,2021)

5.4 Distribution of the Respondents Based Family Size

In the study area, family size refers to the number of individuals residing with the family head. The study area's mean family size was 5.23, which was higher than the 4.06 national average (HIES, 2016). The population was divided into three categories based on family size. Table 5.3 displayed the family sizes of maize farmers, varying from two people at minimum to eleven people at most per household.

Table 5.3: Household Size of Participants in the Study Region

Family Size	**Number of the respondents**	**Percentage of the respondents**
From 2 to 5 members	51	63.75
From 6 to 8 members	26	32.50
Above 8 members	3	3.75
Mean	5.23	
Min	2	
Max	11	

Source: Field survey, 2022

Figure 5.3 showed the different family sizes of maize farmers. 80 farmers were used as a sample, where 63.75 percent of them belonged to 2- 5 members, 32.50 percent for households with 6–8 members, and 3.75 percent for households with more than 8 members.

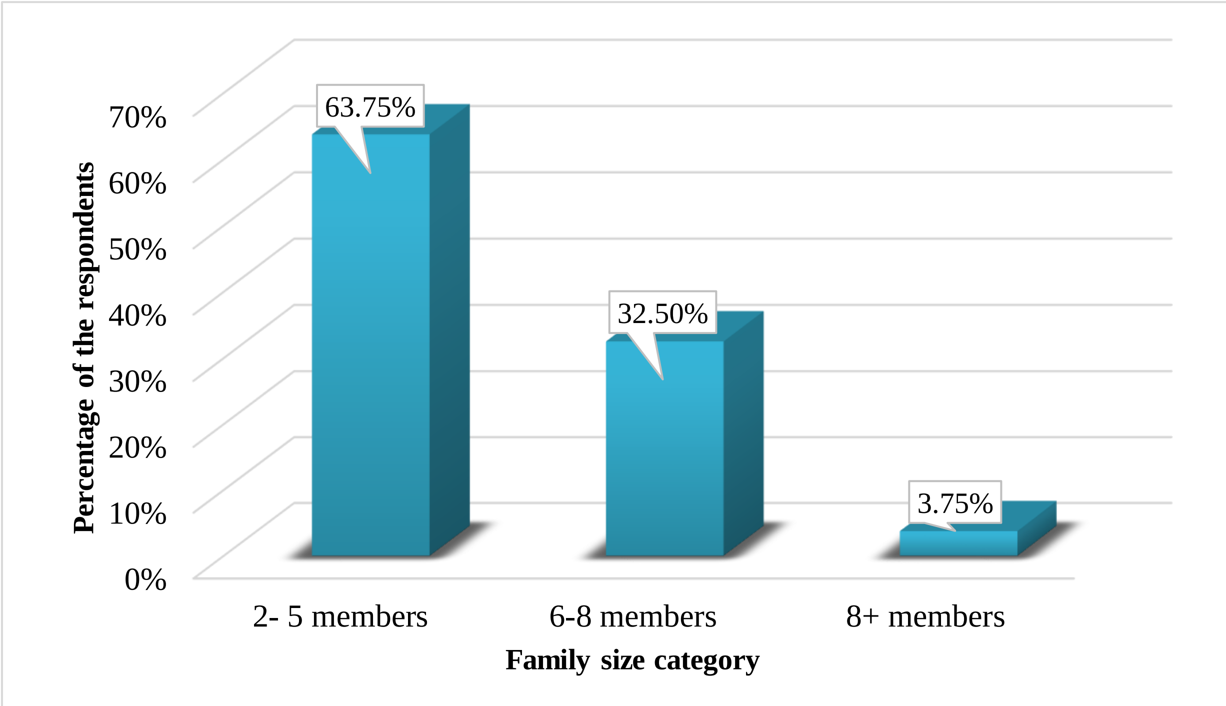


Figure 5.3: Family Size of Maize Farmers in the Study Area

Source: Field Survey, 2022

5.5 Distribution of the Respondents Based on Annual Household Income

The yearly income of the surveyed farmers encompassed earnings from various sources, such as crop farming, raising cattle, fish farming, day labor, remittance, and other avenues. In the 2022 field survey, maize farmers were categorized into three groups according to their annual household income. Table 5.4 displayed the annual household income of maize farmers.

Table 5.4: Average Annual Income of the Respondents in the Study Area

Income group	Number of the respondents	Percentage of the respondents
Up to 3 lakh taka	4	5
3-5 lakh taka	40	50
Above 5 lakh taka	36	45

Source: Field Survey, 2022

Figure 5.4 showed the breakdown of participants based on annual household income according to field survey 2022.

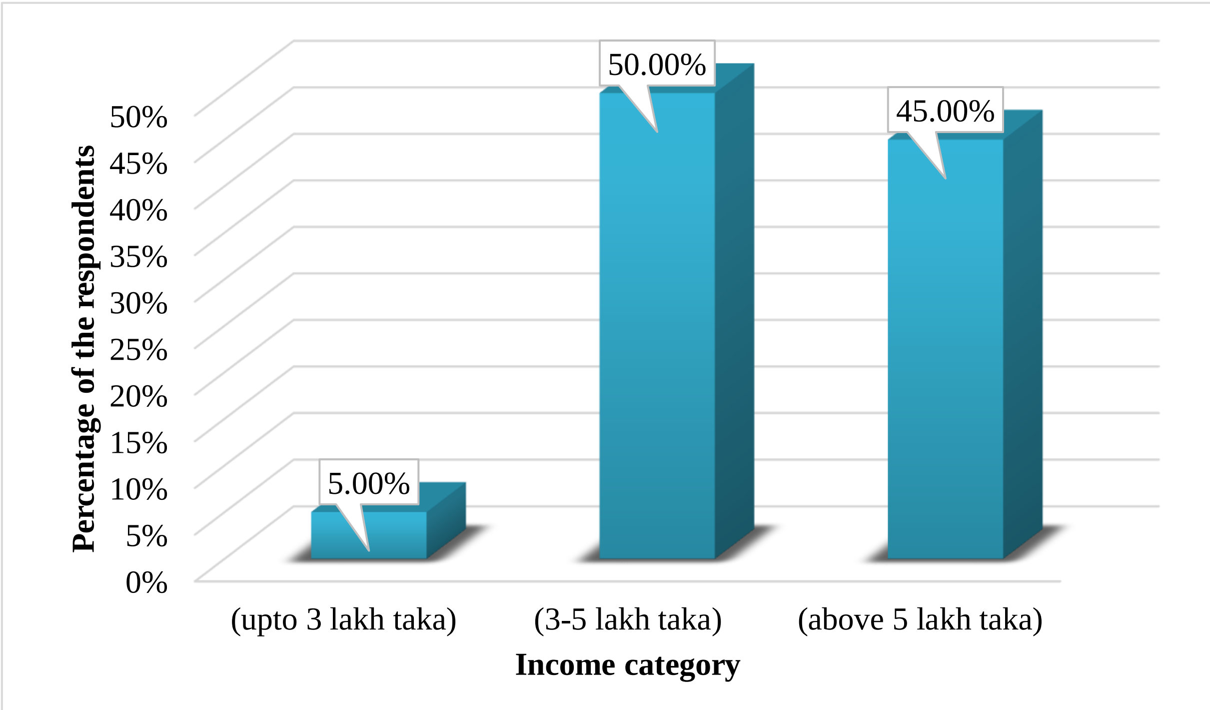


Figure 5.4: Average Annual Income of Maize Farmers in the Study Area
Source: Field Survey, 2022

5.6 Distribution of the Respondents Based on Maize Farming Experience

During the field survey in 2022, maize farmers were categorized into three groups based on their experience in maize farming. The gathered data indicate that the average maize farming experience was approximately 4.72 years. Table 5.4 displayed the category of maize farming experience. In the study area, the minimum and maximum of maize farming experience by the respondents were observed 2 and 13 respectively. The average maize farming experience was 4.72 that showed in table 5.5.

