PROFITABILITY AND TECHNICAL EFFICIENCY OF POTATO PRODUCTION IN SOME SELECTED AREAS OF MUNSHIGANJ DISTRICT IN BANGLADESH

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CERTIFICATE

This is to certify that thesis entitled, ***"PROFITABILITY AND TECHNICAL EFFICIENCY OF POTATO PRODUCTION IN SOME SELECTED AREAS OF MUNSHIGANJ DISTRICT IN BANGLADESH "*** *submitted to the Faculty of Agribusiness Management, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of* ***MASTER OF SCIENCE IN AGRICULTURAL ECONOMICS,*** *embodies the result of a piece of bona fide research work carried out by* ***MOSHIUR RAHMAN****, Registration No.* ***13-05643*** *under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.*

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

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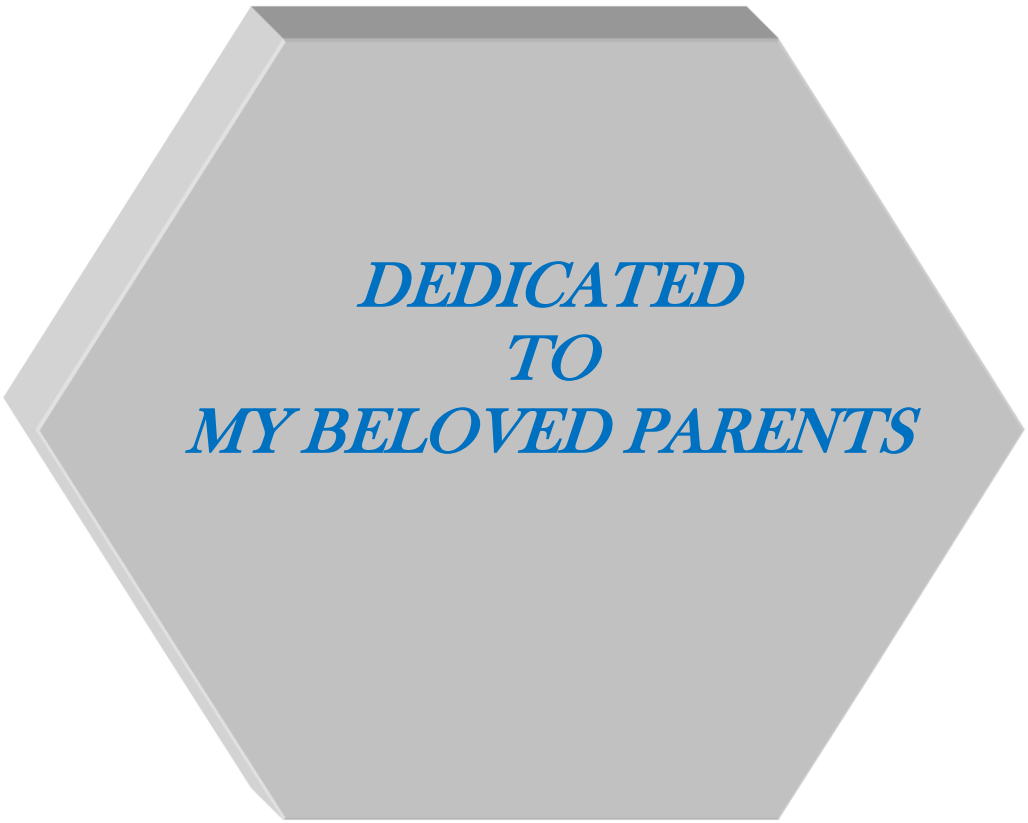
DEDICATED
TO
MY BELOVED PARENTS

ABSTRACT

Bangladesh is predominantly an agricultural country. Agriculture has an enceinte contribution to the Gross Domestic Product (GDP) of the country. Various types of crops are produced in this country. These crops can be categorized into two; food crops and cash crops. Potato is one of the food-stuff of the most people of the world as well as Bangladesh. This research was conducted to find out the problems that the farmers face in cultivation and to study the trend of production of potato and relationship between production and export of potato of Bangladesh. The study aimed to analyze the technical efficiency and profitability of potato production by smallholder farmers in Munshiganj district. A total of 60 farmers were selected randomly from the study area. Data were collected through farm survey by using a suitable pre-tested questionnaire in December 2019-January 2020. Profitability analysis, Cobb-Douglas production function, VP, FC and Net return model were used to analyze the objectives. The major findings of the study reveal that potato production is profitable. Average gross return, gross margin and net return were found Tk. 2,23,202.71, Tk. 1,40,324.91 and Tk. 89,045.35, respectively. Benefit-cost ratio was found 1.66. The key production factors, i.e. human labour, land preparation, seed, fertilizer, insecticides and irrigations had significant effect on gross return of potato. In the technical inefficiency effect model experience, farm size, training and credit service have expected (negative) coefficients. The negative coefficient of farm size implies that large farm households are technically more efficient than small farm households. The negative coefficient of credit service postulates that farmers taking loan for producing potato are technically more efficient than others. The coefficient of training implies that training farmers are technically more efficient than non- training farmers. The positive coefficient of extension service is positive meaning that these factors have no impact on the technical inefficiency. That is, these factors do not reduce or increase technical inefficiency of producing potato. Major problem faced by the potato farmers were lower price of potato during harvesting period, price fluctuation, shortage of capital, high charge of cold storage, lack of good quality seed, perish ability of potato, poor storage facility, higher price of inputs and lack of marketing facility etc. Proper steps should be postulated by Government to puzzle out this problem. At long last it will be helpful to the planners and policy makers in contriving micro or macro level policy for the enlargement of potato production in the country.

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ABBREVIATIONS AND ACRONYMS

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

CHAPTER 1
INTRODUCTION

1.1 General Background

British governor promoted potato cultivation in Bengal in the 1770s, and within a century it was a well-established garden vegetable. However, large scale production was held back by the lack of suitable varieties: European cultivars were not adapted the hot Bengali plains. Today, the potato has become a highly successful October-March winter crop in Bangladesh, with a production value second only to that of paddy rice (Source: www.potatopro.com).

Bangladesh is predominantly an agricultural country, and about 80 percent of her populations live, directly or indirectly, on income derived from agriculture. It has a very rich alluvial soil and moderate climate congenial to the growth of various agricultural crops throughout the year. Economy of this country is almost entirely dependent on agriculture that supplies raw materials for industrial production and food-stuff for human and animal consumption.

(Source:https://www.worldbank.org/en/results/2016/10/07/bangladesh-growing-economy-through-advances-in-agriculture).

Bangladesh, though an agricultural country, cannot produce enough food to feed her own population and has to import lakhs of tons of food grains each year. Such imports cost huge amount of foreign exchange which causes serious drainage of her economy. Two reasons are mainly responsible for the unfavorable food situation in Bangladesh. Firstly, the population is growing at an alarming rate and secondly, the rate of agricultural production per hectare is deplorably low. In fact, Bangladesh is one of the thickly populated regions in the world. Rice is the staple food crop in Bangladesh. But increase in the production of rice has not been able to keep pace with the increase in population. In spite of dominance of agriculture in the national economy, Bangladesh is facing chronic food shortage due to rapid growth of population and has to import on an average 1.5 million tons of food grains in each year (BBS, 2002). The present rice and wheat production are not sufficient to meet the increasing requirements of calories for the growing population of the country. In this regard, potato can play an important role as an alternative and multipurpose food crop of Bangladesh. Potato is the leading

vegetable crops in the world which occupy the top most position after rice and wheat both in respect of production and consumption (Thompson and Kelly, 1957).

Potato is produced in 132 countries out of 193 independent countries of the world. At present, at least 40 countries eat potatoes as a staple food (Islam, 1987).

Potato (alu) edible tuber of the cultivated plant Solanum tuberosum of the family Solanaceae. It was the major CROP for the original Americans. It is now one of the staple foods in Bangladesh. Its history is difficult to trace, partly because the name potato was also used by early writers for the sweet potato (Ipomoea batatas) and for other unrelated plants. Spanish explorers are believed to have brought it in the 16th century from Peru to Spain, whence it spread north and west throughout Europe. European settlers brought it to North America probably around 1600 AD; thus, like the closely related POTATO, it was a food plant reintroduced to the New World. Potato was first accepted as a large-scale crop in the British Isles. (Source: banglapedia.org)

It became the major food in Ireland during the 18th century and is hence often called Irish potato to distinguish it from the sweet potato. Potato was also important for 20th century Europe, especially for Germany, where it kept the country alive during two world wars. With its high carbohydrate content, potato is today a primary food of Western peoples, as well as a source of starch, flour, alcohol, dextrin, and fodder (chiefly in Europe, where more is used for this purpose than for human consumption). It grows best in a cool, moist climate; the greatest potato producing counties are the United States (mostly in Maine and Idaho), Germany, Russia, Holland, and Poland. (Source: banglapedia.org)

It is not known exactly when potato was introduced in this subcontinent. It is assumed that at the beginning of the 17th century the Portuguese navigators first brought potato to India. The first record about the cultivation of potato in India is seen in an 1847 issues of The Gardening Monthly, a magazine published from London. Initially, potato was cultivated in areas around Calcutta, from there its cultivation spread to Cherapunjee. When Warren Hastings was the governor (1772-1785), potato cultivation spread to many provinces of India, including Bombay, through his initiatives.The potato plant is a herbaceous annual, normally propagated by planting pieces of tubers that bear two or three eyes. Nutritionally, the tuber is rich in carbohydrates or starch and is a good source of protein, vitamin C and the B vitamins, potassium, phosphorus, and iron. Most of the

minerals and protein are concentrated in a thin layer beneath the skin, and the skin itself is a source of food fiber.

1.2 Present Status of potato in Bangladesh

The suffering of potato growers is increasing day by day even though their yield is high, as they are stuck with surplus stocks and low exports. Bangladesh is the seventh largest producer of the tuber crop. It produced a record high of 1.09 crore tonnes last year, according to the Department of Agricultural Extension (DAE).

With an annual average demand of around 70 lakh tonnes, the country witnessed a surplus of about 40 lakh tonnes, most of which is wasted. Not all of the surplus can be stored in the cold storages for low capacity. For a lack of better use of the surplus, farmers are left with no option but to feed these potatoes to cattle.

Russia and the European Union were potential markets for Bangladeshi potatoes, but those opportunities ended in 2015-16 when Russia found diseases in potatoes exported from Bangladesh and issued a temporary ban. The Russian Federal Service for Veterinary and Phytosanitary Surveillance said the potatoes from Bangladesh were infected by brown rot disease and potato tuber moth, as there is no accredited or standard lab in Bangladesh to test the quality of potatoes. Bangladesh's export of potato, the world's fourth largest food crop after maize, wheat, and rice, reached a record high of over 100,000 tonnes in 2013-14, plummeting to 53,000 tonnes last year. It was 27,811.6 tonnes till April 2019.

Bangladesh exports potatoes to Malaysia, Sri Lanka, Benin, Vietnam, Canada, Bahrain, Qatar, Myanmar, Nepal, Oman, Kuwait, Brunei, Saudi Arabia, United Arab Emirates and Singapore. Russia has a demand for 2.6 crore tonnes of potatoes a year, facing a shortage of 50 lakh tonnes, said market sources. Bangladesh exported more than 20,000 tonnes of the crop to Russia -- out of 103,000 tonnes of potatoes exported in 2013-14 -- according to the agriculture ministry.In 2015, Russia stopped importing from Bangladesh and suggested the latter to upgrade its phytosanitary system, security measures to prevent the use of fake phytosanitary certificates, and maintain proper inspection at ports to ensure shipment of safe agricultural produce. The production of

potatoes is increasing gradually in Bangladesh, and so is the surplus, according to data from DAE. We should focus more on markets in Asia and the Middle East.

Table 1.1: Potato Production in Bangladesh

Year	Cultivable land (In Lakh Hectors)	Production (In Lakh Tons)	Export (In Tons)
2012-13	4.44	86.03	28,416
2013-14	4.62	89.50	102,983.564
2014-15	4.71	92.83	90,490.967
2015-16	4.75	94.47	40,239.405
2016-17	4.99	102.16	55,652.38
2017-18	4.77	97.44	53,485.639
2018-19	**4.69**	**109**	**27,811.602(till April)**

Source: DAE

1.3 Several varieties of Potato

Varieties several hundred varieties of potatoes are grown in the world. These differ in appearance, tuber structure, size and colour, time of maturity, cooking and marketing qualities, yield, and resistance to pests and diseases. A variety that grows well in one area may do poorly in another. Potato varieties that are cultivated in Bangladesh are broadly categorized into two groups, local and high yielding. The so-called local varieties are in fact, not strictly native. In the distant past those were brought to this part of the subcontinent but in the absence of varietal improvement efforts, gradually degenerated, showing poor yield performance. In spite of poor yields, some of the local varieties are still being cultivated because of their taste and cooking qualities.

