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

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DECEMBER, 2018

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REGISTRATION NO. : 11-04552

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

MASTER OF SCIENCE
IN
AGRICULTURAL ECONOMICS
SEMESTER: JULY-DECEMBER 2018

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CERTIFICATE

This is to certify that thesis entitled, ***"PROFITABILITY AND TECHNICAL EFFICIENCY ANALYSIS OF POTATO PRODUCTION IN SOME SELECTED AREAS OF NAOGAON DISTRICT"*** *submitted to the Faculty of Agribusiness Management, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of* ***MASTER OF SCIENCE IN AGRICULTURAL ECONOMICS,*** *embodies the result of a piece of bona fide research work carried out by* ***NISHAT TASNIM****, Registration No.* ***11-04552*** *under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.*

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

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TO

MY BELOVED

PARENTS

ABSTRACT

The present study was designed to measure the profitability and technical efficiency of Potato farmers in selected areas of three areas as Naogaon sadar upazilla, Bodolgachi and Atrai upazilla under Naogaon District. Primary data were collected from selected 25 farmers of each study area randomly. Total sample was 75. Both tabular and functional analyses were applied in this study. The major findings of the study reveal that Potato production is profitable. Total cost of production was Tk. 173221.86 per hectare of potato land. Gross returns was Tk. 273314 per hectare and net returns was Tk. 1,00092 per hectare. Benefit Cost Ratio (BCR) was found to be 1.58 which implies that one taka investment in Potato production generated Tk. 1.58. The Cobb-Douglas stochastic frontier production function was used for this study to measure technical efficiency of Potato farmers. The significant coefficient of parameter like Human labour cost was negative whereas Seed cost, Fertilizer were found positive and significant. In the technical inefficiency effect model, experience, farm size, extension service and credit service have negative coefficients indicating that this helps in reducing technical inefficiency of Potato farmers. The study revealed that a considerable improvement took place to increase household income of the potato growers in the study area and to improve the socioeconomic conditions with the introduction of large-scale commercial Potato production. Major problems which faced by the potato growers were High price of Fertilizers and Insecticides, Non-Availability of Quality Seeds, Low Price of Product at Late Harvesting Period etc. Yield of Potato would possibly be increased using new modern variety of potato. Major recommendations like both the government and private institutions should take necessary steps to ensure the availability of quality HYV seeds at the door steps of farmers at reasonable price. Government should take necessary steps to train the farmers about the proper use of inputs through Upazilla Extension officer, Government also should take initiatives to search for new market for potato during the harvesting season so that they can get right price are required to improve the present situation.

ACKNOWLEDGEMENT

First of all, I would like to thank Almighty Allah, the most merciful and kindhearted, the most gracious and beneficent to Whom every praise is due and to His prophet Mohammad (SM) Who is forever a torch of knowledge and guidance for humanity as a whole with who's delighting the present and endeavor beautiful. All praises are due to the omnipotent, omnipresent and omniscient Allah, who enabled me to pursue my higher studies in Agricultural Economics and to complete the research work and this thesis successfully for the degree of Master of Science in Agricultural Economics.

Now, I would like to pay ineffable gratitude to my **Dr. Fauzia Yasmin**, Director(TTMU), BARC, Farmgate, Dhaka, for his ever inspiring guidance, scholarly comments and constructive suggestions throughout the research work and preparation of thesis. Without his valuable intellectual advice, precise constructive comments and help this work would never have come to life.

I am especially grateful to my respected **Co-supervisor, Professor Gazi M. A. Jalil,** Chairman, Department of Agricultural Economics, Sher-e-Bangla Agricultural University, Dhaka-1207,for his proper guidance, inspiring co-operation and encouragement during the research work and preparation of thesis.

I would also like to extend my appreciation to **Professor Gazi M. A. Jalil,** Chairman, Department of Agricultural Economics, Sher-e-Bangla Agricultural University, Dhaka, for his sincere cooperation, valuable suggestions and encouragement at every stage of this thesis.

I am highly grateful to all of my honorable teachers, for their valuable teaching, direct and indirect advice, encouragement and co-operation during the whole study period.

I would like to express my gratitude to 75 farmers who actively participate in this survey and most importantly help me to understand their initiatives and activities related to Potato production in general and in particular. They provided important data upon which different models were employed to evaluate the efficiency of farming activities. Their invaluable cooperation during my data collection process is highly acknowledged.

I would like to express my sincere appreciation to my dear friends Suvro Basak Assistant Director, Bangladesh Bank, for his help during data collection and analysis process.

I found no words to thank my parents for their never-ending affection and continuous support, their sacrifice and untiring efforts to fulfill my dream of higher education. They were constant source of inspiration in the critical moments of my studies.

December 2019

Nishat Tasnim

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ABBREVIATIONS AND ACRONYMS

BRRI	: Bangladesh Rice Research Institute
BBS	: Bangladesh Bureau of Statistic
BCR	: Benefit Cost Ratio
BDT	: Bangladeshi Taka
BER	: Bangladesh Economic Review
DAE	: Department of Agricultural Extension
et al.	: and others (at elli)
GR	: Gross Return
gm	: Gram
ha	: 100 Mushroom
HIES	: Household Income and Expenditure Survey
HYV	: High Yielding Variety
IOC	: Interest on Operating Capital
kg	: Kilogram
MoP	: Muriate of Potash
mt	: Metric Ton
NGO	: Non-Government Organization
SRC	: Spices Research Center
t	: Ton
TC	: Total Cost
TFC	: Total Fixed Cost
Tk.	: Taka
TSP	: Triple Super Phosphate
TVC	: Total Variable Cost
US	: United States
USDA	: United States Department of Agriculture
$	: Dollar
BARC	:Bangladesh Agricultural Research Council

CHAPTER 1
INTRODUCTION

1.1 General Background

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

Bangladesh, though an agricultural country, can not produce enough food to feed her own population and has to import lakhs of tons of food grains each year. Such imports cost huge amount of foreign exchange which causes serious drainage of her economy. Two reasons are mainly responsible for the unfavourable food situation in Bangladesh. Firstly, the population is growing at an alarming rate and secondly, the rate of agricultural production per hectare is deplorably low. In fact, Bangladesh is one of the thickly populated regions in the world. Rice is the staple food crop in Bangladesh. But increase in the production of rice has not been able to keep pace with the increase in population.

In spite of dominance of agriculture in the national economy, Bangladesh is facing chronic food shortage due to rapid growth of population and has to import on an average 1.89 million tons of food grains in each year (BBS, 2019). The present rice and wheat production are not sufficient to meet the increasing requirements of calories for the growing population of the country. In this regard, potato can play an important role as an alternative and multipurpose food crop of Bangladesh.

Potato is the leading vegetable crops in the world which occupy the top most position after rice and wheat both in respect of production and consumption (Thompson and Kelly, 1957). Potato is produced in 132 countries out of 193 independent countries of the world.

The importance of potato in the economy of Bangladesh can hardly be over emphasized. Besides, potato is the main source of important nutrients, but the production of potato has not been able to keep pace with the increased demand with the population growth. A comparative picture of area, population and yield per hectare of potato in Bangladesh along with the major potato producing countries are shown in Table 1.1.

Table 1.1: Area, production and yield per hectare of potato in different countries of the world in 2016

Country	Area ('000 hectares)	Production ('000 metric tons)	Yield (kg/ha)
Bangladesh	**149 F**	**1702 F**	**11250**
India	**1300 F**	**23500 F**	**18077**
Pakistan	**110**	**1868**	**16915**
Japan	**98 F**	**2963 F**	**30328**
Netherlands	**18 F**	**8200 F**	**24809**
Germany	**302**	**12633**	**41832**
UK	**165**	**6648**	**40289**
France	**169**	**6652**	**39385**
USA	**547**	**23404**	**42788**
Australia	**41 F**	**2327 F**	**32126**

Source: FAO, 2018; F = FAO estimate

In spite of greater potentiality of potato production, the farmers of Bangladesh are not free from constraints in the field of cultivating potato.. As there is little scope for increasing cultivating area but there is a great scope for increasing per unit production. To increase production of food crops in this country, we need both vertical and horizontal expansions. The possibilities of horizontal expansion of major food crops are very limited due to the scarcity of land.

Vertical expansion by introducing new varieties which is feasible and economical will reduce the per unit production cost, resulting in the availability of the produces at cheaper prices. At present vertical expansion of rice and wheat has reached a high level. But there is ample scope for the vertical expansion of potato production through selection of suitable varieties, using appropriate technologies and high quality seeds. The area and production of potato in Bangladesh during 2017-18 were 0.5 million hectares and 8 million metric tons respectively (BBS, 2016). The trend in the production of potato and gradual increase in the per hectare yield of potato crop remained static at around 5.95 metric tons up to 1960. The increase of yields to 15.25 metric tons per hectare in the recent years is mainly due to use of quality seeds of modern variety and appropriate production technologies. To raise the average per hectare yield of potato from 15.25 to 20.00 metric tons, it is necessary to increase the production and supply of quality seed potatoes.