Table 5.5: Maize Farming Experience in the Study Area

Maize farming experience	Number of the participants	Percentage of the participants
From 1 to 4 years	47	58.75
From 5 to 8 years	22	27.50
Above 8 years	11	13.75
Mean	4.72	
Min	2	
Max	13	

Maize farming experience was presented in the figure 5.5. The study's findings displayed that the majority of the sample farmers maize experience was from 1 to 4 years (58.75%).

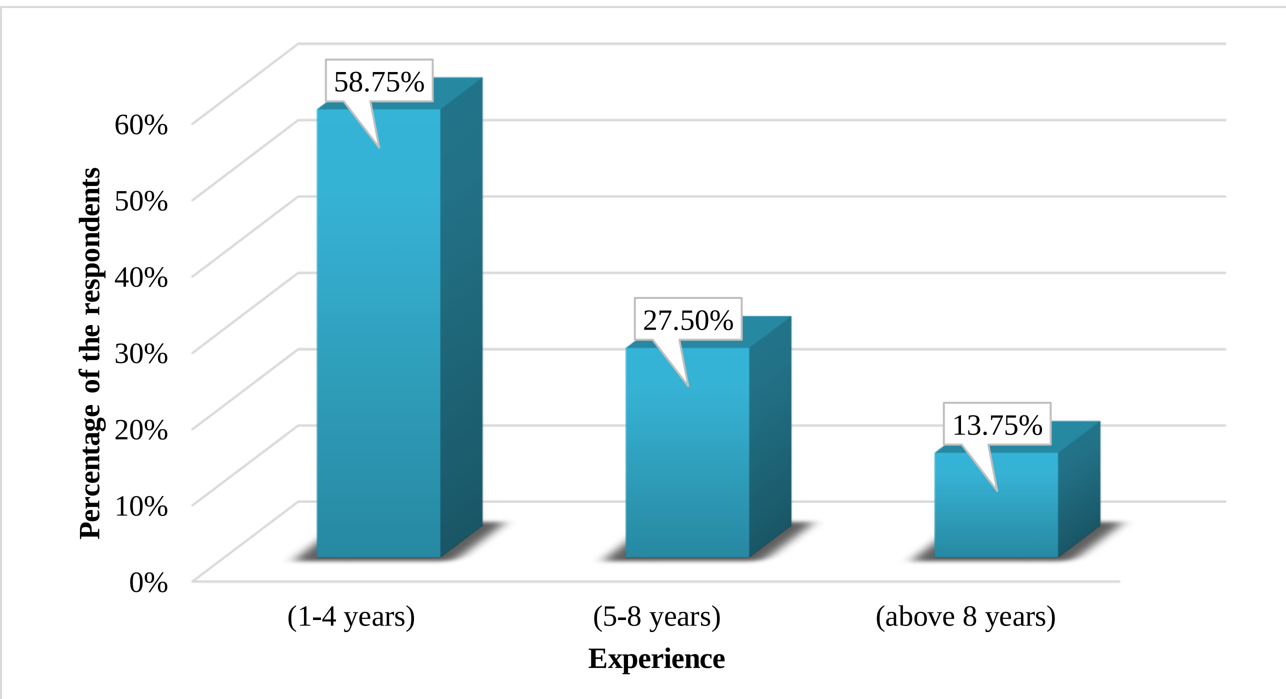


Figure 5.5: Maize Farming Experience in the Study Area

Source: Field Survey, 2022

5.7 Distribution of the Respondents Based on Receiving Agricultural Training

Among the respondent farmers, 41.25% did not receive training in crop cultivation, whereas 58.75 % were trained in the cultivation of various agricultural crops.

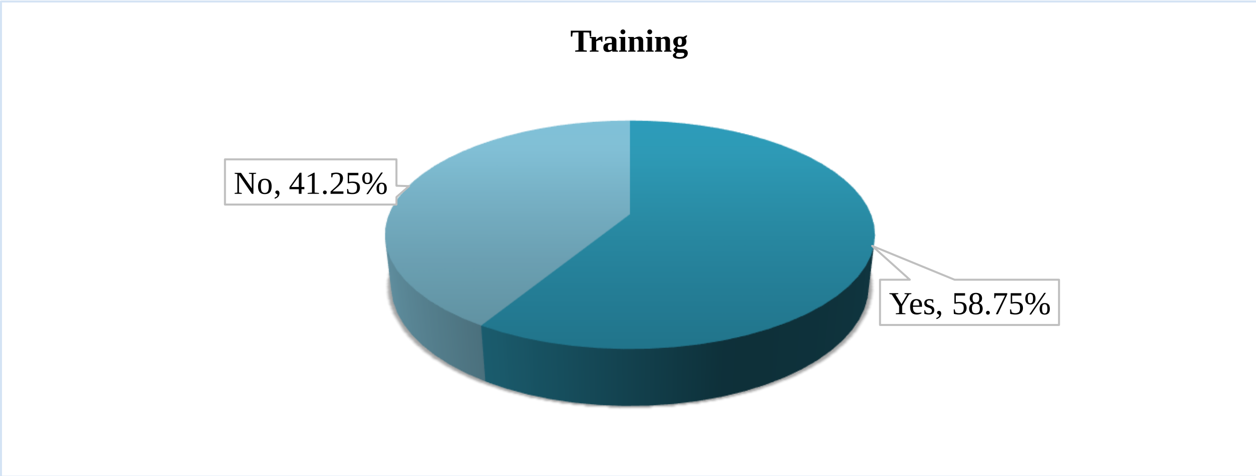


Figure 5.6: Agricultural Training in the Study Area

Source: Field Survey, 2022

5.8 Distribution of the Respondents Based on Extension Service

Figure 5.7 showed that among the respondent farmers, 41.25% of farmers received extension services, indicating that they spoke with agricultural extension officers either directly or indirectly. The remaining 587.5% of farmers, however, do not receive any extension services

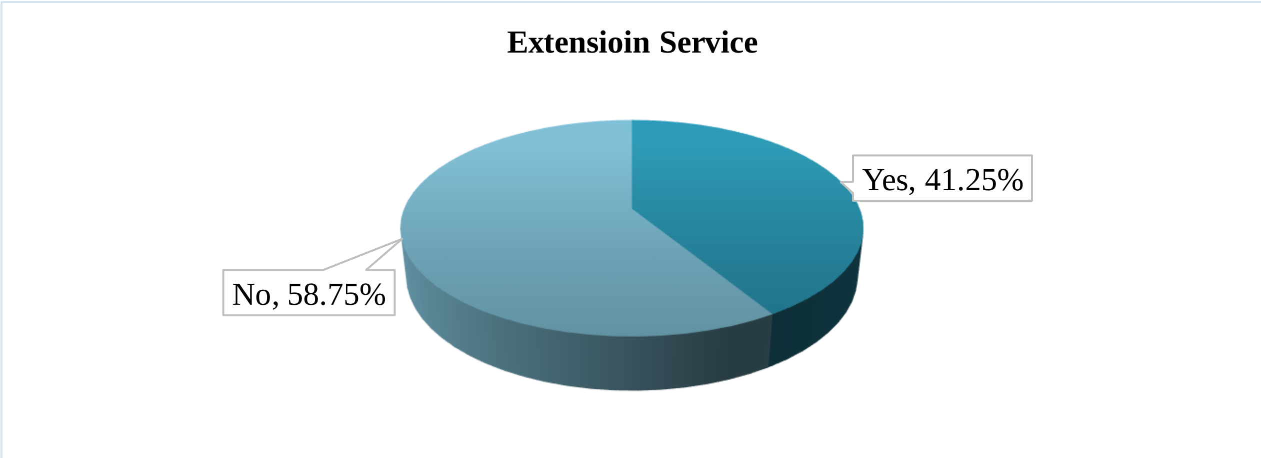


Figure 5.7: Distribution of Farmers Received Agricultural Extension Service in the Study Area

Source: Field Survey, 2022

5.9 Distribution of the Respondents Based on Receiving Credit Service

Adequate funding is essential for any farming venture. Approximately 51.25 % of farmers obtained loans from banks and various NGOs for maize cultivation, while 48.75 % of farmers did not secure credit from any banks or non-bank financial institutions. (Figure 5.8).