There are about 27 local varieties of potatoes cultivated in different parts of the country. They have familiar local names. The familiar local varieties are (a) Sheel Bilatee- mostly cultivated in Rangpur. The tuber is oblong, reddish. Each tuber weighs about 30 g. (b) Lal Sheel- primarily cultivated in Bogra with tubers rounded, reddish, each having a weight of about 55 g. This variety is also known as Lal Madda and Bograi. (c) Lal Pakri - cultivated widely in Dinajpur, Bogra and Sirajganj districts with tubers reddish and round, each weighing about 30 g. (d) Du Hajari - mostly cultivated in the

Chittagong area. Tubers appear round and pale, each weighing about 25 g. Among other indigenous varieties Diamond, Stick and Cardinal are notable.

In the last few decades, several dozens of high yielding varieties (HYV) of potato were brought to Bangladesh and tried experimentally under local conditions before being recommended for general cultivation. During the 1970s, about 16 varieties were initially selected, but subsequently 10 were dropped. Through constant evaluation of the traits, varietal performance, and considerations of other characteristics, about 10 HYV have been released for cultivation in the country. However, huge amount of potato seeds are imported every year by the Bangladesh Agricultural Development Corporation (BADC) for distribution among farmers.

Bangladesh Agricultural Research Institute (BARI) has also established a farm at Debiganj in Panchagar district for production of HYV seed potatoes. Among the high yielding popular varieties the following are notable: (a) Cardinal- probably most popular among the foreign varieties with oblong, reddish tubers, shallow eyes, and smooth skin. The variety has been introduced from Holland and has yield potential of 20-25 m tons per ha. (b) Diament - another Holland variety with oval to oblong, pale yellow tubers, skin smooth, and eyes shallow.

It is quite disease resistant. Per hectare yield ranges from 18-24 m tons. (c) Bhutan - tubers reddish, round, and eyes deep with rough skin. This variety was introduced from India and is comparatively less susceptible to pests and diseases. It has a yield potential of 18 to 22 m tons per ha. Other notable exotic varieties are stick, Saata, Diamond, Holland etc.

Cultivation Potato is widely cultivated in all the districts of Bangladesh during winter. Of the total 3,36,740 acres (1,36,332 ha) of land used for potato cultivation during 1997-98, 1,13,540, 2,18,445, and 4,755 acres were for local, high yielding, and Indian varieties respectively. Well-fertilized, sunny land with sufficient moisture in soil is appropriate for potato plantation. The first fortnight of November is the right time. In certain northwestern areas, farmers even plant potato in October to harvest the crop early. Virtually all potatoes in this country are planted manually.

On the basis of the soil quality and potato variety farmers determine the spacing in between the seed tubers and the adjacent rows. Row spacing is usually from 45 to 60 cm. Optimum depth of planting depends on temperature and moisture of the soil, probable weather following planting, and mode of conducting field operations later.

If planting is shallow and only about 5 cm deep, the soil must be gradually ridged over the row incidental to cultivation. This ensures that the developing tubers are well covered with soil to protect them from light and pests. Mulching is frequently done over the rows with water hyacinth, straw etc to preserve the soil moisture and to prevent the growth of weeds.

Production as the potato plants become mature and the tubers are fully formed, the leaves become gradually yellowish and then brownish, and finally the plants die. It is always better to harvest the crop after these signs are evident in the field. Most varieties are harvested in this country during February-March. Collection of the tubers is usually done in Bangladesh manually using a spade or other devices.

1.4 Nutritive, Medical Value of Potato

Potatoes are an excellent source of many vitamins and minerals. One medium baked potato (6.1 ounces or 173 grams), including the skin, provides.

Table 1.2: Biochemical Substances of Potato

Name of substances	Quantities
Calories	161
Fat	0.2 grams
Protein	4.3 grams
Carbs	36.6 grams
Fiber	3.8 grams
Vitamin C	28% of the RDI
Vitamin B6	27% of the RDI
Potassium	26% of the RDI
Manganese	19% of the RDI
Magnesium	12% of the RDI
Phosphorus	12% of the RDI
Niacin	12% of the RDI
Folate	12% of the RDI

Source: healthline.com

The nutritional content of potatoes can vary depending on the variety and how they are prepared. For example, frying potatoes adds more calories and fat than baking them. It's also important to note the skin of the potatoes contains a great amount of the vitamins and minerals. Peeling potatoes can significantly reduce their nutritional content.

a. Contain Antioxidants

Potatoes are a good source of antioxidants, which may reduce the risk of chronic diseases like heart disease, diabetes and certain cancers. However, more human-based research is required before making any recommendations.

b. May Improve Blood Sugar Control

Potatoes contain resistant starch, which may help reduce insulin resistance. In turn, this can help improve blood sugar control.

c. May Improve Digestive Health

Resistant starch in potatoes is a source of nutrition for beneficial gut bacteria. They convert it to the short-chain fatty acid butyrate, which has been linked to reduced inflammation in the colon, improved colon defenses and a lower risk of colorectal cancer.

d. Naturally Gluten-Free

Potatoes are naturally gluten-free, which makes them an excellent food choice for people with celiac disease or a non-celiac gluten sensitivity.

e. Incredibly Filling

Studies have shown that potatoes are among the most filling foods. They may increase the levels of fullness hormones, such as cholecystokinin (CCK).

f. Extremely Versatile

Potatoes are delicious, versatile and easy to add to your diet. Try boiling, baking or steaming them and consuming them with the skin intact.Potatoes are rich in vitamins, minerals and antioxidants, which make them very healthy. Studies have linked potatoes and their nutrients to a variety of impressive health benefits, including improved blood sugar control, reduced heart disease risk and higher immunity. They may also improve digestive health and combat signs of aging.

1.5 Export Earning of Potato

The fact that the country produces close to 11 million tonnes of potato annually - a surplus of approximately 4.0 million tonnes is no mean achievement. The shocking part, however, is that most of the surplus stock which could have fetched substantial earnings from export gets wasted. While dearth of adequate storage facilities denies the growers luck from bumper harvest, absence of effective steps on the part of the concerned authorities to facilitate overseas marketing is responsible for the useless glut. For some years now, good harvest of potatoes has turned out to be the cause of the growers' misery. While concerned quarters put it on lack of planning, which among others includes dearth of sufficient storage facilities in the vicinities of potato growing areas, the burden of bumper harvest falls squarely on the farmers who are extremely ill at ease with their produce in a severely underpriced domestic market. Not only potatoes, the same are often the case with some other horticulture products such as potatoes, leafy vegetables, pineapples etc. The case of potatoes is perhaps more distressing than the others.

In Bangladesh most of the potatoes consumed is unprocessed. Only 2% of the potatoes are processed to mainly chips and crackers. Bangladesh Agriculture Research Institute (BARI) has so far developed 44 potato varieties. But the majority of Bangladesh's potato production is used for direct consumption. The varieties used for table potatoes are not appropriate for processing (the dry matter content is too low) or export (foreign consumers have different tastes). Moreover, the quality of the potato seed also an influencing factor, the formal sector seed potato production is only 5-9% of the total requirement. Both private and public sector together supplies only 5% quality seed of the total requirement. Remaining 95% is the low quality seed potato which is produced by the farmers themselves. The low quality seed produce is not preferred for processing and export.

Though the record amount of potato is produced, but the quantity of export is not considerable. According to Bangladesh Bureau of Statistic, the revenue generated from exporting potato was $33.8 million in 2013-2014 financial year where the amount came down to $13 million in 2016-2017 financial year.

Currently, there are only a few, around 8-10 established private companies that export fresh or processed potatoes, mostly to Singapore, Malaysia and the UAE and very recently to Russia, Vietnam and Sri Lanka.

Bangladeshi company to export 20,000 tons of potatoes in 2017. PRAN, a processed food company in Bangladesh, has started exporting potatoes for the second year, setting the export target for this year at 20,000 tonnes (source: businessnews24bd.com). The first consignment of 52 tonnes of potatoes was sent to Malaysia on February 9 through Chittagong port, said a press release today.The potatoes are grown by PRAN's contract farmers. Now, PRAN has around 2000 farmers who cultivate potatoes in Dinajpur, Rangpur, Joypurhat, Kurigram and Thakurgaon districts.

PRAN provides quality seeds and fertilizer at a low cost to the farmers to grow quality potatoes."PRAN exports quality potatoes as we give training, technical support and modern varieties to contract farmers. Farmers are benefiting as we purchase potatoes at a fair price," said Mahatab Uddin, chief operating officer at PRAN Agro Business Ltd. "We offer a buy-back guarantee to the farmers so that they feel encouraged to grow potatoes," he said, adding that collection and packaging of the potatoes is done according to International standards.

1.6 Production of Potato in Munshiganj District

Potato-growers of Munshiganj district, which is known as the country's key potato farming zone. Despite a lower production of potatoes this year, farmers are making a profit owing to the quality yield and the demand remaining unchanged in Munshiganj.

According to the local Department of Agriculture Extension sources, the storms delayed potato cultivation this season and farmers have taken up cultivation of corn and summer vegetables as they suffered huge loss in potato cultivation last year.However, potato farmers have yielded quality potatoes this year without ringworms or other diseases. On top of that, as the demand of potatoes remains unchanged; farmers have been able to make profits as much as twofold this year.

Due to the fair prices of potatoes this year, many farmers were seen at Munshirhat bazar in Sadar upazila selling their potatoes. Potatoes are going for Tk530-540 per ton.According to District's Agriculture Extension Department, around five lakh tons of potatoes can be stored in 74 cold storages in the district. Farmers have to store the rest of the potatoes in traditional methods and need to sell them as early as possible. Last year, potato was cultivated in 38,300 hectares whereas this year it was cultivated in 37,600 hectares. DAE have set the target for this year at 13,27,000 tons, where as last year the district yielded 13,78,000 tons of potatoes. Due to the recent urbanization in Sreenagar, Sirajdikhan, and Gajaria upazila, farmlands are dwindling in number. Besides, this year farmers are more interested in cultivating summer vegetables and corn. This year vegetables were cultivated in 4,700 hectares which is 500 hectares more than last year. Munshiganj has always been ahead of other districts in terms of potato cultivation per hectare. Although several varieties of potatoes are cultivated here, the diamond variant is most common in the district.

1.7 Statement of the Problem

Agriculture plays a vital role in the economic development of the country. Agricultural development is considered to be a prerequisite for the economic development of most Asian countries. In Bangladesh, agricultural (mainly crop) production has remained constant over the past few years whereas population increased several times. At present, the Government of Bangladesh has to import some major crops and industrial goods. Although Bangladesh exports many agricultural products, the export earnings from these products are unable to pay the import costs. Consequently, balance of trade is always negative. The excess import costs are paid by foreign currency retained in the country and by foreign loans. Production of agricultural crops including potato will have to increase to boost the economy.As agriculture evolves, several factors ranging from institutional to economic, and from physical to natural calamities can limit agricultural development. An increase in potato production by increasing area is not possible since total cultivable area is decreasing day by day due to the increased use of land for non-agricultural purposes.

Production can be increased by increasing the technical efficiency of potato using existing technology. If farmers are found to be technically inefficient, production can be increased to a large extent using the existing level of inputs and available technology. A decline in agricultural production could also be caused by sub-optimal utilization of the existing technology or due to productive inefficiency. Several studies in other countries have shown that there is significant potential for raising agricultural output or profitability by improving productive (technical and allocative) efficiency using existing resources. Moreover, these studies have also indicated that there may be significant efficiency differentials between different groups of farms and between different regions among all farms and it should be possible to improve the performance of the less efficient farms or regions without major investment from outside at least in the short run. The possibilities of economic growth solely through the more efficient use of existing resources will obviously be exhausted when an efficient production technology is reached.

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

1.8 Objectives

Following specific objectives were formulated to give proper direction to the study:

1. To determine the socio economic condition of the potato growers in study area;
2. To measure the profitability of potato production;
3. To estimate technical efficiency of potato production and
4. To identify the major constrains associated with production of potato production and suggest the probable solutions.

1.9 Justification of the study

Agriculture sector continues to play a very important role in the economy of Bangladesh. It attained its modest growth and experienced in slow transition since independence. Thus, it is essential to ensure easy availability of agriculture inputs, execution of agriculture extension principle and modernization of research techniques government programs have been aimed at achieving self-sufficiency in food grain production. This illusive chasing toward self-sufficiency in food grain production led to adverse effect on the acreage and production of winter vegetables. As a result, the people of Bangladesh are suffering from severe malnutrition.

Potato is an important vegetable crop in Bangladesh. It covered 56 thousand hectares (about 10 percent of cultivated area) with a total production of 1550 Mt in 1999. Bangladesh experienced much progress in its potato production in the past decades; it has increased by 5 percent per annum.