Constraints faced by the farmers may vary from one farmer to another depending on the influence of various factors. Behavior of an individual is greatly influenced by his characteristics. It is, therefore, likely that the constraints faced by the farmers in quality seed potato production might be influenced by their personal, economic, social and psychological characteristics. An understanding of the constraints in quality seed potato production by the BADC contract growers and its relationship with their various characteristics will be greatly helpful for planning and execution of programs by Bangladesh Agricultural Development Corporation (BADC).

But little effort has been made to undertake systematic investigation in this respect. These facts indicate the need for conducting a research study entitled “Constraints Faced by the BADC Contract Growers in Quality Seed Potato Production”.

1.2 History of Potato

The history of potato started around 350 million years ago, when they started to evolve from the poisonous ancestor of the plant nightshade (this family of plants eventually evolved not only into potatoes, but also into tobacco, chili peppers, bell peppers and tomatoes). Potato slowly evolved into its current form in the South American Andean highlands between Peru and Bolivia.

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

1.3 Potato and Potato Plant

Fig. 1.1: Potato with potato plant

Source: en.wikipedia.org

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

The potato plant is a herbaceous annual, normally propagated by planting pieces of tubers that bear two or three eyes. Nutritionally, the tuber is rich in carbohydrates or starch and is a good source of protein, vitamin C and the B vitamins, potassium, phosphorus, and iron. Most of the minerals and protein are concentrated in a thin layer beneath the skin, and the skin itself is a source of food fiber.

1.4 Several Varieties of Potato

Varieties several hundred varieties of potatoes are grown in the world. These differ in appearance, tuber structure, size and colour, time of maturity, cooking and marketing qualities, yield, and resistance to pests and diseases. A variety that grows well in one area may do poorly in another. Potato varieties that are cultivated in Bangladesh are broadly categorized into two groups, local and high yielding.

Bangladesh Agricultural Research Institute (BARI) has already been released around 100 varieties of potato some of these are BARI Alu-69(Flamenco), BARI Alu-70(Destiny), BARI Alu-71(Dolly), BARI Alu-72(CIP-139), BARI Alu-73(CIP-127), BARI Alu-74, BARI Alu-75, BARI Alu-76

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

Fig. 1.2: Different types of potato varieties

Source: en.wikipedia.org

1.5 Season and Method of Potato Cultivation

Fig. 1.3: Method of potato cultivation

Source: en.wikipedia.org

Cultivation Potato is widely cultivated in all the districts of Bangladesh during winter. 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.

1.6 Production of Potato Seed

Production of seed potato In Bangladesh potato is grown in an area of about 8,06,294 acres. For this purpose about 3,50,000 m tons of seed potatoes are necessary. Most of the seeds used are not of high quality. The farmers generally use the tubers they keep for their own consumption as seeds. This results in poor yield in the following season.

Usually, two types of potato seeds are imported by the government, one known as foundation or basic seeds, and the other certified seeds. Bangladesh Agricultural Development Corporation (BADC) distributes certified seeds to the growers produced locally from the imported foundation seeds in their own farms or in lands of farmers on contract basis. Imported seeds are also sold to growers through local BADC offices directly.

BARI has now started producing seed potatoes in it own farms at the Debiganj Breeders Potato Seed Production Centre to make seeds available to growers at a reasonable price. Available quality seeds, however, are not sufficient to meet the demand. During 1997-98, the country imported 3,96,331 kg fresh or chilled potato seeds.

1.7 Uses of Potato

Uses 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. Millions of tons of potatoes are processed annually in Europe into starch, alcohol, potato meal, flour, dextrose and other products. Some are processed into potato chips, dehydrated mashed potatoes, French fries and canned potatoes. Large quantities of potatoes in the Netherlands, Ireland, Germany and other countries of Europe are grown specifically for manufacture of alcohol, starch, potato meal or flour, and for livestock feeding. Europeans consume much larger quantities of potato than the North Americans. Asian countries consume more rice than potato for carbohydrate foods.

In Bangladesh, although 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. Notable 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.

1.8 Pests and Diseases of Potato

The potato plant is attacked by several dozens insect, mite, and nematode pests and under ecological conditions favorable to them, these may inflict heavy damage to the growing crop. The following, however, probably cause most of the damage: cutworm, crickets, leafhoppers, potato tuberworm, aphids,

Fig. 1.4: Pest and diseases affectes seed

Source: en.wikipedia.org

The cutworm, *Agrotis psilon* (Noctuidae, Lepidoptera) cuts the young potato plants at the ground level and feed on tender leaves and shoots during the night. The C-shaped caterpillar remains hidden under the soil during daytime. Adult moths often can be seen flying in the field. The field cricket, *Brachytrypes portentosus* (Gryllidae, Orthoptera) inflicts a feeding damage like the cutworms. This pest also cuts the young plants at the base or the underground root system. They do more damage through cutting of the growing plants rather than feeding of the plant parts. Several species of leafhoppers infest the potato plant.

Of these, the most serious is *Empoasca devastans (Cicadellidae, Homoptera).* Both adults and nymphs constantly suck the sap of leaves, causing the foliage to curl and dry up. Severe infestations may result in 'hopper-burn'. These insects also transmit virus diseases.

The aphids *Myzus persicae* and *Apis gossypii* (Aphididae, Homoptera) are probably the most serious pests of potato. Both adults and their young suck the sap from the potato foliage, causing leaves to curl downward. Under favorable environmental conditions their population may increase enormously.

In addition to the feeding damage they cause, aphids are known to transmit the potato mosaic virus disease, which may seriously affect production. The potato tubeworm, *Phthorimaea operculella* (Gelechiidae, Lepidoptea), is another serious pest of potato. The caterpillars mine leaves and stems, and later infest tubers.

The damage reaches to the climax in storage, if tubers are left unprotected. Initially, they burrow just under the skin and then tunnel into the flesh of tubers. Local varieties, particularly the Lal Pakhari, is very susceptible to their attacks. There are instances of 80% damage in the farmer's home stored potatoes in some locations. Among nematodes, the root knot nematode (Meloidogyne species) and the golden or cyst nematodes (Heterodera species) cause damage to roots and tubers.

1.9 Remedy of Pests and Diseases of Potato Production

Several insecticides, including diazinon, dimecron and malathion are recommended for field application to control potato pests. For control of potato tuberworm in the storage, fumigation with methyl bromide is recommended. The best way to prevent or reduce the incidence of potato diseases is the use of disease-free seeds. Seed materials must be examined carefully prior to planting, and if required, seeds should be treated by dipping in recommended chemicals. It is always advisable to use certified disease-free seed potatoes and disinfected seed cutting knives.

1.10 Nutritional Facts

Here are the nutritional facts for a potato:

1.10.1 Health Benefits

Potatoes are stuffed with phytonutrients, which are organic components of plants that are thought to promote health, according to the USDA. Phytonutrients in potatoes include carotenoids, flavonoids and caffeic acid. The vitamin C in potatoes acts as an antioxidant. These substances may prevent or delay some types of cell damage, according to the National Institutes of Health. They may also help with digestion, heart health, blood pressure and even cancer prevention.

Purple potatoes are especially good sources of phytonutrients and antioxidants. A 2012 study published in the Journal of Agriculture and Food Chemistry found that six to eight small purple potatoes twice a day helped lower blood pressure and risk of heart disease and stroke among people who were overweight and suffering from hypertension. Despite the carbohydrates in purple potatoes, the participants did not gain weight.

1.10.2 Blood Pressure

Potatoes may help lower blood pressure for several reasons. Jarzabkowski (is a Professor of Strategic Management) said that the fiber found in potatoes could help lower cholesterol by binding with cholesterol in the blood. "After it binds, we excrete it."

1.10.3 Source of Potassium

Potatoes are also a good source of potassium. "All potatoes are potassium rich," Jarzabkowski said. "They have even more potassium than a banana, and a lot of it is found in the [potato's] skin." She noted that the outer potato peel also contains a good deal of fiber. Potassium is a mineral that helps lower blood pressure, according to the U.S. Food and Drug Administration.

1.10.4 Source of Vitamin

The B6 vitamins in potatoes are critical to maintaining neurological health. Vitamin B6 helps create useful brain chemicals, including serotonin, dopamine and norepinephrine, according to the University of Maryland Medical Center. This means that eating potatoes may help with depression, stress and even perhaps attention deficit hyperactivity disorder (ADHD).

1.10.5 Source of Carbohydrate

Potatoes' high level of carbohydrates may have some advantages, including helping maintain good levels of glucose in the blood, which necessary to proper brain is functioning. A 1995 study published in the American Journal of Clinical Nutrition found that modest increases in glucose could help enhance learning and memory. Potassium, which encourages the widening of blood vessels, also helps ensure your brain gets enough blood.

1.10.6 Immunity

Vitamin C can help prevent everything from scurvy to the common cold, and potatoes are full of this nutrient, with about 45 percent of the recommended daily intake per medium baked potato, according to the Washington State Potato Commission.

1.10.7 Inflammation

Some people think potatoes and other members of the nightshade family — such as eggplants, tomatoes and peppers — trigger arthritis flares. However, there is limited scientific evidence to support this hypothesis, according to the Arthritis Foundation. The organization suggests that people with arthritis try cutting nightshade vegetables from their diets for two weeks to see if symptoms improve.

1.10.8 Digestion

The largest health benefit offered by potatoes is how they can help with digestion due to their high fiber content, Jarzabkowski said. Potatoes' high level of carbohydrates makes them easy to digest, while their fiber-filled skin can help keep you regular.

1.10.9 Heart Health

Potatoes give your heart plenty of reasons to swoon, due to the fiber content. Jarzabkowski said fiber is associated with clearing cholesterol from blood vessels; vitamins C and B6 help reduce free radicals; and carotenoids help maintain proper heart functioning.

1.10.10 Athletic Performance

Jarzabkowski described how potatoes could be a win for athletes. "Potatoes can help restore electrolyte balance," she said. "Sodium and potassium, which are found in potato peels, are two important electrolytes, and athletes lose them in sweat." Electrolytes are necessary for optimum body function, and having too few can cause cramps, as many athletes know.

1.10.11 Skin Care

According to Organic Facts, vitamin C, vitamin B6, potassium, magnesium, zinc and phosphorous can all help keep skin as smooth and creamy as, well, mashed potatoes. These nutrients are all present in potatoes.

1.10.12 Cancer Risk

A 2017 study published by the Journal of Nutritional Biochemistry found that consuming purple potatoes might reduce the risk of colon cancer. Purple potatoes are high in antioxidants and anti-inflammatory properties that can reduce levels of interleukin-6 or IL-6, a protein linked to cancer cell growth within the colon.

1.11 Production of Potato in Bangladesh

The suffering of potato growers is increasing day by day even though their yield is high, as they are stuck with surplus stocks and low exports. Bangladesh is the seventh largest producer of the tuber crop. It produced a record high of 1.09 core tones last year, according to the Department of Agricultural Extension (DAE). With an annual average demand of around 70 lac tones, the country witnessed a surplus of about 40 lac tones, most of which is wasted. Not all of the surplus can be stored in the cold storages for low capacity, said experts.

Table 1.2: Total potato production and export in various years

Year	Cultivable Land (In Lakh Hectares)	Production (In Lakh Tones)	Export (In Tones)
2012-2013	**4.44**	**86.03**	**28,416**
2013-2014	**4.62**	**89.50**	**102,983.564**
2014-2015	**4.71**	**92.83**	**90,490.967**
2015-2016	**4.75**	**94.47**	**40,239.405**
2016-2017	**4.99**	**102.16**	**55,652.38**
2017-2018	**4.77**	**97.44**	**53,485.639**
2018-2019	**4.69**	**109**	**27,811.602**

Source: Department of Agriculture Extension (DAE)

1.12 Export Earning of Potato

The fact that the country produces close to 11 million tonnes of potato annually - a surplus of approximately 4.0 million tonnes is no mean achievement. The shocking part, however, is that most of the surplus stock which could have fetched substantial earnings from export gets wasted. While dearth of adequate storage facilities denies the growers luck from bumper harvest, absence of effective steps on the part of the concerned authorities to facilitate overseas marketing is responsible for the useless glut.

For some years now, good harvest of potatoes has turned out to be the cause of the growers' misery. While concerned quarters put it on lack of planning, which among others includes dearth of sufficient storage facilities in the vicinities of potato growing areas, the burden of bumper harvest falls squarely on the farmers who are extremely ill at ease with their produce in a severely under-priced domestic market. Not only potatoes, the same are often the case with some other horticulture products such as tomatoes, leafy vegetables, pineapples etc. The case of potatoes is perhaps more distressing than the others.

1.13 Production of Potato in Naogaon District

Cultivators and local agro-officials are expecting a bumper potato production across the district this season. According to the Department of Agriculture Extension (DAE) statement,a total of 21,000 hectares of land have been brought under potato cultivation in the eleven upazilas of Naogaon district against the official target of 24,000 hectares of land.

The potato plants are now growing well amid a favorable climatic condition. The DAE officials are providing necessary suggestions to the farmers on the cultivation of potato during rough weather, the sources added. Shahidul of Modondanga village under Atrai Upazila said, he cultivated Lalpapri variety of potato on 2.2 acres of land this year. Seeing the excellent growth of the potato plants, He is very hopeful for getting a bumper production and handsome profit.

Agriculture officials said farmers in the district are trying to recoup the losses they incurred in the previous years due to flood and low price. If this good climate condition prevails throughout the season, the potato farming will increase gradually in the area the next years, they added.

1.14 Justification of the Study

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

Potato is an important vegetable crop in Bangladesh. Bangladesh experienced much progress in its potato production in the past decades; it has increased by 5 percent per annum. However, cost of tuber seed is an important constraint in potato production. It accounts 35 to 40 percent of total production costs.

1.15 Objectives

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

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

1.16 Organization of the Study

This study is consists of nine chapters which have been organized in the following sequences. After this Introduction, chapter-2 finishes a brief review of literature related to this study.chapter-3 provides information about the research design used in this study.

A brief description of the study area is presented in chapter-4. Socioeconomic and demographic profile of the sample farmers have been presented in chapter-5. Chapter 6 presents costs, returns, and therefore profitability of potato production. Chapter-7 provides effects and resource use efficiency of inputs used. Chapter-8 information regarding constraints of potato production faced by the farmers and suggests possible solutions.Chapter-9 furnishes an executive summery of the overall study with policy recommendations.

1.17 Assumptions of the Study

An assumption is the supposition that an apparent fact or principle is true in the light of the available evidence (Goode, 1945). The researcher had the following assumptions in mind while undertaking the study:

1. The responses furnished by the potato growers were valid, reliable and free from bias.
2. The potato growers were included in the sample were capable of furnishing proper responses to the questions as contained in the interview schedule.
3. Information furnished by the selected farmers included in the sample was the representative views and opinions of the whole population of the study area.

CHAPTER 2
LITERATURE REVIEW

Literature Review

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

Abedullah (2006) did a study on **"**Technical Efficiency and its Determinants in Potato Production, Evidence from Punjab, Pakistan" using Cobb-Douglas stochastic production frontier approach. The result showed that potato farmers are 84 percent technical efficiency implying significant potential in potato production that can be developed. There was high correlation between irrigation of the potato crop and technical efficiency. However, it is different in terms of type of dataset used, focus area, some regressions used as well as geographical location.

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

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

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

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

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

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

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

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

CHAPTER 3
METHODOLOGY

3.1 Introduction

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

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

The drawback of this method is to rely on the memory of the respondents. To overcome this problem, repeated visits were made to collect data in the study area and in the case of any omission or contradiction; the farmers were revisited to obtain the missing and/or correct information.

3.2 Selection of the Study Area

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

The present study was conducted in Naogaon district. Apart from these, although a lot of production economics studies were conducted on different region of Bangladesh specially on Mymensingh, Jessore, Rajshahi, Narsingdhi, Tangail, Gazipur, Pabna, Netrokona, Bogra, Keraniganj etc. Thirteen villages of 3 upazila under Naogaon district namely Namanurpur,Taznagar, Tilakpur, Shingbacha, Baktarpur, Shajadpur villeges under Naogaon sadar upazila, Singarpara, Chokobir, labargram villeges under Bodolgachi upazila, Sutkigacha, Modondangga, Choubari villeges under Atrai upazila were selected. The main reasons for selecting the villages were as follows:

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

ii. A large number of potato growers and reliable sources of data were expected to obtain under these study areas

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

3.3 Selection of Sampling Technique

At first, Naogaon district which is in Rajshahi division of Bangladesh was selected purposively. After that, among 11 upazillas in Naogaon district,3 upazillas namely Naogaon sadar, Bodolgachi and Atrai upazillas were selected through purposive random sampling. These upazillas are divided into several unions. Union wise information for the specified vegetable of each union has been taken from the upazilla office of the DAE for selecting the union.

The unions have also been selected based on the highest concentration of potato production, among highly concentrated potato produced villages under some unions were randomly selected. The villages were Namanurpur,Taznagar, Tilakpur, Shingbacha, Baktarpur, Shajadpur villeges under Naogaon sadar upozila, Singarpara, Chokobir, labargram villeges under Bodolgachi upozila, Sutkigacha, Modondangga, Choubari villeges under Atrai.

3.4 Sample Size

It was not possible to include all the farmers in the study area due to limitation of time, money and personnel. Here a reasonable size of sample was taken into account to satisfy the objectives of the study. In total 75 farmers were selected to achieve the ultimate objective of the study.

To get the desired sample at first the list of potato producers were collected from the agricultural extension officer of the selected upazilla agricultural office. It was found that 200 farmers of the selected study area had grown potato. The next task was to identify small farmers (having land 0.05 to 2.49 acres) who cultivated potato minimum for three years. Out of 200 farmers 100 farmers were identified as small farmer who cultivated potato minimum for 3 years. Then a total of 75 farmers were randomly selected from the selected villeges.

Table 3.1 Sample Distribution

SL. No,	Upazilla	Number of Respondents
1	**Naogaon sadar**	**25**
2	**Bodolgachi**	**25**
3	**Atrai**	**25**

Source: Field Survey, 2019

3.5 Preparation of Survey Schedule and Pre-testing

Preparation of the survey schedule is very important in any farm management or production Economics study (Amin, 2013). The main consideration in this respect is to obtain reliable data from the respondents for the preparation of a suitable survey schedule.

In conformity with the objective of the study a draft survey schedule was prepared in such a way that reliable data could be collected from the farmers. Then the draft schedule was tested and attention was paid for inclusion of new information which was not included in the draft schedule. The draft survey schedule was pre-tested by researcher herself. The draft survey was conducted among 5 potato producers of small farmers in selected area. Thus the draft schedule was improved, rearranged and modified in the light of the actual and practical experience gained during the pretest. After making necessary adjustment a final survey schedule was developed in logical sequence.

The final schedule included the following information parts:

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

The first part of the questionnaire contained potato grower's identification, village and union name. Second part contained information about Potato grower's socio-economic conditions, their age, sex, education, occupation, income etc.

Different code was used for this purpose. This part also contained questions about respondent's family member's source of income, education, occupation etc. The third part provided the farm holding status of the farmers such as the information on homestead land, owned land, land given to others, land taken from others etc. The fourth part contained the potato production related information such as the unit cost of inputs and the price and quantity of output. The last part of the questionnaire contained respondent's perception regarding impact of potato production in socio economic status of the farmers and constraints faced by them to potato production.

3.6 Period of the Study

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

3.7 Collection of Data and Accuracy of Data

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

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

Usually, the respondents do not keep records of daily/ annual transactions of their activities. Hence, it was very difficult to collect actual data and the researcher has to rely on the memory of the respondents. Questions were asked systematically in a simple manner and explanation was made whenever felt necessary.

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

3.8 Entry and Processing of Data

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

3.9 Analytical Technique

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

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

3.9.1 Profitability Analysis

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

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

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

Cost of Land Preparation

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

Cost of Human Labor

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

Cost of Seed

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

Cost of Urea

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

Cost of TSP

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

Cost of MoP

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

Cost of Insecticides

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

Cost of Irrigation

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

Interest on Operating Capital

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

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

IOC= AIit

Where,

IOC= Interest on operating capital

i= Rate of interest

AI= Total investment / 2

t = Total time period of a cycle

Land Use Costs

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

Calculation of Returns

Gross Return

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

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

Gross Margin

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

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

Gross margin = Gross return – Variable cost

Net Returns

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

Net return = Total return – Total production cost.

Undiscounted Benefit Cost Ratio (BCR)

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

BCR = Total return (Gross return)/ Total cost

3.9.2 Technical Efficiency Analysis

Technical efficiency refers to the ability of a firm to produce the maximum possible output from a given set of inputs and given technology. A technically efficient farm will operate on its frontier production function.

Given the stated relationship the firm is technically efficient if it produces on its outer-bound production function to obtain the maximum possible output which is feasible under the current technology. Putting it differently a firm is considered to be technically efficient if it operates at a point on an isoquant rather than interior to the isoquant. The homogeneity of inputs is a vital factor for achieving technically efficient output.

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

3.9.2.1 The Stochastic Frontier Model

The most widely discussed, theoretically reasonable and empirically competent method of measuring efficiency is the stochastic frontier model.

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

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

3.9.2.2 The Stochastic Frontier with Cobb-Douglas Production Function

The Cobb-Douglas production function is probably the most widely used form for fitting agricultural production data, because of its mathematical properties, ease of interpretation and computational simplicity (Heady and Dillion, 1969; Fuss and Mcfadden, 1978). The Cobb-Douglas function has convex isoquants, but as it has unitary elasticity of substitution; it does not allow for technically independent or competitive factors, nor does it allow for Stages I and III along with Stage II. That is, MPP and APP are monotonically decreasing functions for all X- the entire factor-factor space is Stage II-given $0 < b < 1$, which is the usual case.

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

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

$Y_i = f(X_i,\beta) \exp.(V_i-U_i)$ i = 1, 2, 3, ……., 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, b the elasticity of Y with respect to X, a is intercept and Ɛ = V-U is a composed error term as defined earlier. For simplicity, we have ignored the subscript.

3.9.2.3 Specification of Production Model

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

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

The above function is linearized double-log form:

Y = Returns per hectare (Tk/ha);

In a = Intercept of the function;

X_1 = Cost of human labor (Tk/ha)

X_2 = Cost of seed (Tk/ha);

X_3 = Cost of fertilizer and manure (Tk/ha);

X_4 = Cost of insecticides (Tk/ha);

X_5 = Cost of irrigation (Tk/ha);

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

Ui = Error term.

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

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

Where,

Z_1…….. Z_5 are explanatory variables.

The equation can be written as:

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

V is two-sided uniform random variable beyond the control of farmer having N (0, σ 2) distribution, U is one-sided technical inefficiency effect under the control of farmer having a positive half normal distribution $\{U_i \sim |N (0, \sigma u2)|\}$ and W_i is two-sided uniform random variable. W is unobservable random variable having a positive half normal distribution. The model was estimated simultaneously using STATA.

CHAPTER 4
DESCRIPTION OF THE STUDY AREA

4.1 Introduction

A brief description on important characteristics of the study area and the sampled households such as location, population and households, physical features and topography, communication, literacy rate, educational facilities, cropping pattern, land control etc.

4.2 Geographic area and location of the study area

Naogaon is a district in Northern Bangladesh. It is the part of the Rajshahi Division. Naogaon was one of the subdivisions of former Rajshahi District. It was upgraded to district on March 1, 1984. It is believed that the present district headquarters initially developed in a mauza comprising of nine (meaning 'Nao' in Bengali) villages (meaning 'Gaon' in Bengali). The district might have derived its name as Naogaon from the words 'Nao' and 'Gaon'. The district is bounded on the north by India, on the east by Joypurhat and Bogra districts, on the south by Natore and Rajshahi Districts and on the west by Nawabganj and India. The total area of the district is 3435.65 sq.km.(1326.51 sq.miles) of which 9.09 sq.km.(3.51 sq. miles) is riverine and 19.45 sq.km (7.51 sq. miles) is under forest. The district lies between 24º32' and 25º13' north latitudes and between 28º23' and 89º10' east longitudes.

4.2.1 Annual Average Temperature: The annual average temperature of this district varies maximum 37.8°C to minimum 11.2°C.The annual average rainfall is 1862 mm. Main Rivers: The Atrai, Punarbhaba, Little Jamuna, Nagar, Chiri Tulsi Ganga etc. are notable.

4.2.2 Administration: Naogaon subdivision was established in 1877 under Rajshahi district and was turned into a district in 1984. The district consists of 11 upazilas, 99 unions, 2565 mauzas, 2779 villages, 3 paurashavas, 27 wards and 92 mahallas. The upazilas are Naogaon Sadar, Atrai, Badalgachhi, Dhamoirhat, Manda, Mahadevpur, Niamatpur, Patnitala, Porsha, Raninagar and Sapahar.

4.2.3 Archaeological Heritage and Relics: The Major Archaeological Heritage and Relics of Naogaon district are Paharpur, Kusumba Mosque and Patisar.

4.2.4 Vegetables: Farmers grow both summer and winter vegetables. Main vegetables are potato, brinjal, raddish, arum, lady's finger, cauliflower, cabbage, bean, tomato, patal, gourd, cucumber, pumpkin, knoll-kal-turnip, dhundal, barbati, khirai, chichinga, carrot, kakrol and sak.

Table 4.1 Broad classification of area

Upazila (In sq. km.)	Total area	Land area	Reserve forest	Riverine Area
Atrai	**284.40**	**282.89**	**0**	**1.51**
Badalgachhi	**213.97**	**213.97**	**0**	**0**
Dhamoirhat	**300.79**	**297.78**	**5.44**	**0**
Manda	**375.93**	**372.92**	**0**	**3.01**
Mahadebpur	**397.66**	**395.79**	**0**	**1.87**
Naogaon sadar	**275.72**	**274.45**	**0**	**1.27**
Niamatpur	**449.09**	**449.09**	**0**	**0**
Patnitala	**382.38**	**366.94**	**14.01**	**1.43**
Porsha	**252.83**	**252.83**	**0**	**0**
Raninagar	**258.32**	**258.32**	**0**	**0**
Sapahar	**244.48**	**244.48**	**0**	**0**
Total	**3435.65**	**3407.04**	**19.45**	**9.09**

Source: BBS (2015)

Figure 4.1: Naogaon District Map

Source: BBS (2019)

Figure 4.2: Naogaon Sadar Upazila Map

Source: BBS (2019)

Table 4.2: Temperature, rainfall, humidity during the years 2015-2019

Years	Temperature (centigrade)		Rainfall (millimeter)	Humidity (%)
	Maximum	Minimum		
2015	36.13	9.4	1160	79.0
2016	37.5	11.6	1076	77.0
2017	38.3	9.4	567	55.8
2019	22.6	8.6	1477	78.0

Source: BBS 2019

Table 4.3 Naogaon Weather by Month

Month	Min. Temperature (°C)	Max. Temperature (°C)	Avg. Temperature (°F)
January	11.4	25	64.8
February	13.2	27.8	68.9
March	17.7	32.9	77.5
April	22	35.3	83.5
May	23.8	34	84.0
June	25.5	32.6	84.2
July	26.1	31.7	84.0
August	26.3	31.7	84.2
September	25.9	31.9	84.0
October	23.2	31.4	81.1
November	17.4	29	73.8
December	12.8	25.9	66.7

Source: BBS 2019

CHAPTER –5

SOCIO-ECONOMIC PROFILE OF THE SAMPLE FARMERS

5.1 Introduction

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

5.2 Age

There are 20 samples in every upazila named Sadar, Attari and Bodolgachi represented the total population. In Sadar upazila, 35 percent of the sample populations were 20-40 years, 50 percent were 40-60 years and 15 percent were above 60 years old. In Attari upazila, 15 percent of the sample populations were 20-40 years, 65 percent were 40-60 years and 10 percent were above 60 years old. In Bodolgachi upazila, 15 percent of the sample populations were 20-40 years, 80 percent were 40-60 years and 5 percent were above 60 (Figure 5.1**)**. In this figure we saw most of the people age between 40 to 60 years in every upazila.

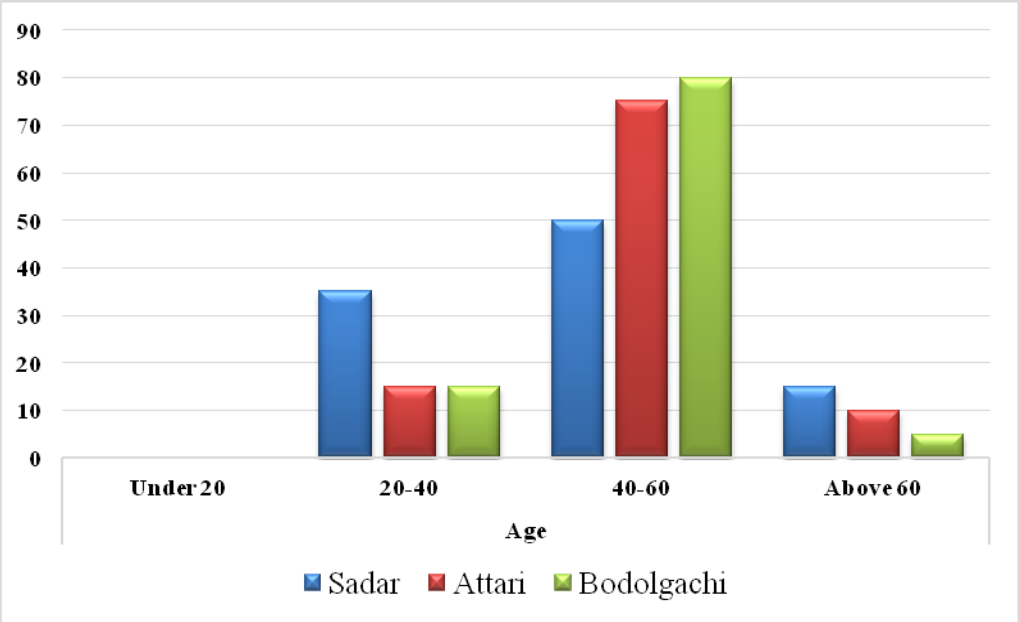

Figure 5.1: Age of the respondent by Study Area

Source: Field survey, 2019

5.3 Education

Figure 5.2 showed that, in sadar upazila, about 45 percent of the study population aged 5 years or more were found to have no education and/or read/write, about 10 percent were found to have primary level education, about 45 percent were found to have secondary and/or higher secondary level education and no percent people were found to have attained/completed graduation level of education. In Attari upazila, about 10 percent of the study population aged 5 years or more were found to have no education and/or read/write, about 20 percent were found to have primary level education, about 65 percent were found to have secondary and/or higher secondary level education and zero percent people were found to have attained/completed graduation level of education. In Bodolgachi upazila, about 20 percent of the study population aged 5 years or more were found to have no education and/or read/write, about 50 percent were found to have secondary and/or higher secondary level education and only 5 percent people were found to have attained/completed graduation level of education. The proportion of attainment of post-secondary or higher level of education was relatively higher for men than women in both study areas, partly due to gender discrimination against female.

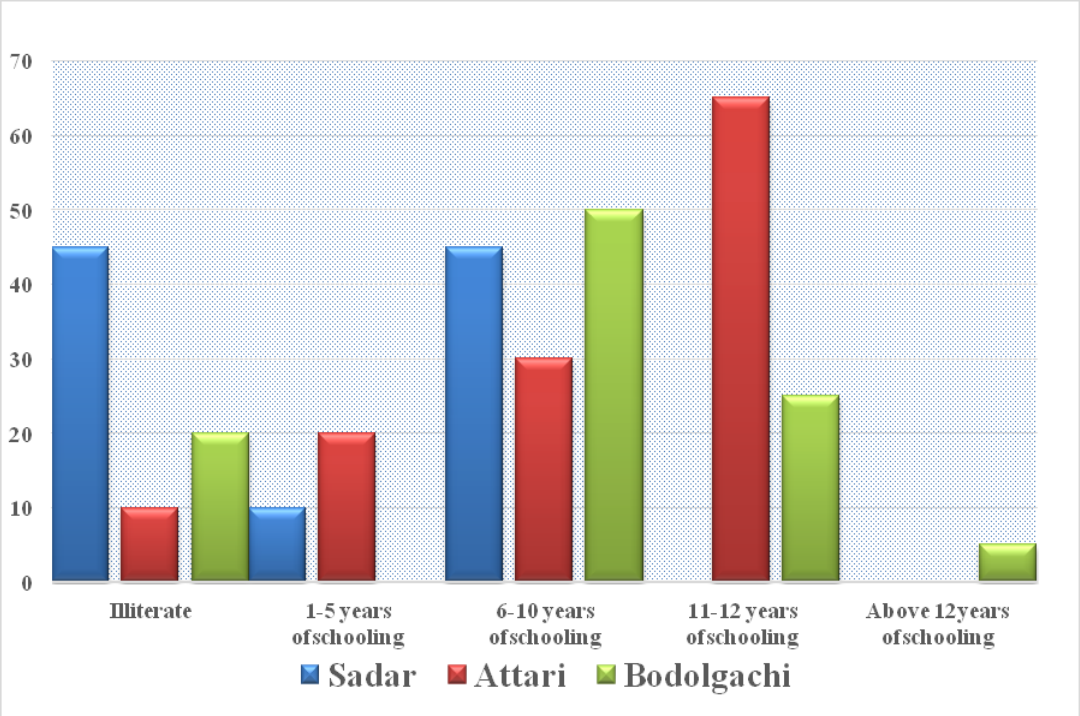

Figure 5.2: Education of the Household Members by Study Area
Source: Field survey, 2019

5.4 Land Use Pattern

Land use pattern at sample farms is presented in Table 5.1. It is evident from table that the per farm total cultivated area is observed as 1.02 hectare, 1.61 hectare, 2.89 hectare and 6.64 hectare at marginal, small, medium and large farms respectively along with 3.05 hectare as an overall average. The overall percentage of irrigated area is estimated as 55.64 percent to the total cultivated land which varied from 43.14 percent at marginal farms, 60.82 percent at small farms, and 60.42 percent at medium farms and 53.31 percent at large farms. The allocation of area under potato varies from the 10.38 percent at medium farms to 20.33 percent at large farms. It is clear from the figures given in this table that the leased-in area at sampled farms is decreasing as the size of holding increased. It varied from 50.98 percent at marginal farms to 1.20 percent at large farms of the total cultivated area.

Table 5.1: Size of holding and irrigation at sampled farms

(Hectare/farm)

Sl. no.	Particular	Marginal	Small	Medium	Large	Average
1.	Total owned land	0.50 (49.02)	1.55 (89.08)	2.59 (89.62)	6.66 (100.45)	2.83 (92.68)
2.	Leased-in land	0.52 (50.98)	0.16 (9.19)	0.30 (10.38)	0.08 (1.20)	0.25 (8.20)
3.	Leased –out land	-	-	-	0.11 (1.65)	0.026 (0.85)
4.	Total cultivated area	1.02 (100.00)	1.61 (100.00)	2.89 (100.00)	6.64 (100.00)	3.05 (100.00)
5.	Irrigated area	0.44 (43.14)	1.04 (60.82)	1.64 (60.42)	3.54 (53.31)	1.60 (55.64)
6.	Non irrigated area	0.58 (56.86)	0.66 (39.18)	1.14 (39.58)	3.10 (46.69)	1.35 (44.26)
6.	Area under potato	0.15 (14.61)	0.19 (11.11)	0.30 (10.38)	1.35 (20.33)	0.49 (16.06)

Note: Figures in the parentheses indicate the percentages to the total cultivated area.

Source: Field survey, 2019

5.5 Annual Family Income

Annual family income of the respondent farmers ranged from 54-300 thousand taka with the mean of 139.88 and standard deviation 60.98 respectively. The farmers were classified into three categories on the basis of their annual family income (Table 5.2). Data presented in Table 5.2 indicated that the highest proportion (46.66 percent) of the farmers had low annual family income compared to 31.66 percent and 21.66 percent having medium and high annual family income respectively. Thus a large proportion of the farmers had low to medium annual family income.

Table 5.2: Annual family income

Characteristics	Scoring method	Observed range	Categories	N=60	%	Mean	SD
Annual family income	(1000) taka	54.0-300	Low (up to 100)	28	46.66	139.88	60.98
			Medium (>100-160)	19	31.66		
			High (above 160)	13	21.66		

Source: Field survey, 2019

5.6 Family Size of the Farmers

Family size score of the respondents ranged from 3-8 with a mean and standard deviation of 5.56 and 1.416 respectively. According to family size, the respondents were classified into three categories as shown in Table 5.3. Data presented in Table 5.3 shows that majority (66 percent) of the farmers had medium family size; while 12 percent had small family and 11 percent had large family.

Table 5.3: Family size of the farmers

Characteristics	Scoring method	Observed range	Categories	N=60	%	Mean	SD
Family Size	No. Of members	3-8	Small (up to 3)	12	20	5.56	1.41
			Medium (4-6)	38	63.33		
			Large (6 and above)	10	16.66		

Source: Field survey, 2019

5.7 Agricultural Training

Among the respondent farmers in Sadar upazila, only 90 percent farmer's got training of potato farming whereas, 60 percent farmers got training in Attari upazila, 65 percent farmers got training in Bodolgachi upazila (Table 5.4). These training have improved their perceptions of good seed use, use of resistant varieties, application of insecticides and pesticides, water management and so on.

Table 5.4: Agricultural Training of the respondent by Study Area

Training Received	Sadar		Attrai		Bodolgachi	
	No.	%	No.	%	No.	%
Yes	18	90	12	60	13	65
No	2	10	8	40	6	35
Total	20	100	20	100	20	100

Source: Field survey, 2019

5.8 Membership of any Social Organization

Among the respondent farmers in Sadar upazila, 60.00 percent potato producers were found to have membership in different NGOs such as BRAC,ASA,PROSHIKA, THENGAMARA etc and/or farmers' organizations whereas Attari upazila 60 percent of potato farmers had membership in different NGOs and/or farmers' organizations and 55 percent of potato farmers had membership in different social organization in Bodolgachi upazila (Table 5.5).

Table 5.5: Membership in any organization of the respondent by Study Area

Membership in any organization	Sadar		Attari		Bodolgachi	
	No.	%	No.	%	No.	%
Yes	14	60	12	60	11	55
No	6	30	8	40	9	45
Total	20	100	20	100	20	100

Source: Field survey, 2019

CHAPTER –6

PROFITABILITY OF POTATO PRODUCTION

6.1 Introduction

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

6.2 Profitability of Potato Production

6.2.1 Variable Costs

6.2.1.1 Cost of Land Preparation

Land preparation is the most important components in the production process. Land preparation included ploughing, laddering and other activities needed to make the soil suitable for potato cultivation. For land preparation in potato production, no. of tiller was required 2 with Tk. 1573 per tiller. Thus, the average land preparation cost of potato production was found to be Tk. 3146 per hectare, which was 1.82 percent of total cost (Table 6.1).

6.2.1.2 Cost of Human Labour

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

The quantity of human labour used in potato production was found to be about 149 man-days per hectare and average price of human labour was Tk. 400 per man-day. Therefore, the total cost of human labour was found to be Tk. 59600 representing 34.41 percent of total cost (Table 6.1).

Table 6.1: Per Hectare Cost of Potato Production

B. Gross Cost

Cost Items	Quantity	Price Per Unit (Tk.)	Costs/Returns	Cost Items(%)
C. Variable Cost				
Seedlings			48183.71	27.82
Irrigation	4	400	1600.00	0.92
Power tiller	2 times	1573	3146.00	1.82
Hired labour	149	400	59600.00	34.41
Urea	158.80	18	2858.48	1.65
DAP	278.80	36	10036.82	5.79
MOP	278.80	20	5576.01	3.22
Gypsum	8.46	180	1522.38	0.88
Fertilizers cost			19993.69	11.54
Manure	171	10	1710.00	0.99
Insecticides			1995.33	1.15
Total			**136228.74**	**78.64**
D. Fixed Cost				
Land use cost	28820	1	28820.00	16.64
Interest on operating capital			8173.12	4.72
Total			**36993.12**	**21.36**
E. Total costs			**173221.86**	**100.00**

Source: Field survey, 2019

6.2.1.3 Cost of Seed

Cost of seed varied widely depending on its quality and availability. Per hectare total cost of seed for Potato production were estimated to be Tk. 48183.71, which constituted 27.82 percent of the total cost (Table 6.1).

6.2.1.4 Cost of Urea

In the study area, farmers used different types of fertilizers. On an average, farmers used urea 159 kg per hectare. Per hectare cost of urea was Tk. 2858, which represents 1.65 percent of the total cost (Table 6.1).

6.2.1.5 Cost of DAP

Among the different kinds of fertilizers used, the rate of application of DAP (279kg). The average cost of DAP was Tk. 10037 which representing 5.79 percent of the total cost (Table 6.1).

6.2.1.6 Cost of MoP

The application of MoP per hectare (279 kg) was similar to DAP. Per hectare cost of MoP was Tk. 5576, which represents 3.22 percent of the total cost (Table 6.1).

6.2.1.7 Cost of Insecticides

Farmers used different kinds of insecticides to keep their crop free from pests and diseases. The average cost of insecticides for Potato production was found to be Tk. 1995.33 which was 1.15 percent of the total cost (Table 6.1).

6.2.1.8 Cost of Irrigation

Cost of irrigation is one of the most important costs for Potato production. Production of Potato largely depends on irrigation. Right doses application of irrigation water help to increase bulb diameter, number of cloves, and number of leaves and plant height. As a result yield per hectare is being increased. The average cost of irrigation was found to be Tk. 1600 per hectare, which represents 0.92 percent of the total cost (Table 6.1).

6.2.1.9 Cost of Manure

It was observed in the present study area that farmers used cow dung for producing their enterprises. They bought a large portion of cowdung from the milk producers. It was found that cow dung application 171 var per hectare for potato production, respectively. And the cost of cowdung for potato production was Tk. 1710 (Table 6.1).

6.2.1.10 Total Variable Cost

Therefore, from the above different cost items it was clear that the total variable cost of Potato production was Tk. 1,36,228.74 per hectare, which was 78.64 percent of the total cost (Table 6.1).

6.2.2 Fixed Cost

6.2.2.1 Rental Value of Land

Rental value of land was calculated on the basis of opportunity cost of the use of land per hectare for the cropping period of three months. Cash rental value of land has been used as cost of land use. On the basis of the data collected from the potato farmers the land use cost was found to be Tk. 28820 per hectare, and it was 16.64 percent of the total cost (Table 6.1).

6.2.2.2 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 at Tk. 8173.12 per hectare, which represents 4.72 percent of the total cost (Table 6.1).

6.2.3 Total Cost (TC) of Potato Production

Total cost was calculated by adding all the cost of variable and fixed inputs. In the present study per hectare total cost of producing Potato was found to be Tk. 1,73,221.86 (Table 6.1).

6.2.4 Return of Potato Production

6.2.4.1 Gross Return

Return per hectare of Potato cultivation is shown in Table 6.2. Per hectare gross return was calculated by multiplying the total amount of product with respective per unit price. It is evident from table that the average yield of Potato per hectare was 18343.21 kg and the average price of Potato was Tk. 14.90. Therefore, the gross return was found to be Tk. 2,73,314 per hectare (Table 6.2).

Table 6.2: Per Hectare Cost and Return of Potato Production

Cost Item	Cost/Returns (Tk/ha)
A. Gross Return	273314
B. Variable Cost	136228.74
C. Fixed Cost	36993.12
D. Total costs	173221.86
E. Gross Margin (A-B)	137085.26
F. Net Return (A-D)	100092.14
G. Undiscounted BCR	1.58

Source: Field survey, 2019

6.2.4.2 Gross Margin

Gross margin is the gross return over variable cost. Gross margin was calculated by deducting the total variable cost from the gross return. On the basis of the data, gross margin was found to be Tk. 1,37,144.27 per hectare (Table 6.2).

6.2.4.3 Net Return

Net return or profit was calculated by deducting the total production cost from the gross return. On the basis of the data the net return was estimated as Tk. 1,00,151.15 per hectare (Table 6.2).

6.2.5 Benefit Cost Ratio (Undiscounted)

Benefit Cost Ratio (BCR) is a relative measure, which is used to compare benefit per unit of cost. Benefit Cost Ratio (BCR) was found to be 1.58 which implies that one taka investment in potato production generated Tk. 1.58 (Table 6.2). From the above calculation it was found that Potato cultivation is profitable in Bangladesh.

6.3 Concluding Remarks

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

CHAPTER 7

FACTORS AFFECTING AND TECHNICAL EFFICIENCY OF POTATO PRODUCTION

7.1 Introduction

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

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

7.2 Interpretation of ML Estimates of the Stochastic Frontier Production Function

Maximum likelihood estimation begins with writing a mathematical expression known as the Likelihood Function of the sample data. The likelihood of a set of data is the probability of obtaining that particular set of data, given the chosen probability distribution model. This expression contains the unknown model parameters.

The values of these parameters that maximize the sample likelihood are known as the Maximum Likelihood Estimates or MLE's. 7.1

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

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

Variables	Parameter	Coefficients	T-ratio
Stochastic Frontier:			
Constant (X_0)	β_0	-2.055	-0.52
Human Labour (X_1)	β_1	-0.1644*	-1.64
Seed (X_2)	β_2	0.6253***	2.10
Fertilizer (X_3)	β_3	0.7760***	3.27
Insecticide (X_4)	β_4	0.02154	1.17
Irrigation (X_5)	β_5	0.12	0.38
Inefficiency Model:			
Constant	δ_0	0.8332*	0.63
Experience (Z_1)	δ_1	-0.0723*	1.90
Farm size (Z_2)	δ_2	-0.1480***	-2.84
Extension service (Z_3)	δ_3	-0.0298	-0.32
Training (Z_4)	δ_4	0.8348	0.46
Credit service (Z_5)	δ_5	-0.8330	-0.80
Log-likelihood Function		-53.8461	

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

Source: Field survey, 2019.

Human Labor (X1)

The regression coefficient of labour cost (X1) of potato production was negative and significant at 10 percent level of significance, which implied that if the expenditure on labour was increased by 1 percent then the yield of potato would be decreased by 0.1644 percent, other factors remaining constant (Table 7.1).

Seed (X2)

The regression coefficient of seed cost (X2) of potato production was positive and significant at 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 0.6253 percent, other factors remaining constant (Table 7.1).

Fertilizer (X3)

The regression coefficient of fertilizer cost (X3) of potato production was positive and significant at 1 percent level of significance, which implied that if the expenditure on fertilizer was increased by 1 percent then the yield of potato would be increased by 0.7760 percent, other factors remaining constant (Table 7.1).

Cost of Insecticide (X4)

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

Irrigation (X5)

The regression coefficients of irrigation cost (X5) was not significant.

7.3 Interpretation of Technical Inefficiency Model

In the technical inefficiency effect model experience, farm size, extension service and credit service have expected (negative) coefficients. The negative and significant (1 percent) coefficient of experience implies that experienced farmers are technically more efficient than non-experienced farmers.

The negative coefficient and significant at 10 percent level of significance of farm size implies that large farm households are technically more efficient than small farm households.

The negative coefficient of extension service postulates that farmers having contacts with extension officers are technically more efficient than others. Although this coefficient is not statistically significant.

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

The coefficients of training is positive meaning that these factors have no impact on the technical inefficiency. That is, these factors do not reduce or increase technical inefficiency of producing potato.

Table 7.2: Frequency Distribution of Technical Efficiency of Potato Farms

Efficiency (%)	No. of farms	Percentage of farms
0-50	**3**	**5.00**
51-60	**7**	**11.67**
61-70	**8**	**13.33**
71-80	**10**	**16.67**
81-90	**22**	**36.67**
91-100	**10**	**16.66**
Total number of farms	**60**	**100**
Minimum	**0.20**	
Maximum	**0.99**	
Mean	**0.83**	
Standard Deviation	**0.15**	

Source: Field survey, 2019

7.4 Technical Efficiency and Its Distribution

Table 7.2 shows frequency distribution of farm-specific technical efficiency for potato farmers. It reveals that average estimated technical efficiencies for potato are 83 percent which indicate that potato production could be increased by 17 percent with the same level of inputs without incurring any further cost. Increase of only managerial skills result a substantial increase of output for potato.

It was observed that about 52 percent of sample farmers were found to have received outputs which were very close to the maximum frontier outputs maintaining the efficiency level more than 95 per cent.

On the other hand, 48 per cent of sample farmers obtained up to 80 percent technical efficiency level. The minimum and maximum technical efficiencies were observed to be 20 and 99 per cent respectively, where standard deviation was maintained at 0.15.

7.5 Concluding Remarks

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

CHAPTER 8

CONSTRAINTS AND POSSIBLE SOLUTION OF POTATO PRODUCTION

8.1 Introduction

Bangladesh is an agro-based country where agriculture is considered as backbone of her economy. Although agriculture plays a vital role through employment generation, poverty alleviation, food, security, and income generation but it has a number of problems particularly in cultivation practices. Farmers in Bangladesh do not get the sufficient quantity of seeds, fertilizers, pesticides, technical supports and finally the desirable price of their products (Awal, 2013). Moreover, the farmers are economically unable to invest the required amount inputs for producing crops due to their low capital base. Farmers generally complain of getting insufficient support from governmental agencies. As a result they fail to achieve their target. However, this chapter is design to identify the major problems and constraints confronted by the potato growers in the study area. Although potato production was profitable at the farm level, multiple numbers of constraints were reported by the farmers in the production of potato in the study area.

8.2 Major Constraints Reported by the Farmers

The respondents were asked to give their opinion regarding the problems and constraints of potato production. It was observed that the problems were not identical and they were differed from farmer to farmer. However, major problems according to the intensity reported by the farmers are given below:

8.2.1 High Price of Fertilizers and Insecticides

Fertilizer is vital inputs in the production of potato. Farmers reported that they have to apply fertilizer for vegetative growth of the plants as well as to persuade the production of fruits. It was reported that about 91.67 percent potato growers complained about high price rate of fertilizers and insecticides.

8.2.2 Non-Availability of Quality Seeds

Seed is another most important input. Production of crops or vegetables are mainly depends on quality of seed or seedling. But non-availability of improved seeds was another limiting factor in producing potato. In the study area it was found that about 90 percent of potato farmers used purchased seeds. They reported that in local market HYV seeds were not available at their desired level. Most of the growers purchased seeds from local markets as HYV seed but they opined that in many cases, those seeds were not good quality which ultimately results in low production of vegetables.

8.2.3 Lack Of Knowledgw About Pests And Diseases

Attack by pest and disease was not a serious problem in production of potato in the study area. Some incidence of pest and disease attack was noticed. However the main problem is that most of the farmers have no scientific knowledge of production technology and, management of pests and disease. They have to rely on the dealer of the insecticide about what insecticide is for what kind of insects and diseases. Highest 58.23 percent small farmers were reported that they have least idea about pests and diseases.

8.2.4 Low Price of Product at Late Harvesting Period

At the beginning of the season farmers get high price of potato. But in late season they get low price of the vegetable. About 48.00 percent small farmers reported that they have faced with this problem.

8.2.5 Lack of Financial Capital

Like labor, capital is another important factor of production. However, approximately 42 33 percent farmers' in this study area reported that they faced scarcity of operating capital during production period particularly in buying seed and hired labors which require cash money. They were unable to produce potato commercially in the large scale due to lack of operating capital. They often have to borrow money from relatives or in some cases different institutional and non institutional sources at a high rate of interest.

8.2.6 Carrying and Handling Problems

About 33.33 percent of the selected potato growers treated about carrying and handling as a problem. Due to carrying and handling problem the growers used to sell their product to 'paikar' at farm gate and a few growers sold their products in the local market. As a result most of the growers deprived from their desirable output price.

8.2.7 Crop Damage by Domestic Animal

Crop damage by domestic animals was also a problem in the production of potato. Potato growers reported that damage by cow and goat was a considerable problem to them. Farmers gathered an experience that in the early stages the plants were affected by pest and diseases. About 20.00 percent vegetable growers reported that their products were attacked by pest and diseases.

8.2.8 Social Problems Faced by Female Family Labor

Potato production is a profitable enterprise for small farmers mainly due to its labor intensive characteristic. In the study area most of the small farmers use their home supplied female labor in production. Female labors mainly engaged in seed sowing, hilling up, irrigation and harvesting. But in most cases these female labor face the problems of social criticism and bindings. In most of the society of our country people consider female works outside their home as impertinences. About 13.33 percent of all sample respondents reported this as a problem.

8.3 Probable Solutions of the Identified Problems Suggested by Farmers

The farmers in the rural Bangladesh have been facing a lot of problems during the production circle of different crops. Potato farmers are not an exception. They also faced a lot of constraints at the time of producing potato. After identification of different problems and constrains some probable solutions were suggested by the farmer in the study area.

They are briefly described below:

- Most of the farmers suggested that supply of quality high yielding variety (HYV) seeds should be available in sowing period

- Formation of cooperative market for ensuring fair price of potato and increasing bargaining power of farmers is very important suggested by the farmers in the study area.

- Government should take necessary steps to decrease the price of fertilizer used in potato farming

- Government should take necessary steps to inform them about insecticides use and provide different insecticides at reasonable prices

From the above discussion it is clear that farmers of the study area are facing numerous problems regarding cultivation practices of potato. However, in spite of these problems and constraints the farmers in the study area are still producing this vegetable because of its high profitability and easy cultivation process. Moreover, its production is labor intensive. Thus, the idle family labor could be utilized during the production period.

8.4 Conclusion

Potato can play an important role in earning cash money. Since it is profitable and has huge domestic demand, its production should be expanded. Therefore, it may be concluded that potato production per hectare as well as its commercial production could possibly be increased to a large extent if the above mentioned problems and constraints could be solved. Then it could help farmers to increase their income as well as their living standard.

CHAPTER 9
SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

9.1 Introduction

This chapter highlights the major findings and conclusion of the research. This chapter was summarized on the basis of previously discussed chapter. The findings of the study and farmer's observation and perceptions on various issues related to production of potato as well as its impact on their socio economic status are summarized in this chapter. Finally, conclusion and some important policy recommendation of the study were also presented in this chapter.

9.2 Summary of the Study

Bangladesh is predominantly an agricultural country where, rise is main food item for the people of country. But rice alone cannot solve demand of balanced diet. Nutritional deficiency is a very serious problem for the people of Bangladesh today. Potato is considered as one of the most important groups of food crops. Among different foods and vegetables potato is important for their dietary values and sources of income in Bangladesh. Therefore, the study was an attempt to analyze the relative profitability and resource use efficiency of potato production in selected are of Bangladesh. Besides this, an attempt has made to measure the impact of potato production on socio economic status of the farmers.

The present study was conducted in Naogaon sadar upazilla, Badalgachi upazilla and Attrai upazilla of Naogaon district which was selected purposively. In this study a purposive random sampling technique was applied.

In total 75 farmers were selected to achieve the ultimate objective of the study. To get the desire sample at first the list of potato producers were collected from the Agricultural Extension officer of the selected upazilla agricultural office. Out of 200 potato farmers 100 small farmers (having land 0.05-2.49 acres) who cultivated potato minimum for three years were selected purposively. Then out of 100 total 75 farmers were randomly selected. Tabular technique as well as statistical techniques such as Cobb-Douglas production function, Technical Inefficiency Model were used to process and analyses the gathered data.

Economic profitability is a major criterion to make decision for producing any crop at farm level. It can be measured based on net return, gross margin and ratio of return to total cost. The average land preparation cost of Potato production was found to be Tk. 3146 per hectare. The quantity of human labor used in potato production was found to be about 149 man-days per hectare and average price of human labor was Tk. 400 per man-day. Therefore, the total cost of human labor was found to be Tk. 59600 representing 34.41 percent of total cost. Per hectare total cost of seed for Potato production was estimated to be Tk. 48183.71. On average, farmers used Urea, TSP, MoP 158.8 Kg, 278.80 kg and 278.80 kg respectively per hectare. The average cost of insecticides for potato production was found to be Tk. 1995.33. Whereas the average cost of irrigation was found to be Tk. 1600 per hectare. The total variable cost of Potato production was Tk. 136228.74 per hectare, which was 78.64 percent of the total cost. The average yield of Potato per hectare was18343.21 kg, total price of Potato was Tk.2,73,314 per hectare. The gross return, gross margin and net return were found to be Tk. 273314, Tk. 137085.26 and Tk. 100092.14per hectare. Benefit Cost Ratio (BCR) was found to be 1.58 which implies that one taka investment in Potato production generated Tk. 1.58.

Technical efficiency reflects the ability of a farmer to obtain the maximum possible output from a given level of inputs and production technology. Technical efficiency is then measured as the deviation of a farmer from the best-practice frontier. The regression coefficients of seed (X2), fertilizer (X3) and insecticides cost (X4), irrigation (X5) were positive but the coefficient of human labour (X1) was found negative. It indicates that if seed (X2), fertilizer (X3), insecticides cost (X4) were increased by one percent, the production of Potato would be increased by 0.6253, 0.7760, 0.02154 percent of sample farmers respectively.

In the technical inefficiency effect model, experience, farm size, extension service and credit service have expected (negative) coefficients. The negative coefficient of experience implies that experienced farmers are technically more efficient than non-experienced farmers. The negative coefficient of farm size implies that large farm households are technically more efficient than small farm households.

The negative coefficient of extension service postulates that farmers having contacts with extension officers are technically more efficient than others. The negative credit service coefficient indicates that taking loan by farmers helps reduce technical inefficiency. The coefficients of training are positive meaning that these factors have no impact on the technical inefficiency.

It reveals that average estimated technical efficiencies for potato are 83 percent which indicate that potato production could be increased by 17 percent with the same level of inputs without incurring any further cost. Increase of only managerial skills result a substantial increase of output for potato. It was observed that about 52 percent of sample farmers were found to have received outputs which were very close to the maximum frontier outputs maintaining the efficiency level more than 95 per cent. On the other hand, 48 per cent of sample farmers obtained up to 80 percent technical efficiency level. The minimum and maximum technical efficiencies were observed to be 20 and 99 per cent respectively, where standard deviation was maintained at 0.15.

9.3 Conclusion

From the result of the present study, it can be concluded that considerable scope apparently exists in the study area to increase the productivity of potato and to increase income, employment and nutritional status of the farmers. The management practices of selected crop production in the study area were not found efficient enough. Farmers had less idea about the application about inputs in right time with right doses. Thus, well planned management training in accordance with their problems, needs and resource based can lead to viable production practices and sustainable income from potato production.

9.4 Recommendation

On the basis of the findings of the study, it was evident that potato production was profitable and it can generate income earning and employment opportunities to the rural people of Bangladesh. But some problems and constrains came out into the production of potato. So policy recommendations constitute important guide lines for overcoming these constrains and increasing potato production in Bangladesh.

Some policy recommendations based on the findings and conclusion of the study are presented below:

- Since quality seeds played a significant role on potato yield, both the government and private institutions should take necessary steps to ensure the availability of quality HYV seeds at the door steps of farmers at reasonable price.
- Government should take necessary steps to train the farmers about the proper use of inputs. Department of Agricultural Extension can play an important role in this case. They can provide training program to the farmers in rural areas directly through Upazilla Extension officer.
- Different government agencies like DAE and non government agencies should continue strong extension program in order to increase cultivation area in other potential areas where land remain fellow in potato producing season.
- The bank should reduce the complexity in getting loans and should be encouraged to provide loans at a reasonable rate of interest. Government should take necessary steps to control the interest rate of banks and NGOs at a reasonable level.
- Government also should take initiatives to search for new market for potato during the harvesting season so that they can get right price.

9.5 Limitations of the Study

This study was based on the profitability and resource use efficiency of potato production. Though awareness had been taken to eliminate the error and inconsistency of the study but it is not free from its limitations which are as follows:

- It was very difficult to convince the resonances to give necessary information relating to such a research work, some of them demanded for money or other financial support for their farming since they thought it was government survey.

- Most of the respondents initially hesitated to answer questions, since the thought the investigator might use the information against their interest especially they were hesitated to provide their income and land holding data.

- Most of the farmers are illiterate or quite ignorant and they did not keep any written record of their annual, monthly or daily transaction and activities. It was very difficult to collect actual data.

- Sometimes the interviewees were not available in house, which needed multiple visits to conduct a single interview.

- Resources such as time, money etc was limited.

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Sl. No.:
Mobile No. :

Profitability and Technical Efficiency Analysis of Potato Production in Some Selected Areas of Naogaon District

Village/Community.....
Upzilla.....

A. SOCIO-ECONOMIC CHARACTERISTICS

1. Name of farmer……

2. Details of House hold

Sl. No	Name of the member	Sex (M/F)	Age	Level of Education(Years)	Occupation (in terms of income)
01.	Self				
02.	Husband/wife				
03.	Son(s)				
04.	Daughter(s)				
05.	Others, if any				

3. Farm Size

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

Sl. No.:
Mobile No. :

4. Source of Income

a) Agricultural Service :

Sector	Income per year
Crop	
Poultry	
Animal production	
Fisheries	

b) Nonagricultural Service :

Sector	Wage/day	Income per year
Day labor		
Rickshaw puller		
Construction worker		
Tailoring		
Shop keeping		
Others (if any)		

5. 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			

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

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

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

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

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

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

12. If yes,

- ✓ How many times……
- ✓ How many days……..

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

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

B. INFORMATION ON INPUTS

15. Planting time: Month……

Week……

16. Variety Name……..

17. Soil Type……..

18. Source of Seed

a) Home	
b) Purchase	

19. 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) Draft power cost/ Machinery cost :

C) 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		

D) Rest :

20. Production in survey area

Product	1st Harvesting	2nd	Total	Price TK/KG
Main product				

Sl. No.:
Mobile No. :

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: