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

NUSRAT FATEMA JUTHY

DEPARTMENT OF AGRICULTURAL STATISTICS
SHER-E-BANGLA AGRICULTURAL UNIVERSITY
SHER-E-BANGLA NAGAR, DHAKA -1207

JUNE, 2020

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

BY

NUSRAT FATEMA JUTHY

REGISTRATION NO. : 13-05376

A Thesis Submitted to the Faculty of Agribusiness Management Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of

AGRICULTURAL STATISTICS
SEMESTER: JANUARY-JUNE, 2020

Approved by:

Md. Zulfikar Ahmed Reza	**Md. Abdul Latif**
Professor	Associate Professor
Department of Agricultural Statistics	Department of Agricultural Statistics
Sher-e-Bangla Agricultural University	Sher-e-Bangla Agricultural University
Supervisor	Co-supervisor

Professor Md. Zulfikar Ahmed Reza
Chairman
Department of Agricultural Statistics
Faculty of Agribusiness Management
Sher-e-Bangla Agricultural University, Dhaka-1207

CERTIFICATE

This is to certify that thesis entitled, **"PROFITABILITY AND TECHNICAL EFFICIENCY OF POTATO PRODUCTION IN SOME SELECTED AREAS OF BOGURA 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 STATISTICS,** *embodies the result of a piece of bona fide research work carried out* **NUSRAT FATEMA JUTHY** *, Registration No.* **13-05376** *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.

Zulfikar Ahmed Reza

Professor

Dept. of Agricultural Statistics

Sher-e-Bangla Agricultural University

Supervisor

Dated:…………2020

DEDICATED

TO

MY BELOVED PARENTS

ACKNOWLEDGEMENT

i

ABSTRACT

Potato is third largest food crop in Bangladesh by tonnage of production. Its acreage and production are also increasing in day after day. This study was accomplished to examine the profitability and technical efficiency of potato cultivation in Bogura district of Bangladesh. A total of 60 cultivators were selected from three upazilas of Bogura district. Data were collected through farm survey by using a suitable pre-tested questionnaire in February to March, 2018. Descriptive statistics and problems faced index (PFI) were used to attain the objectives. Average gross return, gross margin and net return were found Tk 237236, Tk. 77438 and Tk 55944 respectively. Benefit cost ratio was found 1.31. And there we evaluated that the Log likelihood is 41.3964 and Standard deviation is 0.135. Land preparation, human labour, seed, fertilizer, insecticides, irrigations and harvesting cost were the key factors of potato production. The study identified some major post-harvest problems, unavailability of quality seed, storage problem, holding capacity problem, lower market price, transportation problem, lack of public procurement and load shedding. The potato cultivators opined that potato production would be economically viable if quality seeds with affordable price, processing facilities, storage facilities, marketing facilities, fertilizer or insecticides with reasonable price are ensured.

LIST OF CONTENT

TITLE	PAGE

LIST OF TABLE

ABBREVIATION

Agril.	=	Agricultural
BADC	=	Bangladesh Agricultural Development Corporation
BARI	=	Bangladesh Agricultural Research Institute
BBS	=	Bangladesh Bureau of Statistics
BCR	=	Benefit Cost Ratio
DAE	=	Department of Agriculture Extension
DAM	=	Department of Agricultural Marketing
DEPS	=	Development and Poverty Studies
et.al	=	All Others
FAO	=	Food and Agriculture Organization
FY	=	Fiscal Year
ha	=	Hectare
HYV	=	High Yielding Variety
Kg	=	Kilogram
m	=	million
MoA	=	Ministry of Agriculture
MS	=	Master of Science
mt	=	Metric tons
NGO	=	Non Government Organization
No.	=	Number
SAAO	=	Sub Assistant Agricultural Officer
SAARC	=	South Asian Association of Regional Co-Operation
SAU	=	Sher-e-Bangla Agricultural University
SD	=	Standard Deviation
%	=	Percent
UAO	=	Upazila Agricultural Officer

CHAPTER I

INTRODUCTION

1.1 General Background

Bangladesh is chiefly an agro-based country. It is a thickly populated and small country with an area of 14.48 million ha. This sector also accommodates around 40.6% (in 2016-17) of labour force (BBS, 2018).

Agriculture has a great contribution to the Gross Domestic Product (GDP) of the country. Earlier more than 50% of GDP came from this sector. At the beginning of industrialization, the activities of the population got diversification towards different sectors. As a result, the contribution of the agriculture sector is slowly reducing and now declined to 14.10% of the GDP (BBS 2018). Still agriculture plays a vital role and is taken as the most important sector of the economy. Despite increase in the shares of fisheries, livestock, and forestry, crop sub-sector alone accounts for 43 percent share of agricultural GDP in FY 2015-16 (BER, 2017) (Fig 1.1). Although the contribution of crop sub-sector in GDP marginally decreased from 9.49 percent in FY 2016-17 to 9.11 percent in FY 2017 -18.

 GDP growth rate of Bangladesh mainly depends on the performance of the agriculture sector. Due to natural calamities like flood cyclone, drought, loss of production in both food and cash crops are almost a regular occurrence. Yet in recent years, there has been a substantial increase in food grain production. Agricultural holding in Bangladesh is generally small but use of modern machinery and equipment is gradually increasing. rice, jute, sugarcane, potato, pulses, wheat and tea are the main crops of Bangladesh. Crop diversification programme, credit supply, extension work, research and input distribution policies followed by the government are yielding positive results.

Potato is an important food crop in tropical and subtropical countries. It is the fourth most important crop in Bangladesh. It is important and popular crop because of its quick economic return and multiple uses. It has a greater scope and potentiality for food security and poverty alleviation occupying a dominant position in both area and production among the vegetable growers in Bangladesh. Almost every family in Bangladesh consumes potato as a vegetable throughout the year. As a cheapest source of carbohydrates it is used, though not so extensively, as a supplement of the diet rice. Potato can play an important role as an alternative and a multipurpose food crop of

1

Bangladesh. It has the desirable characteristics of high yield, nutritious or delicious food and palatable in taste. It is one of the most important sources of carbohydrates and contains an appreciable amount of vitamin B and C and some other materials. In Bangladesh soil and climatic condition offer high potential of potato production. Bangladesh produces potato in about 9.47 million hectares of land with an average yield of 19.93-ton ha-1 (BBS, 2016). Production of potato has been increasing rapidly compared to cereal crops like rice and wheat (Azimuddin et. al., 2009). Potato cultivation under the institutional loan was a profitable business. Potato tuber follows only rice and wheat in world as an important food crop for human consumption. It is used as a popular vegetable by both the poor and rich people in Bangladesh. It has high nutritive value as per 100 gm of edible potato contains 97 k. calories, 1.6 gm protein, little amount of fat, 10.07 gm minerals and little amount of iron. It contains 74.7% moisture and 22.6% carbohydrate in combination with many other items of food (Hossain and Bose, 2000). People consume potatoes in various forms such as curry cooked food, fries, potato crackers and flour to make breads, biscuits, chips, etc. in both home and abroad. From the viewpoint of nutritional requirement Bangladesh has deficit in producing nutritional crops specially the tubers and vegetables. To solve the malnutrition problem, emphasis should be given on producing more non-cereal crops like potato. Realizing the above situations, the government of Bangladesh has been maintaining a crop diversification strategy to reduce the dependency on rice by increasing the consumption and production of potato. In Bangladesh, the amount of cultivable land is gradually decreasing because of infrastructural and industrial development activities. For that reason, production strategies require to be formulated according to the demand of the situation and time so that farmers can increase food production. The cultivation of potato was a profitable business and the medium farm was more profitable than the small and marginal farms (Sarkar and Yesmin, 2014). Potato is one of the main commercial crops grown all over the country. In Bangladesh, potato is primarily used as a vegetable, although in many countries of the world it constitutes the staple food and contributes more than 90% of the carbohydrate food source. Here potatoes are processed annually in Asia into starch, potato meal, flour, dextrose and some are processed into potato chips, dehydrated mashed potatoes, French fries and canned potatoes. Although in our country the principal use of potatoes is to make potato curry along with fish, meat, and eggs, there exists a great diversity in the consumption of potatoes. Among potato-based food items are the boiled potato, fried

potato, mashed potato, baked potato, potato chop, potato vegetable mix, potato singara, potato chips, French fry etc. In recent years, bakeries and fast food shops have started preparing a wide variety of potato-based food delicacies.

Adequate supply of potato stabilizes the vegetable market. al.l around the year. Recently, the government has been trying to diversify food habits and encourage potato consumption to reduce pressure on rice. So, potato is becoming an important food for food security in Bangladesh. Potato growing is one of the promising farming businesses to the farmers due to its higher yield, diversified use, low risk involvement and high profitability. But it is most difficult for the farmers to maintain the production cost (Awal, 2013). In Bangladesh, potato occupies a dominant position in both area and production among the vegetables growers. However, compared to other crops, cost of production of potato is relatively high. Keeping this view in mind the present study is a modest attempt to analysis the socio-economic condition and cost and return of potato production in some selected areas of Bogra district.

Potato is a staple food in the developed countries and which accounts for 37% of the total potato production in the world (FAO and CIP, 1995). Potato is a popular and important vegetable in Bangladesh. For the whole year, it is used as main vegetable. Potato is widely cultivated in all the districts of Bangladesh during winter. Considering the trend of population growth and consequently the increased demand for food in the country and dwindling cultivable land area, the potato is likely to play a very important role in the future. 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.

A 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 - estimated at $560 million in 2005 - second only to that of paddy rice. In 2007, Bangladeshi farmers harvested 4.3 million tons of potatoes (12 times more than in 1961), which placed the country at No. 14 among the

world's potato producers and No. 4 in Asia. The potato is usually grown for cash sale, and much of national production is concentrated near the capital, Dhaka, the country's largest urban market. Annual consumption has been growing briskly, from around 7 kg per capita in 1990 to more than 24 kg in 2005.According to Directorate General of Food (DGoF), annual demand for potato in the country is 6.5-7.0 million tone's against its production of 8.95 million tones' (FY 2014).

Normally, a farmer cultivated potato on 54 decimals of land spending Tk 23,000 and got some 120 mounds of the yield. In their perspective they got a satisfactory production this season. Agriculture officer are working to make the farming programme a success. Growers are also delighted over the market price in potato production.

1.2 Present Status of Bangladesh Agriculture

Bangladesh is predominantly an agricultural country where this sector plays a vital role in accelerating the economic growth. It is therefore important to have a profitable, sustainable and environment-friendly agricultural system in order to ensure long-term food security for people. Broad agriculture sector has been given the highest priority in order to make Bangladesh self-sufficient in food. The Government determined to develop the overall agriculture sector keeping in view of the goals set out in the Seventh Five Year Plan and National Agriculture Policy. Over the last few years, there has been an increasing trend in food production. Agriculture sector plays an important role in overall economic development of Bangladesh. The agricultural sector (crops, animal farming, forests and fishing) contributes 14.10 (BBS, 2018) percent to the country's GDP, provides employment about 39 percent of the labour force according to Quarterly Labour Force Survey 2016-17. Moreover, agriculture is the source of wide range of consumer demanded agricultural commodity markets, especially in rural areas. GDP from Agriculture in Bangladesh increased to 10739.10 BDT Million in 2019 from 10468.80 BDT Million in 2018. GDP from Agriculture in Bangladesh averaged 9012.60 BDT Million from 2006 until 2019, reaching an all-time high of 10739.10 BDT Million in 2019 and a record low of 7017.10 BDT Million in 2006. (BBS).

1.3 History of potato

Potato (Solanum tuberosum) is an edible tuber of the cultivated plant of the family Solanaceae has been cultivated in this part of the sub-continent for more than a century and has recently occupied an important place in the list of major food and cash crop of

Bangladesh (Hussain, 2008). sIt assumed that Portuguese navigators first brought potato to India Sub-continent at the beginning of the 17th century. During the history of potato cultivation in our country, different varieties were introduced here from different parts of the world and, in course of time, they become familiar and had lost their identity (Siddique, 1995). The varieties are normally known as indigenous potato varieties (IPV); and despite their low yield potentiality, the IPVs are still in cultivation in this country under different popular names. Until late fifties, only IPVs were grown here and in 1959-60 about 277 thousand MT of potatoes were produced in about 47.34 thousand hectares of land with an average yield of about 5.96 t/ha (Hussian, 1985).

Introduction of Modern Potato Varieties (MPV) started in early sixties. Since then the area, production and yield of potato gradually began to rise although in a slow pace initially. In the meantime, there had been an approach of popularizing TPS (True Potato Seed) technology in potato production with the support of CIP. (Rashid and Rashid, 1990). There had been thorough studies on production and utilization of TPS derived seeding tubers (Hossain, 2003), production of hybrid TPS (Banik, 2005) and quality of hybrid TPS (Yasmin, 2006), as reported in Ph.D. dissertations of the agricultural universities.

Sustained efforts of TCRC of BADC led to the development of the potato sector, in respect of recommendation of varieties, seed potato production and improvement of production technology of MPV.

1.4 Importance of Potato in Bangladesh

Food grains are a main consumption item in Bangladesh accounting for about 35 percent of total consumption expenditure and provide more than 80 percent of the total calorie intake. Bangladesh has long been striving to achieve food self-sufficiency by setting production targets through the successive five-year plan. Virtually, cereal production stood at approximately 28.7 million tons in 2012-2013 and the country attained self-sufficiency in the recent past. Increased potato production will provide more low-priced calories food for human consumption. The adoption of potato as potato flour substitute for bread would be beneficial to the economy of our country in its nutritional value. It will increase supply availability for starch and processed food. It can replace important cereals like rice thereby reducing the foreign exchange requirements.

Potato has been decided to play an important role in improving this modern situation by providing more balanced diets to increase nutritional quality of food. It is also calculated as an excellent source of vitamin B and C and, the sunshine vitamin. Vitamin B6 plays numerous roles in our nervous system, many of which involve neurological (brain cell) activity. B6 is necessary for the creation of amines, a type of messaging molecule or neurotransmitter that the nervous system relies on to transmit messages from one nerve to the next. Vitamin B6 plays another critically important role in methylation, a chemical process in which methyl groups are transferred from one molecule to another. Many essential chemical events in the body are made possible by methylation, for example, genes can be switched on and turned off in this way. Vitamin B6 is also necessary for the breakdown of glycogen, the form in which sugar is stored in our muscle cells and liver, so this vitamin is a key player in athletic performance and endurance. Vitamin C is essential to help maintain healthy connective tissue and heal wounds. The many varieties of potatoes are also good sources of B vitamins, helping the body make healthy red blood cells and amino acids.

Potato states first among the 10 major food crops in calories production per unit area of land. Potatoes contain no fat or cholesterol and minimal sodium. Fiber of potatoes in the skins, all those vitamins and minerals and great flavor. And a six-ounce potato contains 2 grams of highly digestible protein, almost as much as half a glass of milk, making it a great foundation for a whole meal. Because of the variety of potato colors, shapes, sizes and textures and their versatility as recipe ingredients, potatoes for breakfast, lunch or dinner (or all three) which support the daily fruit and vegetable servings for good health and nutrition. Glucose, dextrose, Lactic acid, alcohol and some other chemicals are prepared from potato for using in medical treatment.

Table 1.4: Nutritional status of potato and sweet potato per 100g portion

NUTRIENT	POTATO	SWEET POTATO
Water (g)	79	77
Energy (kJ)	322	360
Protein (g)	2	1.6
Fat (g)	0.09	0.05
Carbohydrates (g)	17	20
Fiber (g)	2.2	3
Sugar (g)	0.78	4.18
Minerals		
Calcium (mg)	12	30
Iron (mg)	0.78	0.61
Magnesium (mg)	23	25
Phosphorus (mg)	57	47
Potassium (mg)	421	337
Sodium (mg)	6	55
Zinc (mg)	0.29	0.3
Copper (mg)	0.11	0.15
Manganese (mg)	0.15	0.26
Selenium (µg)	0.3	0.6
Vitamins		
Vitamin C (mg)	19.7	2.4
Thiamin (B1) (mg)	0.08	0.08
Riboflavin (B2) (mg)	0.03	0.06
Niacin (B3) (mg)	1.05	0.56
Pantothenic acid (B5) (mg)	0.3	0.8
Vitamin B6 (mg)	0.3	0.21
Folate Total (B9) (µg)	16	11
Vitamin A (IU)	2	14,187
Vitamin E, alpha-tocopherol (mg)	0.01	0.26
Vitamin K1 (µg)	1.9	1.8
Beta-carotene (µg)	1	8,509
Lutein+zeaxanthin (µg)	8	0

NUTRIENT	POTATO	SWEET POTATO
Fats		
Saturated fatty acids (g)	0.03	0.02
Monounsaturated fatty acids (g)	0	0
Polyunsaturated fatty acids (g)	0.04	0.01

Source: Bose and Som, 1986; Wahed and Anjan, 2008

It can contribute to create rural employment opportunities through the development and expansion of potato industry. In the developing country, food availability is not well balanced, consequently the quantity dietary intake in bigger because people tend to eat much cereals (mainly rice) to compensate for the poor nutrition and The results in greater demand for food and higher pressure on the limited land available to produce required quantity of food (Azimuddin et. al.,2009).

In our country the production of potato is very high comparing other cash crops, Potato is a cash crop which used a multipurpose food crop of Bangladesh (Siddique and Hossain, 1988). Besides it is used as vegetable, it is highly used for making gum, starch for adhesives and other purposes, in textile and paper industries, for processing ink, dyes, toys, soap and for leather processing. Potatoes are used in textile, paper industry and other processing industries Glucose and dextrose are also prepared from potatoes for using in media treatment (Thompsom and Kelly, 1957). Lactic acid, alcohol and some chemicals are now being produced from which have a great value in chemical sciences. Glucose and dextrose are prepared from potato for use in medical treatment. Lactic acid, alcohol and some other chemicals are now being produced from potato. In terms of nutritional potential, it states first among the 10 major food crops in calories production per unit area of land.

Table 1.4.1: production of potato acres/tones

Year	Acreage ('000 acres)	potato (000'tons)	Acreage ('000 acres)	sweet potato(000'tons)
2010-11	1137	8326	75	298
2011-12	1063	8205	61	253
2012-13	1098	8603	67	263
2013-14	1142	8953	64	260
2014-15	1164	9254	62	255
2015-16	1175	9474	61	259
2016-17	1235	10216	64	263
2017-18	1176	9725	59	247
2018-19	1157	9655	60	236

Source: BBS 2018

In Bangladesh potato is still considered merely as a vegetable, i.e. as a complementary food with rice and potato but not as a staple food it is regarded as one of the world's leading food crop (Begum,2017).It is now well recognized that to meet the demand for food for increased population, dependence on rice and potato has to be reduced and the food habit of the masses have to be diversified. The food problem is one of the most critical aspects of Bangladesh struggle to achieve economic growth, rate of inflation, poverty and nutrition, the trade balance and the Government's fiscal position.

There the production history of previous 8 years of potato and sweet potato. Which has shown a great progress and become a successful crop in economy sector and made a strong position for its usefulness.

1.5 Varieties of Potato

Varieties of potato differs about their tuber structure, size and color, 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 area and they are cultivated in Bangladesh divided into two groups and they are local and high yielding. The local varieties are in fact, not strictly native. In spite of being poor yields, some of the local varieties are still being cultivated because of their taste and cooking qualities. It is stated that local varieties were cultivated in about 18, 465 acres of land, producing about 5, 00,800 m tons of tubers during 2011-12 (Source: BBS, 2015). There are about 27 local

varieties of potatoes cultivated in different parts of the country and mostly familiar with local names. In the distant past those were brought to this part of the subcontinent but in the absence of varietal improvement efforts, gradually degenerated, presenting poor yield performance.

Table 1.5: Commonly used potato varieties by farmers in Bangladesh

Potato Varieties	% Response of potato variety cultivation
Diamant	65.4
Cardinal	29.6
Granula	25.8
Lal-pakhri	14.8
Estarise(local)	5.2
Newly imported potato	4.8

Source: field survey

The familiar local varieties and their shortly known matters are-

i.   **Diamond-** one of the most popular varieties and mostly cultivated in Munshiganj ,Rangpur,Bogura District.

ii.   **SheelBilatee**- The tuber is oblong, reddish. Each tuber weighs about 30 g and mostly cultivated in Rangpur,Lalmonirhat etc.

iii.   **LalSheel**- primarily cultivated in Bogra with tubers rounded, reddish, each having a weight of about 55 g. This variety is also known as LalMadda and Bograi.

iv.   **LalPakri** - cultivated widely in Dinajpur, Bogra and Sirajganj districts with tubers reddish and round, each weighing about 30 g.

v.   **Du Hajari** - mostly cultivated in the Chittagong area. Tubers appear round and pale, each weighing about 25g.Among other indigenous varieties JhauBilatee and Suryamukhi are also popular in country.

In the last few decades, several dozens of high yielding varieties (HYV) of potato were brought experiment under local conditions since it recommended for general cultivation. During the 1970s, about 16 varieties were selected and 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, major amount of potato seeds are imported every year by the

Bangladesh Agricultural Development Corporation (BADC) for distribution. 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 are

a) **Cardinal**- known as also BARI Alu -8, 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**- also known as BARI Alu-7, 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) **KufriShindhury** – it contains tubers reddish, round, and eyes deep with rough skin. This variety was introduced from India which is comparatively less susceptible to pests and diseases. It makes a high yield potential of 18 to 22 m tons per ha. Other varieties are Patronis, Alpha, Archa, Multa, Ukama, Hira, Maurin, Origo, Alisa, etc.