However, cost of tuber seed is an important constraint in potato production. It accounts 35 to 40 percent of total production costs. Attempts were taken by the potato scientist to introduce True Potato Seed (TPS) technology to reduce substantial production costs and increase potato productivity. The present paper analyses productivity and resource use efficiency of potato production using TPS technology in the farmer's field under Bangladesh environment using Cobb-Douglas production function and input costs data. Also, it compared profitability of TPS technology with the traditional tuber technology. Data were gathered from a sample of 200 growers located in major potato growing districts of Bogra and Jessore of Bangladesh.

The study revealed that resource use and management varied in two productions systems of TPS and tuber technology causing variability in costs and returns. The TPS technology found to have a higher benefit-cost ratio (BCR) than the traditional technology. It was revealed from efficiency analysis that the potato growers using TPS technology allocated their resources in rational stage of production (i.e., Stage IE). However, there exists inefficiency in the uses of human labour, seed, manure and fertilizers in TPS technology and had a potentiality to increase potato output by 20 percent with efficient organization of resources.

1.10 Organization of the study

This study is consists of nine chapters which have been organized in the following sequences. After this Introduction, chapter-2 finishes a brief review of literature related to this study.chapter-3 provides information about the research design used in this study. A brief description of the study area is presented in chapter-4.Socioeconomic and demographic profile of the sample farmers have been presented in chapter-5. Chapter 6 presents costs, returns, and therefore profitability of potato production. Chapter-7 provides effects and resource use efficiency of inputs used. Chapter-8 information regarding constraints of potato production faced by the farmers and suggests possible solutions.Chapter-9 furnishes an executive summary of the overall study with policy recommendations.

CHAPTER 2
LITERATURE REVIEW

Literature review

Review of literature in any research is essential because it provides opportunities for reviewing the stocks of knowledge and information for the researcher which give a guideline in designing the future research problems. The purpose of this chapter is to review the results of some previously completed researches related to the present study. This study is concerned with the profitability and resource use efficiency of potato production. The economic studies on potato production are limited in Bangladesh. However, some of the important works regarding present study are viewed here.

Kiptoo *et al*., (2016) examined the technical efficiency of smallholder Irish potato farmers in Koibatek sub County, Kenya using data from 261 farmers. They used a Cobb-Douglas stochastic production frontier and Tobit models to estimate the farm level technical efficiency and the influencing factors respectively. The Results indicated that mean farm technical efficiency was 65.41 percent. This implies given the existing level of technology and inputs, output could be increased through better use of available resources.

Umar and Abdulkadir (2015) investigated the determinants of technical efficiency in potato production among small scale farmers in Ghana. Descriptive statistics was used to present the characteristics of potato producing households and the stochastic frontier analysis was used to estimate the determinants of technical efficiency and the inefficiency effect models. The analysis suggests average technical efficiency of 85.4%.In addition, factors such as extension services, land, frequency of weeding and fertilizer positively influenced technical efficiency of potato farmers. Conversely, factors such as pesticide, labor and the frequency of pesticide application had negative effects on technical efficiency**.** The average production of potato was approximately 3975.03 kg per household, which translates to a mean yield of approximately 1967.84 kg ha-1.

Jwanya *et al.* (2014) estimated technical efficiencies and identified the determinants of technical efficiencies of rain-fed Irish potato farmers in Plateau State, Nigeria. Data were analyzed using stochastic frontier production function. The study showed that technical efficiency ranges from 2.37 to 95.6 percent with a mean technical efficiency of 74 percent. This widely varying index of technical efficiency among the rain-fed Irish potato farmers indicates great potential to achieve productivity growth through improved efficiency using existing technologies and the available resource base in the study area. The determinants of technical efficiencies were education, farming experience, potato variety and off-farm income.

Rahman et al. (2014) studied about the technical efficiency of fresh water golda (Macrobrachium rosenbergii) farming in the coastal empoldered area of Bangladesh. The study used frontier production function and inefficiency model to analyze the cross-section data. The result showed that the inefficiency factors among the golda farmers were level of education, training and farm size.

Rahman et al. (2013) conducted a study to estimate the technical efficiency of maize production in Bangladesh. The study used activity budgeting technique to calculate profitability and stochastic frontier production function model to measure the efficiency of maize farming. It showed that the farmers' age, education and training had positive significant impact on efficient maize production.

Maganga (2012) examined empirically the technical efficiency of Irish potato producers of Dedza district, Central Malawi using cross section data from 200 farmers. Translog stochastic production frontier model was used to predict farm level technical efficiency using maximum likelihood method. He found that individual farm level technical efficiency was about 83%. His results showed that non-farm employment, education, farm experience, degree of specialization and weeding were positively related to technical efficiency and significant at 1% level, whereas, age and household size were negatively related to technical efficiency and significant at 5% and 10%, respectively. His result also revealed that there was no significant relationship between technical efficiency and extension visits and credit access.

Nyagaka (2009) carried out a study on Economic Efficiency of Smallholder Irish Potato Producers in Kenya: A Case of Nyandarua North District using stochastic frontier function. The Tobit model Tobit model is used to derive efficiency indices as a function of a vector of socio-economic characteristics and institutional factors. The result show decreasing returns to scale in production, education, access to extension, access to credit and membership in a farmers' association positively and significantly influence economic efficiency.

According to Noor-e-Alam Siddique (2008), potato has greater scope and potential for food security and poverty alleviation in Bangladesh.

Kakhobwe (2007) carried out an analysis of technical efficiency of mixed intercropping and relay cropping Agroforestry technologies in Zomba district in Malawi and a stochastic production model of parametric approach specified by Battese and Coelli (1995) to evaluate technical efficiency of Mixed and Relay cropping Agroforestry Technologies and identify factors that determine the technical efficiency of farmers.

The results revealed that larger proportion of the farmers practicing, and relay cropping Agroforestry technologies and NA produce maize below their frontier levels implying that farmers did not effectively use their resources in maize production. The study further revealed that age of household head and land fragmentation were the determinants of technical efficiency of relay cropping agroforestry technology.

T.S. Hyuha et al. (2007) analyzed the inefficiency in Uganda using stochastic profit and inefficiency function. The result showed that the rice farmers in Uganda were not in the profit frontier. The causes of inefficiency were low education and limited access to extension services.

Abedullah (2006) did a study on **"**Technical Efficiency and its Determinants in Potato Production, Evidence from Punjab, Pakistan" using Cobb-Douglas stochastic production frontier approach. The result showed that potato farmers are 84 percent technical efficiency implying significant potential in potato production that can be developed. There was high correlation between irrigation of the potato crop and

technical efficiency. However, it is different in terms of type of dataset used, focus area, some regressions used as well as geographical location.

Temesgen and Ayalneh (2005) examined the technical efficiency of farmers in the production of irrigated potato in Districts of Awi Zone in North-western Ethiopia. The Translog stochastic frontier production function was used for data analysis. Technical efficiency of farmers was estimated independently for the farms under modern irrigation schemes and traditional irrigation schemes. The mean level of technical efficiency was found to be 77 percent and 97 percent respectively for modern and traditional schemes. Therefore, improving the level of efficiency could raise productivity under modern schemes, whereas improving productivity under traditional schemes needs introduction of new technology as the farmers‟ level of production has approached the frontier. Irrigation experience, commodity rate of production and size of livestock are found to be the important variables that determine the level of efficiency.

Ahmed *et al.*, (2004) carried out a study on Cotton Production Constraints in Sudan: Economic Analysis Approaches". The main objective of the economic study was to identify, analyze and evaluate the major constraints of cotton production in the Gezira Scheme. To analyze technical efficiency the study employed a stochastic frontier model. Stochastic Production Frontier Analysis results revealed that 48 percent of cotton yield variability was due to tenant and scheme management specific factors. And that 25 percent of the variability was due to the tenants' technical inefficiency and 23 percent is due to the scheme management's inefficiency.

Rahman (2003) conducted a study to measure the profit among Bangladesh rice farmers. The analysis was done by using a stochastic profit frontier and inefficiency effect model. The results showed that there was 23% level inefficiency in modern rice cultivation. The efficiency differences were explained largely by infrastructure, soil fertility, experience, extension services, tenancy and share of non-agricultural income.

Quazi and Paul (2002) conducted a study on comparative advantages of crop production in Bangladesh. In their study, the economic profitability analysis demonstrates that Bangladesh has a comparative advantage in domestic production of rice for import substitution. However, at the export parity price, economic profitability of rice is generally less than economic profitability of many non-rice crops, implying that Bangladesh has more profitable options other than production for rice export. Several non-cereal crops, including vegetables, potatoes and onions have financial and economic returns that are as high as or higher than those of High Yielding Variety (HYV) rice.

Akhter et, al. (2001) conducted a survey on potato production in some selected areas of Bangladesh. This study showed that potato production is highly profitable and it could be provide cash money to farmers. In terms of profitability, potato production was more attractive than any other winter vegetables. Per unit yield and gross return of potato were found higher than other competitive crops.

Arif (1998) conducted a study on potato product on selected areas of Comilla district. He showed that the per hectare gross returns were TK. 101858.56 , 102358.56 and 101358.56 ; gross costs were TK. 64251.10, 65179.58 and 64741.42; net returns were Tk. 37607.46, 37178.98 and 366617.14 for small, medium and large categories of farmers respectively.

Banik (1994) carried out a study on technical efficiency of irrigated farms in a village of Bangladesh and used a stochastic production frontier. He used a Cobb-Douglas function and used the Maximum Likelihood estimates (MLE) method to estimate the parameters of the stochastic frontier Cobb-Douglas production function. The index of the technical efficiency level for each individual farm was calculated estimating the one side error component. The results showed that 88 out of 99 farms had a technical efficiency of 71 percent or above. A very interesting finding was that ten out of thirteen most efficient farms belonged to the category of small farms. The study also revealed that owner-tenant farms were technically more efficient than owner farms.

Hakim (1993) conducted a comparative economic study on Cardinal and multi varieties of potatoes in Bogra district. He found that per hectare total costs were TK. 32097.25 and TK. 30818.50 for Cardinal and multi varieties respectively. The costs were estimated at TK. 15896.15 and 12701.60. Net returns per hectare on full costs basis were TK. 45196.65 and 451.65.

Das (1992) conducted a study on the profitability of potato cultivation and found that the average yield of potato was 4720 kg per hectare and the average gross return amounted to TK. 33040 per hectare.

Sabur (1988) conducted a study on marketed surplus of potatoes in two districts of Bangladesh, he found that production and marketed surplus of potatoes moved in some positive direction. He observed that the average production cost per hectare was TK. 29635.57 and net return was TK. 30947.82.

Elias et al, (1982) studied improved technology of potato in two district of Bangladesh, Bogra and Munshiganj. They found that the yield per acre hectre was much higher Munshiganj (25009 kg) than that of Bogra (13278 Kg) they estimated average net return per hectre was TK. 7211 which was higher in Munshiganj TK. 8751 than in Bogra TK. 4953.

Elias et al. (1980) conduct an economic study on potatoes production in some selected areas of Bangladesh. They estimated the average per acre production cost of potato at Tk. 7376 and the average gross return at TK. 9931. They obtained average potato yield of 242 mounds per acre.

Research Gaps

The above-mentioned opinions evidently show that only a few studies were conducted on profitability analysis potato cultivation but no research was found in technical efficiency of potato. As far from the knowledge of the researcher, no profitability and technical efficiency of potato was conducted in my study area. The present study was, therefore, undertaken to determine the profitability and technical efficiency of potato and thereby to facilitate farmers and policy maker's decision making by providing information on potato cultivation.

CHAPTER 3
METHODOLOGY

3.1 Introduction

The word method originates from the Greek words meta and hodos which mean "a way" and methodology is thus defined as "the underlying principles and rules of organization of a philosophical system and inquiry procedure" (Amin, 2013). The methodology of the study is adopted by various steps to select the best method fit to attain the set objectives of research. Methodology is not a formula but set of practices. This chapter deals with the methodology used for the study which included the selection of study area, selection of samples, collection of data and analytical techniques. The farm management study usually involves with the collection of information on individual farmers. The reliability of a scientific research depends to a great extent on the appropriate methodology used in the research. The design of any survey is predominantly determined by the nature, aims and objectives of the study. This study was based on field level data where primary data were collected from different potato producers. There are several methods of collecting this basic information. For the present study farm survey method was adopted for collecting the primary data. The word "survey" refers to a method of study in which an overall picture of a given universe is obtained by systematic collection of all available data on the subject. There are three methods by which farm survey data can be gathered (Dillon and Hardaker 1993). These are:

i. Direct observation
ii. Interviewing respondents, and
iii. Records kept by the respondents

Since the farmers of Bangladesh do not usually maintain records and accounts of their farm operations, the second method was followed to achieve the objectives of this study. The survey method has advantages over other methods. This method is less expensive and its coverage is much wider. However, survey method is not free from drawbacks.

The drawback of this method is to rely on the memory of the respondents. To overcome this problem, repeated visits were made to collect data in the study area and in the case of any omission or contradiction; the farmers were revisited to obtain the missing and/or correct information. The selection of the study area, period of the study, sampling technique and sample size, preparation of the survey schedule, data entry and processing, and analytical techniques are given in the following section:

3.2 Selection of the Study Area

The selection of the study area is an important step for farm management or production economics study and such a study usually requires selection of an area for collecting data in accordance with the objectives set for the study. The area in which a farm business study is to be made depends on the particular purposes of the survey and possible cooperation from the farmers.

The present study was conducted in Munshiganj district. As Munshiganj is my close relative's birthplace so I had selected this area for easy accessibility, time and resources constraints. Apart from these, although a lot of production economics studies were conducted on different region of Bangladesh specially on Mymensingh, Jessore, Rajshahi, Narsingdhi, Tangail, Gazipur, Pabna, Netrokona, Bogra, Keraniganj etc. There were hardly any research conducted on Munshiganj district. So I made an attempt to analyze the profitability of potato production and socio economic condition of potato growers. Thirteen villages of 3 upozila under Munshiganj district namely Munshiganj sadar, Sirajdikhan and Srinagar were selected. The main reasons for selecting the villages were as follows:

i. These villages had some identical characteristics e.g. homogeneous soil type, topographical and climatic conditions those are favorable for producing potato

ii. The study areas were well communicated with researcher's house that helped her in data collection. It was also easier and less expensive to collect data from that area

iii. The large number of respondents and reliable sources of data were expected to obtain under these study areas

iv. Accessibility to the area is good due to developed communication system. Before selection of the study areas, the researcher made a few visits in these villages to get her acquainted with the characteristics of the farmers and more especially to know the cultural practices of potato production.

3.3 Selection of Sampling Technique

The main purpose of sampling is to select a small group which will represent a reasonably true picture of the population. In selecting samples for a study two factors need to be taken into consideration. The sample size should be as large as to allow for adequate degrees of freedom in the statistical analysis. On the other hand, administration of field research, processing and analysis of data should be within the limitation imposed by physical, human and financial resources (Mannan, 2001). Because of diversity in the technical and human environment, it is necessary to several numbers of the population before any conclusion can be drawn. Therefore, the purpose of sampling is to select a sub-set of the population that is representative of the population (Rahman, 1993). The term 'population' refers to the households, the farms etc. where a sample is representative under a study. In this study a purposive random sampling technique was applied. At first, Munshiganj district which is in Dhaka division of Bangladesh was selected purposively. After that, among 3 upazillas in Munshiganj district namely Munshiganj sadar, Sirajdikhan and Srinagar. The upazillas have also been selected based on the highest concentration of potato production, among highly concentrated potato produced villages under some unions were randomly selected.

3.4 Sample Size

It was not possible to include all the farmers in the study area due to limitation of time, money and personnel. Here a reasonable size of sample was taken into account to satisfy the objectives of the study. In total 60 farmers were selected to achieve the ultimate objective of the study. To get the desired sample at first the list of potato producers were collected from the agricultural extension officer of the selected upazilla agricultural office.

It was found that 200 farmers of the selected study area had grown potato. The next task was to identify small farmers (having land 0.05 to 2.49 acres) who cultivated potato minimum for three years. Out of 200 farmers 100 farmers were identified as small farmer who cultivated potato minimum for 3 years. Then a total of 60 farmers were randomly selected from the selected villages.

Table 3.1 Sample Distribution

SL. No,	Upazilla	Number of Respondents
1	Sadar	20
5	Sirajdikhan	20
13	Srinagar	20

Source: Field Survey, 2020

3.5 Preparation of Survey Schedule and Pre-testing

Preparation of the survey schedule is very important in any farm management or production Economics study (Amin, 2013). The main consideration in this respect is to obtain reliable data from the respondents for the preparation of a suitable survey schedule. In conformity with the objective of the study a draft survey schedule was prepared in such a way that reliable data could be collected from the farmers. Then the draft schedule was tested and attention was paid for inclusion of new information which was not included in the draft schedule. The draft survey schedule was pre-tested by researcher herself. The draft survey was conducted among 5 potato producers of small farmers in selected area. Thus the draft schedule was improved, rearranged and modified in the light of the actual and practical experience gained during the pretest. After making necessary adjustment a final survey schedule was developed in logical sequence.

The final schedule included the following information parts:

i. General information of respondents
ii. Respondent's socio-demographic information
iii. Farm holding status of the respondents
iv. Information about potato production
v. Respondent's opinion

The first part of the questionnaire contained respondent's identification, village and union name. Second part contained information about respondent's socio-economic conditions, their age, sex, education, occupation, income etc. Different code was used for this purpose. This part also contained questions about respondent's family member's source of income, education, occupation etc.

The third part provided the farm holding status of the farmers such as the information on homestead land, owned land, land given to others, land taken from others etc. The fourth part contained the potato production related information such as the unit cost of inputs and the price and quantity of output. The last part of the questionnaire contained respondent's perception regarding impact of potato production in socio economic status of the farmers and constraints faced by them to potato production.

3.6 Period of the Study

The researcher himself collected necessary data through personal interviews with the selected farmers. Data were collected during the period from 1 March to 15 April 2019.Data relating to inputs and outputs involved in the production of potato were collected by visiting the study area during this period.

3.7 Collection of Data and Accuracy of Data

Collection of accurate and reliable data and other necessary information from the field is not an easy task. It must be done properly since the success of the survey depends on the reliability of data. The researcher himself collected the relevant data from the farmers through face to face interview. Data was collected according to the structured questionnaire and face to face interviews had been carried out by paper and pencil.

After fixing the survey schedule, the researcher himself stayed in the respective area and collected the primary data from individual households. Before conducting actual interviews, the whole academic purpose of the present study was clearly explained to the respondents. Initially, the farmers hesitated to answer the questions but when they were assured that the study was purely an academic one and it would not affect them adversely then they were cooperative with the researcher. Farmers were requested to provide correct information as far as possible.

Usually, the respondents do not keep records of daily/ annual transactions of their activities. Hence, it was very difficult to collect actual data and the researcher has to rely on the memory of the respondents. Questions were asked systematically in a simple manner and explanation was made whenever felt necessary. After each interview was over, the schedule was checked so as to ensure that information to each item had properly recorded.

If there were such items which was over looked or contradictory were corrected by another interview. In order to minimize the errors, data were collected in local unit and later those were converted into standard international units. In the case of any inconsistency and lapses, the neighboring farmers were asked for necessary verification and data were checked and corrected through repeated visits.

3.8 Entry and Processing of Data

For the sake of consistency and completeness each survey schedule was verified after data collection. For proper editing the filled interview schedules were sorted, scrutinized and checked to avoid inconsistency. The data were then transferred from the interview schedule to MS Excel sheet and analysis was done.

3.9 Analytical Technique

Data were analyzed with a view to achieving the objectives of the study. Several analytical methods were employed in the present study. Tabular method was used for a substantial part of data analysis. This technique is intensively used for its inherent quality of purporting the true picture of the farm economy in the simplest form. Relatively simple statistical techniques such as percentage and arithmetic mean or average were employed to analyze data and to describe socioeconomic characteristics of potato growers, input use, costs and returns of potato production and to calculate undiscounted benefit cost ratio (BCR).

In order to estimate the level of technical efficiency in a manner consistent with the theory of production function, Cobb-Douglas type stochastic frontier production function was used in the present study.

3.9.1 Profitability Analysis

The net returns of potato were estimated using the set of financial prices. The financial prices were market prices actually received by farmers for outputs and paid for purchased inputs during the period under consideration in this study.

The cost items identified for the study were as follows-

- ✓ Land preparation
- ✓ Human labor
- ✓ Seedlings
- ✓ Urea
- ✓ TSP
- ✓ MoP
- ✓ Insecticide
- ✓ Irrigation
- ✓ Interest on operating capital
- ✓ Land use

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

Cost of Land Preparation

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

Cost of Human Labor

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

Cost of Seed

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

Cost of Urea

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

Cost of TSP

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

Cost of MoP

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

Cost of Insecticides

Farmers used different kinds of insecticides for 5-7 times to keep their crop free from pests and diseases. Cost of insecticides was calculated based on the market price of the insecticides which was used in the study areas per hectare.

Cost of Irrigation

Water management helps to increase potato production. Cost of irrigation varies from farmers to farmers. It was calculated based on how many times irrigation was needed per hectare and what was its cost.

Interest on Operating Capital

Interest on operating capital was determined on the basis of opportunity cost principle. The operating capital actually represented the average operating cost over the period because all costs were not incurred at the beginning or at any single point of time. The cost was incurred throughout the whole production period;

Hence, at the rate of 12 percent per annum interest on operating capital for four months was computed for potato. Interest on operating capital was calculated by using the following formula:

IOC= AIit

Where,

IOC= Interest on operating capital

i= Rate of interest

AI= Total investment / 2

t = Total time period of a cycle

Land Use Costs

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

Calculation of Returns

Gross Return

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

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

Gross Margin

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

Per hectare gross margin was obtained by subtracting variable costs from gross return. That is,

Gross margin = Gross return – Variable cost

Net Return

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

Net return = Total return – Total production cost.

Undiscounted Benefit Cost Ratio (BCR)

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

BCR = Total return (Gross return)/ Total cost

3.9.2 Technical Efficiency Analysis

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

No one would dispute that the output produced from given inputs is a genuine measure of efficiency, but there is room for doubt whether, in a particular application, the inputs of a given firm are really the same as those represented by the corresponding point on the efficient isoquant. But it is important to note that mere heterogeneity of factors will not matter, as long as it is spread evenly over firms, it is when there are differences between firms in the average quality (or more strictly, in the distribution of qualities) of a factor, that a firm's technical efficiency will reflect the quality of its inputs as well as the efficiency of its management.

3.9.2.1 The Stochastic Frontier Models

The most widely discussed, theoretically reasonable and empirically competent method of measuring efficiency is the stochastic frontier model. It is an improvement on the traditional average production function and on all types of deterministic frontiers in the sense that it introduces in addition to one-sided error component a symmetric error term to the model. This permits random variation of the frontier across farms, and captures the effects of measurement error, other statistical noise arid random shocks outside the firm's control. A one-sided component captures the effects of inefficiency relative to the stochastic frontier. The stochastic frontier model is also called the 'composed error' model introduced by Aigner, Lovell and Schmidt (1977). It was later extended and elaborated by Jondrow *et al*. (1982).

The notion of a deterministic frontier shared by all farms ignores the very real possibility that a farm's performance may be affected by factors entirely outside its control (such as poor machine performance, bad weather, input supply breakdowns, and so on), as well as by factors under its control (inefficiency). But stochastic frontiers consider all the factors while estimating the model and accordingly it separates firm-specific efficiency and random error effect. Thus the efficiency measurements as well as the estimated parameters are unbiased.

3.9.2.2 The Stochastic Frontier with Cobb-Douglas Production Function

The Cobb-Douglas production function is probably the most widely used form for fitting agricultural production data, because of its mathematical properties, ease of interpretation and computational simplicity (Heady and Dillion, 1969; Fuss and Mcfadden, 1978).

The Cobb-Douglas function has convex isoquants, but as it has unitary elasticity of substitution; it does not allow for technically independent or competitive factors, nor does it allow for Stages I and III along with Stage II. That is, MPP and APP are monotonically decreasing functions for all X- the entire factor-factor space is Stage II- given $0 < b < 1$, which is the usual case.

However, the Cobb-Douglas may be good approximation for the production processes for which factors are imperfect substitutes over the entire range of input values. Also, the Cobb-Douglas is relatively easy to estimate because in logarithmic form it is linear in parameters; it is parsimonious in parameters (Beattie and Taylor, 1985).

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

$$Y_i = f(X_i,\beta) \exp.(V_i-U_i)\ i = 1, 2, 3, \ldots\ldots\ldots, N$$

Where the stochastic production frontier is f(Xi,β)exp.(Vi), Vi having some symmetric distribution to capture the random effects of measurement error and exogenous shocks which cause the placement of the deterministic kernel f(Xi,β) to vary across firms.

The technical inefficiency relative to the stochastic production frontier is then captured by the one-sided error component Ui > 0.

The explicit form of the stochastic Cobb-Douglas production frontier is given by Where Y is the frontier output, X is physical input, b the elasticity of Y with respect to X, a is intercept and Ɛ = V-U is a composed error term as defined earlier. For simplicity, we have ignored the subscript.

3.9.2.3 Specification of Production Model

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

$$\text{In } Y = \ln a + b_1 \ln X_1 + b_2 \ln X_2 + b_3 \ln X_3 + b_4 \ln X_4 + b_s \ln X_5 + U_i$$

The above function is linearized double-log form:

Y = Return per hectare (Tk/ha);

In a = Intercept of the function;

X_1 = Cost of human labor (Tk/ha)

X_2 = Cost of seed (Tk/ha);

X_3 = Cost of fertilizer (Tk/ha);

X_4 = Cost of insecticides (Tk/ha);

X_5 = Cost of irrigation (Tk/ha);

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

Ui = Error term.