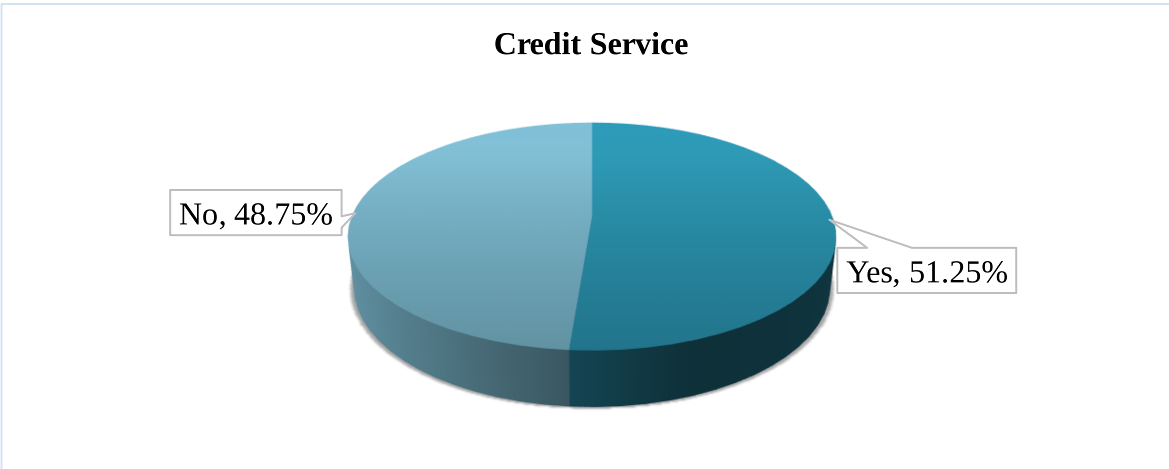


Figure 5.8: Distribution of Farmers Received Credit Service in the Study Area

Source: Field Survey, 2022

5.10 Distribution of the Respondents Based on Livestock Rearing

Figure 5.9 displayed that 48.75 % of the surveyed farmers own livestock, while the remaining 51.25 % do not have any livestock in their households.

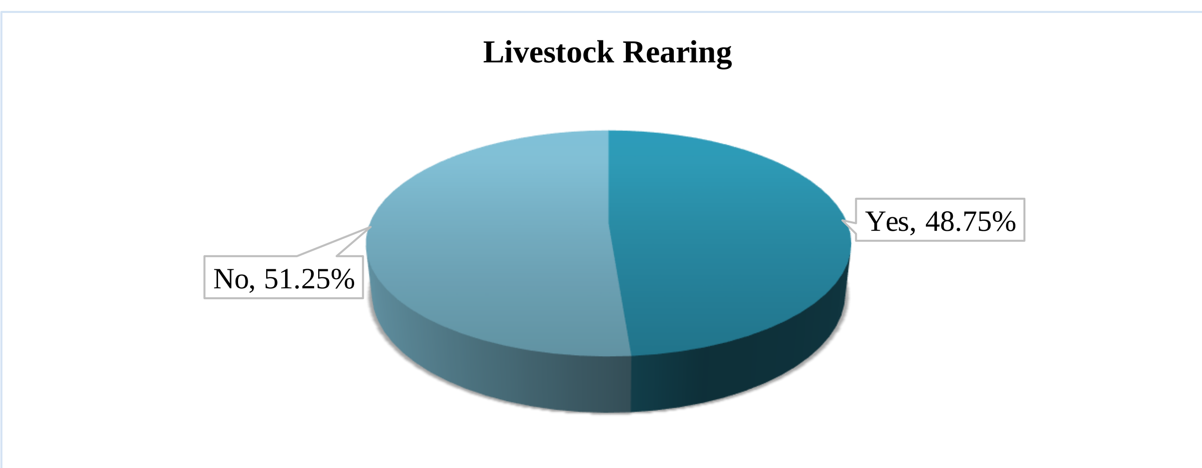


Figure 5.9: Distribution of Farmers Based on Livestock Rearing in the Study Area

Source: Field Survey, 2022

5.11 Membership of Social Organization

Figure 5.10 showed that 52.50% of the respondents who grow maize do not belong to any corporations, whereas 47.50% of them are members of various corporations.

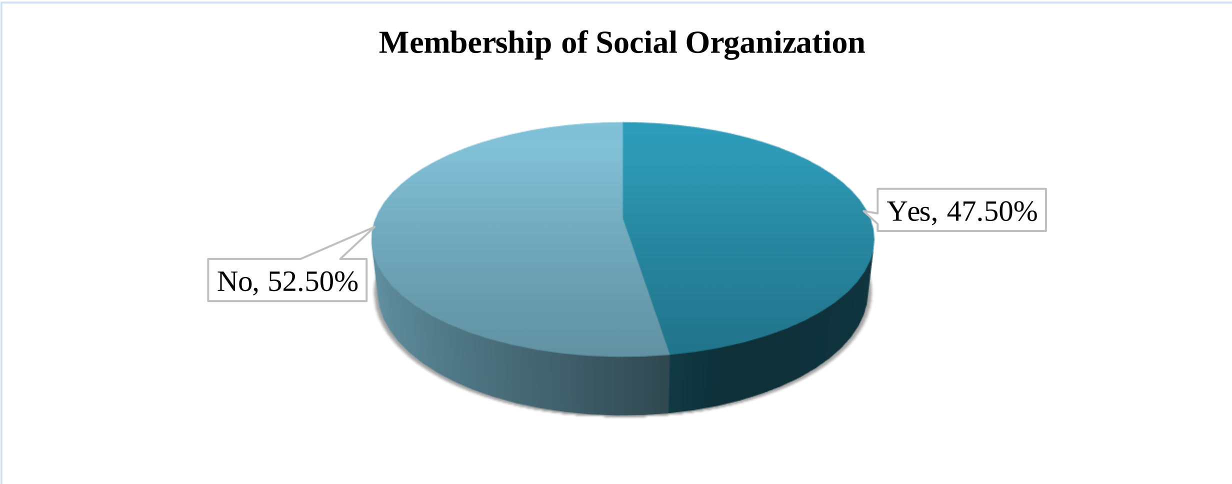


Figure 5.10: Distribution of Farmers Based on the Membership of Social Organization in the Study Area

Source: Field Survey, 2022

5.12 The Distance Between the House and the Local Market

Based on the proximity of residences to the nearby market, the distance is divided into three group that showed in figure 5.11.