In recent years, the Tuber Crops Research Centre of BARI has collected many new varieties of potato from the International Potato Research Centre, Peru, and from other sources. These are being tested under Bangladesh field conditions, to determine whether they can be recommended for cultivation in the country. The Centre has already made good participation towards the development of some high yielding potato varieties.

1.6 Justification of Present Study

In the economy of Bangladesh, Agriculture sector running a very big role. This sector awarded modest growth and experienced slow transition during the four decades. The main goal of the sector was to change the traditional and vulnerable agriculture by a modern agriculture capable of continued growth. Our country is the eighth largest potato producer in the world and third biggest in Asia, potato is consumed as a vegetable here, where in many countries it is a staple food but now excess production is creating havoc due to a glut in the market.

The suffering of potato growers in Bangladesh 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 (10.9 million tonnes) last year, according to the De-partment of Agricultural Extension (DAE). With an annual average demand of around 70 lakh tonnes (7 million tonnes), the country witnessed a surplus of about 40 lakh tonnes (4 million tonnes), most of which is wasted.Not all of the surplus can be stored in the cold storages for low capacity, said experts. For a lack of better use of the surplus, farmers are left with no option but to feed these potatoes to cattle, said growers.

According to Bangladesh Bureau of Statistic, over 10 million tons of potato was produced in 2017, and 5.3 million tons was kept in 390 cold storages across the country to maintain a sustainable supply all the yearlong. There most of the potatoes consumed is unprocessed. Only 2% of the potatoes are processed mainly in the form of chips and crackers. Recently Bangladesh Agriculture Research Institute (BARI) has developed 44 potato varieties. But the majority of Bangladesh's potato production is used for direct consumption. The varieties used for table potatoes are inappropriate for processing (the dry matter content is too low) or export (foreign consumers have different tastes). The quality of the potato seed also is an influencing factor; the formal sector seed potato production is only 5-9% of the total requirement. Both private and public sector together supply only 5% quality seed of the total requirement. Remaining 95% is the low quality seed potato which is produced by the farmers themselves. Potato produced on the basis of low quality seeds is not preferred for processing and export. The amount of potato is produced; the quantity of export is insignificant. According to Bangladesh Bureau of Statistic, the revenue generated from exporting potato was $33.8 million in 2013-2014 financial year whereas the amount came down to $13 million in 2016-2017.

Recently overproduction of potato is seen as a burden from the viewpoint of the farmers. We are concerned about the matter as the poor farmers in Bangladesh work hard to produce the crop but get only financial distress at the end of the day instead of making profit. On the other hand, contribution of this sector to the GDP is dwindling though it has a potential to contribute to the economy. We believe overproduction of potato is not a threat; rather it could be turned into an opportunity by utilizing the resources in the processing industry. The increasing demand for processed food products may drive the proper utilization of the excess potato which can lead to product

diversification. Companies should consider making much diversified processed potato products such as potato soup, hash brown, mashed potato, French fry. And as a precondition, the farmers should consider to produce the suitable verities for processing using high quality seeds.

Total production of potato in our country was about 3311 (000 tones) in the year of 2000 for only 127.27 million. On the other side our country is producing 9918 (000 tones) to feed 168.67 million people.it indicates the higher growth rate of potato production for the fastest growth of population rate. This increased potato production has been possible largely due to the adoption of modern potato varieties on around 66% of the potato land which contributes to about 73% of the country's total potato production. However, there is no reason to be complacent. The population of Bangladesh is still growing by two million every year and may increase by another 30 million over the next 20 years. Potato yield therefore, needs to be increased from the present 2.74 to 3.74 t/ha. The weather condition for potato cultivation was favorable in the growing stage this year.

But due to flash flood, heavy rainfall, and for other constrains in some northern districts the lands hectares of potato was fully damaged and the over production of potato have to controlled in positive way. In a subjective manner, farmers were interviewed on some points relating to management system of seed, fertilizer and rural electricity supply. They seems that proper management and timely distribution of seed, fertilizer and stable supply of electricity led to higher yield and controlled production of potato this year.

1.7 Specific Objectives of the Study

With a view look of the problem and overall situation as stated above, the following specific objectives were formulated for giving proper direction to the study:

a) To determine and describe some selected characteristic of the potato cultivators
b) To analyze technical efficiency of potato farmers
c) To determine the profitability of potato production
d) To draw conclusions and formulate some recommendations for necessary interventions with a view to increasing production of potato

CHAPTER II

REVIEW OF LITERATURE

The aim of current review of the literature to throw light on the studies related to the profitability and technical efficiency of potato production. In this chapter, an effort has been made to review of pertinent literature keeping in view the problem entitled, "Profitability and technical efficiency of Potato production in some selected areas of Bogura District in Bangladesh." Again, some of these studies may not entirely incidental to the present study, but their findings, methodology of analysis and suggestions have a huge influence on the present study. Review of some research works related to the present studies, which have been conducted in the recent past, are discussed below.

Elias et. al. (1980) conducted 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 got the average potato yield of 242 mounds per acre.

Elias et. al. (1982) by his study improved technology of potato in two district of Bangladesh, Bogra and Munshigonj. They estimated that the yield per acre hectre was much higher Munshigonj (25009 kg) than that of Bogura (13278 kg). they estimated average net return per hectre was TK. 7211 which was higher in Munshigonj (TK. 8751) than in Bogura (TK. 4953) which is profitable.

Sabur (1986) 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 increasing direction. He observed the average production cost per hectare was TK. 29635.57 and net return was TK. 30947.82.

Rashid (1994) conducted a study on the profitability of different cropping patterns with and without potatoes in two villages in Dinajpur district, with The average yields per hectare were 15590 and 4720.54 kg for HYVs and LVs of potatoes, respectively and their respective values were TK. 46084.03 and 2457.82. He also observed that the HYVs of potatoes were more profitable than other crops.

Q Naher , MA Hossain and MK Hasan (2008)   stated in their study ,was carried out in three potato growing areas viz. Munshiganj, Bogura and Jessore covering 75 potato growers to measure technical efficiency and economic performance of potato

production. Farmers obtained average tuber yield of 24.90 t/ha which was higher than the average yield of Bangladesh (14.90 t/ha) but close to potential yield (25-30 t/ha) of diamant and cardinal varieties. The estimated results showed that gross margin and BCR for potato cultivation were Tk. 174319/ha and 2.40, respectively. The average level of technical efficiency among the sample farmers was 75%. This implies that given the existing technology and level of inputs the output could be increased by 25%. Training on the potato production, extension linkage and quality seed played a significant role in the technical efficiency of the potato production.

Hossain et. al. (2008) estimated the technical efficiency of potato production in Bangladesh. This study was carried out in three potato growing areas viz. Munshigonj, Bogura and Jessore covering 75 potato growers to measure technical efficiency and economic performance of potato production. The estimated results showed that the average level of technical efficiency among the sample farmers was 75%. This implies that given the existing technology and level of inputs the output could be increased by 25%. Training on the potato production, extension linkage and quality seed played a significant role in the technical efficiency of the potato production.

Bakhsh and Ahmad (2006) estimated the technical efficiency in potato production by employing the Cobb-Douglas stochastic production frontier approach in Pakistan. The results indicated that potato farmers were 84% technically efficient, implying significant potential in potato production that can be developed. By shifting the average farmer to the production frontier, the average yield would increase from 8.33 tons per acre to 9.92 tons per acre using the available resources.

Hakim (1993) conducted a comparative economic study on Cardinal and multi varieties of potatoes in Bogura 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.

Jafrullah (1996) studied the technical efficiency of manufacturing industries of Bangladesh and concluded that the manufacturing industries of Bangladesh analyzed were not highly technical and also efficient.

Arif (1998) conducted a study on potato product on selected areas of Comilla district. He showed on his study that the per hectare gross returns were TK. 101857.56,

102458.56 and 101358.56; gross costs were TK. 64251.10, 65179.58 and 64742.42; net returns were Tk. 37616.46, 37178.88 and 366517.14 for small, medium and large categories of farmers.

Baten et. al. (2006) inquired the technical efficiency of selected manufacturing industries of Bangladesh using a stochastic frontier production function approach. In this paper a feasible Cobb Douglas stochastic frontier production function time-varying technical inefficiency effects, was estimated and the estimated average technical efficiency for 4 groups of industries of Bangladesh over the reference period was 40.23% of potential output for the truncated normal distribution, whereas it was 55.58% of potential output for the half-normal distribution.

Krasachat (2003) investigated the technical efficiency in potato farms in Thailand. In this study, the data envelopment analysis (DEA) approached and farm-level cross-sectional survey data of Thai potato farms in 1999. A Tobit regression was used to explain the likelihood of changes in inefficiencies by farm specific factors. The empirical findings indicated an increased diversity of efficiencies from farm to farm and also suggested that the diversity of natural resourced.

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 providing 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.

FAO (2013) stated that in case of potato production, small farmers who depend on their own production for seed in the next season have primitive or improved farm storage. Most seed storage in this case is either in farm houses or in small sheds. Some farmers improve storage conditions by providing ventilation and also using structures with diffuse light to help keep the seed potatoes. In most cases, however, the conditions are poor and result in wastage, thus reducing the total amount of potatoes left for seed to be planted in the next season.

Chowdhury *et. al.* (2015) conducted a study and found that 30 percent of their investment in the current season, which has created a shocking situation for them. Again cold storage charge is Tk. 4.2-4.5 per kg across the country which is a very high rate, on the other hand nearly 420 cold storages across the country can store 3.6 million tons

of potato, which is 44 percent of the total production. Dissemination of market information should be increased so that farmers can get the fair price of the potato.

Muktasha Deena Chowdhury et. al. (2015) conducted a survey on potato production in some selected areas of Bangladesh. It showed that found that in the context of production and export potato has a great prospect in Bangladesh and it is assuming a greater dimension, however bringing pressure on the government to expand its use as alternative food in the domestic sector as well as to explore it for greater export markets in overseas trade.

Begum (2017) also estimated a study about an economic study of potato production in selected areas of Sylhet district and found the large farms receive the highest amount of yield but it was the lowest for small farms. Potato cultivation is financially profitable among the farmers in the study area. Most of potato growers face same category problems but in various ways. Non-availability of quality seed and high price is the major constraint of potato cultivations for the farmers. The quality seeds as well as other inputs need to be available to the potato growers in time at reasonable price.