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

$$Ui = \delta_0 + \delta_1 Z_1 + \delta_2 Z_2 + \delta_3 Z_3 + \delta_4 Z_4 + \delta_5 Z_5 + + W_i$$

Where,

Z_1…….. Z_5 are explanatory variables.

The equation can be written as:

$U_i = \delta_0 + \delta_1$ Potato farming experience + δ_2 Farm size + δ_3 Extension service + δ_4 Training + δ_5Taking loan + W_i

V is two-sided uniform random variable beyond the control of farmer having N (0, σ 2) distribution, U is one-sided technical inefficiency effect under the control of farmer having a positive half normal distribution {U_i~|N (0, σu2)|} and W_i is two-sided uniform random variable. W is unobservable random variable having a positive half normal distribution. The model was estimated simultaneously using STATA and MS excel.

CHAPTER 4
DESCRIPTION OF THE STUDY AREA

4.1 Introduction

Bikrampur (Munshiganj) was the political and cultural centre of ancient Bengal. It was officially known as Bikrampur until 1986 and was part of Dhaka District. A brief description on important characteristics of the study area and the sampled households such as location, population and households, physical features and topography, communication, literacy rate, educational facilities, cropping pattern, land control etc.

4.2 Geographic area and location of the study area:

Munshiganj was a sub-division of former Dhaka district. It was upgraded to a district on 26 February, 1984.There are different views about the origin of the district name. The most popular view goes with the fact that the present area of the district was under the jurisdiction of a Zaminder named Munshi Enayet Ali who set up a trading centre locally called Ganj in the present district headquarters. It is generally believed that the district might have originated its name from the words Munshi and Ganj. The district is bounded on the north by Dhaka and Narayaganj districts, on the east by Comilla and Chandpur districts, on the south by Shariatpur and Madaripur districts and on the west by Dhaka and Faridpur districts. The total area of the district is 1004.29 sq.km.(387.00 sq.miles) The district lies between 23° 23' and 23°'38' north latitudes and between 90° 10' and 90° 43'east longitudes.

The southern and eastern parts of the district often fall victim to erosion caused by the mighty Padma and the Meghna respectively. Main depression is Arial Beel covering an area of 4330 hectare.

For More Information: https://www.thebangladesh.net/munshiganj-details.html.

4.3 Physical Features, Topography and Soil Type

The Munshiganj district consist Arial Beel agro-ecological zones. Arial Beel (144 km) this region occupies a low-lying basin between the Ganges and dhaleshwari rivers in the south of the former greater Dhaka district.

It has much in common with the lower Atrai Basin and the Gopalganj-Khulna Beels. The soils of this area are dark grey, acidic heavy clays. Non-calcareous dark grey floodplain soil is the chief general soil type. Organic matter content generally exceeds two percent in the top subsoil. Available moisture holding capacity is inherently low. General fertility level is medium to high.

Land Type: Medium high 13%, Low 73% and others 14%.

Suitable crops:

Kharif: Aus rice, Jute

Robi: Potato, Pulses, Mustard, Boro rice.

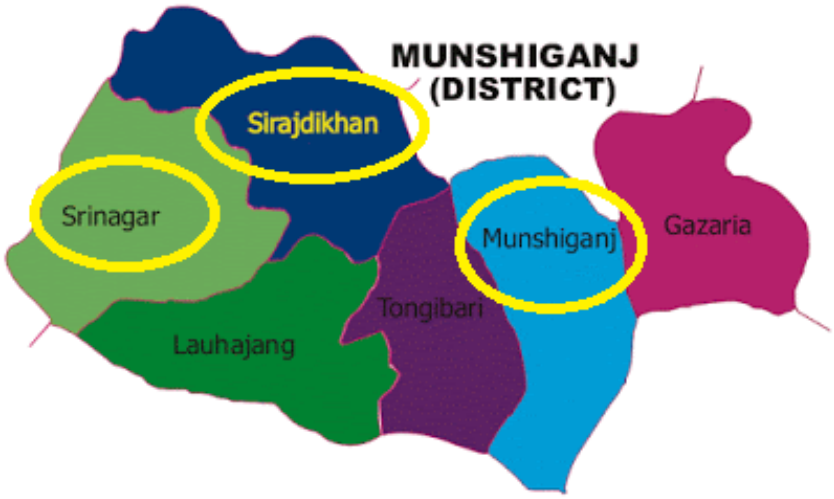

Figure 4.1: Map of Munshiganj district

4.4 General Information of study area

Table 4.1: Broad classification of Study area (In sq. km.)

Upazila	Total area	Land area
Sadar	218.07	150.79
Sirajdikhan	180.19	172.51
Srinagar	203.00	198.53

Source: BBS, population census 2011

Table 4.2: Number of household, population and density of study area

Upazila	House hold	Population (000)			Sex ratio (M/F)	Average size of household	Density per sq. km
		Male	Female	Total			
Sadar	82060	194508	188755	383263	103	4.62	1757
Sirajdikhan	59873	143559	144548	288107	99	4.74	1599
Srinagar	57344	127374	132513	259887	96	4.47	1280

Source: BBS, population census 2011

Table 4.3: Population and literacy rate of study area

Upazila	**Population (000)**			**Literacy rate (%)**		
	2001	2011	2018	2001	2011	2018
Sadar	295	327	383	50.6	55.2	59.2
Sirajdikhan	229	242	288	33.9	47.7	54.9
Srinagar	206	229	260	39.9	52.7	57.3

Source: BBS, 2019

4.5 Climate

The data of the last 35 years of some areas of the northwestern region, it was found that the trend in temperature rise in summer over 1981 to 2016 is very high. On average, the temperature in the summer is 36 degrees Celsius. However, in some cases it went up to 42 degrees. It is estimated that in the coming years, it will go up by 2/3 degrees more. In the same way, we see abrupt changes in rainfall as well. The average rainfall in a year remains the same over the years but the timing is changing; sometimes there is more rainfall before the rainy season but less during. The annual average temperature of the district varies maximum 32.3°C to minimum 11.2°C and the annual average rainfall of the district is recorded 2931 mm. We are seeing reflections of the same findings in our household surveys and participatory research studies conducted in the region. This coalescence will help to do a proper vulnerability analysis and find an effective adaptation strategy.

Also shows that the indigenous people of the northwest are suffering from food insecurity. They remain unemployed for six months. They don't have enough means to buy three meals. Their food basket is also very narrow – only carbohydrates. Hence, they suffer from malnutrition which directly affects their ability to work. It is a vicious cycle. They are the worst sufferers of climate change. In the existing patriarchal social structure, women are already in a vulnerable position. The climate change factors are pushing them further into the danger zone.Through effective adaptation strategies for these vulnerable groups. Although they have their own form of adaptation techniques, they are still lagging behind in terms of knowledge, skills and resources. We have pinpointed some specific sectors where they can find employment such as small farming, courtyard vegetation, and poultry.

Table 4.4: Temperature, rainfall, humidity of Munshiganj

Years	Temperature (centigrade		Rainfall (millimeter)	Humidity (%)
	Maximum	Minimum		
2016	32.2	10.0	1881	71.0
2016	33.0	12.3	2140	77.0
2017	33.1	10.2	1526	63.4
2018	21.2	9.3	1821	77.4

Source: Bangladesh Meteorological Department, 2019

4.6 Agriculture and Economic Condition

Munshiganj is one of the largest producer of potato in Bangladesh. It produces significant amount of jute, rice, wheat and other vegetables. It also produces sugar cane and banana.

Main occupations: Agriculture 27.43%, agricultural labourer 21.96%, commerce 19.46%, service 9.28% etc.

Main Crops: Munshiganj is one of the largest producer of rice and potato in Bangladesh. Beside these it produces significant amount of jute, wheat. It also produces sugar cane, tobacco, pulse, onion, garlic and turmaric etc.

Main fruits: Banana, mango, papaya, jackfruit, litchi, melon, watermelon, black berry, pomegranate, guava, wood apple, shaddock, plum, palm, coconut and elephant apple etc. Munshiganj produces a big amount of banana.

Main exports: Potato, banana, paddy, pathal, jute, betel leaf, sweet pumpkin, vegetables, milk, milk food, sack, cotton yarn, copper utensil, bamboo and cane materials.

4.7 Transportation

The district is bounded by DHAKA and NARAYANGANJ districts on the north, MADARIPUR and SHARIATPUR districts on the south, COMILLA and CHANDPUR districts on the east, Dhaka and FARIDPUR districts on the west. Main mode of transportation is bus. Communication is by road and by waterways.

4.8 NGO Activities

Operationally important NGO's are BRAC, ASHA, CARE, RDRS, Grameen Krishi Foundation, RDRS etc.

4.9 Concluding Remarks

From the above discussions it is found that the location of the study area near to the district. Physical features and topography, soil type, temperature and rainfall are favorable for cultivating Potato. This district is well transport system over marketing to others Bangladesh. Therefore, various types of agricultural crops were cultivated in the study area. Communication are good for marketing of agricultural crops.

CHAPTER –5

SOCIO-ECONOMIC PROFILE OF HOUSEHOLD POPULATION

5.1 Introduction

The point of this part is to present a brief description of the socio-economic characteristics of the potato cultivators. Socioeconomic is the parts of the growers can be viewed from various perspectives relying on various factors identified with their degree of living, the financial condition where they live and the nature and the degree of the growers support in national advancement exercises. It was impractical to gather all the data with respect to the financial attributes of the example growers because of confinement of time and assets. Financial state of the example growers is significant in the event of research arranging in light of the fact that there are various interrelated and constituent qualities describes an individual and significantly impacts advancement of his/her conduct and character. Individuals contrast from each other for the variety of financial perspectives.

5.2 Composition of the Family Size

Family size is significant in connection to generation of enough nourishment grain for ranch family. In this study family has been characterized as the all-out number of people living respectively and taking meals from a similar kitchen under the influence of one leader of the family. The relatives considered as spouse, children, unmarried little girl, father, mother, sibling and different relatives who live for all time in the family.

Table 5.1: Average Family Size and Distribution of Members According to Sex of the Sample Farmers

Particulars	Sadar Upazila		Sirajdikhan Upazila		Srinagar Upazila		All Farmers		**National Average Family Size**
	No	%	No	%	No	%	No	%	
Male	3.26	59.06	3.16	59.07	3.05	50.83	3.16	56.13	4.06
Female	2.26	40.94	2.19	40.93	2.95	49.17	2.47	43.87	
Total	5.52	100.00	5.35	100.00	6.00	100.00	5.63	100.00	

Source: Field Survey, 2020

5.3 Age

There are 20, 20, 20 samples are collected from three upazila named respectively Sadar, Sirajdikhan and Srinagar represented the total population. In Sadar upazila, 50 percent of the sample populations were 20-40 years, 35 percent were 40-60 years and 10 percent were above 60 years old. In Sirajdikhan upazila, 65 percent of the sample populations were 20-40 years, 30 percent were 40-60 years and have 10 percent found sample were above 60 years old. In Srinagar upazila, 40 percent of the sample populations were 20-40 years, 40 percent were 40-60 years and 20 percent sample found who were above 60 (Figure 5.1**)**. In this figure we saw most of the people age between 20 to 40 years in every upazila.

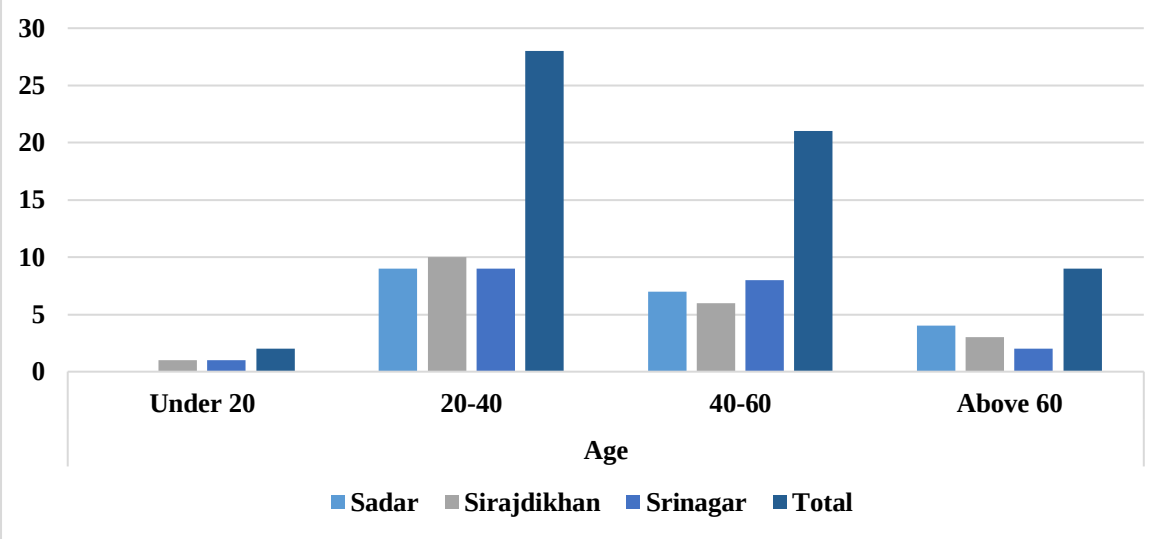

Figure 5.1: Age of the respondent by Study Area
Source: Field survey, 2020

5.4 Education

Figure 5.2 showed that, in Sadar upazila, about 2 percent of the study population aged 5 years or more were found to have no education and/or read/write, about 30 percent were found to have primary level education, about 45 percent were found to have secondary and/or higher secondary level education and 10 percent people were found to have attained/completed graduation level of education. In Sirajdikhan upazila, about 8 percent of the study population aged 5 years or more were found to have no education and/or read/write, about 27 percent were found to have primary level education, about 40 percent were found to have secondary and/or higher secondary level education and 8 percent people were found to have attained/completed graduation level of education. In Srinagar upazila, about 6 percent of the study population aged 5 years or more were

found to have no education and/or read/write, about 27 percent were found to have primary level education, about 40 percent were found to have secondary and/or higher secondary level education and 08 percent people were found to have attained/completed graduation level of education.

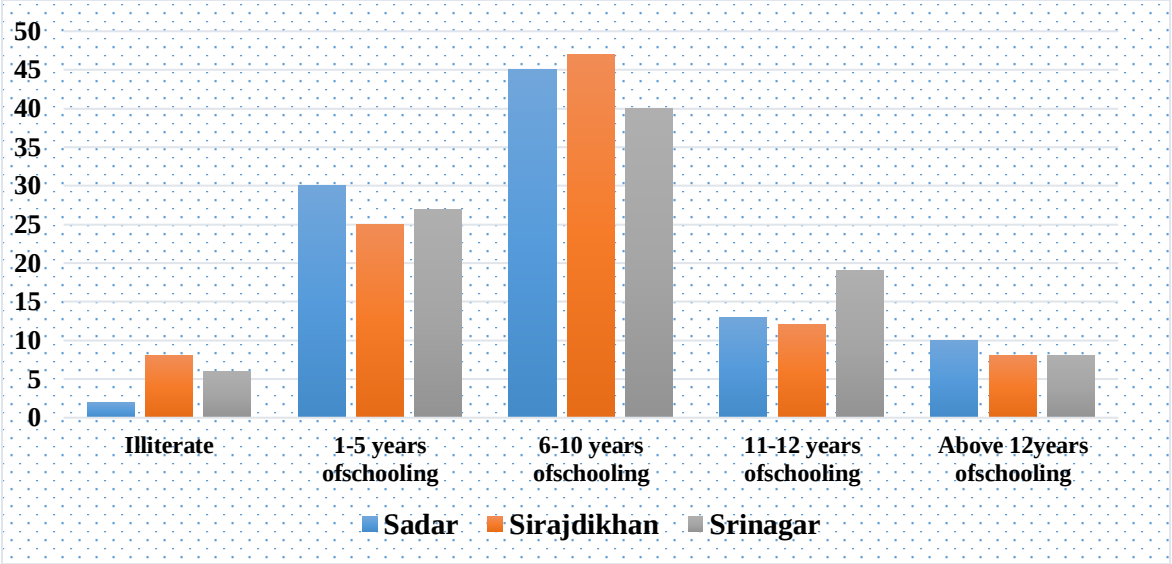

Figure 5.2: Education of the Household Members by Study Area
Source: Field survey, 2020

5.5 Annual Family income

a) Agricultural work

Table 5.2: Agricultural Work

Sector	Average annual Income	Total
Crops	60789.98	143226.78
Poultry	34768.9	
Livestock	36788.9	
Fisheries	10879	

Source: Field Survey, 2020

Crops, poultry, livestock and fisheries are the main agricultural income source of the sample. Most of the framer generate income by agriculture sector. Crop production was the main source of income among them average yearly income from crop production found TK 60789.98. Now a day's poultry and dairy farm have been developed in the study area. Farmers Tk 36788.9yearly income from livestock sectore. The mean value of annual family income by agriculture was Tk 143226.78.

b) Non-Agriculture work

Main non agriculture was found day labor, Auto driver, Truck driver, domestic worker, small business, foreign remittance, services. Annual average income by non-agriculture source was found Tk 150568.75. The total average annual income was found Tk 293795.53.

5.6 Annual Family Expenditure

Sample farmer, annual average expenditure was found Tk. 240076.75. Main family expenditure was use for food consumption. Others main cost were child's education cost, clothing cost, medicine cost transportation, festival cost, entrainment cost etc Average annual family savings was found Tk 53718.78.

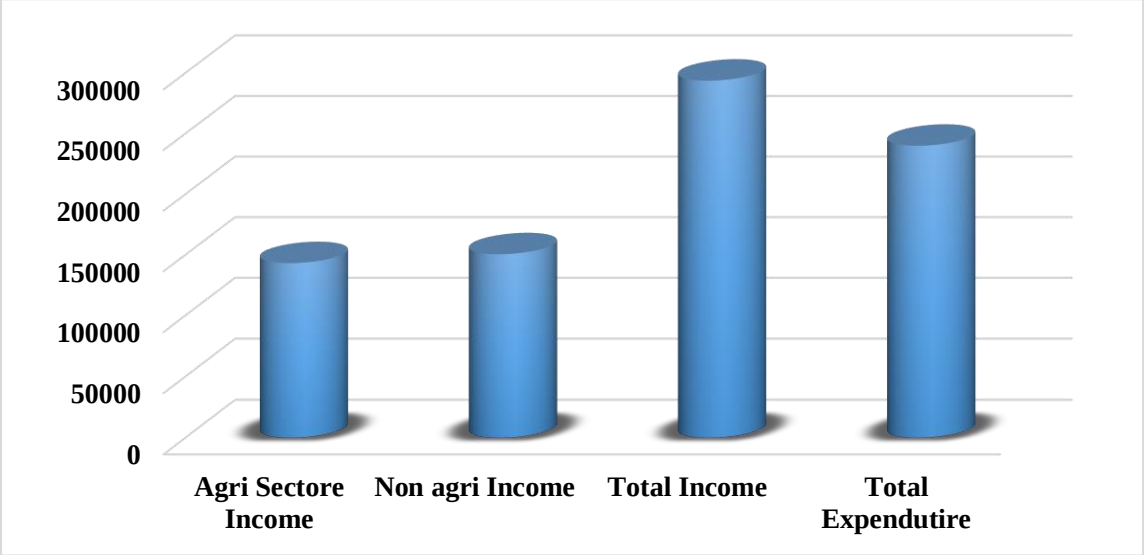

Figure 5.3: Annual Family Income and Expenditure by Study Area
Source: Field survey, 2020

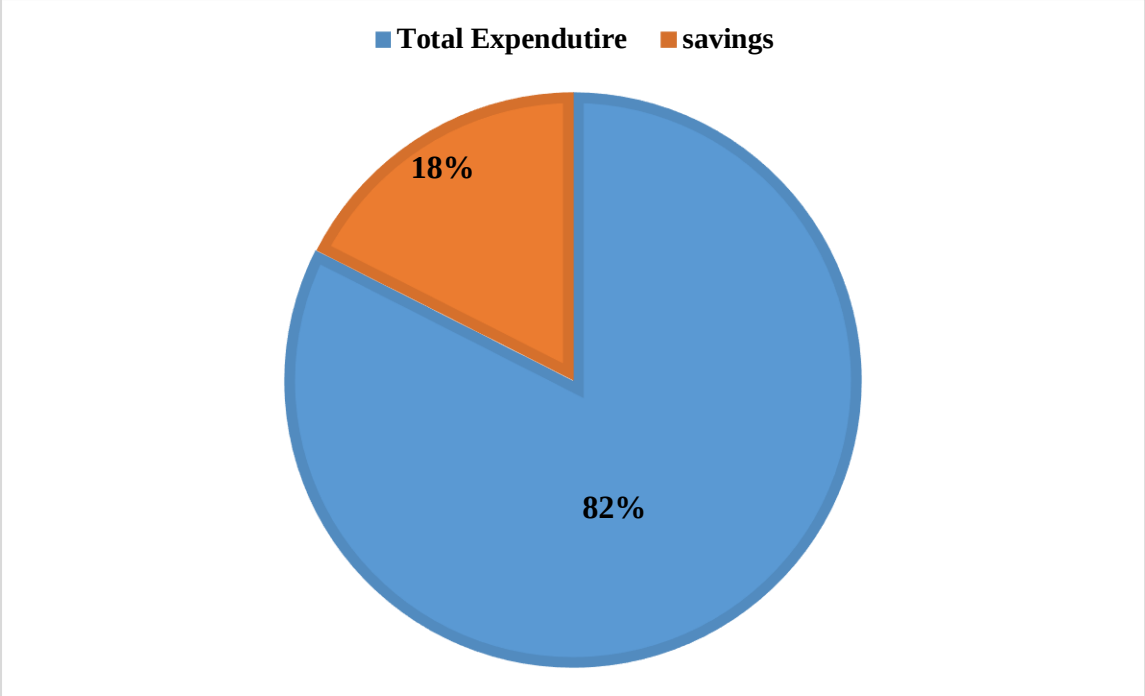

Figure 5.4: Annual Family Expenditure and Savings by Study Area
Source: Field survey, 2020

5.7 Agricultural Training

Among the respondent farmers in Sadar upazila, only 65 percent farmer's got training of Potato cultivation whereas, only 70 percent farmers got training in Sirajdikhan upazila, and 65 percent farmers got training in Srinagar upazila (Table 5.4). These training have improved their perceptions of good seed use, use of resistant varieties, application of insecticides and pesticides, water management, and so on. Most of the training DAE on Integrated Pest Management (IPM).

Table 5.3: Agricultural Training received of the respondent by Study Area

Training Received	Sadar Upazila		Sirajdikhan Upazila		Srinagar Upazila	
	No.	**%**	**No.**	**%**	**No.**	**%**
Yes	13	65	14	70	13	65
No	7	35	6	30	7	35
Total	20	100	20	100	20	100

Source: Field survey, 2020

5.8 Membership of any social organization

Among the respondent farmers in Sadar upazila, 90.00 percent potato growers were found to have membership in different NGOs and/or farmers' organizations whereas Sirajdikhan upazila 85 percent of potatob rice grower's farmers had membership in different NGOs and/or farmers' organizations and 80 percent of potato farmers had membership in different social organization in Srinagar upazila (Table 5.5).

Table 5.4: Membership in any organization of the respondent by Study Area

Membership	Sadar Upazila		Sirajdikhan Upazila		Srinagar Upazila	
	No.	**%**	**No.**	**%**	**No.**	**%**
Yes	18	90	17	85	16	80
No	2	10	3	15	4	20
Total	20	100	20	100	20	100

Source: Field survey, 2020

5.9 Concluding Remarks

From the above discussions it is clear that there are some variations in socioeconomic characteristics between the Sadar Upazila, Sirajdikhan Upazila, Srinagar Upazila potato growers. But the magnitude of the variations was not large. There are substantial indications suggesting that both Sadar Upazila, Sirajdikhan Upazila, Srinagar Upazila potato growers were progressive.

CHAPTER –6
PROFITABILITY OF POTATO PRODUCTION

6.1 Introduction

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

6.2 Profitability of Potato Production

6.2.1 Variable Costs

6.2.1.1 Cost of Land Preparation

Land preparation is the most important components in the production process. Land preparation included ploughing, laddering and other activities needed to make the soil suitable for Potato cultivation. For land preparation in Potato production, no. of tiller was required 2 times with Tk. 3560 per tiller. Thus, the average land preparation cost of Potato production was found to be Tk. 7120.00 per hectare, which was 5.31 percent of total cost (Table 6.1).

6.2.1.2 Cost of Hired Human Labour

Human labour cost is one of the major cost components in the production process. It is one of the most important and largely used inputs for producing Potato. It is generally required for different operations such as land preparation, sowing, weeding, fertilizer and insecticides application, irrigation, harvesting and carrying, threshing, cleaning, drying, storing etc. The quantity of average hired human labour used in Potato production was found to be about 77 man-days per hectare and average price of human labour was Tk. 350 per man-day. Therefore, the total cost of hired human labour was found to be Tk. 26950 representing 20.9 percent of total cost (Table 6.1).

6.2.1.3 Cost of Seed

Cost of seed varied widely depending on its quality and availability. Per hectare total cost of seed for Potato production were estimated to be Tk. 12345.80, which constituted 9.20 percent of the total cost (Table 6.1).

6.2.1.4 Cost of Urea

In the study area, farmers used different types of fertilizers. On an average, farmers used urea 238.7 kg per hectare. Per hectare cost of urea was Tk. 4296.60, which represents 3.20 percent of the total cost (Table 6.1).

6.2.1.5 Cost of TSP

Among the different kinds of fertilizers used, the rate of application of TSP (125.90 kg). The average cost of TSP was Tk. 3273.40 which representing 2.44 percent of the total cost (Table 6.1).

6.2.1.6 Cost of MoP

The application of MoP per hectare (210.50 kg). Per hectare cost of MoP was found Tk. 4210.00, which represents 3.14 percent of the total cost (Table 6.1).

6.2.1.7 Cost of Gypsum

Among the different kinds of fertilizers used, the rate of application of Gypsum (80.60 kg). The average cost of Gypsum was found Tk. 13702.00 which representing 10.21 percent of the total cost (Table 6.1).

6.2.1.8 Cost of Zinc

Among the different kinds of fertilizers used, the rate of application of zinc (8.00 kg). The average cost of zinc was found Tk. 1280.00 which representing 0.95 percent of the total cost (Table 6.1).

6.2.1.9 Cost of Insecticides

Farmers used different kinds of insecticides to keep their crop free from pests and diseases. The average cost of insecticides for Potato production was found to be Tk. 2500 which was 1.86 percent of the total cost (Table 6.1).

Table 6.1: Per Hectare Costs and returns of Potato

Cost Items	Quantity	Price Per Unit (Tk.)	Costs/Returns (Tk ha-1)	% of total
A. Gross Return				
Main product (Potato)	15393.29	14.50	223202.71	100.00
Total return			223202.71	100.00
B. Gross Cost				
C. Variable Cost				
Seedlings			12345.80	9.20
Irrigation	4	800	3200.00	2.39
Power tiller/land preparation cost	2	3560	7120.00	5.31
Hired labour	77	350	26950.00	20.09
Urea	238.70	18	4296.60	3.20
TSP	125.90	26	3273.40	2.44
MOP	210.50	20	4210.00	3.14
Gypsum	80.60	170	13702.00	10.21
Znic	8.00	160	1280.00	0.95
Fertilizers cost			26762.00	19.95
Manure	500	8	4000.00	2.98
Insecticides			2500.00	1.86
Total variable cost			82877.80	61.78
D. Fixed Cost				
Land use cost	1	29920	29920.00	22.30
Family Labor	45	350	15750.00	11.74
Interest on operating capital			5609.55	4.18
Total			51279.55	38.22
E. Total costs			134157.35	100.00

Source: Field survey, 2020

6.2.1.10 Cost of Irrigation

Cost of irrigation is one of the most important costs for Potato production. Production of Potato largely depends on irrigation. Right doses application of irrigation water help to increase bulb diameter, number of cloves, and number of leaves and plant height. As a result yield per hectare is being increased. The average cost of average irrigation was found 4 times in survey area and Tk 3200 to be per hectare, which was found Tk.3200 per heater that represents 2.39 percent of the total cost (Table 6.1).

6.2.1.11 Cost of manure

It was observed in the present study area that farmers used cow dung for producing their enterprises. They bought a large portion of cow dung from the milk producers. It was found about Tk. 4000 per hectare.

6.2.1.12 Total Variable Cost

Therefore, from the above different cost items it was clear that the total variable cost of Potato production was Tk. 82877.80 per hectare, which was **61.78** percent of the total cost (Table 6.1).

6.2.2 Fixed Cost

6.2.2.1 Rental Value of Land

Rental value of land was calculated on the basis of opportunity cost of the use of land per hectare for the cropping period of four months. Cash rental value of land has been used as cost of land use. On the basis of the data collected from the Potato farmers the land use cost was found to be Tk. 29920 per hectare, and it was 22.30 percent of the total cost (Table 6.1).

6.2.2.2 Cost of Family Labour

Human labour cost is one of the major cost components in the production process. It is one of the most important and largely used inputs for producing Potato. It is generally required for different operations such as land preparation, sowing, weeding, fertilizer and insecticides application, irrigation, harvesting and carrying, threshing, cleaning, drying, storing etc.

The quantity of average family supply labour (Without hired labour)used in Potato production was found to be about 45 man-days per hectare and average price of human labour was Tk. 350 per man-day. If we pay those labour it was found to be Tk. 15750 representing 11.74 percent of total cost (Table 6.1).

6.2.2.3 Interest on Operating Capital

It may be noted that the interest on operating capital was calculated by taking in to account all the operating costs incurred during the production period of Potato. Interest on operating capital for Potato production was estimated @ 9% as bank rate and

calculated Tk. 5609.55 per hectare, which represents 4.18 percent of the total cost (Table 6.1).

6.2.3 Total Cost (TC) of Potato Production

Total cost was calculated by adding all the cost of variable and fixed inputs. In the present study per hectare total cost of producing Potato was found to be Tk. **134157.35** (Table 6.1).

Table 6.2: Per Hectare Cost and Return of Potato Production

Cost Item	Cost/Returns (Tk/ha)
A. Gross Return	223202.71
B. Variable Cost	82877.80
C. Fixed Cost	51279.55
D. Total costs	134157.35
E. Gross Margin (A-B)	140324.91
F. Net Return (A-D)	89045.35
G. Undiscounted BCR (A/D)	1.66

Source: Field survey, 2020

6.2.4 Return of Potato Production

6.2.4.1 Gross Return

Return per hectare of Potato cultivation is shown in table 6.2. Per hectare gross return was calculated by multiplying the total amount of product with respective per unit price. It is evident from table that the average yield of Potato per hectare was 15393.29 kg and the average price of Potato was Tk. 14.50. Therefore, the gross return was found to be Tk. 223202.71 per hectare (Table 6.2).

6.2.4.2 Gross Margin

Gross margin is the gross return over variable cost. Gross margin was calculated by deducting the total variable cost from the gross return. On the basis of the data, gross margin was found to be Tk. 140324.91 per hectare (Table 6.2).

6.2.4.3 Net Return

Net return or profit was calculated by deducting the total production cost from the gross return. On the basis of the data the net return was estimated as Tk. 89045.35 per hectare (Table 6.2).

6.2.5 Benefit Cost Ratio (Undiscounted)

Benefit Cost Ratio (BCR) is a relative measure, which is used to compare benefit per unit of cost. Benefit Cost Ratio (BCR) was found to be 1.66 which implies that one taka investment in Potato production generated Tk. 1.66 (Table 6.2). From the above calculation it was found that Potato cultivation is profitable in Bangladesh.

6.3 Concluding Remarks

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

CHAPTER 7

TECHNICAL EFFICIENCY OF POTATO PRODUCTION

7.1 Introduction

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

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

7.2 Interpretation of ML Estimates of the Stochastic Frontier Production Function:

Maximum likelihood estimation begins with writing a mathematical expression known as the Likelihood Function of the sample data. The likelihood of a set of data is the probability of obtaining that particular set of data, given the chosen probability distribution model. This expression contains the unknown model parameters. The values of these parameters that maximize the sample likelihood are known as the Maximum Likelihood Estimates or MLE's. 7.1

The maximum likelihood estimates for parameters of the Cobb-Douglas stochastic frontier production function and technical inefficiency effect model for potato production for all farmers are presented in Table 7.1.

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

Variables	Parameter	Coefficients	T-ratio
Stochastic Frontier:			
Constant (X_0)	β_0	5.072387*	1.84
Human Labour (X_1)	β_1	-0.120691**	-2.25
Seed (X_2)	β_2	0.6530979**	2.14
Fertilizer (X_3)	β_3	0.857025***	3.57
Insecticide (X_4)	β_4	0.2002882	0.90
Irrigation (X_5)	β_5	0.078593**	3.25
Inefficiency Model			
Constant	δ_0	0.3228*	1.88
Experience (Z_1)	δ_1	-0.0532*	1.83
Farm size (Z_2)	δ_2	-0.8023***	-2.87
Extension service (Z_3)	δ_3	0.0143	0.56
Training (Z_4)	δ_4	-0.8483**	-2.89
Credit service (Z_5)	δ_5	-0.8390	-0.90
Sample Size		**60**	

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

Source: Field survey, 2020.

Human Labor (X1)

The regression coefficient of labour cost (X1) of potato production was negative and significant at 5 percent level of significance, which implied that if the expenditure on labour was increased by 1 percent then the yield of potato would be decreased by 0.120691 percent, other factors remaining constant (Table 7.1).

Seed (X2)

The regression coefficient of seed cost (X2) of potato production was positive and significant at 5 percent level of significance, which implied that if the expenditure on seed was increased by 1 percent then the yield of potato would be increased by 0.6530979 percent, other factors remaining constant (Table 7.1).

Fertilizer (X3)

The regression coefficient of fertilizer cost (Urea, TSP, MoP and others fertilizer cost) (X3) of potato production was positive and significant at 1 percent level of significance, which implied that if the expenditure on fertilizer was increased by 1 percent then the yield of potato would be increased by 0.857025 percent, other factors remaining constant (Table 7.1).

Cost of Insecticide (X4)

The regression coefficients of Insecticide cost (X4) was not significant.

Irrigation (X5)

The regression coefficient of Irrigation cost (X5) of potato production was positive and significant at 5 percent level of significance, which implied that if the expenditure on fertilizer was increased by 1 percent then the yield of potato would be increased by 0.078593 percent, other factors remaining constant (Table 7.1).

7.3 Interpretation of Technical Inefficiency Model

In the technical inefficiency effect model experience, farm size, training and credit service have expected (negative) coefficients (Table 7.1).

Experience (Z1)

The negative and significant at 10 percent coefficient of experience implies that experienced farmers are technically more efficient than non-experienced farmers (Table 7.1).

Farm Size (Z2)

The negative coefficient and significant at 5 percent level of significance of farm sizes implies that large farm households are technically more efficient than small farm households (Table 7.1).

Extension Service (Z3)

The positive coefficient of extension service was positive and was not significant meaning that these factors have no impact on the technical inefficiency. That is, these factors do not reduce or increase technical inefficiency of producing potato (Table 7.1)

Training (Z4)

The negative and significant (5 percent) coefficient of training implies that trained farmers are technically more efficient than non-training farmers. (Table 7.1)

Credit Service (Z5)

The negative coefficient of credit service postulates that farmers taking loan for producing potato are technically more efficient than others although this coefficient was not statistically significant (Table 7.1).

Table 7.2: Frequency Distribution of Technical Efficiency of Potato Farms

Efficiency (%)	No. of farms	Percentage of farms
0-50	4	6.67
51-60	8	13.33
61-70	7	11.67
71-80	10	16.66
81-90	19	31.67
91-100	12	20.00
Total number of farms	60	100
Minimum	0.22	
Maximum	0.99	
Mean	0.85	

Source: Field Survey, 2020

7.4 Technical Efficiency and Its Distribution

Table 7.2 shows frequency distribution of farm-specific technical efficiency for potato farmers. It reveals that average estimated technical efficiencies for potato are 85 percent which indicate that potato production could be increased by 15 percent with the same level of inputs without incurring any further cost. Increase of only managerial skills result a substantial increase of output for potato. It was observed that about 51 percent of sample farmers were found to have received outputs which were very close to the maximum frontier outputs maintaining the efficiency level more than 95 per cent. On the other hand, 49 per cent of sample farmers obtained up to 80 percent technical efficiency level. The minimum and maximum technical efficiencies were observed to be 22 and 99 per cent respectively.

7.5 Concluding Remarks

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

CHAPTER 8
PROBLEMS AND CONSTRAINTS TO POTATO PRODUCTION

8.1 Introduction

The focus of this chapter is to identify the extent of problems encountered by the Potato farmers. Farmers faced a lot of problems in producing Potato. The problems were social and cultural, financial and technical. This chapter aims at represent some socioeconomic problems and constraints to producing Potato. The problems and constraints faced by the farmers were identified according to opinions given by them. The major problems and constraints related to Potato cultivation are discussed below:

8.2 Lack of Quality Seed

Lack of quality seed was one of the most important limitations of producing Potato in the study area. From Table 8.1 it is evident that about 85.00 percent Potato growers reported this as high problem. Farmers in both Upazilas told that they were cheated by buying so called hybrid seeds from the local markets and from the seed dealers.

8.3 High Cost of Irrigation Water

Irrigation is the leading input for crop production. Yield of Potato varies with the application of irrigation water. Most of the farmers had no shallow tube well or deep tube well of their own in the study areas and for this they had to pay a higher amount of money to the water supplier. But farmers reported that they had to pay higher charge for irrigation water. Table 8.1 shows that about 83.33 percent Potato growers reported this as high problem. (Table 8.1).

8.4 Attack of Pest and Disease

The growers of Potato were also affected by the problem of attack of pests and diseases. Pests and diseases attack reduce crop yield and increase cost of production. About 76.67 percent Potato growers reported this as high problem (Table 8.1).

8.5 Low Price of Output

Most of the farmers had to sell a large portion of their product at the harvesting period to meet various obligations like, household's expenditure and repayment of loan. But harvest time price of Potato remained low because of ample supply. So they could not get reasonable return for their products. It can be seen from Table 8.1 that 75.00 percent Potato growers reported this as high problem.

8.6 Natural Calamities

It was found that Potato growers faced some acute problems relating to the nature in their production process. Natural calamities like drought, hailstorm, excessive rainfall, caused substantial damage to the crop in the field. Farmers said that excessive rainfall during the harvesting period reduces both the quantity and storability of Potato. Table 8.1 shows that almost 75 percent Potato growers in reported this as high problem.

8.7 High Price of Quality Seed

High price of quality seed was also one of the most important limitations of producing Potato in the study area. From Table 8.1 it is evident that about 73.33 percent Potato growers reported this as high problem.

8.8 High Price of Fertilizers

Farmers claimed that non-availability of fertilizers at fair price was a problem in the way of producing enterprise. It appears from the table 8.1 that about 73.33 percent Potato growers reported this as high problem.

8.9 Inadequate Extension Service

During the investigation some farmers complained that they did not get any extension services regarding improved method of Potato cultivation from the relevant officials of the Department of Agricultural Extension (DAE). As an agricultural extension personnel block supervisor, the main advisor of technical knowledge to the farmers about their farming problems. About 58.33 percent Potato growers reported this as high problem (Table 8.1). Farmers of both areas marked that they hardly ever got help from the block supervisor and Agricultural Extension Officer.

8.10 Lack of Operating Capital

The farmers of the study area had capital constraints. For cultivation of Potato, a huge amount of cash money was needed to purchase various inputs like, human labour, seed, fertilizers, pesticides, etc about 56.67 percent Potato farmers reported that they did not have sufficient amount of money for purchasing the required quantity of inputs for the relevant enterprises and marked this as high problem. (Table 8.1).

8.11 Shortage of Human labour

Most of the human labour is being used during seed/seedling plantation and harvesting period of Potato. Potato are labour intensive spices. Non-availability of human labour was found in different stages of production such as planting, intercultural operations and harvesting. Table 8.1 shows that near 50 percent of Potato growers reported this as high problem.

8.12 Lack of Scientific Knowledge of Farming

Although modern agricultural technologies have been using in the study area, a large number of farmers have no adequate knowledge of right doses and methods of using modern inputs and technologies of producing their enterprises. Near 40 percent Potato growers were encountered this problem. (Table 8.1).

8.13 Adulteration of Fertilizer, Insecticide, and Pesticide

Chemical fertilizers, insecticides and pesticides are the most important inputs of Potato production. They were being intensively used in Potato production in the study area. Many farmers reported to have been cheated by applying adulterate fertilizers and pesticides in their crop field. It can be seen from Table 8.1 that near 38.33 percent Potato growers faced this problem highly.

Table 8.1 Problems and Constraints of Potato Production by no. of Farmers

Type of Problems	No. of farmers	Percentage of farmers	Rank
Lack of quality seed	51	85.00	1
High cost of irrigation water	50	83.33	2
Attack of pest and disease	46	76.67	3
Low price of output	45	75.00	4
Natural calamities	45	75.00	5
High price of quality seed	44	73.33	6
High price of fertilizers	44	73.33	7
Inadequate extension service	35	58.33	8
Lack of operating capital	34	56.67	9
Shortage of human labour	30	50.00	10
Lack of scientific knowledge of farming	24	40.00	11
Adulteration of fertilizer, insecticide, and pesticide	23	38.33	12
Lack of quality tillage	23	38.33	13
Space shortage in the cold storages	18	30.00	14

Source: Field survey, 2020

8.14 Lack of Quality Tillage

Deeply ploughing is essential for successful crop production. Most of the farmers, who use hired power tiller, reported that hired power tiller owners did not till deeply. Never the less, they did not use all the tines when they till others land. Table 8.1 shows that 38.33 percent Potato growers reported this as high problem.

8.15 Space shortage in the cold storages

Usually most of the fanners used to store their Potato in their house. Lack of trained manpower was a great deal of spoilage of Potato in the harvest and the post-harvest period. For this, they had to face some losses like losing weight and rotten of Potato. It appears from Table 8.1 that only 30 percent of sample farmers faced the problem of poor storage facilities highly.

8.16 Concluding Remarks

The above mentioned discussions as well as the results presented in Table 8.1 indicates that Potato growers in the study area have currently been facing some major problems in conducting their Potato farming. These are the major constraints for the producers of Potato in the study area. Public and private initiatives should be taken to reduce or eliminate these problems for the sake of better production of Potato.

CHAPTER-9

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

9.1 Summary

Munshiganj alone produces about 34 percent of the country's potato, according to the Agriculture Extension Department (AED) of the district. Potato is an important and leading food crop in Bangladesh. It is the seventh potato producing country in the world and ranks second after rice in terms of production and is the third most important food crop after rice and wheat in terms of human consumption in Bangladesh (FAOSTAT, 2020). Bangladesh experienced much progress in area, production and yield of potato in the last decade, as its area, production and yield raised to 461 thousand ha, 9605 thousand MT and 20.8 MT/ha in 2019-20 from 435 thousand hectares, 7930 thousand MT and 18.25 MT/ha in 2009-10, with growth rates 6%, 21% and 14%, during the period, respectively. It has happened due to the suitable environment and using high yielding varieties in potato production. As currently production exceeds demand, Bangladesh started exporting fresh potato in the world market and exported 45000 MT of fresh potato in 2019-20 (Hortex Foundation, 2020). Annual potato consumption per capita also increased and reached 25.66 kg in 2016 from 23.65 kg in 2010, bringing the growth rate 8.5% during the only six-year period (HIES, 2016). When potato prices doubled in 2020, year-on-year, traders mentioned the fall in production as well as higher prices of other vegetables arising from flood and pandemic situation fueled up the demand for potato causing surge in potato prices. However, the Department of Agricultural Extension (DAE) said there is no reason for raising potato prices as there is a surplus table potato in 2020. A common question arises how and by whom prices are fixed in the market because of the fact that every now and then the price of essential commodities goes up without any notice. The price is supposed to be fixed by the "invisible hand", as mentioned by the renowned 18th century economist Adam Smith, which is the unobservable market force that determines the price of a commodity in a free market. It is needed to identify the factors behind this invisible hand so that steps can be taken to encounter unnecessary price fluctuation in the market. It is also important to look into the short and long-run factors behind the abnormal fluctuations in market price.

According to the DAE statistics, about 9.61 million MT of potatoes have been produced in 2020 against the annual demand of about 6.82 million MT, bringing a surplus of 3.40 million MT despite some amounts are being exported. Consequently, there is no possibility of shortage. Besides, 3 million MT of table potatoes have been stored in 369 cold storages, of which 55% have been taken out of cold storages before fixing price (DAM, 2020). Thus, 1.3 million MT of potatoes were still in the cold storage for sale. According to these statistics, there is no reason for raising price of potato. Thus, the objective of the study is to find out the factors behind the supply, demand and thereby prices of potato and explore the existence of syndicate in the market. The specific objectives are to: analyze the long-term trend of production of potato in Bangladesh; assess demand and supply situation of potato; estimate the profitability of potato production; analyze price variation over time and reasons for price spiral in 2020; and recommend policy measures for price stability.

The sampling frame for the present study were selected purposively as to select the area where the Potato cultivation was intensive. On the basis of higher concentration of Potato crop production, three upzillas namely Munshiganj Sadar, Srinagar and Sirajdikhan in Munshiganj district was selected. A sample size of 60 is generally regarded as the minimum requirement for larger population that will yield a sufficient level of certainty for decision-making (Poate and Daplyn, 1993). In this case, who were cultivating different varieties of Potato in the selected areas were selected as samples. Farmers generally plant Potato from mid- December to January and harvest after three months. Data for the present study have collected during the period of December2019 to January 2020. Primary data were collected from primary producers. Selected respondents were interviewed personally with the help of pre-tested questionnaires. The collected data were checked and verified for the sake of consistency and completeness. Editing and coding were done before putting the data in computer. All the collected data were summarized and scrutinized carefully to eliminate all possible errors. Data entry was made in computer and analysis was done using the concerned software Microsoft Excel and STATA.

Economic profitability is a major criterion to make decision for producing any crop at farm level. It can be measured based on net return, gross margin and ratio of return to total cost. The average land preparation cost of Potato production was found to be Tk. 7120 per hectare. The quantity of hired human labor used in Potato production was found to be about 77 man-days per hectare and average price of human labor was Tk. 350 per man-day. Therefore, the total cost of human labor was found to be Tk. 26950 representing 20.09 percent of total cost. Per hectare total cost of seed for Potato production was estimated to be Tk. 12385.80. On average, farmers used Urea, TSP, MoP and Gypsum was 238.70 Kg, 125.90 kg, 210.50 kg and 80.60 kg respectively, per hectare. The average cost of insecticides for Potato production was found to be Tk. 2500. Whereas the average cost of irrigation was found to be Tk. 3200 per hectare. The total variable cost of Potato production was Tk. 82877.80 per hectare, which was 61.78 percent of the total cost.

The average yield of Potato per hectare was 15393.29 kg and total price of Potato was Tk. 223202.71. The gross return, gross margin and net return were found to be Tk. 223202.71, Tk. 140324.91 and Tk. 89045.35 per hectare. Benefit Cost Ratio (BCR) was found to be 1.66 which implies that one-taka investment in Potato production generated Tk. 1.66.

Technical efficiency reflects the ability of a farmer to obtain the maximum possible output from a given level of inputs and production technology. Technical efficiency is then measured as the deviation of a farmer from the best-practice frontier. The regression coefficients of Seed (X2), Fertilizer (X3), Irrigation (X4) and Insecticide (X5) were positive but the coefficient of Human labor (X1), was found negative. It indicates that if Human labor (X1), was increased by 1 percent, the production of Potato would be increased by 0.120691 percent of sample.

In the technical inefficiency effect model experience, farm size, Training and credit service have expected (negative) coefficients. The negative and significant (1 percent) coefficient of experience implies that experienced farmers are technically more efficient than non-experienced farmers. The positive coefficient of extension service is positive meaning that these factors have no impact on the technical inefficiency. That is, these factors do not reduce or increase technical inefficiency of producing potato.

Average estimated technical efficiencies for Potato are 85 percent which indicate that Potato production could be increased by 15 per cent with the same level of inputs

without incurring any further cost. Increase of only managerial skills result in a substantial increase of output for Potato.

Farmers faced a lot of problems in producing Potato. The problems were social and cultural, financial and technical. Lack of quality seed was one of the most important limitations of producing Potato in the study area. Lack of operating capital, high price of quality seed, high cost of irrigation water, shortage of human labor and lack of quality tillage were the major problems faced by farmers. These are the major constraints for the producers of Potato in the study area. Public and private initiatives should be taken to reduce or eliminate these problems for the sake of better production of Potato.

9.2 Conclusion

Potato is one of the important vegetables grown by farmers mainly for market purpose. The study areas have tremendous potential for Potato cultivation. The findings of the present study indicate that Potato production is highly profitable and it would help to improve the socioeconomic condition of sample farmers in the study areas. As Potato is a labour intensive crop, it would help to create employment opportunities.

In Bangladesh, it is difficult to increase Potato production by increasing the area of land under cultivation due to the limitation of land. But, there is an opportunity to increase production of Potato by improving the existing production technology. Farmers are relatively inefficient due to land fragmentation, less experience, illiteracy, etc. The present study indicate that farmers are technically efficient that means there is an opportunity to increase production to a large extent using the existing level of agricultural inputs, the agricultural extension services and the available technology.

If the modern inputs could be made available to the farmers in time, production of this crop might be increased which could help them in alleviating rural poverty in many areas. Potato are only produced in winter season. But now the BRRI introduced some verities of summer Potato. However, farmers in the study areas, to some extent have started to produce summer Potato. Farmers were not known about the application of inputs in right time with right dose. Thus, well-planned management training in accordance with their problems, needs, goals and resources base may lead to viable production practices and sustainable income from Potato cultivation.

9.3 Suggestion

The potato in these countries fills a role in diet diversification and improved nutrition. It ranks third in area acreage after rice and wheat and is cultivated in almost all agro-ecological regions of Bangladesh. In addition, potato ranks second after rice in production in Bangladesh. From our data analysis, we found that in the context of production and export potato has a great prospect in Bangladesh. However, it is a matter of great regret that our farmers fail to get back even their production cost. Cost of productions becomes higher, but the price of potato becomes lower at the time of harvest. So, farmers become looser.

Based on the results of the study, the following recommendations are furnished.

1. SAAO should be encouraged to get correct and accurate information of potato.

2. In each upazila, internet facilities should be set up and by using internet, necessary data to be collected.

3. One agricultural graduate needs to be appointed in each union for giving necessary guidance to the farmers for proper adoption of HYVs and utilization of quality seeds approved by BARI.

4. One training institute in each division for the training of farmers and SAAO on modern agriculture needs to be established.

9.4 Limitations of the Study

There are some limitations of the study thus are indicated below.

a. Most of the data were collected through interview of the farmers and sometimes they did not well-cooperate with the interviewer.
b. The information were gathered mostly through the memories of the farmers which were not always correct.
c. Due to resource and time constraints, broad based and in-depth study was hampered to some extent.

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