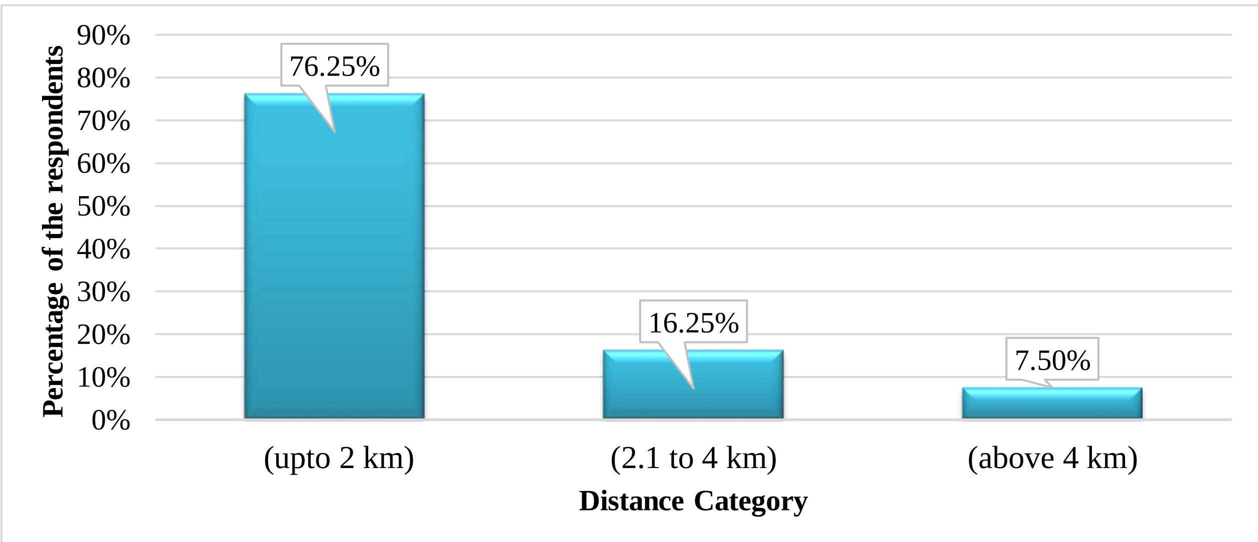


Figure 5.11: Distribution of Farmers Based on the Distance from Market in the Study Area
Source: Field Survey, 2022

Figure 5.11 showed that the largest ratio 76.25 % of the farmer's home to local market distance have ranged up to 2 km, while 16.25 % of the farmers home to local market distance ranged from 2.1 km to 4 km and 7.50 % of the farmers home to local market distance above 4 km.

5.13 Concluding Remarks

This chapter examined the socioeconomic characteristics of the sampled farmers from two distinct upazilas. The preceding conversations highlight differences in socioeconomic characteristics between maize growers in both upazilas, Sirajdikhan as well as Sreenagar. The subsequent chapter will delve into the productivity and technical efficiency of maize-producing farmers.

CHAPTER 6

PRODUCTIVITY AND TECHNICAL EFFICIENCY OF THE MAIZE FARMERS

6.1 Introduction

Econometrics commonly employs the estimation of technical efficiency through the utilization of production functions. Technical efficiency reflects a farmer's ability to achieve the maximum output from a given set of inputs and production technologies. This concept is relative, as each farmer's output performance is assessed against an ideal input-output relationship or production frontier. Farmers are deemed technically inefficient when they are unable to generate the highest output from a specified quantity of inputs. In this chapter, the main objective is to estimate both the technical inefficiency and the frequency distribution of maize farmers through a technical efficiency analysis. The estimation of production's technical efficiency is accomplished using stochastic frontier production.

6.2 Stochastic Frontier Production Function Estimation

The Likelihood Function in the sample data is a mathematical concept utilized to initiate the maximum likelihood estimation process. Within the chosen probability distribution model, the likelihood represents the probability of obtaining a particular set of data. The model parameters are encompassed in this expression. The Maximum Likelihood Estimates (MLEs) refer to the values of these parameters that maximize the sample likelihood. Table 6.1 illustrates the maximum likelihood estimates for the parameters of the Cobb-Douglas stochastic frontier production function and the technical inefficiency effect model for maize production among all farmers.

6.2.1 Seed Cost/ha (X_1)

The magnitude of coefficients of seed cost/ha (X_1) was positive and significant at 1 percent level. The regression coefficients of seed cost/ha (X_1) was 0.357, which implied that, keeping other factors constant (price of maize, price of chemical fertilizer, wage of hired labor and so on), 1 percent increase in seed cost/ha would increase the revenue of maize by 0.357 percent (Table 6.1). The most likely reason for this might be that increase use of seed is linked with more production.

Table 6.1: Estimated Parameters of Cobb-Douglas Stochastic Frontier Production Function and Technical Inefficiency Model for Maize Farmers

Variables	Parameter	Coefficients	Standard errors	P-values
Stochastic Frontier				
Constant (X_0)	β_0	8.28***	0.983	0.000
Seed cost (X_1)	β_1	0.357***	0.043	0.000
Family labor cost (X_2)	β_2	-0.039	0.025	0.119
Hired labor cost (X_3)	β_3	0.0003	0.004	0.936
Machinery used cost(X_4)	β_4	0.110***	0.035	0.002
Chemical fertilizer cost (X_5)	β_5	0.103**	0.051	0.045
Irrigation cost (X_6)	β_6	-0.017	0.062	0.776
Insecticide cost (X_7)	β_7	-0.082	0.057	0.150
Inefficiency Model				
Constant	δ_0	1.066	2.702	0.693
Age (Z_1)	δ_1	-0.001	0.034	0.963
Education (Z_2)	δ_2	-0.005	0.138	0.966
Family size (Z_3)	δ_3	-1.076**	0.472	0.023
Farm size (Z_4)	δ_4	2.798*	1.450	0.054
Training (Z_5)	δ_5	-2.117***	0.793	0.008
Extension service (Z_6)	δ_6	1.404	1.138	0.217
Livestock (Z_7)	δ_7	-1.608**	0.796	0.043
Membership (Z_8)	δ_9	-1.561*	0.809	0.054
R^2	0.688			
Adjusted R^2	0.657			

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

Source: Field survey, 2022

6.2.2 Family Labor Cost/ha (X_2)

The magnitude of coefficient of family labor cost/ha (X_2) of maize production was negative and the value coefficients of family labor cost (X_2) was -0.039. There is no statistical significance for this coefficient. However, the negative sign may be due to the overused of family labor which impact the revenue. (Table 6.1).

6.2.3 Hired Labor Cost/ha (X_3)

The magnitude coefficient of hired labor cost/ha (X_3) of maize production was positive and the coefficients of hired labor cost/ha (X_3) was 0.0003, the regression coefficient of hired labor cost was not statistically significant (Table 6.1).

6.2.4 Machinery Used Cost/ha (X_4)

The magnitude coefficients of machinery used cost/ha (X_4) of maize production was positive and significant at 1 percent level. The regression coefficients of machinery used cost/ha (X_4) was 0.110, which implied that, keeping other factors constant (price of maize, price of seed, price of chemical fertilizer and so on), 1 percent increase in machinery used cost/ha would increase the revenue of maize by 0.110 percent (Table 6.1). The most likely reason for this might be that there has scope to more use of machinery.

6.2.5 Chemical Fertilizer Cost/ha (X_5)

The regression coefficients of chemical fertilizer cost/ha (X_5) of maize production was positive and significant at 5 percent level. The regression coefficients of chemical fertilizer cost/ha (X_5) was 0.103, which implied that, keeping other factors constant (price of maize, price of seed, price machinery used cost and so on), 1 percent increase in chemical fertilizer cost/ha would increase the revenue of maize by 0.103 percent (Table 6.1)

6.2.6 Irrigation Cost/ha (X_6)

The regression coefficients of irrigation cost/ha (X_6) of maize production was negative and the value of coefficients was -0.017 that the regression coefficient of irrigation cost/ha was not statistically significant (Table 6.1).

6.2.7 Insecticide Cost/ha (X_7)

The regression coefficients of insecticide cost/ha (X_7) of maize production was negative and the value of coefficients was -0.821 that the regression coefficient of insecticide cost/ha was not statistically significant (Table 6.1).

6.3 Interpretation of Technical Inefficiency Model

In the model for technical inefficiency effects, variables such as age, education, family size, training, livestock, and membership are anticipated to have negative coefficients (Table 6.1).

6.3.1 Age ($\mathbf{Z_1}$)

The negative age coefficient suggests that older farmers may be more technically efficient compared to their younger counterparts. Nevertheless, it is important to note that the regression coefficient for age is not statistically significant in this study. (Table 6.1).

6.3.2 Education ($\mathbf{Z_2}$)

The negative education coefficient indicates that increased years of schooling are linked to farm efficiency. However, it is noteworthy that the regression coefficient for education lacks statistical is insignificant (Table 6.1).