Rahman et. al. (2017). A total of 40 potato varieties grown in Bangladesh were evaluated for different physical and other quality attributes for processing industry. 17 varieties were oval shaped and 12 varieties were round shaped tubers. Twenty-nine varieties were white coloured and 11 varieties were red coloured skin. Sixteen potato varieties were cream colour flesh. Number of eyes was less in most of the cultivars with shallow eye depth, without scars and green tint. Omega showed the highest average tuber weight (138.6 g) and longest diameter (6.58 cm) while Steffi recorded significantly the highest volume (130.20 ml). The specific gravity was determined to clarify their processing quality. The specific gravity of different potato varieties ranged from 1.053 to 1.123 with the highest in Ludmila and Tomensa (1.123) and the lowest in Espirit, Almerah and Connect (1.053).

Yeasmin (2008) studied the economics of potato production in a selected area of Thakurgaon district. It was estimated that per hectare costs of production were Tk. 129327 and 113060 respectively based on ful cost and cash and basis, while gross returns per hectare was Tk 206623 and net returns were Tk 77296 and 93563 respectively considering full cost and cash cost. Evidence showed that potato

cultivation was profitable both on full cash cost basis. The findings suggest that most of the selected variables had significant impact on production of potato.

Huq et. al. (2005) endeavored to analyze marketable surplus of potato in Bangladesh. Cobb-Douglas type function form was tried in this study. Results of the study indicated that marketable surplus of total production of confirmed that total production was the best predictor in determining the level of marketable surplus. So, emphasis should be given on increasing yield though use of improved technology (irrigation, fertilizer) and hybrid seed with short maturation period.

Rajput et. al. (2003) conducted a study on the relative profitability of different potato cultivars (Kufri Lavkar, Kufre joyti and Sindhuri). Amonng the cultivars, the overall returns (Rs 23333478) and quintal was estimated to be lowest in Kufri Sindhuri, Kufri joyti recored the highest over all gross returns per hectare (Rs 19967) and Kufri Siindhuri recored the highest overall net returns per hectare. The overall profitability in terms of benefit cost ratio for Kufri Sindhuri, Kufre joyti and Kufri, Lavkar were estimated as 1.40, 1.36 and 1.34 respectively.

Majid (2004) performed an analysis on the availability and utilization of potato credit in Bogra district. The findings of the study revealed that potato cultivation under the institutional loan was a profitable business. It was found that the average per acre potato production for small, medium and large farmers were 800, 740 and 780 kg respectively. The findings of the study clearly indicated that then loaner farmers having small farm holding gained higher profit followed by medium and large farmers.

Rahman (1999) carried out a study on "Economic Analysis of Potato production is Some Selected areas of Rangpur District". The study was mainly designed to analyze the socioeconomic characteristics of potato farmers and to determine the costs and returns of producing HYV potato according different varieties and different categories of farmers and identifying the factors affecting yield and returns. One hundred twenty potato farmers were selected as sample. Findings showed that, the total costs Tk. 84291.85 per hectare was the highest for the large farmers growing Cardinal and it was the lowest Tk.56760.85 for the small farmers growing the same variety. The gross return Tk. 113333224.80 per hectare was the highest for the large farmers producing BARI TSP 1. On the contrary, the gross return Tk.95759.16 per hectare was the lowest for the small farmers producing Diamant. The functional analysis showed the effects of

using human labour, animal power, manure, seed and irrigation were positive for Diamant production.

Islam (2009) conducted a study on "Potato Production and Credit-A Study in Lalmonirhat District". The major's findings of this study revealed that potato cultivation under the institutional and non-institutional loan was a profitable business. The overall benefit cost ratio (undiscounted) of potato farming came out to be 1.42 indicating that one Tk investment resulted in a net benefit of Tk 0.42. The findings of the study clearly introduced that the loanee farmers having large farm holding obtained higher profit followed by medium and small farmers in the study villages. The findings showed that science use of inputs has increased the production of potatoes.

In Southeast Asia the potato is an important vegetable in diet diversification and an anchor in intensive cool weather horticulture systems. The potato in these countries fills a role in diet diversification and improved nutrition. Bangladesh is the third largest potato producer in Asia and is among the top 10 of the potato producing countries (source: The Daily Prothom-Alo) of the world. 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.

CHAPTER III

METHODOLOGY

3.1. Introduction

Farm management research depends on the proper methodology of the study. Proper methodology is a prerequisite of a good research. The design of any survey is predominantly determined by the nature, aims, and objectives of the study. It also depends on the availability of necessary resources, materials and time. There are several methods of collecting data for farm management research. A farm business study usually involves collection of information from individual farmers; collection of data for farm business analysis involves judgment of the analyst in the selection of data collection methods within the limits imposed by the resources available for the work (Dillon and Hardaker 1993). In this study, "survey method" was employed mainly due to two reasons:

    i.   Survey enables quick investigations of large number of cases.

    ii.   Its results have wider applicability.

The major disadvantage of the survey method is that the investigator has to rely upon the memory of the farmers. 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 design of the survey for the present study involved the following steps.

3.2. Selection of the Study Area

Selection of the study area is an important step for farm management study. The selection of an area fulfilled the particular purpose which was set for the study and also the possible cooperation from the farmer. Although Potato is grown all over Bangladesh, The district Bogura , Rangpur Dinazpur and most of the northern area of Bangladesh are the important districts where it is grown quite extensively.

So, on the basis of higher concentration of potato production, 3 big upazila namely Sherpur,Shibganj and kahaloo under Bogura district were purposively selected for the study. The main reasons in selecting the study area were as follows:

    a) Availability of a large number of Potato growers in the study area;

    b) Easy accessibility and good communication facilities in these villages;

c) Co-operation from the respondents was expected to be high so that the reliable data would be obtained.

d) These villages had some identical physical characteristics like topography, soil, climatic conditions for producing potato.

3.3. Sampling Technique and Sample Size

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 manageable within the limitation imposed by physical, human and financial resources (Mannan 2001). However, because of diversity in the technical and human environment, it is necessary to sample 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 2000).

It was not possible to include all the farmers of the study area due to limitation of time, money and personnel. In total 70 farmers were randomly selected. A purposive random sampling technique was followed in the present study for minimizing cost, time and to achieve the ultimate objectives of the study.

3.4 Data Collection

As data collection has a noteworthy impact on the quality of survey results, it is treated as a significant part of a survey. Considering its importance, the following measures were taken during the preparation of questionnaire as the tool of data collection:

3.4.1 Questionnaire Design

A questionnaire is a powerful evaluation tool that allows the collection of data through the use of multi-dimensional questions. A questionnaire written without a clear goal and purpose is inevitably going to overlook important issues and waste enumerators' as well as respondents' time by asking and responding useless questions. All these matters were addressed to the extent possible for developing the questionnaire of survey.

3.4.2. Pre-testing the questionnaire

The questionnaire was pre-tested to examine the time necessary to complete the interview, test the reliability i.e. whether it captured the information desired, and also investigated the consistency whether the information gathered by it was related to the whole purpose of the survey. The test had also targeted to check the logistics required for successful operation of the survey. In order to ensure the best performance of the questionnaire in respect of data collection, processing and analyzing, the pre-testing was carried out during the month of December 2018 and January 2019 prior to the survey at rural area of namely sherpur, shibganj and kahaloo under Bogura District. Myself chosen some of the farmers at random as the respondents.

3.4.3. Finalization of the Questionnaire & Method of Data Collection

After addressing all the changes following the recommendations evolved from the pre-test, the questionnaire was placed to my supervisor. My supervisor also put notable contribution to the questionnaire. Eventually, the questionnaire had been finalized with the approval. Face to face interview had been carried out following questionnaire.

3.4.4. Data editing and coding data editing and coding

Data Editing and Coding Data editing and coding were other vital phases of the survey, which were indispensable for data processing. It should be completed before data processing. In case of this survey coding had been done along with questionnaire development so that the enumerator could easily and accurately mark the right answers. Data editing referred to the activity of checking and cleaning data that had already been collected from the field.

3.5. Data processing

Data processing involved many steps that were very important because it affected survey results according to the involved steps. During data processing following steps had been taken.

- Data entry
- Appending and Merging files
- Data validation (further computer checking, editing, and imputation)
- Final decision on errors
- Completion of data processing and generation of data files

- Final documentations
- Conversion of data files to another software.
- Storage of all files.

3.6. Processing, tabulation and analysis of data

The collected data were manually edited and coded. Then all the collected data were summarized and scrutinized carefully. Moreover, data entry was made in computer and analyses were done using the concerned software Microsoft Excel and STATA. It may be noted here that information was collected initially in local units. After necessary checking it was converted into standard international units.

3.7. Analytical Techniques

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

3.7.1 Profitability Analysis

The net returns of boro 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
- Cow dung
- Urea

23

- TSP
- Mop
- Insecticide
- Weeding
- Irrigation
- Pesticides cost
- Interest on operating capital
- Land use

The returns from the crops were calculated 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, weeding pesticide cost 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 Cow Dung

Cow dung may be used from home supplied or through purchased. The value of home supplied and purchased cow dung was calculated at the prevailing market prices which would be added on land preparation cost later.

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 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 potato. 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 chili. 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

3.7.2 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.

3.7.2.1 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.

3.7.2.2 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

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

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

$Y_{i} = \alpha X_{1i}\beta_1 X_{2i}\beta_2 X_{3i}\beta_3 X_{4i}\beta_4 X_{5i}\beta_5 \, e^{ui}$

Where Y is the frontier output, X is physical input, β the elasticity of Y with respect to X, α is intercept and Ɛ = V-U is a composed error term as defined earlier. For simplicity, we have ignored the subscript.

3.7.2.3 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:

$Y = \beta_0 X_1\beta_1 \, X_2\beta_2 \ldots\ldots\ldots\ldots X_5\beta_5 \, e^{Vi-Ui}$

The above function is linearized double-log form:

$\ln Y = \ln\beta_0 + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + \beta_4 \ln X_4 + \beta_5 \ln X_5 + Vi-Ui$

Where,

Y = Output (kg/ha)

X_1 = Human labour (man days/ha)

X_2 = Irrigation cost (Tk./ha).

X_3= Seed (Kg/ha),

X_4= Cost of Fertilizers (Tk/ha)

X_5=MOP(Tk/ha) Cost of insecticide (Tk./ha)

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

$U_i = \delta_0 + \delta_1 Z_1 + \delta_2 Z_2 + \delta_3 Z_3 + Wi$

Where, $Z_1 \ldots Z_3$ are explanatory variables.

The equation can be written as:

$U_i = \delta_0 + \delta_1 \text{ Age} + \delta_2 \text{ Education} + \delta_3 \text{ Experience} + W_i$

There've 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 {Ui~|N (0, σu2) |} and Wi is two-sided uniform random variable. W is unobservable random variable having a positive

29

half normal distribution. The model was estimated simultaneously using STATA and MS excel.