6.3.3 Family Size ($\mathbf{Z_3}$)

The farm size coefficient is both negative and statistically significant at the 5 percent level, indicating that greater family size is associated with higher technical efficiency compared to smaller family sizes. The most likely reason for this might be that participating in subsidiary income activities by household members that increase earnings. The additional earning could be again invested on the farm which leads to technical efficiency (Table 6.1).

6.3.4 Farm Size ($\mathbf{Z_4}$)

Farm size has a negative impact on the technical efficiency of producing maize, according to the positive coefficients of farm size. Nevertheless, it is important to note that the farm size coefficient is statistically significant at the 5 percent level (Table 6.1). This is likely due to the fact that expenses related to purchasing inputs in agricultural production tend to increase with a larger farm size, potentially making larger farms less manageable.

6.3.5 Training ($\mathbf{Z_5}$)

The training coefficient is both negative and statistically significant at the 1 percent level, suggesting that farmers who receive training are likely to be more technically efficient than those without training. (Table 6.1). This is likely because trained farmers perception about modern farming method can be improved compare to those farmers who don’t have received training.

6.3.6 Extension Service (Z_6)

The extension service's positive coefficients imply that it has no effect on maize production's technical inefficiency. In other words, this factor neither decreases nor increases the technical inefficiency in the production of maize (Table 6.1).

6.3.7 Livestock (Z_7)

The negative and statistically significant livestock coefficient at the 5 percent level suggests that farmers who own livestock tend to exhibit higher levels of technical efficiency compared to those who do not possess livestock (Table 6.1). The most likely reason for this might be that farmer could use cow dung as manure in their field. In addition, income from livestock could improve the living standard.

6.3.8 Membership (Z_8)

The negative and statistically significant coefficient for membership at the 10 percent level suggests that farmers engaged in various social organization memberships are likely to be more technically efficient than those who are not involved in such memberships (Table 6.1). This is possibly because engagement in different social groups enables farmers to improve their skills and receive support for establishing diverse non-farm activities, unlike those who do not participate in these groups.

6.4 Technical Efficiency and its Distribution

Determining the level of technical efficiency through estimation aids in determining whether there is room to enhance the current efficiency for increased productivity. A farm is considered technically inefficient if it does not achieve the maximum output from a given set of inputs. The estimation of the technical efficiency of maize cultivation at the farm level in the study area is presented in Table 6.2.

Table 6.2: Frequency Distribution of Technical Efficiency of Maize Producing Farms

Efficiency (%)	No. of farmers	Percentage of total farms
0-75	5	6.25
76-80	3	3.75
81-85	3	3.75
86-90	6	7.5
91-95	17	21.25
96-100	46	57.5
Total number of observations	80	
Minimum	0.558	
Maximum	0.998	
Mean	0.930	
Standard Deviation	0.086	

Source: Field Survey, 2022

Table 6.2 illustrates the distribution of farm-specific technical efficiency among maize farmers. The data indicates that the average estimated technical efficiencies for maize cultivation are 93 percent, suggesting that there is potential to increase maize production by 7 percent with the same inputs and without incurring additional costs. An improvement in managerial skills alone could lead to a significant output increase for maize. Notably, 57.5 percent of the sampled farmers achieved outputs very close to the maximum frontier outputs, maintaining an efficiency level within the range of 96-100. The observed range for technical efficiencies ranged from 55.8 to 99.8 percent, with a standard deviation of 8.6.

6.5 Coefficient of Multiple Determinations (R^2)

The coefficient of multiple determination for maize production was determined to be 0.6882, indicating that approximately 68.82% of the overall variability in the gross return of maize production could be accounted for by the explanatory variables included in the model (Table 6.1).

6.6 Adjusted R^2

Adjusted R2, which considers the degrees of freedom, was calculated for maize production, resulting in a value of 0.6579. This suggests that approximately 65.79% of the variations in the output of maize production can be attributed to the explanatory variables incorporated into the model (Table 6.1).

6.7 Diagnostic Test

To run the stochastic frontier production model, i use both continuous and dummy variables as independent variable. There may be correlations between the variables selected for analysis. Avoiding correlation between the independent variables is very important for research reliability. Hence, a correlation matrix is used to detect the multicollinearity. Here, the correlation matrix indicate that multicollinearity is not an issue in the study (Appendix-A).

In addition, link test has also been conducted to find the validity of the model specification. Results shows that the hatsq value is 0.170 which is insignificant. Hence, the model specification is valid and there is no omitted variable issue in the model (Appendix-A).

6.8 Concluding Remark:

The preceding discussions and the findings presented in Table 6.1 indicate that the coefficients of parameters such as seed cost per hectare, hired labor cost per hectare, machinery used cost per hectare, and chemical fertilizer cost per hectare were positive. Among these, seed and machinery used costs per hectare were highly significant, and the per-hectare cost of chemical fertilizer was significant at the 5 percent level. Conversely, the coefficients of family labor cost per hectare, irrigation cost per hectare, and insecticide cost per hectare were negative, with the per-hectare costs of irrigation and insecticide found to be insignificant. The technical inefficiency effect model revealed that factors such as age, education, family size, training, livestock rearing, and membership in social organizations had negative coefficients, indicating that they contribute to reducing the technical inefficiency of maize farmers. However, the difficulties faced by maize farmers are discussed in the next chapter, Chapter 7.

CHAPTER 7
PROBLEMS OF MAIZE PRODUCTION

7.1 Introduction

The primary objective of this chapter is to pinpoint the challenges encountered by maize farmers. Producing maize presented numerous challenges to farmers. Financial, technical, and societal issues were present. This chapter tries to illustrate some socioeconomic issues and barriers to maize production. According to the feedback provided by the farmers, the issues and limitations they faced were recognized. The following is a discussion of the main issues and limitations associated with maize cultivation:

7.2 High Price of Quality Seed

One major obstacle to maize production in the research area was the elevated cost of seeds. During the survey, farmers were asked about their satisfaction with the seeds they used. They expressed concerns regarding the high prices of quality seeds, which were found to range from Taka 550 to Taka 650 per kilogram in the market on average. Table 7.1 falls this as the top problem, with 93.75% of maize producers expressing it as an acute problem.

7.3 Natural Calamities

It was reported that maize producers encountered some serious issues with nature during their production process. Farmers argued that weather-related events, such as floods and rain, interfered with appropriate agricultural output and quality. In the research area, 87.50% of farmers overall claimed to have suffered noteworthy crop damage as a consequence of flooding and heavy rainfall. (Table 7.1). In the study area, this issue is ranked second.

7.4 High Labor Cost

For maize farmers in Bangladesh, the issue of high labor costs has recently become very problematic. The high expense of labour is borne by farmers from the time of production till harvest. Every household almost always complains about this issue. Table 7.1 revealed that this issue was reported by maize producers in 85.00% of cases.

Table 7.1: Challenges in Maize Production within the Study Region

Name of the Problem	Number of Farmers	Percent of Farmers	Rank
High price of quality seed	75	93.75	1^{st}
Natural calamities	70	87.5	2^{nd}
High labor cost	68	85.00	3^{rd}
Lack of credit facility	64	80.00	4^{th}
High rent charges of agricultural machinery	60	75.00	5^{th}
Attack of pest and disease	55	68.75	6^{th}
Inadequate extension service	53	66.25	7^{th}
Low price of grains	50	62.50	8^{th}

Source: Field survey, 2022

7.5 Lack of Credit Facility

The study area's farmers faced financial limitations. A substantial amount of money was needed to purchase various inputs, including labor, fertilizer, insecticides, etc., for maize production. 80.00% of maize growers in the research area indicated a shortage of funds to acquire the necessary inputs for their respective agricultural activities (Table 7.1).

7.6 Elevated Rental Costs for Farming Equipment

Various agricultural machineries such as power tillers, tractors, threshers are utilized in different phases of maize production. Nevertheless, the cost of renting these machines is exorbitant, according to 75.00% of the surveyed farmers in the research area. (Table 7.1). The fifth issue in the study area is this one.

7.7 Attack of Pest and Disease

Insect and disease attacks were a challenge that the maize producers had to deal with. Diseases and pests cause havoc on crops, lowering yields and raising production costs. The problem was reported by about 68.75% of maize producers (Table 7.1). For the producers of maize, this issue is placed sixth.

7.8 Inadequate Extension Service

Some maize farmers claimed during the investigation that they received no extension services from the relevant Department of Agriculture Extension employees regarding enhanced method maize farming (DAE). As a member of the agricultural extension staff, the block supervisor serves as the farmers' primary source of technical advice regarding their farming issues. However, in the study area, 66.25 % of maize farmers reported that they rarely received assistance from the block supervisor (Table 7.1).

7.9 Reduced Grain Prices

The production of maize faced difficulties due to the extremely low cost of grains. The problem was reported by about 62.50% of maize producers (Table 7.1). For the producers of maize, this issue is placed eighth.

7.10 Concluding Remark

The aforementioned talks and the data in Table 7.1 displayed that the research area's maize farmers are currently facing a number of serious obstacles in carrying out their farming operations. All of these are the elementary barriers to growing maize in the research region. To enhance maize production, efforts should be made to reduce or eliminate these challenges. The producers of maize must receive the proper consideration for better subsidy distribution. However, summary, conclusion and recommendations are represented in the next chapter.

CHAPTER 8

SUMMARY, CONCLUSION AND RECOMMENDATIONS

8.1 Introduction

This chapter concentrates on the summary in light of the preceding chapters' discussions. A deduction has been made based on the empirical data. To improve Bangladesh's currently inefficient maize production, policy recommendations have been made.

8.2 Summary

The agricultural industry plays a vital role in fostering economic development, ensuring food security, and generating employment opportunities in Bangladesh. This sector accounts for 11.50% of the GDP and engages approximately 40.60% of the workforce (BER, 2022). Despite being vulnerable to climate change, Bangladesh has been able to increase crop production and maintain food security. The government has been implementing various planning documents to create sustainable agricultural systems and support farmers. Bangladesh has become close to being self-sufficient in food grain production, with crops and fisheries subsectors experiencing growth. Fishing, raising cattle, and forestry have grown to be pertinent revenue streams; during the initial four years under the 7th Plan, the forestry division saw a mean increase of 6.1% (BER, 2022). Crops, which make up over half of agricultural GDP, have expanded at an average annual rate of 1.7% (BER, 2022). The fisheries subsector has consistently achieved an annual growth rate of over 6% (BER, 2022).

Maize cultivation in Bangladesh has grown significantly in recent years, surpassing both wheat and rice in terms of yield. Originally introduced as a commercial crop in the 1990s, maize has become a major cash crop in the country. Despite an annual production of around 4,700 thousand tons, the country of Bangladesh needs over 2 MT of maize annually. (BBS, 2021), leading to significant imports. Maize has a promising future in the country due to its ability to grow well in every environment and exhibit potential productivity, and it is increasingly being used as food for humans, animal feed, and poultry feed across all market sectors.

The cultivation area for maize expanded from 1,100,000 acres in 2018-19 to 1,186,000 acres in 2020-21. During this period, there was a noticeable increase in the yield rate, rising from 3,245 kg per acre in 2018-19 to 3,471 kg per acre in 2020-21. According to the Bangladesh Bureau of Statistics (BBS) in 2021, the total production volume of maize reached 4,116,000 metric tons in 2020-21. In Munshiganj district during 2020-21, the separate areas under cultivation for kharif maize and rabi maize were 31,582.12 acres and 10,394 acres, respectively. In contrast, the nationwide figures for the same period were 206,440.73 acres for kharif maize and 979,210.77 acres for rabi maize in Bangladesh. The total production in Munshiganj district during 2020-21 was 23,219.15 metric tons for kharif maize and 1,932.64 metric tons for rabi maize (BBS, 2021).

The present research utilized purposive sampling to identify regions characterized by extensive maize cultivation. Two villages, specifically Kusumpur (from Ichhapur Union) and Jibsara (from Kola Union) in Sirajdikhan Upazila, along with Majidpur (from Birtata Union) and Singpara (from Tantar Union) in Sreenagar Upazila of Munshiganj district, were intentionally selected due to their elevated concentration of maize production. A total of 80 maize farmers (40 from Sirajdikhan Upazila and 40 from Sreenagar Upazila) were selected as samples for the study. Maize cultivation thrives throughout the year in Bangladesh due to favorable climatic conditions. Given this context, the study aimed to assess the productivity and technical efficiency of maize production in specific areas of Bangladesh, outlining several specific objectives.

1. To identify the socio-demographic profile of maize farmers;
2. To measure the productivity of maize production;
3. To estimate the technical efficiency of maize production;
4. To identify the problems facing by maize farmers and suggest policy options to solve these problems.

Data for the existing study was gathered between November and December 2022.Field surveys were used to get primary data, while publications and statistics bulletins were used to gather secondary data. Chosen participants underwent individual interviews using semi-structured questionnaires that had been pre-tested. To ensure consistency as well as accuracy, the gathered data were examined and verified. Editing as well coding were done on the data ahead of it was entered into the computer. Every piece of data was meticulously examined along with condensed to prevent any possible errors. Tabular data presentations were the norm because they were widely used, required little computation, and were quick to grasp.

The study area's features have been briefly summarized. The geographical position, locale, people, monthly mean temperatures, precipitation amounts, alongside farms of the area chosen were discussed in order to attain the research intended goal.

The socioeconomic variables were taken into consideration in this study were years of age, level of schooling, size of family, annual household income, maize farming experience, agricultural training, receiving credit service, extension service, livestock rearing, membership of social organization and distance from market. In the study area, 26.25 percent of respondents were under the ages of 17 and 35, 36.25 percent of respondents were under the ages of 36 and 50, and 37.50 percent were over the age of 50. However, 50 percent lacked formal education, 53.75 percent respondents who have completed their schooling 1-5 is considered primary education, 38.75 percent respondents who have completed their schooling 6-10 is considered secondary school, and only 5.00 percent had completed their higher secondary (schooling 11-12) and above schooling (13-17). According to Preliminary Report on Household Income and Expenditure Survey (HIES) 2016, respondent’s family size was divided into three groups where 63.75 percent of them belonged to 2-5 members, 32.50 percent 6–8 Companions, as well as 3.75 percent belong to beyond 8 members. Based on how long they had been growing maize, the farmers in the investigation area were split to three groups. The end result from the research disclosed that most of the sample farmers had been growing maize for one to four years (58.75%). Of the farmers who responded, 58.75 percent received training on growing various crops, while 41.25 percent did not receive any type of instruction on cultivating crops. Additionally, 41.25% of the farmers who responded received extension services, indicating that they spoke with extension agents for agriculture either directly or indirectly. The remaining 587.5% of farmers, however, do not receive any extension offerings. Albeit, For the purpose of growing maize, roughly 51.25 % of the farmers derived loans from banks and different non-governmental organizations. The percentage of farmers who were denied any credit from banks or non-bank financial organizations was about 48.75 %. In the study area, 48.75 % have cattle in their homes, while the remaining 51.25 % do not. On the other hand, 66.67% of the farmers who responded are not members of any corporations, while 33.33% of the farmers who grow maize are members of various corporations. Albeit, from home to local market distance, the highest proportion 76.25 percent of the farmer's home to local market distance have ranged up to 2 km, while 16.25 percent of the farmers home to local market distance ranged from 2.1 km to 4 km and 7.50 percent of the farmers home to local market distance above 4 km.

The ability of a farmer to optimize yield with a particular combination of the inputs and production technology is reflected in technical efficiency. Next, the degree to which a farmer deviates from the frontier of optimal practices is used to quantify technical inefficiency. Regression coefficients for the costs of seeds (X_1), machinery (X_4), and chemical fertilizer (X_5) were all positive and highly significant at the 5% significance level. The regression coefficients of Hired labor cost (X_3) was positive but insignificant. But the coefficient of Family labor cost (X_2), Irrigation cost (X_6) and Insecticide cost (X_7) had been negative. However, it shows that 1% percent increase in the costs of seeds (X_1), machinery (X_4), and chemical fertilizer (X_5) would result in a corresponding increase in maize revenue of 0.357, 0.110, as well as 0.103 % for the group of farmers. Educational background, family size, training, livestock, and membership are expected to have negative coefficients in the technical inefficiency effect model. Although the regression coefficient of years of age is negligible, the negative coefficient of age suggests that older farmers are theoretically more productive than younger farmers. The negative coefficient of education implies that more years of schooling is associate with efficiency of the farm, however the regression coefficient of education is insignificant. The larger family size is technically more productive than the smaller family size, according to the negative coefficient along with 5 percent significance level of family size. According to the training's negative coefficient and significance level of 1%, farmers who receive training are theoretically more productive than those who don't. The fact that livestock has a negative coefficient and is significant at the 5% significance level suggests that farmers who own livestock are, in technically, more productive than those who do not. The hypothesis that farmers who participate in multiple social groups are technically more efficient compared to those who do not is supported by the membership's negative coefficient and significance level of 10%. Despite the fact that the farm size coefficient is significant at the 5% level, the positive coefficients of farm size imply that farm size has no bearing on the technical inefficiencies of maize production. According to the extension service's positive coefficients, there is no effect of extension services on the technical inefficiencies in maize production. In other words, this factor has no effect on the technical inefficiency of maize production. With the same amount of inputs, the yield of maize could be raised by 7% without adding to the cost, according to average projected technical efficiencies of 93%. Merely improving managerial abilities leads to a notable rise in the production of maize. It was discovered that 57.5 percent of the sample farmers had outputs that, while still maintaining the efficiency level of 96–100, were extremely close to the maximum frontier outputs. The technical efficiencies were found to range from 55.8 to 99.8 percent at the minimum and maximum, respectively, with a standard deviation of 8.6.

There were numerous challenges for farmers in growing maize. The issues encompassed financial, technical, social, and cultural aspects. One of the biggest issues with growing maize in the focus area was the high cost of high-quality seed. The main issues that producers had to deal with were natural disasters, expensive labour costs, high rental fees for agricultural equipment, low availability of credit, pest and disease attacks, fertilizer counterfeiting, insufficient extension services, low grain prices, and an absence of scientific knowledge. These are the principal obstacles facing the study area's maize producers. To improve maize production, private as well as public efforts should be made to lessen or eradicate these issues.

8.3 Conclusion

After rice and wheat, maize is among the three most commonly grown grains crop in Bangladesh. The current study's findings support the view that there is clearly room for improvement in the focus region's maize productivity. Despite substantial potential for maize cultivation in the study areas, increasing production by expanding the land under cultivation is difficult due to a decrease in available land. However, production can still be boosted by enhancing existing technology. Currently, farmers' inefficiencies, including traditional farming practices, illiteracy, and extension service contribute to their technical inefficiency. By making use of the prevailing resources, services for extension, alongside equipment available, this inefficiency offers a chance to greatly increase production levels. A thorough analysis of the current and projected demand for maize is required before launching an extensive national programme for its production.

8.4 Recommendations

The study reveals that maize farmers encounter several challenges. The decision-makers ought to propose the required actions. The study's conclusions allow for the specific recommendation that follows for the expansion of maize production.

a. Farmers should receive a reasonable price reduction on quality seed. To encourage farmers to grow maize, subsidies for the purchase of seed should be made available. However, to increase productivity, it is necessary to develop maize varieties that can withstand heat, salinity, and drought.
b. Maize cultivation relies heavily on labor, resulting in high labor costs for farmers. Therefore, it is essential to implement measures that promote farm mechanization, given the potential for increased machinery usage.
c. Farmers should be urged to apply more fertilizer at the suggested rate in order to increase maize productivity.
d. To increase the productivity and technical efficacy of maize, maize farmers should receive adequate extension services on better technology adoption.
e. Sufficient training on the correct usage of fertilizer, use of pesticides, use of premium seed, cross-cultural operations, etc. should be provided to maize farmers. By enhancing the farmers' technical expertise, this would boost output and technical efficiency.
f. To boost productivity and technical efficiency, household members should engage in supplementary income-generating activities that can support investment in agricultural farming activities.
g. To enhance productivity and technical efficiency, it is crucial to prioritize effective farm management.
h. To enhance productivity and technical efficiency, farmers should be encouraged to engage in livestock rearing, which can contribute to an improved standard of living.
i. In order to boost productivity and technical efficiency, it is advisable to promote farmers' engagement in various social organizations that can enhance their skills and aid with establishing diverse nonfarm activities.
j. Weather is a big factor for maize production. Large-scale production is destroyed by floods, excessive rain, and other natural disasters. The farmer will benefit if weather forecasting

technology, such as mobile phone apps, is introduced since they would be able to take preventative measures to safeguard the maize field.

8.5 Constraints of the Research

There are certain constraints to the study. Some of these are as follows:

a. Most of the information was gathered through interviewing farmers, however occasionally they exhibited little interest to respond.
b. The farmers' recollections, which weren't always reliable, accounted for the majority of the information that was assembled. There might be some room for erroneous.
c. In-depth research was somewhat impeded by the time and resource limitations.

8.6 Potential Areas for Future Research

The present study does not come without criticism, despite the fact that it is intended to provide some helpful guidance for producers, extension personnel, lawmakers, and even investigators. Certain important topics could not be covered in this study because of time as well as financial constraints. Naturally, the present study's limitations create opportunities for additional research, some of which are listed below

a. The current study was limited to two upazilas. A similar study might be carried out and include data from various geographical regions of the country.
b. It is possible to undertake research on the comparative productivity and profitability of various crops.
c. In Bangladesh, maize output can be evaluated in terms of acreage response, growth, and instability.

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APPENDICES

Table A-1: Average Unit Price and Quantity Per Hectare

Items	Quantity (kg/ha)	Price per unit (Tk/kg)
Family labor	73	511.25
Hired labor	37	
Seed	19.10	528.56
Machinery usage		19978
Urea	372.88	22.2
TSP	481.95	22.2
MoP	167.13	15.3
Irrigation		5561.08
Insecticide		6339.76
Yield		
Maize	7768.85	29.78
Cattle feed		726.34
Maize stalk		

Table A-2: Summary Statistics of Different Variables

Variable	Obs	Mean	Std. Dev.	Min	Max
lnfamilyla~t	80	10.31493	.7067765	8.50512	11.48283
lnhiredlab~t	80	8.362117	3.594582	0	10.82891
lnmachiena~t	80	9.829082	.427768	8.50512	10.30871
lnseedcost	80	9.297986	.326921	8.322799	9.817307
lnchemical~t	80	9.94576	.2548608	8.891355	10.43099
lnirrigati~t	80	8.5974	.2139584	7.880966	9.554943
lninsectic~t	80	8.727225	.2477539	7.986327	9.084939
age	80	45.9625	14.42259	21	75
education	80	5.4125	3.092227	0	15
familysize	80	5.2375	1.780654	2	11
farmsizeha	80	.3841093	.3235337	.0566802	1.700405
training	80	.5875	.4953901	0	1
extensions~e	80	.4125	.4953901	0	1
distancefr~t	80	1.75625	1.290162	.5	5
livestock	80	.4875	.5029973	0	1
membership~g	80	.475	.5025253	0	1

Table A-3: Correlation Matrix

	lnfami~t	lnhire~t	lnmach~t	lnseed~t	lnchem~t	lnirri~t	lninse~t
lnfamilyla~t	1.0000						
lnhiredlab~t	-0.6159	1.0000					
lnmachiena~t	-0.4848	0.4387	1.0000				
lnseedcost	-0.1675	0.2045	0.3683	1.0000			
lnchemical~t	-0.1079	0.1998	0.1336	0.4412	1.0000		
lnirrigati~t	-0.0059	-0.1210	0.1814	-0.2654	-0.2832	1.0000	
lninsectic~t	-0.3198	0.3301	0.3139	0.1563	0.2414	0.1368	1.0000
age	-0.3527	0.1047	0.4199	0.2123	-0.0818	0.2454	0.2005
education	-0.1303	-0.0117	0.0197	0.0269	0.1226	-0.0410	0.1153
familysize	0.0907	-0.0873	0.0285	0.1437	0.1647	0.1388	0.1938
farmsizeha	-0.8841	0.4476	0.4440	0.2013	0.1091	0.0058	0.3406
training	-0.2282	0.2503	0.1946	0.1892	0.1833	0.0123	0.2219
extensions~e	-0.5493	0.3441	0.3651	0.1373	0.0919	0.1540	0.1741
distancefr~t	0.0480	0.1620	-0.0115	0.1143	0.4731	-0.0518	0.1839
livestock	0.0699	-0.0523	0.2042	0.1878	0.2216	0.0427	0.1315
membership~g	-0.1001	-0.0100	0.1485	0.3033	0.1942	-0.0907	0.2539

	age	educat~n	family~e	farmsi~a	training	extens~e	distan~t
age	1.0000						
education	-0.0104	1.0000					
familysize	-0.0085	0.1981	1.0000				
farmsizeha	0.3029	0.1752	0.0742	1.0000			
training	0.3947	0.0712	0.0694	0.2727	1.0000		
extensions~e	0.5177	0.0693	0.1458	0.5654	0.4958	1.0000	
distancefr~t	-0.1005	0.2508	0.1715	0.0651	0.1279	0.0009	1.0000
livestock	0.1387	0.0318	-0.1026	-0.0010	0.0552	0.0464	0.1172
membership~g	0.1474	0.1167	0.1977	0.1610	0.1360	0.2199	0.0246

	livest~k	member~g
livestock	1.0000	
membership~g	0.1740	1.0000

Table A-4: Link Test

Stoc. frontier normal/half-normal model — Number of obs = 80; Wald chi2(2) = 265.14; Prob > chi2 = 0.0000

Log likelihood = 42.777937

lnrevenue	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
_hat	-3.053901	12.38498	-0.25	0.805	-27.32802	21.22022
_hatsq	.170538	.5013063	0.34	0.734	-.8120044	1.15308
_cons	24.10541	76.47735	0.32	0.753	-125.7874	173.9983
/lnsig2v	-8.466097	1.206983	-7.01	0.000	-10.83174	-6.100454
/lnsig2u	-2.598492	.1693325	-15.35	0.000	-2.930377	-2.266606
sigma_v	.0145081	.0087555			.0044455	.0473482
sigma_u	.2727374	.0230917			.2310344	.321968
sigma2	.0745962	.0125461			.0500062	.0991862
lambda	18.79898	.0263254			18.74739	18.85058

LR test of sigma_u=0: chibar2(01) = 26.53 Prob >= chibar2 = 0.000

Appendix-B: Research Questionnaire

An Interview Schedule for the Study Entitled

Productivity and Technical Efficiency of Maize Producing Farms Across Different Farm Sizes in Some Selected Areas of Munshiganj District in Bangladesh

Serial number: [ ] **Date:**

Dear Respondent,
All of your information will be kept confidential and will be used for research purpose only.
Please provide the following information.

A. General information

Respondent's Name: ....…………………………………………………………...........

Address: Village: ……..………..…….……… Upazila: …………………..………………..

District: ………………….……….. Mobile: ……………………..………………

B. Socio-economic information

1. Household Information

Name of Household Member	Relation with Respondent	Age (Years)	Years of Schooling	Sex (M/F)	Sources of income		Yearly Income (Tk)	
					Main	Subsidiaries	Main	Subsidiaries
Respondent	Self							

(Use code: Crop Farming= 1, Livestock Rearing=2, Fish Farming=3, Day labour=4, Service=5, Business =6, Remittances=7, House Rent= 8, Others=9

2.

Owner cultivation of maize (decimal)	Tenant cultivation of maize (decimal)

3. **Farm Size**

Types of Land	**Area (decimal)**
Homestead land	
Own cultivable land	
Mortgaged in land	
Mortgaged out land	
Rented in land	
Rented out land	
Leased in Land	
Leased out land	
Pond	
Fallow	
Total	

C. Productivity related information

4. **Cost of production (a) Human labour use**

Activities	Types of labour	Man-days	Wage rate (Tk./day)	Total Value (Tk)
1. Land preparation	a. Family			
	b. Hired			
2. seed sowing rates	a. Family			
	b. Hired			
3. Weeding	a. Family			
	b. Hired			
4. Irrigation	a. Family			
	b. Hired			
5. Applying fertilizer	a. Family			
	b. Hired			
6. Applying insecticide or others	a. Family			
	b. Hired			
7. Harvesting	a. Family			
	b. Hired			
8. Threshing	a. Family			
	b. Hired			
9. Drying and storing	a. Family			
	b. Hired			

(b) Machinery Inputs

Purpose of use	Types of ownership	Unit	Cost/unit	Total Cost (Tk.)
1. Land preparation (Power tiller / Tractor)	a. Owned			
	b. Hired			
2. Harvesting (Corn harvester)	a. Owned			
	b. Hired			
3. Carrying (Tractor / Power tiller / Van)	a. Owned			
	b. Hired			
4. Threshing (Thresher)	a. Owned			
	b. Hired			
5. Others (specify)	a. Owned			
	b. Hired			

(c) Materials Inputs

Inputs (unit)	Types	Quantity	Unit	Price/unit	Total Value (Tk.)
1. Seed (Kg)	a. Home supplied				
	b. Purchased				
2. Transport cost (TK)	a. Marketing				
	b. Buying inputs				
3. Manure	a. Home supplied				
	b. Purchased				
4. Fertilizer (Kg)	Urea				
	TSP				
	MoP				
	Gypsum				
	Zinc sulphate				
	Boric acid				
5. Irrigation					
6. Insecticide (Liter)					
7. Others (Specify)					
8.How much cost incurred for rental house per month? OR, if it is your own house how much will be the rent if you rent the house?					

5. Return from maize cultivation

Output(s)	Quantity (Kg)	Price (TK/Kg)	Total income (Tk)
Maize			
Cattle feed (Maize leaves)			
Maize stalk			

6. Annual Expenditure (Tk)

Purpose	Unit	Expenditure (Tk)
a. Consumption expenditure		
i) Food	Weekly	
b. Non-food expenditure		
i) Housing	Yearly	
ii) Cloths	Yearly	
iii) Education	Yearly	
iv) Medical	Yearly	
v) Festivals	Yearly	
vi) Others (If any)	Yearly	

D. Technical Efficiency Related Information

7. Maize Farming Experience: ………………Years

8. Do you receive any training on agriculture? Yes / No

9. Do you have access to extension service? Yes / No

10. Do you receive any agricultural credit? Yes / No

If Yes: Source of Loan? Bank / NGO / Relatives / Others

Amount of Loan (last year): ………………… Taka

11. What is the distance from home to local market: .... Km

12. Do you have livestock: Yes / No

13. Do you a member on any social organizations? Yes / No

14.Please mention the problems in maize cultivation

I. High price of quality seed
II. Natural calamities
III. Inadequate extension service
IV. Lack of credit facility
V. Lack of technical knowledge
VI. Low Price of Grains
VII. High Labor Cost
VIII. Adulteration of fertilizer
IX. High Rent Charges of Agricultural Machinery
X. Attack of Pest and Disease

Thank you for your nice cooperation