CHAPTER IV

DESCRIPTION OF THE STUDY AREA

4.1 Introduction

This chapter presents a brief description of the study area. Knowledge of the study area is essential to understand the location, physical features and topography, soil type, temperature, rainfall, agricultural and economic condition, population, education and other socioeconomic infrastructure available in the area. This aims at present the above-mentioned characteristics of the study area.

4.2 Location

The study was conducted on some villages of three Upazila namely Sherpur,shibganj,kahaloo under Bogura District. In 1984 Bogra Zila was divided into Bogra and Joypurhat. The total area of the Bogura is 2898.68 sq. km (1119.18 sq. miles). The zila is bounded on the north by Gaibandha Zila and Joypurhat Zila, on the east by Jamalpur Zila and Sirajganj Zila, on the south by Sirajganj Zila and Natore Zila and on the west by Naogaon Zila and Joypurhat Zila. It lies between 24°32' and 25°07' north latitudes and between 88°58' and 89°45' east longitudes. Bogra Zila forms of 12 upazilas, 108 unions, 1672 populated mauzas, 2618 villages, 11 paurashavas, 111 wards and 360 mahallas. The upazilas are Adamdighi, Bogra Sadar, Dhunat, Dupchanchia, Sariakandi, Shajahanpur, Gabtali, Kahaloo, Nandigram, Sherpur, Shibganj and Sonatola.

4.3 Soil and Climate

In bogura district the eastern tract is rich with alluvial soil, subject to fertilizing inundations, yielded heavy crops like potato, rice, oil seeds, and jute, while the soil of the higher western portion of the district mainly allowed for growing potato and rice. Bogura is belongs to the barind tract and the soil is mainly Grey terrace soil and this tract belongs to an old alluvial formation which is usually composed of massive agrillaceous beds of pale reddish brown colour that often turns yellowish on weathering. Lime nodules and pisolitic ferruginous concretions occur throughout the soil. Locally the soils are rich in lime. Soil pH varies between 6.0 and 7.5. Soils are deficient in nitrogen and phosphorus.Bogura is mainly a tropical climate, with 2major seasons;winter and summer. Bogra experiences more rainfall during the summer.The

annual average temperature of the zila varies maximum 34.6°C to minimum 11.9°C and the average annual rainfall of the zila is recorded 1610 mm.

4.4 Agriculture and Economic Condition

Statistically, Bogra's workforce is still dominated by their work in the agriculture sector (29.95%) and agricultural manufacturing (12.53%). They are followed by general commerce (18.11%), customer service (15.62%), transportation (6.66%), wage labor (2.2%), and other industries (14.93%). (BBS 2018)

Their farmlands are fulfilled with the varieties of crops namely aus, aman, boro paddy, jute, wheat, potato, betel leaf, vegetables, spices, pulses, oilseed, cotton, sugarcane etc. are produced in Bogra Zila. Paddy covers about 76.05% of the temporary cropped gross area. The zila is very famous for modern irrigation and scientific cultivation system. Main fruits of bogura are; Mango, guava, black berry, custard apple, tamarind, Indian palm, jackfruit, papaya,pineapple, wood apple, lemon, betel nut, banana, coconut, litchi, pomegranate, date palm, ficus, etc.

4.5 Transportation

In Bogura Palanquin, dhuli, horse carriage, bullock cart, gaina boat and country boat were the traditional transports in the rural areas of Bogra Zila, these means of transport are either extinct or nearly extinct except of country boat. Now-a-days, all the upazilas are connected to the zila headquarters by metaled roads. Bus, minibus, three wheelers ply over the zila. Bogra is also connected with the capital by railroad.

4.6 NGO Activities

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

4.7 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 and fruits.

CHAPTER V

SOCIO-ECONOMIC PROFILE OF HOUSEHOLD POPULATION

5.1 Introduction

The point of this part was to present a brief description of the socio-economic characteristics of the growers of delivering potato. Socioeconomic parts of the farmers can be viewed from different 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 grower's support in national advancement exercises. It was impractical to meet. al.l the data with respect to the financial attributes of the example farmers because of confinement of time and assets. Financial state of the example farmers was 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. Nonetheless, for the present research, a couple of the financial qualities have been contemplated for exchange.

5.2 Composition of the Family Size

Family size was 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. But mainly my studied area considered the male farmers mainly.

5.3 Age

There are 20, 20, 20 samples were collected from three upazila named respectively sherpur,shibganj and kahaloo represented the total population. In total calculation there we can divide the farmers five age limitations less than 30, in that limit there were 3 farmers, age limit 31to 39 there were 8 farmers ,40 to 49 there were 20 farmers ,50 to 59 there were 17 and above 60 there were 12 farmers in the study area. the average calculation was given below.

Table 5.3: Age distribution of farmers

Age	Frequency	Valid Percent
less than 30	3	5
31 to 39	8	13.3
40 to 49	20	33.3
50 to 59	17	28.3
above 60	12	20
Total	**60**	**100**

Source: Field Survey

5.4 Education

Figure 5.4 showed that, in sherpur,shinganj,kahaloo upazila, there among the farmers there were 45 % farmers who passed their secondary level education and 25% were passed their higher secondary level .on the contrary there 25% farmers were illiterate and the percentage of primary level,honours levels and masters level were same that was 1.7% which was very low.so the education level of the study area were not so much well nor so much good .the education level was not too much valuable for them on the production of potato according to them .the believe in their practical knowledge.
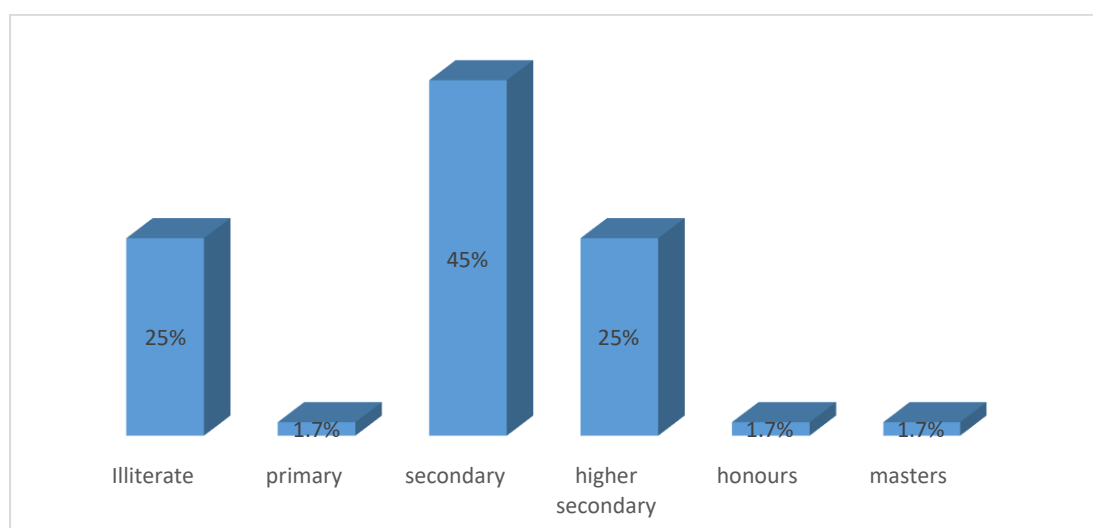
Figure 5.4: Education level of study area

5.5. Annual Family income

a) Agricultural work

Table 5.5: Average income of agricultural work

Sector	Average annual Income
Crops	55987.57
Poultry	44989.8
Livestock	26845
Fisheries	12678

Source: Field Source

Crops, poultry, livestock and fisheries were 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 55987.57. Now a day's poultry and dairy farm have been developed in the study area. Farmers Tk 44989.8 yearly income from poultry and 26845 and 12678 of livestock and fisheries respectively. The mean value of annual family income by agriculture was Tk 140500.37.

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 90678.78. The total average annual income was found Tk 231179.15 which were calculated on study area.

5.6 Annual Family Expenditure

Sherpur,shibganj ,kahaloo area mainly agricultural work based professionally but other sectors also popular there like Sample farmer, annual average expenditure was found Tk. 190678.79. 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 40500.36 estimated by study area.

5.7 Agricultural Training

Among the respondent farmers in Sherpur upazila, only 40 percent farmer's got training of Potato cultivation whereas, only 30 percent farmers got training in Shibganj upazila, and 15 percent farmers got training in Kahaloo upazila, 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).

5.8 Membership of any social organization

Among the respondent farmers in Sherpur upazila, 70 percent potato growers were found to have membership in different NGOs and/or farmers' organizations whereas Shibganj upazila 60 percent of potato 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 Kahaloo upazila .

5.9 Concluding Remarks

From the above discussions it was clear that there were some variations in socioeconomic characteristics between the Sherpur Upazila, Shibganj Upazila, Kahaloo Upazila potato growers. But the magnitude of the variations was not large. There were substantial indications suggesting that both Sherpur Upazila, Shibganj Upazila, Kahaloo Upazila potato rice growers were progressive.

CHAPTER VI

PROFITABILITY OF POTATO PRODUCTION

6.1 Introduction

The main purpose of this chapter was to measure the costs, returns and profitability of growing potato. Profitability was 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 estimated to identify the total cost of production. The returns from the crops have been estimated based on the value of the production.

6.2 Profitability of Potato production

Table 6.2: Per Hectare Costs of potato production

Cost Items	Quantity	Price Per Unit (Tk.)	Costs/Returns (Tk. ha-1)	% of total
A. Gross Return				
Potato	17682.23	13.42	237236.54	100
B. Gross Cost				
C. Variable Cost				
Seed	1588.56	30	47656.65	26.29
Irrigation	4.00	370	1480.00	0.82
Hired labor	218.00	370	80660.00	44.49
Urea	158.48	16	2535.75	1.40
TSP	144.73	22	3184.01	1.76
MOP	274.06	15	4110.90	2.27
Zn	8.52	180	1533.83	0.85
Manure	157.83	8	1262.67	0.70
Insecticides			17374.31	9.58
Total			**159798.12**	88.14
D. Fixed Cost				0.00
Land use cost			6500	3.59
Family labour	25.00	370	9250	5.10
Interest on operating			5744.13	3.17
capital @ 9%				0.00
Total Fixed cost			**21494.13179**	11.86
E. Total costs			**181292.25**	100.00

6.2.1 Variable Costs

From the table of PROFITABILTY OF POTATO PRPDUCTION we get the cost of variables, which are given below.

Cost of Seed

Cost of seed differs mainly depending on its quality,quantity and availability. Per hectare total cost of seed for potato production were estimated to be Tk. 47656.65 which constituted 26.30% of the total cost.

Cost of Irrigation

Cost of irrigation was one of the most important costs for Potato production. Production of potato about largely depends on irrigation. Right application of irrigation water helps to maximize the yield of potato and quality by maintaining soil water content within specified limit through timely and controlled water application on the potato on each growing season. The average cost of irrigation Tk 1480 to be per hectare,which has done 4 times on land and that represents 0.82 percent of the total cost.

Cost of Hired Human Labour

Human labour cost was one of the major cost components in the potato production process. It was one of the most important and largely used inputs for producing potato. It was generally required for various 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 218 man- days per hectare and average price of human labour was Tk. 370 per man-day. Therefore, the total cost of hired human labour was found to be Tk. 80660 representing 44.49 % of total cost.

Cost of Urea

In the study area,potato farmers used different types of fertilizers,among them urea was always used fertilizers.. On an average, farmers used urea 158.48 kg per hectare. Per hectare cost of urea was Tk.2535.75, which represents 1.40 percent of the total cost.

Cost of TSP

Among the different kinds of fertilizers used second used fertilizer was TSP, the rate of application of TSP 144.73kg per hectare. The average cost of TSP was Tk. 3184.01 which representing 1.76 percent of the total cost.

Cost of MoP

The application of MoP which was hugely used and one of the most valuable fertilizer for potato production applied 274.06kg per hectare. MOP have the impact of growing storability yield quality and quantity. Per hectare cost of MoP was found Tk 4110.90, which represents 2.27 percent of the total cost.

Cost of zinc

Among the different kinds of fertilizers used, there a little amount of Zn was used and the rate of application of zn(8.52kg). The average cost of Zn was found Tk.1533.83 which representing 0.85 percent of the total cost.

Cost of manure

It was observed in the present study area that potato farmers used cow dung for producing their enterprwases. They bought a large portion of cow dung from the milk producers. It was found about Tk. 1262.67 per hectare. Which representing 0.70% of the total cost.

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. 17374.31 which was 9.58 percent of the total cost.

Total Variable Cost

Therefore, from the above different cost items it was clear that the total variable cost of potato production was Tk. 159730.29 per hectare, which was 88.14 percent of the total cost.

6.2.2 Fixed Cost

6.2.2.1 Land use cost

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. Cash rental value of land has been used as cost of land use. On the basis of the data collected from the potato cultivators the land use cost was found to be Tk. 6500.00 per hectare, and it was 3.59 percent of the total cost.

6.2.2.2 Cost of Family Labour

Human labour cost is one of the major cost components in the production process. It was one of the most important and largely used inputs for producing potato. It was generally necessary for different operations such as land preparation, sowing, weeding, fertilizer and insecticides application, irrigation, harvesting and carrying, cleaning, storing etc. The quantity of average family supply labour (Without hired labour) used in potato production was found to be about 25 man-days per hectare and average price of human labour was Tk. 370 per man-day. If we pay those labour it was found to be Tk. 9250 representing 5.10 percent of total cost.

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.5744.13 per hectare, which represents 3.17 percent of the total cost.

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. 181292.25.

6.2.4 Return of Potato Production

Table 6.2.4: Per Hectare Cost and Return of potato Production

Cost Item	Cost/Returns (Tk/ha)
A. Gross Return	237236.54
B. Gross Cost	
C. Variable Cost	159730.29
D. Fixed Cost	21494.13
E. Total costs	181292.25
F. Gross Margin (A-C)	77438.42152
G. Net Return (A-E)	55944.28972
H. Undiscounted BCR (A/E)	1.308586211

6.2.4.1 Gross Return

Return per hectare of Potato cultivation is shown in that table Per hectare gross return was calculated by multiplying the total amount of product with respective per unit price. It was obvious from table that the average yield of Potato per hectare was 17682.23kg and the average price of Potato was Tk.13.42. Therefore, the gross return was found to be Tk. 237236.54 per hectare.

6.2.4.2 Gross Margin

Gross margin was the gross return over variable cost. Gross margin was calculated by deducting the total variable cost(159730.29Tk) from the gross return. On the basis of the data, gross margin was found to be Tk. 77506.25 per hectare.

6.2.4.3 Net Return

Net return or profit was counted by deducting the total production cost from the gross return. On the basis of the data the net return was estimated as Tk. 55944.29per hectare.

6.2.5 Benefit Cost Ratio (Undiscounted)

Benefit Cost Ratio (BCR) was a relative measure, which was used to compare benefit per unit of cost. Benefit Cost Ratio (BCR) was found to be 1.47 which meant that one-taka investment in Potato production generated Tk. 1.31. From the above estimation it was found that Potato cultivation was profitable in Bangladesh.

6.3 Concluding Remarks

From the above discussion it is very simple 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 obligate to use modern inputs such as seeds, fertilizers, human labour, pesticides and irrigation efficiently. Timely and efficient use of these inputs are the most necessary to increase production and profitability. On the basis of this discussions, it could clear to be concluded here that cultivation of Potato is a profitable. Production of Potato would help farmers to increase their income earnings.

CHAPTER VII

TECHNICAL EFFICIENCY OF POTATO PRODUCTION

7.1 Introduction

The estimation of efficiency with the help of production function has been a familiar 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 farmer's 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 Estimates of the Stochastic Cobb-Douglas Frontier Production Function:

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

The estimates for parameters of the Cobb-Douglas stochastic frontier production function and technical inefficiency effect model for Potato production for all farmers were presented in Table7.2.

Table 7.2: Results of the estimation of stochastic Cobb-Douglas frontier production function Technical Inefficiency Model

Variables	Coefficient	Standard error	T-ratio
Cobb-Douglas Production function:			
Intercept	-12.4213***	3.2879	-3.78
Human labour	-0.1661^NS	0.1297	-1.28
Irrigation	-0.1928^NS	0.2599	-0.74
Seed	1.1858***	0.4521	2.62
Fertilizers	1.3100***	0.3417	3.83
Insecticides	-0.1292^NS	0.3276	-0.39
Coefficient of Technical inefficiency model:			
Intercept	10.4038***	0.3026	34.38
Age	-0.0001^NS	0.0049	-0.03
Education	0.0068^NS	0.0149	0.46
Farm Size	-0.148***	0.0156	-9.49
Experience	-0.3586**	0.1437	-2.50
Variance Parameter:			
Sigma square	-2.5612***	0.6345	-4.04
Gamma	-0.7350*	0.4164	-1.76
Log Likelihood	**-41.3964**		

***Significant at 1% significance level; **significant at 5% significance level * Significant at 10% significance level; NS Represent Non-Significant.

Human Labor (X1)

The regression coefficient of labour cost (X1) of potato production was negative and insignificant.

Seed (X2)

The regression coefficient of seed cost of potato production was positive and significant at 1 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 1.1858 percent, other factors remaining constant.

Irrigation (X3)

The regression coefficient of irrigation cost of potato production was negative and insignificant.

Fertilizers(X4)

The regression coefficient of fertilizers (Urea,TSP,MOP,Manure) cost of potato production was positive and significant at 1 percent level of significance, which implied that if the expenditure on fertilizers was increased by 1 percent then the yield of potato would be increased by 1.3100 percent, other factors remaining constant .

Insecticide (X5)

The regression coefficients of Insecticide cost were negative and not significant which implied that if the expenditure on irrigation was decreased by 1 percent then the yield of potato would be increased by 0.1292percent, other factors remaining constant.

7.3 Coefficient of Technical inefficiency model:

Age

In the technical inefficiency effect model age is negative and insignificant.

Education

In the technical inefficiency effect model Education is positive and insignificant which implies that if there the education class or level will increase 1 year or class or level there the efficiency of farmers would be increased 0.0068%.

Farm size

Farm siza of potato cultivation in that study case is negative and significant at 1% level means that the farm size increase 1 level when efficiency will decrease 0.148%.

Experience

In the technical inefficiency effect model experience is negative and significant at 5% level which implies that if there the experience level will increase 1 year or level there the efficiency of farmers would be decreased 0.3586%.

7.4 Variance parameter:

Sigma square: variance parameter of technical inefficiency model sigma square is negative and 1% level of significant and the value is -2.5612 and the standard error is 0.6345.

Gamma: variance parameter of technical inefficiency model sigma square is negative and 10% level of significant and the value is -0.7350and the standard error is 0.4164.

Log Likelihood: The value of Log Likelihood is negative and it is -41.3964

7.5 Technical Efficiency and Its Distribution:

Table7.5: Frequency Distribution of Technical Efficiency of Potato Production

Efficiency (%0	No of farms	Percentage of farms
0-50	15	25
51-70	2	3.33
71-80	4	6.67
81-90	17	28.33
91-100	22	36.67
Total number of farms	60	100
Minimum	0.14	
Maximum	0.87	
Mean	0.72	
Standard Deviation	0.135	

Source: Field Survey

Table 7.5 shows frequency distribution of farm-specific technical efficiency for potato farmers. It reveals that average estimated technical efficiencies for potato are 72 percent which indicate that potato production could be increased by 28 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. Above 35 percent farm were efficient 70 to 90 percent the maximum frontier outputs maintaining the efficiency level. On the other hand, 37 per cent of sample farmers obtained up 90 to 100 percent technical efficiency level. The minimum and maximum technical efficiencies were observed to be 14 and 87 per cent respectively, where standard deviation was maintained at 0.13

7.6 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, irrigation and labor intensive enterprise. It is most essential to use modern inputs such as seeds, fertilizers, human labour, 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 VIII

PROBLEMS AND CONSTRAINTS TO POTATO PRODUCTION

8.1 Introduction

The main 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 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 96.67 percent Potato growers reported this as high problem.

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 91.67 percent Potato growers reported this as high problem. (Table 8.1).

8.4 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 83.33 percent Potato growers reported this as high problem.

8.5 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 81.67 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.

8.6 Attack of Pest and Disease

More damaging insect pests are Aphid, Cut worm, Potato tuber worm, rat in potato production. The growers of Potato were also affected by the problem of attack of pests and diseases. these Pests and diseases attack reduce crop yield and increase cost of production. About 70% percent Potato growers reported this pests as high problem.

There was a relationship among insect pest and disease incidence with weed infestation; as well as disease infection with the incidence of insect vector in the potato field. This study showed that the insect infestation and disease infection become high when weed infestation become high. Similarly, disease infection become high when insect vector populations become high.

8.7 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.

8.8 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.

8.9 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 50 percent Potato growers in reported this as high problem.

8.10 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. Table8.1 shows that near 50 percent of Potato growers reported this as high problem.

8.11 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).

8.12 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.

8.13 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 36.67 percent Potato growers reported this as high problem.

8.14 Poor Storage Facilities in House

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.

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

Type of Problems	No. of farmers	Percentage of farmers
Low price of output	58	96.67
High cost of irrigation water	55	91.67
High price of quality seed	50	83.33
Lack of quality seed	49	81.67
Attack of pest and disease	46	76.67
Inadequate extension service	35	58.33
Lack of operating capital	34	56.67
Natural calamities	30	50.00
Shortage of human labour	30	50.00
Lack of scientific knowledge of farming	24	40.00
Adulteration of fertilizer, insecticide, and pesticide	23	38.33
High price of fertilizers	22	36.67
Poor storage facilities in house	18	30.00

Source: Field Survey

8.15 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 IX

SUMMARY, CONCLUSION AND RECOMMENDATION

In the light of discussions made in the earlier chapters, a summary of the results, some conclusions on the basis of empirical findings and policy implications to improve the existing inefficiency of potato production in Bangladesh is presented in this chapter.

9.1 Summary of the Study

Agriculture, being the mainstay of Bangladesh economy, contributes about 13.60 percent to the GDP and provides employment to 39.07 percent of its alive national labour force. (BBS,2018) Crop as a major sub-sector (in terms of GDP contribution about 10.74 percent) of agriculture have a crucial importance in the economy of Bangladesh. This sector plays a significant role in supplying nutrition, creation of rural employment, poverty alleviation, earning foreign exchange and more importantly socioeconomic stability in the rural areas.

Bangladesh is turning to be a sick society due to huge malnutrition with a vast majority of people living below the poverty line. High population growth with declining death rate together with low growth in agricultural productivity adversely affects the living standard in the country. The present food production situation is not sufficient to meet domestic requirement. And the food deficiency will become more in the subsequent years due to rapid and higher population growth rate compared to food production.

The present production of rice in no way can meet the total food needs especially nutrient requirements of Bangladesh. Potato can supplement rice and play a vital role from the viewpoint of food self-sufficiency. It is highly nutritious and high energy food source. The popularity of potato as a food is gaining momentum year after year and it has reached such a point that very few people in Bangladesh refuse this cereal on the dining table. Potato area and production continuously fluctuated over the time.

Potato has become now an important cereal crop in Bangladesh due to its higher yield, nutritional value and versatile uses. Demand for potato in Bangladesh is augmenting day by day due to increasing population and rapid expansion of poultry and livestock industries.

High production of potato depends on the expansion of high yielding variety of seed, improved management and timely supplying of inputs. The rate of adoption of modern

technology and sustainability of potato production depend largely on its economic profitability. Profitability is certainly an important consideration to the farmers" for selection of crops and adoption of new technologies. The returns from the potato crops and the productivity of inputs or resources determine the ability of farmers to acquire, utilize and sustain a certain type and quantity of resources which in turn will be used for further increase of productivity.

The efficient use of resources is an important indicator of increased production in agriculture. Like other food grains, potato output could be raised by utilizing the productive inputs, such as land, labour, capital and organizing the management of production efficiently. Efficiency utilization of present level of inputs may be advised for higher productivity. As there is a limited scope for further increase of potato area, production can be increased by increasing the productive efficiency of potato using existing technologies. Understanding the determinants of economic inefficiency of potato production is very important for both farmers and policy makers to increase the productivity and profitability of potato production. Therefore, to keep pace with the future demand of the growing population, the current trend of potato production and productivity should be raised and to increase yield level for maintaining food security of the population without substantial and unaffordable imports, and also an appropriate research and production plan should be undertaken to boost up the potato production in Bangladesh.

The main aim of the study is to identify and explain possibilities for improving productivity and profitability of potato by increasing the productive efficiency of potato farmers in Bangladesh. The present study was undertaken in Thakurgoan district of Bangladesh with the specific objectives to document the socio-demographic profiles, to determine the cost and relative profitability of producing potato under different farm sizes and to estimate the farm specific technical, allocative and economic efficiency of potato production.

The present study was undertaken in purposively selected Pirgonj upazilla, Baliadangi upazilla and Sadar upazilla of Tahkurgoan district for discussion and necessary data collection. A total of 60 farmers were selected from the collected lists by simple random

sampling methods, whereas taking 20 small, 20 mediums and 20 large farmers, respectively from each village. Primary data were collected by the researcher himself from potato farmers of the selected district through direct interview method with the help of pre-tested interview.

The collected data were then entered into the computer and data analysis was done by using the concerned computer software packages like Microsoft Excel and Statistical Package for Social Science (SPSS). A combination of descriptive and statistical techniques as demanded by the study was used to achieve the objectives and to get the meaningful results. Various descriptive statistical measures (i.e., sum, average, percentages, ratios, standard deviation etc.) were employed to examine the objectives. For sustainable production of potato under potato based cropping patterns, some technologies related to tillage, crop management, nutrients and water management practices were analyzed. In these issues, growth rate of potato area, production and yield, total factor productivity index, sensitivity analysis, employment opportunity, economic benefit, farmer"s intension for further potato cultivation, food and nutrition security, etc. are discussed for analyzing the final objective.

In this study, an attempt has been made to identify the socio-demographic profiles of the sample farmers. It was observed from farm category, 22.50 percent sample farmers were illiterate and 77.50 percent literate. Household income was spent on different head such as food, clothing, health care, education, housing and furniture, agriculture, electricity and miscellaneous cost in the study areas. Farmers spent a major portion of income on their food items (29.53%) and agricultural activities (31.57%). The average agricultural farming experience was recorded as 20 years of which potato farming experience was about 13 years in all categories of farmers. These differences indicated that irrespective of farm category, farmers go for potato cultivation after gathering some farming experience other than potato. About half of the respondents (42.50%) had no contact with extension personnel.

However, only about 9.17 percent had weekly contact and the rest of the contact had irregular. To determine the profitability of potato production, the inputs were valued either at their market prices prevailing in the study areas during the study period or at the price at which those were bought for computing all the cost items. Farmers in the study areas used purchased as well as home supplied inputs.

9.2 Conclusions and Recommendations

The study revealed some valuable information regarding potato production. The overall findings of this research suggested that potato production is a profitable enterprise. In spite of its profitability most of the farmers were not interested in potato production due to its high production cost especially human labour cost relative to other crops. If the problems are removed and potato growers are given incentives then the production of potato could help in improve income, employment generation and poverty alleviation of the rural poor's. Moreover, there are bright prospects for the development of potato due to its high nutritive values and rising demand in home and abroad. Therefore, meeting local consumption, it can be exported in the international market.

Conclusions and recommendations were drawn on the basis of the results and discussions made in earlier chapters. Based on the findings of the study, these are stated below in brief:

i. Expansion of potato output by increasing area has now become extremely limited because of scarcity of land. In such situation, improvement of potato output should be vertical and concerted efforts of the researchers is essential to develop new high yielding varieties responsive to high input and management practices.

ii. Extension contact has a positive impact in increasing production of potato and farmers having frequent contact with extension personnel produced higher yield. About half of the farmers in the study areas had no contact with extension personnel and the rest of the farmers had irregular contact. Hence, farm level extension service should be strengthened so that farmers" consciousness regarding improved production and management practices is ensured.

iii. It was observed that about 73 percent farmers had no formal training regarding agricultural as well as potato production. Further, it was noted that potato training receiver obtained higher yield than that of non-receiver, i.e., training had positive relation to yield. To develop interest among the farmers to participate in training sessions, some incentives might be arranged such as quality input supply at cheap rate, short term credit facility, etc. Both government and non-government organizations should take initiatives to provide training to the farmers on the different aspects of potato production.

iv.   Micro finance has influential effect not only on the farmers" technical efficiency but also on economic efficiency. Farmers who have access to credit can purchase inputs at right time and low price. In the present study, a few farmers have received this facility. So, institutional credit should be made more flexible for the potato producers. Besides, the interest rate for credit should reasonably be low.

9.3 Policy Implications

Based on the results of the study, the following policy recommendations are made for increasing the production and financial returns as well as sustainable development of potato production in Bangladesh.

i.   Steps should be taken to motivate the farmers to mix cropping in their potato included cropping patterns to maintain soil fertility in the long run and increase the crop yield.

ii.   Newly released high yielding varieties of potato should be popularized. High quality seeds of those varieties must be available to the farmers in time at cheap rate. Farmers" seed storage programed, and BADC seed production and distribution programmed should be strengthened by marketing more efficiently and making BADC semi-autonomous. Tuber Crops Research Centre (TCRC) must have strong research and training program on potato. Motivation efforts must go on.

iii.   Spot scarcity, adulterated and high price of fertilizers affected their application in the potato field. In this regard concerned authority should take necessary steps so that sufficient fertilizers are made available to the farmers in time and with fair price.

iv.   To control the pest and disease, supply of insecticides should be available and special emphasis should be given on integrated pest management practices.

v.   Different Government agencies like DAE and non-government agencies should run strong extension program in order to increase area under potato production and diversified uses of highly nutritious potato should be encouraged to the farmers through books, papers, leaflets and other mass media.

vi.   GOs and NGOs should arrange multi-disciplinary training on potato production to enrich farmers" knowledge and skill.

vii. Research and extension need to be closely coordinated to learn what farmers are doing, to develop alternative resource conserving tillage options (e.g., bed planting) for increasing and sustaining potato yields, and to facilitate a smooth transfer of technical knowledge from researchers to farmers for the better earnings to their production and economic development. Therefore, the Government should recast the system so that more effective contact is ensured between extension personnel and potato growers and it can disseminate new technologies more quickly and effectively.

viii. Collection and dissemination of marketing information should be needed for the producers through radio broadcast and daily newspaper during before starts the harvesting period. Finally, Government potato grain procurement programme should also be strengthened.

ix.   The scheme of crop insurance may be introduced to cover the potato production activity which involves climatic risks

9.4 Limitations of the Study

The present study would determine the productive efficiency of farmers, and the nature and extent of sustainable potato production at the farm levels. In order to conduct the research in a manageable way the researcher considered.

i.   Most of the farmers did not keep record of their production. Then the researcher had to depend on the memory of the farmers. To overcome this problem, several visits were made by the researcher himself to ensure the collection of reasonably accurate data from the field.

ii.   The profitability study of all cash crops would be better than that of a single crop. Due to lack of time and resources, the inclusions of all cereal crops were not possible as they would increase measurement errors. Non-farm activities were not included. For this, the observed inefficiencies in producing potato would have to be interpreted with caution. Identification of exact qualification of family labour was a difficult task. Because the procedures often could not estimate distinctly the use of family labour for different purpose properly. In the present study, the researcher had carefully

asked the period of time spent by family members in different operations of potato production.

iii. In this study, only one important potato growing area of Bangladesh was selected due to the practical situation. Covering all regions of Bangladesh would increase the accuracy and reliability of the study for comprehensive development policy about production efficiency and sustainability of potato production in the long run.

iv. Profitability of potato production is certainly influenced by the degree of efficiency of the marketing of inputs and outputs. The result of the study would be more enriched, if the study would include marketing aspects of input and output.

9.5 Scope for Further Study

A number of areas are identified where further economic study may be conducted to develop and fine-tune policies dealing with the cereals as a whole or some of it. The weaknesses of the present study, of course, open avenues for further research which are given below:

i. A broad based study on the profitability of potato production should be undertaken with and without intercropping of potato.

ii. A comparative study can also be undertaken to assess the relative profitability of different potato varieties and other competing crops.

iii. An aspect requiring further study is the variety of potato currently being used by the farmers. It suggested that carrying out a detailed topographic survey for the development of potato variety.

CHAPTER X

REFERENCE

Acharya, S.S. and Agarwal, N.L. (2004). Agricultural Marketing in India. New Delhi, Oxford and IBN Publishing Co. Pvt. Ltd.

Ahmed, K.U. (1977). Potato for the Tropics Published by Mamtaj Kamal, Bunglow No. 2, Krishi Khamarsharak, Farmgate, Dhaka.

Ahsan, N. (1964). Production and Marketing of Potato in Comilla Thana. Research and Survey Bulletin No.5, Bangladesh Academy for Rural Development, Comilla. Bangladesh.

Akhter, S.M., Anwar, M., and Asaduzzaman, M. (2001). Potato production in some selected areas of Bangladesh .TCRC, BARRI, Joydebpur, Gazipur, Bangladesh.

Arif, A (1998). An Economic Study of Potato Production in Selected Areas of Comilla District. M.S. Thesis submitted to the Department of Cooperation Marketing, Bangladesh Agricultural University, Mymensingh. Bangladesh.

Awal, M.A. (2013). An Economic Analysis of potato and Carrot Production in selected Areas of Mymensingh District. Unpublished MS Thesis, Submitted to the Department of Agricultural Economics (Production Economics), Bangladesh Agricultural University, Mymensingh.

Azimuddin, M., Alam, Q.M. and Baset M.A. (2009). Potato for Food Security in Bangladesh. Int. J. Sustain. Crop Prod.4(1):94-99.

BADC, 2012. Annual report, 2011-12 of Bangladesh Agricultural Development Corporation, Monitoring Division, pp.177.

Bajracharya, M., and Sapkota, M. (2017). Profitability and productivity of potato (Solanumtuberosum) in Baglung district, Nepal. Agriculture & Food Security, 6, 47. doi:https://doi.org/10.1186/s40066-017-0125-5.

BBS, (2011). (Bangladesh Bureau of Statistics). 2011. Year book of Agricultural Statistics of Bangladesh, Statistics Division, Ministry

of Planning, Government of the People's Republic of Bangladesh, Dhaka, Bangladesh.

BBS, (2016). Yearbook of Agricultural Statistics of Bangladesh, Bangladesh Bureau of Statistics, Statistics Division, Ministry of Planning, Government of peoples Republic of Bangladesh.

BBS, (2018). Yearbook of Agricultural Statistics of Bangladesh, Bangladesh Bureau of Statistics, Statistics Division, Ministry of Planning, Government of peoples Republic of Bangladesh.

Begum, (2017). An Economic Study of Potato Production in Selected Areas of Sylhet District, Sylhet Agril. Univ. 4(1): 129-136, 2017, ISSN: 2308.

Bhuiyan et. Al. (2002). Effect of Mulch and Crop Management Practices on Growth and Yield of Potato.

Chowdhury, (2015). Problems and Prospects of Potato Cultivation in Bangladesh, Asian Business Review,Volume 5, Number 1/2015 (Issue 10), ISSN 2304-2613.

DAE (1999). Agricultural Extension Mannual. Department of agricultural extension, Ministry of Agriculture. Government of the people's Republic of Bangladesh.

e.g http://potatoconference.com/Research.cfm

e.g https://doi.org/10.3329/jard.v6i1.1665

e.g https://www.potatopro.com/bangladesh/potato-statistics

e.g https://www.thedailystar.net/country/natural-cold-storage-potato- preservation-1468687

Elius et. al. (1982). Socio-Economic Assessment of improved Technology of potato and Identification and Constraints to its Higher Production. Agricultural Economics Research Report No. 4. Joydevpur, Agricultural Economics Division, BARI.

Elius et. al. (1982). Socio-Economic Assessment of improved Technology of potato and Identification and Constraints to its Higher Production. Agricultural

Economics Research Report No. 4. Joydevpur, Agricultural Economics Division, BARI.

FAO, (2013). Food Wastage Footprint Impacts on Natural Resources.Summury report Rome.

Geoffrey, S.K., Hillary, N.K., Antony, K.M., Mariam, M. and Mary, M.C. (2014). Challenges and Strategies to Improve Tomato Competitiveness along the Tomato Value Chain in Kenya, International Journal of Business and Management, Volume 9,Number 9, pp. 205-212

Hakim M. A. (1993). A Comparative Economic Analysis of Cardinal and Malta Varieties of Potato in Kotwali Thana in Bogra District.

Hossain, M. and Bose, M.L. (2000). Growth and Structural Changes in Bangladesh Agriculture; Implication of Strategies and Policies for Sustainable Develompent in M. A. S. Mandal ed. Changing Rural Economy of Bangladesh, Bangladesh Economic Association, Dhaka, 1- 20.

Hossain, M.A. and Miah, M.A.M. (2009). Post-harvest losses and technical efficiency of potato storage system in Bangladesh, Final Report CF # 2/08; National food policy capacity strengthening program.

Islam, S.M.F., Anwar, M.M., and Manos, B. (2000). Potato production system in Bangladesh: Resource use, productivity, efficiency and comparative profitability of true potato seed technology over traditional tuber technology ActaHortic,536,261-268doi: 10.17660/ActaHortic.2000.536.30.

Khandker, Saifullah and Basak, Ashish. (2018). Scope for Potato Processing Industry in Bangladesh. (2018, February 2). Daily Sun. Retrieved November 4, 2018, from http://www.daily-sun.com/post/286321/Scope- for-Potato-ProcessingIndustry-in-Bangladesh.

Moazzem, K. G. and Fujita, K. (2004). Potato marketing system and its changes in Bangladesh: From the perspective of village study in Comilla district. The Developing Economics, XLII-1 (March): 63-94.

Muktasa Deena Chowdhury et. al. (2015). Problems and Prospects of Potato
    Cultivation in Bangladesh.

Nasrin, S. (2010). "Marketing Efficiency of Selected Vegetable at Shibganj Upazila in
    Bogra District". M.S. Thesis, submitted to the Department of Agribusiness and
    Marketing, Bangladesh Agricultural University, Mymensingh. Bangladesh.

Rahman, A. (2010). "Value chain Analysis of Musroom in Selected Areas of Dhaka
    District". M.S. Thesis, submitted to the Department of Agribusiness and
    Marketing, Bangladesh Agricultural University, Mymensingh. Bangladesh.

Sarkar, M.M.A. and Yesmin, F. (2014). Profitability of potato cultivation in some
    selected areas of Rangpur district in Bangladesh. Int. J. Sustain. Crop Prod. 9
    (1):11-15.

Satter, M.A., Rahman, M.M., Rashid, M.H., Ali, M.S. and Alam, M.S. (2005). Krishi
    Projukti Hatboi(Hand book on agro technology), 3rd ed, BARI, Gazipur.

Seraj, S. (2017). Natural cold storage for potato preservation. (2017, September 28).
    The Daily Star. Retrieved November 4, 2018, from

Thompson, H.C. and Kelly, W.C. (1957). Vegetable crops; McGraw Hill Book
    Company Inc. New York

Uddin, M.A., Yasmin, S. Rahman, M.L. Hossain, S.M.B. and Choudhury, R.U.
    (2010). Challenges of Potato Cultivation. In: Bangladesh And Developing
    Digital Databases Of Potato. Bangladesh J. Agril. Res. 35(3): 453-463.

Wikipedia. (2019). Maps of Bangladesh.

Yasmin. M.S. (2008). An Economic Analysis of Potato Production in a Selected Area
    of Thakurgoan District. M.S. Thesis, Department of Agricultural Economics,
    Bangladesh Agricultural University, 3-176.

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

Village/Community..

Upzilla...

A. SOCIO-ECONOMIC CHARACTERISTICS

1. Name of farmer……………………………………………

2. Sex: Male ( )   Female ( )

3. Age: ……………. Years

4. Level of Education: ………………. Years

5. Number of family member …………..

6. Farm Size

Items	Area(Decimal)
Net cultivation land	
Leased in land	
Leased out land	
Mortgage in	
Mortgage out	
Potato cultivation land	

7. Source of Income

a) **Agricultural Service :**

Sector	Income per year(Tk)
Crop	
Poultry	
Animal production	
Fisheries	

b) **Nonagricultural Service :**

Sector	Wage/day	Income per year (Tk)
Day labor		
Rickshaw puller		
Construction worker		

Tailoring		
Shop keeping		
Others (if any)		

8. Credit Access: (sources of credit facilities)

Sources of credit	Amount (TK)	Instalment	Rate of Interest (%)
1.Self sufficient			
2.Borrowing money from neighbors			
3.Borrowing money from relatives			
4.Borrowing money from NGO			
5.Borrowing money from co-operatives			
6.Borrowing money from Bank			

9. Do you belong to any potato related co-operative/association?YES (   )   NO (   )

10. Years of experience (How long have you been in Potato farming)? ....

11. Do you have membership in any social organization? YES (   )   NO (   )

12. Have you ever been visited by an extension agent?   YES (   )   NO (   )

13. If yes, how many times in last one year? ....

14. Do you received any training for Potato cultivation?   YES (   )   NO (   )

15. If yes,
   - ✓ How many times………………
   - ✓ How many days………………..

16. Distance of your farm land from DAE office …………….. KM

17. Distance of your farm land from Market ……..………….. KM

B. INFORMATION ON INPUTS

18. Planting time: Month…………………………
Week…………………………………

19. Variety Name…………………………………..

20. Soil Type……………………………………..

21. Source of Seed

Source	Kg	Tk/Kg
a) Home		
b) Purchase		

22. Cost of cultivation of crop

A) Human Labor cost (Per unit area)

	Operations	Human labor (Hrs./Days)		Price/wage
		Family	**Hired**	
01.	Land preparation			
02.	Planting			
03.	Fertilize application			
04.	Intercultural operation			
05.	Insecticide application			
06.	Harvesting			
07.	Others			

B) Material cost (Per unit area)

Sl. No.	Particulars	Quantity/Times	Rate
01.	Seed		
02.	Irrigation		
03.	Manure		
04.	UREA		
05.	TSP		
06.	DAP		
07.	MOP		
08.	Others		
09.	Bio-fertilizers		
10.	Insecticide & Pesticides		
11.	Others		

C) Rest :

23. Production in survey area

Product	KG	TK/KG
Main product		
By Product (Straw)		

Constraints of Potato production

1.
2.
3.
4.
5.

Suggest possible solution to the constraints in Potato production

1.
2.
3.
4.

Thank you so much for your cooperation

Name of the enumerator:

Signature:

………………………

Date: