PROFITABILITY AND RESOURCE USE EFFICIENCY OF POTATO CULTIVATION IN SOME SELECTED AREA OF PANCHARAGH DISTRICT IN BANGLADESH

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CERTIFICATE

This is to certify that the thesis entitled **"PROFITABILITY AND RESOURCE USE EFFICIENCY OF POTATO CULTIVATION IN SOME SELECTED AREA OF PANCHARAGH DISTRICT IN BANGLADESH"** submitted to the Department of Development and Poverty Studies, Faculty of Agribusiness Management, Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka in partial fulfillment of the requirements for the degree of Master of Science (M.S.) in Development and Poverty Studies, embodies the result of a piece of bona fide research work carried out by **SAMS JERRY RAHAT, Reg. No.: 12-05147** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.

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

Dated:
Dhaka,Bangladesh

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Abstract

Bangladesh is an agricultural country and potato is one of the most important horticultural crop of our daily life. The study was conducted at Debiganj of Pancharagh district to examine the profitability, resource use efficiency socioeconomic conditions, problems and some probable solutions for potato cultivation. A total of 70 respondents selected from the four villages as a sample for the present study. A simple random sampling technique was used for the selection of samples. Both primary and secondary data were used for the study. Different statistical analysis including Cobb-Douglas model are employed to fulfill the objectives of the study. The results reveal that the total variable cost was Tk 193827.00 and fixed cost Tk 1938.27 per hectare for potato production. Gross return of the potato production was 279400.00. Net return was Tk. 83634.73 and cost benefit ratio was 1.42. In the study area, use of insecticide, fertilizer and irrigation for potato farming was under used as well as seed and labor were over used. Insecticide, seed, and irrigation were statistically significant. Potato cultivars faced some problems such as lack of capital, high price of fertilizers and insecticides, scarcity of good quality seeds, attack by pest and disease, lack of storage facilities, lack of marketing facilities, and lack of market information. The findings of the study can help the policy makers to make policy for eliminating the problems of the farmers; over all the development the economy. Government should emphasize on providing sufficient cold storage facilities, proper financial support and support of agricultural inputs with low-price.

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CHAPTER ONE

INTRODUCTION

1.1 Background of study

Bangladesh is only 147,570 km^2 in South Asia with a population density of about 1,115.62 persons/km2 (World Population Review, 2019). Bangladesh is an agrarian nation. Agriculture sector plays an important role in the overall economic development of Bangladesh. The agricultural sector (crops, animal farming, forests, and fishing) contributes 14.23 percent to the country's GDP, provides employment about 40.62 percent of the labour force (Bangladesh Economic Review, 2018).

Potato (Solamum tuberosum) is the leading vegetable in the world. It is originated South American such as Peru, Ecuador etc. It has high nutritive value. It supplies more carbohydrate combination with many others items of food. Since provision of food security, improvement of living standard and employment opportunity of the huge population of the country are directly linked to the development of agriculture. With a view to developing the agriculture sector, the following steps should be included, these are the expansion of small irrigation facilities, enhancing the production of domestic food grains, production of improved quality and high yielding varieties of seeds and their preservation and distribution, development and expansion of the varieties of crops adaptable for the weather and environment of a particular region and producing crops suitable for a particular type of land as well as proper use of fertilizers (Heady and Dillion,1961).

Agriculture being the engine of growth of Bangladesh economy. Since provision of food security, improvement of the living standard and generation of employment opportunities of the huge population of the country are directly linked to the development of agriculture. Potato production plays vital role for accelerating the growth of agricultural sector. Bangladesh stood ninth position in the potato

production throughout the world (BBS, 2015). Now potato and different potato products such as potato chips are exported in different countries. It helps to earn foreign currencies. In the winter season it grows well. The climate of our country is favorable for potato cultivation. From the very beginning of Bangladesh, agriculture sector is characterized by some cropping patterns of which cultivation of potato is the most important one. It is very unlikely that a farmer does agricultural activities but does not cultivate potato.

Potato (*Solamum tuberosum*) is the leading vegetable of the World. It has high nutritive value (Suraiya, 2008). It supplies more carbohydrate combination with many other items of food. Per 100gm of edible raw part of potato gives: Moisture - 75percent, Carbohydrates -15.09g, Protein -1.89g, Total fat -0.10g, Cholesterol -0g, Dietary fiber -2.5g, Energy- 97 Kcal. 10 Vitamins: Folates -18mcg, Niacin -1.149mg, pantothenic acid- 0.279 mg, Pyridoxine- 0.239mg, Riboflavin - 0.038mg,Thiamine-0.081mg,-VitaminC-11.4mg,VitaminA-7I.U,VitaminK-2.9micro gm. Electrolytes: sodium-10gm, potassium-455mg. Minerals: calcium-10gm, iron-.073mg, magnesium-22gm, manganese-0.141mg, phosphotus-61mg, zinc-0.33mg. Phyto-nutrients: carotene beta-4mcg, carotene alpha- 0mcg (Dillon and Hardaker, 1993).

Table 1.1 Potato production in Bangladesh 2010-11 to 2016-2017

Year	**Production(m.tones)**	**Area(hectare)**
2010-11	8326389	460197
2011-12	8205470	430255
2012-13	8603120	444135
2013-14	8950024	462032
2014-15	9254285	471013
2015-16	9474098	475488
2016-17	10215957	499725

Source: BBS, 2018

Table 1.2 Potato production at Panchagarh district 2010-11 to 2016-2017

Year	Production (m.tones)	Area (hectare)
2010-11	103369	7962
2011-12	121794	9162
2012-13	147453	10988
2013-14	139408	10376
2014-15	146779	10602
2015-16	160069	10800
2016-17	204601	10323

Source: BBS, 2018

1.2 **Justification of the study**

The population of Bangladesh is much higher compared to that of other countries of the world. There is little scope of bringing more land under cultivation due to limited cultivable area. In this context, potato may be considered as to important diversified crops, which may deal pride such opportunities (BER 2015). Before giving emphasis on the production of potato, relevant and adequate information on different aspects of production of potato at farm level are required. Such knowledge of production is also necessary to make appropriate decision by the growers especially when several alternatives are open to them. However, some systematic economic investigations on this potato production may have undertaken either by the government or private organization in order to satisfy the demand of extension workers, policy makers, research personnel, NGO officials and the farmers. The present study is an attempt to analyze the profitability of potato production and to identify the main factors that affect the yields. Therefore, the individual farmers would be benefited from this study for effective operation and management of their farms. This study will be helpful to the research workers for further studies of similar nature and to extension personnel that are directly involved in the different agricultural development programs and help them to learn about various problems of potato.

1.3 Objectives of the study

The objectives of the study are given bellow:

1. To determine the socioeconomic characteristics of the potato producing farmers.
2. To assess the profitability of the potato producing farmers.
3. To determine factors affecting the gross return of the potato producing farmers.
4. To identify the major problems associated with potato production.

1.4 Outline of the study

The study consists of nine chapters. Chapter 1 describes introduction of the study, Chapter 2 relevant of literature. Chapter 3 deals with the methodology of the study Socioeconomic characteristics of the sample farmers are presented in Chapter 4. Chapter 5 estimated and analysis the costs and returns of the potato production. The results of Cobb- Douglas production function analysis are given in Chapter 6. Chapter 7 is designed to identify production problems of the potato growers. Finally, conclusion and recommendations of the study are presented in Chapter 8.

CHAPTER TWO
REVIEW OF LITERATURE

2.1 Introduction

The purpose of this chapter is to review some previously completed researches relatedto the present study. The economic studies on potato production are limited in Bangladesh. Some of the important works regarding present study are reviewed here.

Sujan et al. (2017) conducted a study on resource use efficiency and profitability of potato. A total of 52 farmers were selected randomly from the study area. Profitability analysis, Cobb-Douglas production function, MVP, MFC and Farm Budgeting model were used to analyze the objectives. Average gross return, gross margin and net return were found Tk. 3,47,200, Tk. 1,47,125 and Tk. 1,17,300, respectively. Benefit-cost ratio was found 1.51 and 1.74 on full cost and variable cost basis, respectively. Resource use efficiency analysis revealed that farmers were not efficient in using resources in potato cultivation. Human labor, land preparation, insecticide and irrigation were under-utilized and therefore increasing use of those resources could maximize the profitability.

Begum et al. (2017) carried out a study to assess the profitability of potato cultivation in some selected areas of Sylhet district in Bangladesh. A total of 50 farmers were selected from different villages of Fenchugong upazila in Sylhet district. On an average 50% of the total income obtained from potato production. The annual savings of the sampled farmers was found to be higher in large farm followed by medium and small farm. On an average BCR was the highest in large farms (1.68) appearing lowest in small farms (1.34). The study identified some major problems like nonavailability of quality seeds and high ppotato, low market ppotato, shortage of human labor, lack of storage facilities etc.

Sarkar and Yesmin (2014). Reported rgatRealizing the situations, the government of

Bangladesh has been maintaining a crop diversification strategy to reduce the dependency on potato by increasing the consumption and production of potato. In Bangladesh, the amount of cultivable land is gradually decreasing because of infrastructural and industrial development activities. For that reason, production strategies require to be formulated according to the demand of the situation and time so that farmers can increase food production. The cultivation of potato was a profitable business and the medium farm was more profitable than the small and marginal farms.

Suraiya (2008) studied on an economic analysis of some selected summer vegetables production in PurbadhalaUpazila of Netrokona District. The selected vegetables were potato, okra, white gourd and snake gourd. The major findings of the study revealed that all the selected vegetables cultivation were profitable.

Saiyem (2007) investigated the potato marketing system in selected areas of Rangpur district. The samples include 60 sample farmers and intermediaries. In this study production cost, yield, marketing cost, marketing margin, net margin and channel of marketing were estimated.

Hossain (2004) studied the potato marketing system in selected areas of Bogra district. This study was mainly based on SadarUpazila of Bogra district. The sample included 30 farmers and 30 intermediaries. Production cost, yield, marketing cost, marketing margin and net margin of potato farmers and intermediaries were calculated in this study.

Hossin (2004) conducted a research on a comparative economic analysis of some selected high yielding verities of winter vegetables in an area of Bangladesh. The major findings of the study revealed that production of all selected homestead potato were profitable. Per acre gross cost of production of potato Tk 75215.50 and gross returns were Tk 148540. Per acre net returns of potato was Tk 73324.50. Benefit cost

ratio of was1.97.

Kawsar (2001) carried out a-study entitled "An Economic Analysis of Diamant Potato Production in Some Selected Areas of Bangladesh". The study was mainly designed to analyze the socio-economic characteristics of farmers and to estimate the costs and returns of Diamant variety of potato and to determine the factors affecting yield and returns. One hundred thirty nine farmers were purposively selected from 5 Upazilas of five districts Bogra, Comilla, Munshiganj, Rangpur and Thakurgaon. Findings showed that Diamant potato production is profitable considering the selected farm categories both in East and North Bengal.

Rahman (2000) conducted women's employment in Bangladesh agriculture and composition determinants and scope. The major findings of the study were that the potato production were profitable from the viewpoint of marginal, small, medium and large farmers and it helps to women employment.

Nahar(1998) reported that the farmers of Mymensingh district were profitable to get the bumper production of potato in 1998. About 20 thousand farmers of the upazilla, who were cultivating potato on there a total of 180 hectares of land, were brought under potato cultivation in that year.

Shaikh (1997) conducted a study on Agricultural Research and Development in Bangladesh: Present and Future, Agribusiness. The study found that in exporting marketing channels the vegetables farmers sold their major portion of potato to selected agents. The study revealed that it was more profitable to export potato to Asian countries compared to Middle East countries. Although profit was the highest in exporting potato to EU countries, there exists a lot of formalities and risk for exporting potato in those countries. The fresh vegetable exporters were facing problems in exploiting export market due to lack of required cargo facilities and high frigate rate charge by the Biman BangladeshAirlines.

Islam and Karim (1997) conducted a study to assess the comparative profitability of selected winter vegetables like potato, cauliflower and tomato. It revealed that all the vegetables were profitable. Per hectare total costs of production of potato, cauliflower and tomato were tomato Tk. 51396.79, Tk. 64406.06 and Tk. 61663.87, respectively and the corresponding gross incomes were Tk. 99401.44, Tk. 119165.12 and Tk. 93442.24, respectively. The estimated net return of producing potato, cauliflower and tomato were Tk.48004.65, Tk. 54759.06 and Tk. 31778.38 respectively. However, for producingthree alternate winter vegetables, net returns was the highest for cauliflower followed by potato and tomato.

Hossain (1997) carried out a study on a comparative economic analysis of some selected high yielding varieties of winter vegetables such as potato, cucumber, cauliflower and cabbage production in an area under Baraigram thana in the district of Natore. Author observed that the per hectare gross returns potato, cucumber, cauliflower and cabbage were Tk. 74725, Tk. 75847, Tk. 62313 and Tk. 59626, respectively. He found that cucumber growers received the highest per hectare gross and net returns above cash costs.

Rahman (1993) conducted a cooperative `study of HYV potato and wheat production in some area of Jamalpur District. Potato cultivation is getting popular in Jamalpur. Farmers have become inclined because sustainable cost and good production.

Roy (1993) conducted a research on relative profitability of potato-based cropping patterns in Bangladesh: A study in a selected area of Lalmonirhat district. He found that sixty three percent potato growers reported that their income, 57.00 percent children education, 80.00 percent household furniture increased due to potato production. Improvement of health and sanitation for potato growers was better than before. Sixty three percent overall socioeconomic improvements occurd due to potato cultivation. Finally he found that livelihood of potato farmers were better off than before and from non-potato growers.

Haque, (1993) conducted a study on the comparative profitability of sweet potato and groundnut with particular reference to small farmers in six villages under Kuliachar thana of Kishoreganj district. He showed that both sweet potato and groundnut were profitable enterprise.

Basak (1992) undertook a study in three villages of Gabtoli thana in Bogra district and found that the average returns to each taka spent on full-costs and cash-costs were Tk.1.53 and 3.43 for LV and Tk. 1.69 and 3.62 for HYV, respectively. The farmer's preference for potato was found to be mainly due to high returns and consumptions.
Islam (1987) carried out a study on potato preservation in cold storage inBangladesh including the marketing aspects. He found that ppotato spread per tonnes of potato appropriated by traders was higher in the case cold stored potato than that of non-stored potato.

Miah(1987) conducted a study in Sadar thana of Mymensingh district to assess the performance of crops and potato producing on the marginal land and resource efficiency of the farmers. Profitability's of different cropping patterns were compared in respect to farm size and types of land. In order to measures the efficiency to dominant cropping patterns, potato grain equivalent, land use efficiency and production efficiency were calculated. In the most cases, theses are the highest in the cases of vegetable based cropping patterns. The author found that farmers achieved more profit from potato than other crops.

Sabur and Gangwar (1984) carried out a study on production and ppotato structure of potato in Bangladesh and showed that the growth rate of potato in terms of production, area and productivity during the proliferation period. The study also showed that the growth rates in terms of area, production and productivity for the western districts were higher than those for the northern districts**.**

2.2 Research Gap

The above review reveals that some studies were found on profitability of potato production in different area of the country (Sujan et al. 2017; Begum et al. 2017; Suraiya, 2008; Hossain, 2004; Kawsar, 2001; Islam and Karim, 1997; Hossain 1997; Rahman, 1993; Roy, 1993). Few studies were found on coparative study of profitability of potato with other vegetables in different study area (Hossain, 2004; Islam and Karim, 1997; Rahman, 1993; Haque, 1993; Miah, 1987).We got in hand very few studies that investigated about marketing system potato and storage facilities in Bangladesh (Saiyem, 2007; Hossain 2004; Islam, 1987). So far of researcher knowledge, there is no study on resource use efficiency of potato and their constraints in the study area. This research gap motivated me to study regarding issue.

CHAPTER THREE
RESEARCH METHODOLODY

3.1 Introduction

This chapter presents a detailed sequential steps of research work for instance, selection of study areas, selection of study period, sources of data, processing of data and analytical techniques.

3.2 Selection of the Study Area

Debiganj Upazila is under the district of Panchagarh. Its area is 309.04 sq km, located in between 26°00' and 26°19' north latitudes and in between 88°39' and 88°49' east longitudes. It is bounded by boda and Panchagarh sadar upazilas on the north, Birganj, Khansama and Nilphamari sadar upazilas on the south, Domar upazila and West Bengal state of India on the east, Thakurgaon sadar and Boda upazilas on the west. There are a number of Indian enclaves in the upazila, most noted of which are Behula Danga, Balapara, Court Bhajni and Dahala Khagrabari. Total population IS 185960 where male is 94581, female is 91379. Main sources of income is agriculture (70.96%), and non-agricultural. Non agriculture includes labourer 5.42%, industry 0.47%, commerce 9.6%, transport and communication 3.72%, service 4.83%, construction 0.73%, religious service 0.15%, rent and remittance 0.13% and others 3.99% (BBS 2018).

Source: Banglapedia.com/map/debiganj

The reasons for selecting this study area for the present study are given below:

*Comparatively higher concentration of potato farming.

*These villages had some identical characteristics like homogeneous soil type, topographical and climatic condition for producing potato.

*Easy accessibility and good communication facilities.

*Researcher's belief about getting well co-operation from the selected respondent and

*No such study was conducted in this area.

3.3. Study population and sampling strategy

The population of this study is all farm households residing in the selected villages (Table. 3.1). Thus there are many farm households. The standard statistical formula for selecting a sample size results in a huge number which is impractical for an individual researcher because of time and funding constraints (Blaikie 2010; Gilbert 2008). Since all the farmers in the area face similar socio-economic, environmental and climate conditions in their farming activities, they make up a mostly homogeneous group which validates the use of a small sample size which can be representative of the whole population (Alam, 2016; Blaikie 2010; Gilbert 2008). Therefore, sample size is determined purposively depending on the context rather than a statistical formula. This study aimed to survey a sample of 70 potato farming households. Respondents were selected randomly within the villages. This was expected to reflect the farming features of all farmers in the villages.

A completed list of all potato farming households in the respective villages was collected from the Sub-Assistant Agricultural Officers (SAAOs) in the study areas. The numbered list provided names and addresses of farmers with their farm sizes. Afterwards, a computer-generated random number table was applied to the list to select 70 farm households. In this way the randomness in the sampling procedure was ensured.

Table 3.1 Selected study areas for primary data collection**:**

Upazilla		
Upazilla	Villages	No. of Respondents
Debiganj	Debiganj Sadar	20
	Kaliganj	15
	Sonaher	15
	Vaolaganj	20

3.4 Sources of Data

Data required for the present study were collected from primary and secondary sources. Primary data were obtained from farmers and secondary data were collected from various published sources. Secondary sources were Bangladesh Bureau of Statistics (BBS), Department Agricultural Extension (DAE), Department of Agricultural Marketing, and other related agencies in Bangladesh.

3.5 Preparation of the Survey Schedule

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

3.6 Collection of Data

To satisfy the objectives of the study, necessary data were collected by visiting each farm personally and by interviewing them with the help of a pretested interview schedule. Usually most of the respondent does not keep records of their activities. Hence it is very difficult to collect actual data and the researcher has to rely on the memory of the respondent. Before going to an actual interview, a brief introduction of

the aims and objectives of the study was given to each respondent. The question was asked systematically in a very simple manner and the information was recorded on the interview schedule. When each interview was over the interview schedule was checked and verified to be sure that information to each of the items had been properly recorded. In order to minimize errors, data were collected in local units. These were subsequently converted into appropriate standard unit. Data collection period was 1st August to 31st August, 2019. In order to obtain reliable data the researcher initially visited for several times to introduces himself with the people of the study areas during the season. Secondary data were collected through literature and different publications.

3.7 Editing and Tabulation of Data

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

3.8 Analytical Techniques

Data were analyzed with the purpose of fulfilling the objectives of the study. Both descriptive and statistical analysis was used for analyzing the data.

3.8.1 Descriptive Analysis

Tabular technique of analysis was generally used to find out the socio-demographic profile of the respondent, to determine the cost, returns and profitability of potato farm enterprises. It is simple in calculation, widely used and easy to understand. It was used to get the simple measures like average, percentage etc.

3.8.2 Production Function Analysis

The production function represents the technological relationship between output and factor inputs. To estimate the production function, one requires development of its properties leading to specification of an explicit functional form. One of the most widely used production function for empirical estimation is the Cobb Douglas production. This function was originally used by C.W. Cobb and P.H. Douglas in twenties to estimate the marginal productivities of labor and capital in American manufacturing industries. Their main purpose was to estimate the shares of labor and capital in total product; hence they used this function with the constraint that the sum of elasticities or regression coefficients should total one. Later on, they relaxed this restraint. Cobb and Douglas originally fitted the function to time series 1930s and 1940s; the same form was used for cross section of industries. This form of the function was subsequently used in many production functions studies for technical units (crops, livestock) and farm-firms in agricultures. The popularity of this function is because of the following characteristics of the function:

(i) It directly provides the elasticities of production with respect to inputs;
(ii) It allows more degrees of freedom than other algebraic forms (like a quadratic function) which allow increasing or decreasing marginal productivities, and
(iii) It simplifies the calculations by reducing the number of regression to be handled in regression analysis. The original form used by Cobb and Douglas was

$$\mathbf{Q = aL^{\beta}K^{1-\beta}U}$$

This forces sum of elasticities to one. Their later modification was

$$\mathbf{Q = aL^{\alpha}K^{\beta}U}$$

Where, $\boldsymbol{\alpha} + \boldsymbol{\beta}$ need not equal one. In agriculture, this form of function has not been used in its original form. Neither the sum of elasticities is kept equal to one nor is the number of variables limited to two. Even then as the basic idea of functional form was

provided by Cobb and Douglas, various forms of this function have continued to be called as Cobb-Douglas production function. The Cobb–Douglas production function, in its stochastic form, may be expressed as

$$Yi = \beta_1 X_{1i}^{\beta 1} X_{2i}^{\beta 2} \ldots\ldots\ldots\ldots\ldots\ldots X_{ni}^{\beta n} e^{u} \quad (3.1)$$

Where,

Y = output

X_1 = labor input

X_2 = Capital input

u = stochastic disturbance term,

e = base of natural logarithm.

From Eq. (3.1) it is clear that the relationship between output and the two inputs is nonlinear. However, if we log-transform this model, we obtain:

$$\ln Y_i = \ln\beta_1 + \beta_2 \ln X_{2i} + \beta_3 \ln X_{3i} + \ldots\ldots\ldots\ldots\ldots\ldots\ldots B_n \ln X_{ni} + u_i$$

Thus written, the model is linear in the parameters β_0, β_2, and β_3

The properties of the Cobb–Douglas production function are quite well known and is, therefore, a linear regression model. Notice, though, it is nonlinear in the variables Y and X but linear in the logs of these variables. In short, (3.2) is a log-log, double-log, or log-linear model, the multiple regression counterpart of the two-variable log-linear model.

The properties of the Cobb–Douglas production function are quite well known:

1. β_1 is the (partial) elasticity of output with respect to the labor input, that is, it measures the percentage change in output for, say, a 1 percent change in the labor input, holding the capital input constant.

2. β_2 is the (partial) elasticity of output with respect to the capital input, holding the labor input constant.

3. The sum (β_1+ $\beta_{2)}$ gives information about the returns to scale, that is, the response

of output to a proportionate change in the inputs. If this sum is 1, then there are constant returns to scale, that is, doubling the inputs will double the output, tripling the inputs will triple the output, and so on. If the sum is less than 1, there are decreasing returns to scale—doubling the inputs will less than double the output. Finally, if the sum is greater than 1, there are increasing returns to scale— doubling the inputs will more than double the output.

Before proceeding further, note that whenever you have a log–linear regression model involving any number of variables the coefficient of each of the X variables measures the (partial) elasticity of the dependent variable Y with respect to that variable. Thus, if you have a k-variable log-linear model:

$$\ln Y_i = \alpha + \beta_1 \ln X_{1i} + \beta_2 \ln X_{2i} + \ldots \ldots + \beta_n \ln X_{ni} + u_i \ldots\ldots\ldots\ldots (3.3)$$

Each of the (partial) regression coefficients, β_1 through β_n, is the (partial) elasticity of Y with respect to variables X1 through X_n. Assuming that the model (3.2) satisfies the assumptions of the classical linear regression model; we obtained the regression by the OLS. (Acharaya, 1988; Sujan et al. 2017; Rasha et al. 2018).

3.8.3 Specification of the Cobb-Douglas Production Function

The Cobb-Douglas production function was transformed into following logarithmic form so that it could be solved by ordinary least squares (OLS) method.

$$\ln Y = \alpha + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + \beta_4 \ln X_4 + \beta_5 \ln X_5 + \beta_6 \ln X_{6+} U_i \ldots\ldots\ldots\ldots (3.5)$$

Where, Y= Gross income from year round potato (Tk/ha);

X_1= Cost of human labor (Tk/ha)

X_2= Cost of seed (Tk/ha)

X_3= Cost of manure (Tk/ha)

X_4= Cost of fertilizer (Tk/ha)

X_5 = Cost of insecticide (Tk/ha);

X_6 = Cost of irrigation (Tk/ha);

α = Intercept of the function

β_1, β_2. . ….. β_6 are coefficients of the respective input to be estimated; and

U_i = Error term. Coefficient of the respective variable; i= 1, 2,…….6

Few studies were found where they used return as return as dependenrt variable and cost of factors as independent variable (Haque,1993; Islam 1997; Islam 2017; Sujan et al. 2017).

3.9 Measurement of Resource Use Efficiency

In order to test the efficiency, the ratio of Marginal Value Product (MVP) to the Marginal Factor Cost (MFC) for each input were computed and tested for its equality to 1. i.e., (Rasha et al. 2018).

MVP/MFC = 1.

The marginal productivity of a particular resource represents the additional to gross returns in value term caused by an additional one unit of that resource, while other inputs are held constant.

When the marginal physical product (MPP) is multiplied by the product ppotato per unit, the MVP is obtained. The most reliable, perhaps the most useful estimate of MVP is obtained by taking resources (Xi) as well as gross return (Y) at their geometric means.

In this study the MPP and the corresponding values of MVP were obtained as follows:

MPPxi*Pyi = MFC,

Where,

MPPxi *Pyi=MVP

But, MPP = bi*(Y/Xi),

So, MVP = bi* (Y/Xi) Pyi

Y = Mean output

bi = regression coefficient per resource

Xi = Mean value of inputs

Pyi= output

MFC = potato per unit of input.

3.10 Decision Criteria

The decision criteria for choosing efficiency will be-

*When the ratio of MVP and MFC is equal to unity indicates that the resource is efficiently used.

*When the ratio of MVP and MFC is more than unity implying the resource is underutilized.

*When the ratio of MVP and MFC is less than unity implying the resource is overused.

3.11 Profitability Analysis

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

3.11.1 Calculation of Gross Return

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

Gross Return= Quantity of the product * Average ppotato of the product + Value of byproduct.

3.11.2 Calculation of Gross Margin

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

3.11.3 Calculation of Net Return

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

Net return = Total return – Total production cost.

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

Net profit, $\pi = \Sigma P_m Q_m + \Sigma P_f Q_f - \Sigma (P_{xi} X_i) - TFC$.

Where, π = Net profit/Net return from potato farming (Tk/ha);

P_m = Per unit ppotato of potato (Tk/kg); Q_m= Total quantity of the potato production (kg/ha);

Q_f = Per unit ppotato of other relevant potato (Tk/kg);

P_f = Total quantity of other relevant potato (kg/ha);

P_{xi} = Per unit ppotato of i-th inputs (Tk);

TFC = Total fixed cost (Tk); and

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

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

3.11.4 Undiscounted Benefit Cost Ratio (BCR)

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

BCR= Total Return /Total Cost

3.12 Problem Faced Index

In the study area potato farmers faced various problems such as higher price of potato inputs, storage problems, perishability, lack of quality seed, lack of capital, lack of labor, lack of fertilizer, lack of irrigation, potato instability. They are economically not very capable of investing the required amount for producing crops due to low capital base. A three-point Likert-type scale was used to measure each activity. The

scores of 3, 2 and 1 were assigned for high problem, medium problem and low problem respectively. For clear understanding of problem faced index (PFI) was computed using the following formula:

PFI = (Php x 1) + (Pmp x 2) + (Plp x 3)

Where,

Php= Number of high problem respondents

Pmp = Number of medium problem respondents

Plp = Number of low problem respondents

3.13 Problem Faced in Collecting Data

During the period of data collection, the researcher faced the following problems.

i) Most of the farmers felt disturbed to answer questions since they thought that the researcher might use the information against their interest. To earn the confidence of the farmers a great deal of time was spent.

ii) The farmers do not keep records of their activities and day to day expenses. Therefore, the author had to depend upon their memory.

iii) The farmers were usually busy with their filed works. So, the researcher sometimes also had to pay extra visits to meet the farmer.

CHAPTER FOUR
SOCIOECONOMIC CHARACTERISTICS

4.1 Introduction

This chapter deals with the socioeconomic characteristics of the sample farmers. Socioeconomic characteristics of the farmers are important in influencing production planning. People differ from one another in many respects. Behavior of an individual is largely determined by his/her characteristics. There are numerous interrelated and constituent attributes that characterize an individual and profoundly influence development of his/her behavior and personality. It was, therefore, assumed that enterprise combination, consumption pattern, purchase pattern, and employment patterns of different farm household would be influenced by their various characteristics. Finally socioeconomic aspects of the sample households were examined. These were family size and composition, age distribution. Occupation, level of education, involvement of women, land ownership pattern etc. A brief discussion of these aspects is given below.

4.2. Socio-economic characteristics of sample households

4.2.1. Age Distribution

This entry provides the distribution of the population according to age. The age group as follows: 0-14 years (children), 15-24 years (early working age), 25-54 years (prime working age), 55-64 years (mature working age), 65 years and over elderly (WB, 2019). In the study, all categories of farmers of the study area were classified into different age groups as presented in figure 4.2.1. It is evident from the table that most of the farmers were middle aged in the study area. Out of the total sample farmers 25.00 percent belonged to the age group of 15-24 years, 57 percent belonged to the age group of 25-54 years and 18 percent fell into the age group of above 55-64. This finding imply that majority of the sample farmers were in the most active age group of 25-54 years indicating that they provided more physical efforts for farming.

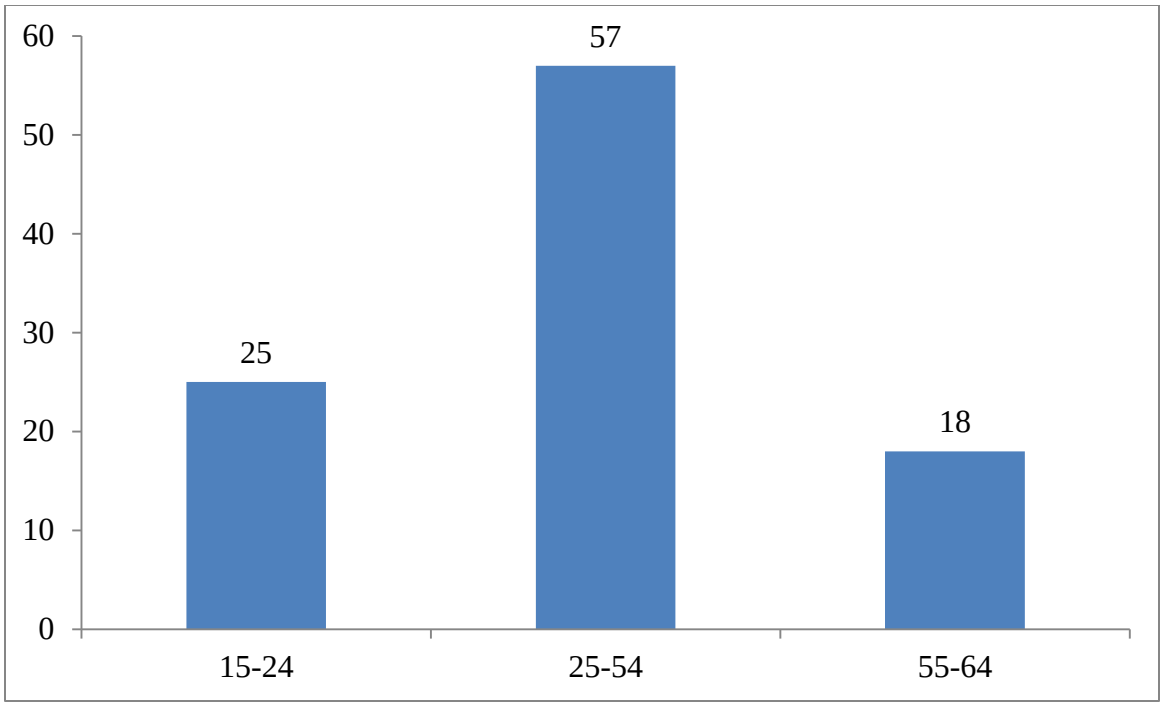

Figure: Age distribution of the respondents

Source: Field Survey, 2019.

4.2.2. Educational status

Education increases the efficiency of man. Education of farmers helps to adopt due to climate change. Figure 4.2.2 shows 11 percent farmers were illiterate, 48.70 percent farmers had primary education, 32.80 percent farmers had completed J.S.C level education, 7.50 percent farmers had completed their secondary level education. In 2019, adult literacy rate for Bangladesh was 74.7 % (WB, 2019). It indicates that the educational status is higher than the national level.

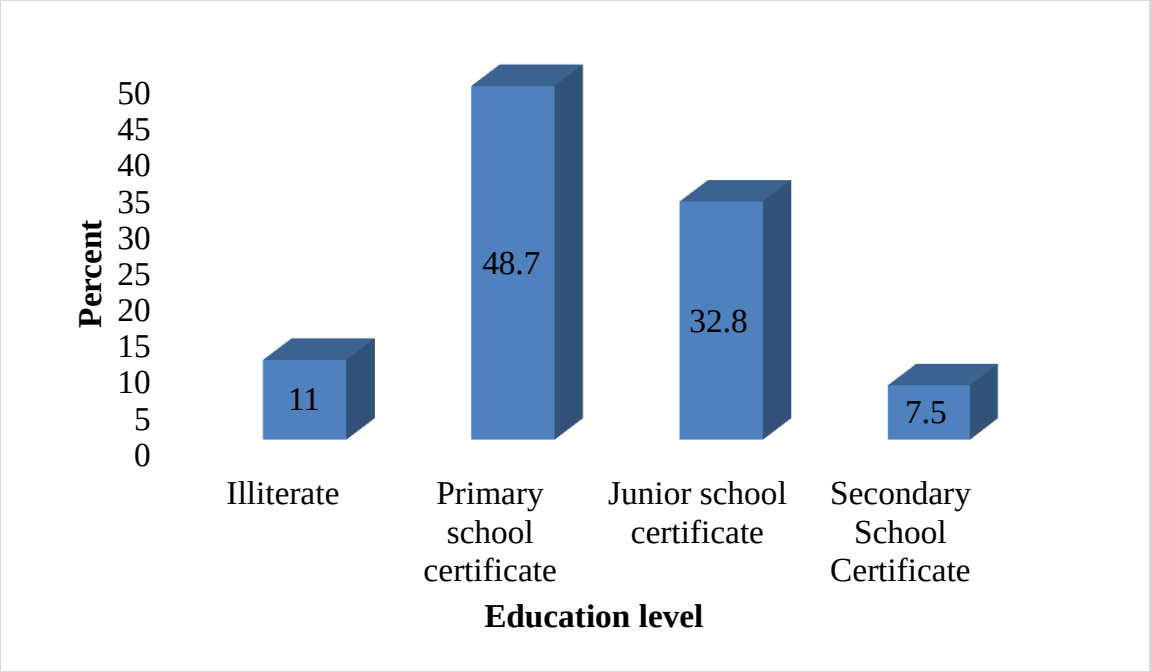

Figure 4.2.2: Education status of the respondents, Source: Field Survey, 2019.

4.2.3. Occupational Status

In the study area, the selected farmers were engaged with various types of occupation along with potato cultivation. It was observed that, as a main source of income, agriculture was the main occupation for potato farmers. Some of them had opportunity to be engaged in other activities. Occupational status of farmers is shown in the following table 4.2.3. It is evident from the figure that 68.25 percent farmers were involved in agriculture and 14.19 percent farmers were involve d in potatoeries. Very few of them were also involved in business. Agriculture provides employment about 41 percent of the labour force according to Quarterly Labour Force Survey 2018-19.

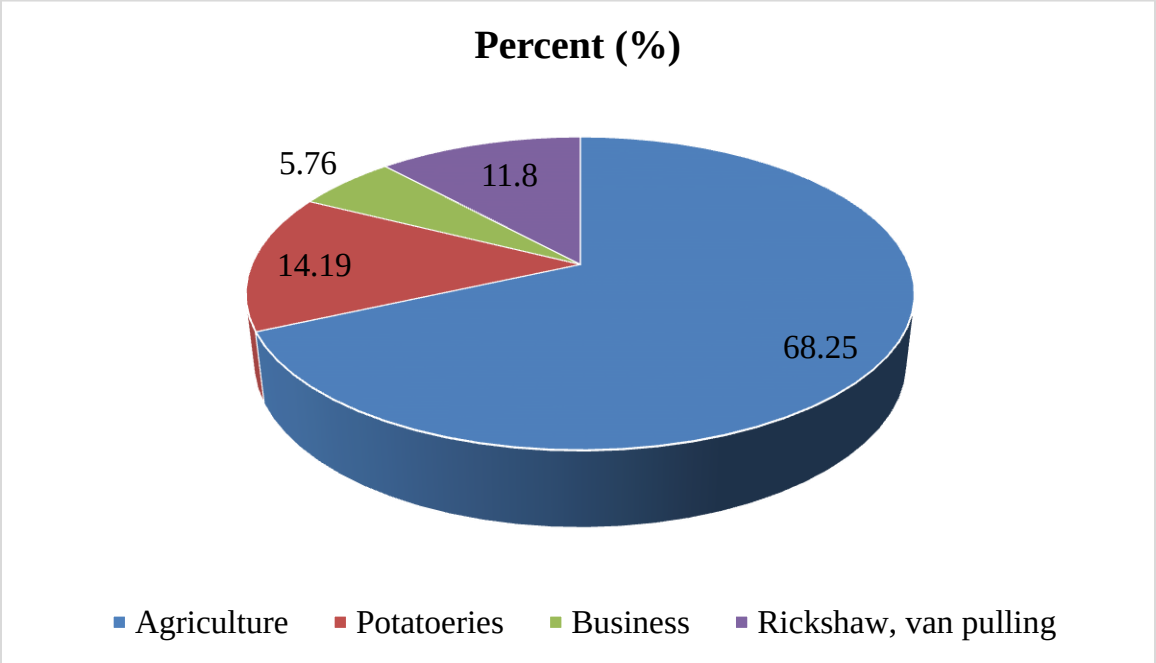

Figure 4.2.3. Occupational status

Source: Field Survey, 2019.

4.2.4. Gender and marital status

Table 4.2.4 depicts that 93.83 percent of farmers were male and 6.17 percent were female. In the study area, 98.33 percent of the farmers were married and 1.67 percent were unmarried.

Table 4.2.4. Gender and marital status

Particulars	**Percent (%)**
Male	93.83
Female	6.17
Married	98.33
Unmarried	1.67

Source: Field Survey, 2019

4.2.5. Farm size and ownership

The study farmers are categorized as: landless farmers (less than 49 decimal), small farmer (50-249 decimal), medium farmer (250-749 decimal) and large farmer (above 750 decimal) (GOB, 2009). The table 4.2 shows that in the sample, 21.46 percent

were landless farmer, 65.19 percent were small farmer, 11.48 percent were medium farmer and only 1.87 percent were large farmer.

Table 4.2.5: Farm size and ownership

Types of farmers	Percentage (%)	No. of respondents
Land less (less than 49 decimal)	21.46	15
Small Farmer (50-249 decimal)	60.19	42
Medium Farmer (250-749 decimal)	11.48	8
Large Farmer (above 750 decimal)	6.87	5

Source: Field Survey, 2019.

4.2.6. Income status

Almost 21.80 percent of the population live in poverty, and 11.30 percent of the population live in extreme poverty (BER, 2018). The $1.90/person/day Purchasing Power Parity (PPP) line is the current definition of extreme poverty (World Bank, 2011). It is evident from the table 4.2.6 that 12.15% farmers are below the extreme poverty line, which indicates that their yearly income below Tk. 56000. Most of the farmer's yearly income belonged to the category of Tk. 57000-150,000. The per capita income of a Bangladeshi is Tk.160060 (BER,2019). Therefore, in the study area about 62% farm households are below per capita income, this result showed the inequality of income among the population.

Table 4.2.6.: Income status

Level of income	**Percent (%)**	**No. of the respondents**
Less then 56000	12.15	8
57000-160,000 Tk.	50.21	35
161,000-250,000 Tk.	28.61	20
Above 261,000 Tk.	9.03	7

Source: Field Survey, 2019.

4.2.7 Access to medical services

The figure 4.3.2 exhibits, in the study area 20 percent farmers had the access of medical service from MBBS doctor, 42.50 percent farmers had the access of medical service from village doctor, 35.83 percent farmers had the access of medical service from homeopathic doctor. A very few farmers received for medical service from quack.

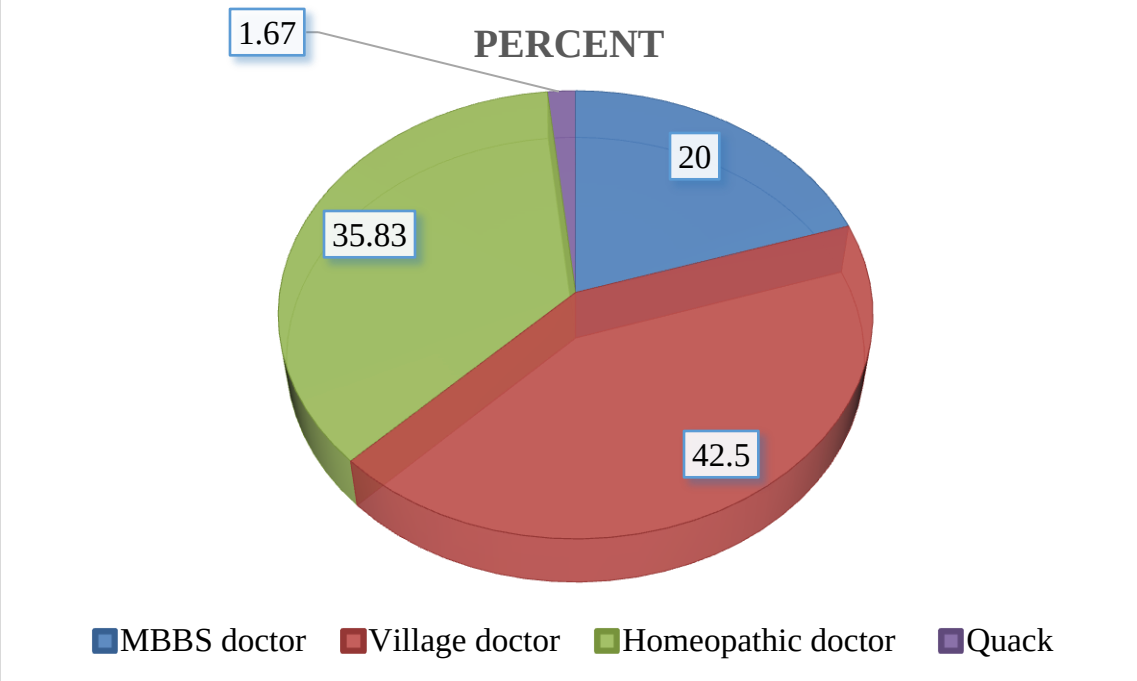

Figure 4.3.2.: Access to medical services

Source: Field Survey, 2019.

4.2.8 Dependency Ratio

In economics, geography and demography the dependency ratio is an age-population ratio of those typically not in the labor force (the dependent part) and those typically in the labor force (the productive part). The real (or effective) dependency ratio looks at the ratio of economically active workers compared to inactive. The effective dependency ratio doesn't just look at the age profile but, whether people are economically active or not. It is used to measure the pressure on productive population. Table 4.2.8 present the depending members per income earner. In this present study the average dependency ratio was found 1.75.

Table 4.2.8: Dependency Ratio

Types of farmers	**Percentage (%)**
Total family members	280
Total dependent members	178
Total earning members	102
Dependency ratio	1.75

Source: Field Survey, 2019.

4.2.9 Sources of Credit Facilities of the Respondent

Available amount of funding is an important factor for any kind of farming. The sources of credit facilities for the potato producing farmers include Banks, NGOs, Relatives and also their own funding. About 19.25 percent farmers were taken loan from Banks, 26.75 percent farmers were taken credit from NGOs and 18.55 percent farmers were taken loan from their relatives as reported by the sample farmers. And 35.50 percent farmers were used their own funding (Table 4.2.9).

Table 4.2.9 Sources of Credit Facilities of the Sample Farmers

Items No.	Percent (%)	No. of respondents
Bank	19.25	14
NGOs	26.7	19
Relatives	18.55	12
Own	35.5	25

4.2.10 Involvement of Women

Women in our country are the most deprived one but at present this situation is changing. About half of the population of our country is women. So without their

development, the total social and economic development of our country is not possible. In the present study, involvements of women in potato farming were categorized into three categories: 1 women involvement, 2 women involvement and 3 women involvement. It is evident from the table 4.2.10 that 19.62 percent farmers used 1women labor in their farm, 10.12 percent farmers used 2 women labor in their farm. So the result implies that involvement of women in potato farming activities were very small. About 69.50 percent farmers did not use women labor in their farm.

Items No.	**Percent (%)**
No women involvement	69.50
One women involvement	19.62
Two women involvement	10.12

4.2.11 Size of Land Holdings of the Sample Farmers

In the present study the size of land holdings of the potato producing farmers are classified into different categories. Size of land holdings includes homestead area, orchard, pond, cultivated land, fellow land, leased in, leased out and mortgage in as reported by the sample farmers. It is evident from the table 4.2.11 that the average area18.27 decimal, 85.12 decimal, 15.31 decimal, 22.10 decimal were homestead area, cultivated land, leased out and leased in area respectively hold by the sample farmers on an average.

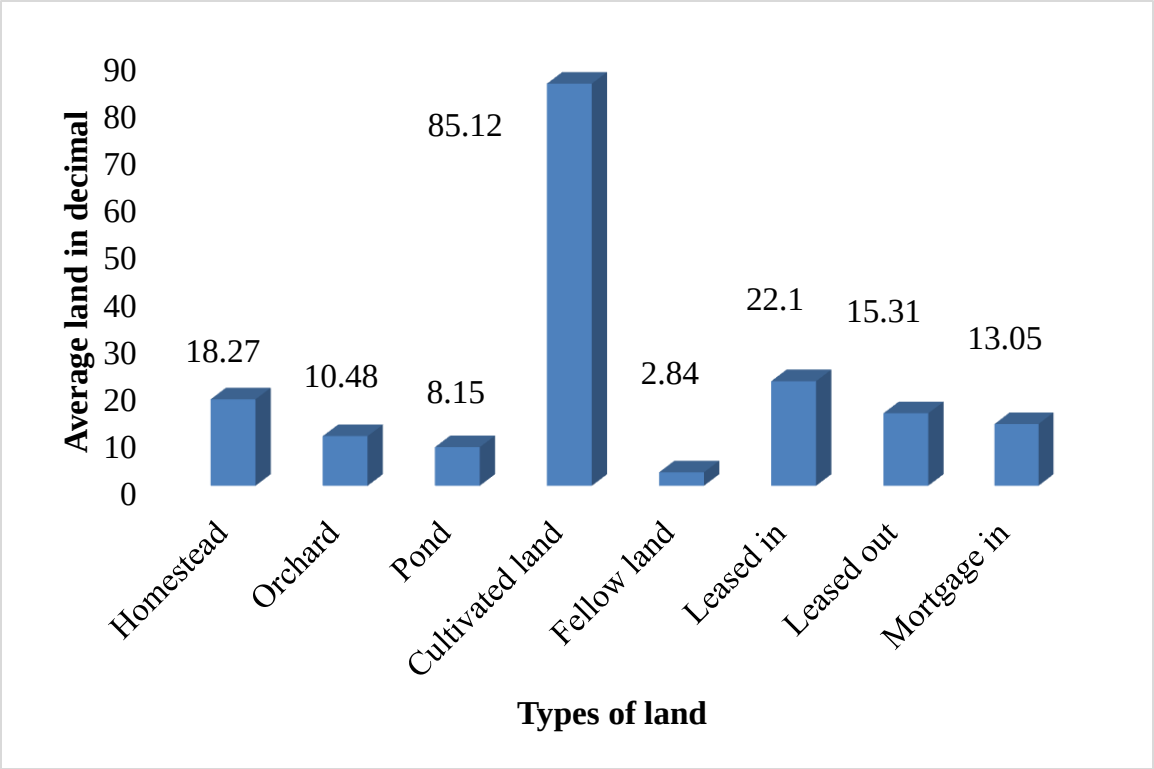

Figure 4.2.11: Size of Land Holdings of the Sample Farmers

Source: Field survey, 2014.

CHAPTER FIVE
COST AND RETURNS OF POTATO FARMERS

5.1 Introduction

The main purpose of this chapter is to assess the costs and returns through potato production. Moreover, an attempt has been made to compare the costs and returns of growing per hectare potato. Hence, costs and returns of potato are estimated in this chapter. For calculating the costs and returns of potato production, the costs items were classified in to two groups: (1) variable cost; and (2) fixed cost. Variable cost included the cost of all variable factors like human labor, tillage, seed, fertilizer, manure and oil cake, irrigation water, and insecticides. On the other hand, fixed cost was calculated for interest on operating capital. On the return side net return and undiscounted benefit cost ratio (BCR) were determined in this chapter.

5.2 Variable cost

5.2. l Cost of human labour

Human labour was considered the most important and largely used input in producing potato. It shared a large portion of total cost of potato production. Human labour is required for various activities and management such as land preparation, weeding, fertilizing, using insecticides and herbicides, harvesting etc. There were two sources of human labour in the study area, one was family supplied labour and another one was hired labour. The valuation of hired labour was done as the nominal cash wages paid to the farmers. It can be seen from Table 5.1 that the amount of human labour used for potato cultivation was 209 man days per hectare. Total cost of human labour amounted to Tk. 95600 per hectare. The valuation of family supplied labour was done as the average wage of the hired labour was taken as the opportunity cost of the family supplied labour. It can be observed that potato growers used on an average 209 man-days/ha total human labour where on an average 55 man-days/ha was family

supplied labour. In the study area on an average wage rate was Tk 400.00 per man-day. So, total cost of family supplied labour for potato amounted to Tk 22000.00 per hectare. Table 5.1 shows that for the operation of weeding and mulching and harvesting carrying most of the human labour were forced to operate the activities. Here the cost of land preparation is Tk. 18800, the cost of operation of weeding and mulching is Tk. 20400. For the operation of harvesting and carrying the cost is also Tk. 30400; this is the highest labour cost. As the potato production is the labour intensive work. It reduces the unemployment problem. Group based potato cultivation in the selected area plays vital role for the reduction of the poverty at Debiganj thana in Panchagarh district. Table 5.1 shows that harvesting and carrying cost is the highest cost item during potato production in Debiganj .

Table 5.1 : Operation wise per hectare human labor cost of potato production

Operation	**Total labour (Man-days)**	**Total cost (TK)**
Land preparation	47	18800
Sowing	20	8000
Weeding and mulching	51	20400
Fertilizer, manureand Insecticide application	15	6000
Irrigation	10	4000
Harvesting and carrying	76	30400
Others	20	8000
Total	209	95600

Source: Field Survey, 2019

5.2. 2 Cost of tillage

For potato production the average per hectare tillage cost was Tk 5400.00. (Table 5.2)

5.2.3 Cost of seeds

The cost of seed is the single most important cost item for potato production. In the study area, it was found that farmers used both home supplied and purchased seeds. The total amount of seed requirement per hectare for producing potato were 1220 kg/ha. The average potatos of seeds were Tk. 45 per kg for potato production. Table 5.3 shows that the total cost of seeds for potato production was Tk. 54900.00. To maintain the higher production high yield verity is required for the production. TPS (true Potato seed) is available in Debiganj thana under Panchagarh district. The production of these seed is very satisfied. So the agricultural extension officer always advice to use these TPS.

Table 5.2 : Variable cost (per hectare)

Items of returns/costs	**Unit**	**Quantity**	**Ppotatoper unit(Tk)**	**Total value (Tk)**
Human (hired) labour	Man-day	154	400	61600
Human (family) labour	Man-day	55	400	22000
Tillage	Tk	3 times	1800	5400
Seeds	Kg	1220	45	54900
Urea	Kg	310	22	6820
TSP	Kg	155	25	3875
MOP	Kg	180	15	2700
Gypsum	Kg	29	8	232
Fertilizer (Total Cost)				14200
Manure	Kg	7200	3	21600
Insecticides	Tk	n.a	-	6500
Irrigation	Tk	n.a	-	8200

Total	Tk	-	-	193827

Source: Field Survey, 2019

5.2.3 Cost of fertilizers

It was found that farmers used different kinds of fertilizer in producing potato. Such as Urea, MOP, TSP and Gypsum. The cost of urea is TK 6820.00 and the others are TK 3875.00, TK 2700.00, TK 232 respectively.

5.2.4 Cost of manure and oilcake

They also used cow dung and oil cake as manure. In this study total manure and oil cake cost is 21600.00 Tk per hectare when per unit manure and oil cake cost is 3.00 Tk (Table 5.2).

5.2.5 Cost of irrigation

Irrigation water is an important input in winter potato cultivation. Per hectare cost of irrigation water was Tk 8200.00 for potato (Table 5.2).

5.2.7 Cost of insecticides

In the study area, farmers applied insecticides to protect from the attack of pests and diseases. Cost of insecticides amounted to Tk 6500 per hectare for potato (Table 5.2).

5.2.8 Total variable cost

Summation of the costs of variable inputs gave the total variable costs which were Tk 193827.00 per hectare for potato production.

5.3 Total Fixed Cost

5.3.1 Interest on operating capital

Interest on operating capital was calculated by taking into account all the operating costs incurred during the production period of potato (Sujan et al. 2017; Rasha et al. 2018) . It is fixed cost because if the finance takes from the bank then farmers must pay the interest of the finance. Per hectare interest on

operating capital was Tk 6460.90 and rental value of one hectare land is Tk. 18000.00 for potato production. So total fixed cost is Tk. 24460.90

Table 5.3: Fixed cost (per hectare)

Items of returns/costs	**Unit**	**Quantity**	**Potato per unit (Tk)**	**Total value (Tk)**
Interest on OC for 4 month	Tk	193827.00	@10%	6460.90
Rental value	Tk	18000.00	1	18000.00
Total	Tk	-	-	24460.90

5.4 Total cost

In order to estimate total cost per hectare all the resources used in potato production has been recapture together. Per hectare total cost of potato production was Tk. 220,287.9(Tables 5.4).

Table 5.4: Total cost (Variable cost + Fixed cost) (per hectare)

Items of returns/costs	**Unit**	**Variable cost**	**Fixed cost**	**Total (Tk)**
Total cost	Tk	193827	24460.90	218,287.9

Source: Field Survey, 2019

5.5 Activity budgets: Per hectare potato production are written bellow: -

Table 5.5: Gross returns

Items of returns/cost	**Unit**	**Quantity**	**Potato per unit(TK)**	**Total value(Tk)**
Main product	Kg	25600.00	11.50	294,400.00
By-product	TK	n.a	-	8000.00

Gross returns	TK	-	-	302,400.00

Source: Field Survey, 2019

The valuation of by-product of potato is very little. Total value of by products is Tk. 8000.00. The quantity of main product is 25600 Kg. If the potato of the potato per unit is 11.50 then it becomes the total value of potato main product is Tk. 294,400. So the gross return of the potato production is= (294,400+ 8000) = 302,400.00.

Table 6.6: Net return **(**Gross return – Total cost**)**

Items of returns/costs	**Unit**	**Quantity**	**Potato per unit (Tk)**	**Total value (Tk)**
Net return	Tk	-	-	84,112.10

Source: Field Survey, 2019

Here

Net return= Gross return – Total cost= 302,400- 218,287.9= 84,112.1

So the net return of potato production is depending on both gross return and total cost of the potato production.Net return is Tk. 84112.10.

5.7 Undiscounted BCR

Benefit cost ratio was calculated by dividing gross return by gross cost or total cost. It implies return per taka invested. It helps to analyze financial efficiency of the farm. It was evident from the study that the benefit cost ratio of potato farming was accounted for 1.34 implying that Tk. 1.34 would be earned by investing Tk. 1.00 for potato production. So, the potato farming was found to be profitable for farmers (Table 5.7).

Table 5.7: Undiscounted BCR

Items of returns/cost	**Gross Return**	**Gross cost**	**Ratio**
Undiscounted BCR	302,400.00	218,287.90	1.38

Source: Field Survey, 2019

CHAPTER SIX
FACTORS AFFECTING OF POTATO PRODUCTION

6.1 Introduction

An attempt has been made this chapter to identify and measure the effects of the major variables on potato production. Cobb-Douglas production function was chosen to estimate the contribution of key variables on the production process of potato farming. The estimated values of the model are presented in Table6.1.

6.2 Functional Analysis for Measuring Production Efficiency

Production function is a relation or a mathematical function specifying the maximum output that can be produced with given inputs for a given level of technology. Keeping in mind the objectives of the study and considering the effect of explanatory variables on output of potato farming, six explanatory variables were chosen to estimate the quantitative effect of inputs on output.

Management factor was not included in the model because specification and measurement of management factor is almost impossible particularly in the present study, where a farm operator is both a labor and manager. Other independent variables like water quality, soil condition, time etc., which might have affected production of farm enterprises, were excluded from the model on the basis of some preliminary estimation. A brief description is presented here about the explanatory variables included in the model.

6.3 Estimated Values of the Production Function Analysis

F-value was used to measure the goodness of fit for different types of inputs.

The coefficient of multiple determinations (R^2) indicates the total variations of output explained by the independent variables included in the model.

Coefficients having sufficient degrees of freedom were tested for significance level at 1 percent, 5 percent and 10 percent levels of significant.

Stage of production was estimated by returns to scale which was the summation of all

the production elasticity of various inputs.

The estimated coefficients and related statistics of the Cobb-Douglas production function for potato production are shown in Table 6.4

Table 6.4 Estimated Values of Coefficients and Related Statistics of Cobb-Douglas Production Function Model for potato.

Explanatory variables	Values of coefficients	Standard error	P-value
Intercept/Constant	8.185***	0.912	0.000
Labor	0.059	0.059	0.322
Seed	0.103**	0.049	0.039
Manure	0.035	0.035	0.313
Fertilizer	0.157	0.086	0.071
Insecticide	0.124***	0.047	0.010
Irrigation	0.034**	0.016	0.039
F-value	26.10***		
R^2	0.685		
Returns to scale	0.513		

Note: *** = Significant at 1% level
**=Significantat 5%level
* = Significant at 10%level
Source: Authors Estimation

6.4 Interpretation of the results

Seed cost (X2). The magnitude of the regression coefficient of human seed cost was 0.103 with a positive sign. It was highly significant at five percent probability level. It implies that one percent increase of seed cost, keeping other factors constant, would lead to an increase in the gross return by 0.103 percent for potato (Table 6.4).

Insecticide cost (X5). The magnitude regression coefficient of insecticide cost was 0.124 for potato. It was positive and was significant at one percent probability level. This indicates that an increase in one percent insecticide cost, remaining other factors constant, would result in an increase in the gross return by 0.124 percent.

Irrigation cost (X6). It can be seen from Table 6.4 that the magnitude of the regression coefficient of irrigation cost was 0.034 for potato. It was positive and was statistically significant at five percent probability level. This indicates that an increase in one percent of irrigation remaining other factors constant, would result in an increase in the gross return by 0.034 percent.

Coefficient of multiple determinations (R^2). It is evident from Table 6.4 that the value of the coefficient of multiple determinations (R^2) was 0.685 for potato. It indicates that about 68 percent of the total of the gross returns are explained by the explanatory variables included in the model.

Goodness of fit (F -value). The F-value was 26.10 for potato, which implies good fit of the model. That is, all the explanatory variables included in the model were important for explaining variation of potato production.

Returns to scale: The summation of all the regression coefficients or production elasticity's of the estimated model gives information about the returns to scale that is in response of output to a proportionate change in all inputs. The sum of all the production coefficients of the equations for potato production was 0.513 (Table 6.4).

6.5 Resource Use Efficiency in Potato Production

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

The ratio of MVP and MFC of labor (0.027) for potato production was positive and less than one, which indicated that in the study area labor was over used (Table 7.5). So, farmers should decrease the use of labor to attain efficiency considerably.

Table 6.5 showed that the ratio of MVP and MFC of seed (0.543) for potato farming was positive and less than one, which indicated that in the study area seed for potato production was over used. So, farmers should decrease the use of seed to attain efficiency level.

The ratio of MVP and MFC of lime was found to be 0.745 for potato farming was positive and less than one, which indicated that in the study area use of manure was over used (Table 6.5). So, farmers should decrease the use of manure for potato production to attain efficiency considerably.

Table 6.5 revealed that the ratios of MVP and MFC of fertilizer used for potato production was positive and more than one (2.029), which indicated that fertilizer application was underutilized. So, farmers should increase the use of fertilizer to attain efficiency in potato production.

It was evident from the table 6.5 that the ratio of MVP and MFC of insecticide (5.673) for potato farming was positive and more than one, which indicated that in the study area use of insecticide for potato farming was under used. So, farmers should increase the use of insecticide to attain efficiency in potato production.

The ratio of MVP and MFC of irrigation (1.220) for potato production was positive and more than one, which indicated that in the study area irrigation was under used (Table 6.5). So, farmers should increase the use of irrigation to attain efficiency considerably.

Table 6.5 Estimated Resource Use Efficiency in Potato Production

Variables	Geometric mean (GM)	Y(GM)/Xi (GM)	Co-efficient	MPV (Xi)	MFC	r=MVP/MFC	Comment
Yield	302,400						
Labor	86300	3.504	0.059	0.207	1	0.207	Over utilized
Seed	57400	5.268	0.103	0.543	1	0.543	Over utilized
Manure	14200	21.296	0.035	0.745	1	0.745	Over utilized
Fertilizer	23400	12.923	0.157	2.029	1	2.029	Under utilized
Insecticide	6610	45.749	0.124	5.673	1	5.673	Under utilized
Irrigation	8430	35.872	0.034	1.220	1	1.220	Under utilized

Source: Field survey, 2019

CHAPTER SEVEN

CONSTRAINTS ASSOCIATED WITH PRODUCTION OF POTATO

7.1 Introduction

In the study area potato farmers faced various problems such as higher price of potato inputs, storage problems, perishability, lack of quality seed, lack of capital, lack of labor, lack of fertilizer, lack of irrigation, potato instability. They are economically not very capable of investing the required amount for producing crops due to low capital base. In this chapter, an attempt has been made to identify constraints faced by potato production.

7.2 Problems Faced Index (PFI)

Items	High	Medium	Low	Index	Rank
Higher price potato of inputs	135	34	8	177	2
Storage problems	126	26	15	167	5
Low Price	162	24	4	190	1
Perishability	117	48	7	172	4
Lack of capital	123	46	6	175	3
Lack of fertilizer	108	42	13	163	6
Lack of quality seed	96	30	23	149	8
Lack of irrigation	63	28	35	126	9
Transportation	66	72	12	150	7

Source: Field survey, 2019

7.2.1 Low market potato of product at harvesting period

It was observed that the potatos of potato in the harvesting period were very low.

Table 7.2 showed that the index point is 190 of low price of potato and which ranks at the 1st position, it indicates that low price of potato is the most important problem in the study area of potato growers. Many of the farmers is compelled to make distress sale in order to meet the urgent needs of cash for their day - to -day's household expenditures that led to increase the supply of their products in the village market at harvesting period and thereby lowering the selling price potato per unit.

7.2.2 Storage Problems

In the study area lack of proper storage facilities was also an important problem regarding selected potato marketing. Total indexing point of storage problem of potato is 167 and ranks 5th. (Table 7.2) Storage of potato is not possible under ordinary condition because these vegetables are perishable. Therefore, due to lack of proper storage facilities the farmers did not get fair price potato.

7.2.4 Lack of capital

Production of selected winter vegetables needs proper doses of fertilizer, irrigation water and insecticides in addition to special agronomic care and therefore potato growers need sufficient money to buy the necessary inputs. In the study area, among the problems it ranks 3th position among the problems, it indicated that they did not have adequate amount of operating capital (Table 7.2). Most of the growers did not get institutional credit and therefore, they had to borrow money from neighbors, relatives, bank and money lenders at exorbitant rate of interest.

7.2.5 Insufficient irrigation

Water was an important input for producing potato. In the study area about lack of irrigation ranks at position 9th among the problems (Table 7.2). The selected potato grower's lack of irrigation facilities was a major constraint for potato production.

7.2.6 Non-availability of quality seeds

LACK of improved seeds was another limiting factor in producing potato and which ranks at position 8th among the problems (Table 7.2). They reported that in local market HYV seeds were not available.

CHAPTER EIGHT
CONCLUSION AND POLICY RECOMMENDATION

8.1 Introduction

This chapter attempts to summarize the major findings of the study. Section 8.2 presents a summary of the major findings of the study. Conclusion, policy recommendations, limitation and scope for the further study are given in Sections 8.3, 8.4, 8.5 and 8.6 respectively.

8.2 Conclusion of the Study

In Bangladesh, potato sub-sector plays an important role for developmentof the economy. Potato production is generally labour intensive crops thus offer a considerable promise for increased rural employment opportunities. Climate and soil of Bangladesh is very much suitable for growing potato.

The area selected for the study covered at four villages namely Debiganj upazila sadar, Sonaher, Vowlaganj, Kaliganjof Panchagarh District. In all 70 samples were selected through a procedure. Simple statistical techniques as well as Cobb- Douglas production function were used to process and analyze the data to achieve the objectives of the study.

From the econometric model Cobb- Douglas production function we saw that Insecticide, seed, and irrigation were statistically significant. These three variable have strong effct on production of potato in the study area.

In the study area use of fertilizer, insecticide and irrigation for potato farming was under used as well as seed and labor were over used.

In analyzing socioeconomic characteristics, age structure, composition of family size, educational status, occupation, Farm size, dependency ratio, and land ownership pattern were considered. The study revealed that out of the total sample farmers 67 percent belonged to the age group of 31-50 years, 48.70 percent farmers had primary education, 68.25 percent farmers were involved in agriculture, 93.83 percent of farmers were male, 21.46 percent were landless farmer, 65.19 percent were small

farmer, 1.87 percent were large farmer, 59.73 percent of the potato farmers were earned Tk. 150,000 to 250,000 per year, the average area 18.27 decimal, 85.12 decimal, 15.31 decimal, 22.10 decimal were homestead area, cultivated land, leased out and leased in area respectively hold by the sample farmers on an average.

The amount of human labour used for potato cultivation was 209 man days per hectare. Total cost of human labour amounted to Tk. 93600 per hectare. The valuation of family supplied labour was done as the average wage of the hired labour was taken as the opportunity cost of the family supplied labour. It can be observed that potato growers used on an average 209 man-days/ha total human labour where on an average 55 man-days/ha was family supplied labour. In the study area on an average wage rate was Tk 400.00 per man-day. So, total cost of family supplied labour for potato amounted to Tk 22000.00 per hectare. Table 6.1 shows that for the operation of weeding and mulching and harvesting carrying most of the human labour were forced to operate the activities. Here the cost of land preparation is Tk. 18800, the cost of operation of weeding and mulching is Tk. 20400. For the operation of harvesting and carrying the cost is also Tk. 30400; this is the highest labour cost. For potato production the average per hectare tillage cost was Tk 5400.00. The total amount of seed requirement per hectare for producing potato were 1220 kg/ha. The average price potatos of seeds were Tk. 45 per kg for potato production. The total cost of seeds for potato production was Tk. 54900.00. Summation of the costs of variable inputs gave the total variable costs which were Tk 193827.00 per hectare for potato production.

Per hectare interest on operating capital was Tk 1938.27 for potato production. So, the gross return of the potato production is 279400.00. Net return Tk. 83634.73ofpotato production is depending on both gross return and total cost of the potato production. It was evident from the study that the cost benefit ratio of potato farming was accounted for 1.42. In the study area various problems which were faced by farmers were identified. These common problems were categorized in to four major groups such as, economics, technical, marketing and social problems. Economic problems and constraints were lack of capital, high ppotato of fertilizers and insecticides. Technical

constraints were lack of scientific knowledge and method, insufficient irrigation, scarcity of good quality seeds, attack by pest and disease. Marketing problems were lack of adequate transport facilities, lack of storage facilities, lack of marketing facilities, and lack of market information. Social problems were loss of production due to theft, wastage and damage by wild or domestic animals. In order to increase the production of potato, these problems should be solved as far aspossible. At last we can say the the study area is very potential area for potato cultivation.

8.3 Recommendation

Based on the findings of the study the following recommendations were concluded to improve the present production and marketing system.

- ✓ Farmers reported that they feel the lack of quality of seed and the high price of agricultural inputs. In this situation the government organization like BADC can regulate this system and they can provide good quality of seed where it is also a responsibility to monitor the seed company.
- ✓ In the study area we found that labour are over utilized. Labour are the important facor of production so it should be used efficiently otherwise it causes the economic loss. On the other hand fertilizer, insecticide and irrigation are under ulilized it indicates that the use of these factors are not used properly. So the Department of Agricultural Extension can make the awarenesss the farmers regarding this through farmers meeting.

- ✓ Low price of potato in harvesting period is also a common phenomenon of our country. Farmers did not get fair price and every year they become looser. To ensure the fair price government should be more attentive to farmers and they must active agricultural price related institution like department of marketing (DAM), this institution can monitor the price system of agricultural products.

- ✓ Most of the farmers of our country have not enough finance to continue his jobs. So, government should provide institutional credit on easy terms as a measure for solution of problem of capital shortage. There are mainly banks and other types of financial institutional such as credit unions, savings and credit cooperatives and various types of microfinance organizations.

- ✓ For storage problem farmers have pay a lot of financial damage. Modern storage facilities (such as cold storage) should be developed considering the economic feasibility, cold storage may establish at important assemble center.

- ✓ Transportation facilities should be improved in the rural areas. On the basis of priority village roads should be developed at least brick bedded road should be made so that the rickshaw, van, truck and other vehicles could move easily. It would also help reducing the transportation cost.

- ✓ In the developed country we see the farmers organization but in our country it is very rare in visible. Farmer's organization should be established which might improve the bargaining power of the farmers, enabling them to face the intermediaries and ensuring better return for their produce.

8.4 Limitation of the study

The present study suffers from a number of limitations. The limitations of the study areas follows: Inadequate fund and time availability for the study was an important limitation. Due to a shortage of funds and time, the study could not cover wide areas for collection of the necessary information from the farmers; only 50 farmers were selected for the purpose of the study. The researcher had to depend on the memory of the farmers for collecting necessary information because many of them did not keep any written record or kept record partially. Despite a few limitations, the findings of the present study may provide some valuable information for the farmers, extension workers and researchers.

8.5 Scope of further research

Although the present study provides some useful information for researchers, policy makers as well as farmers, it is not free from criticisms. The weaknesses of the present study, of course, open up scopes for further research which are outlined below: It could be mentioned here that the future researchers could take up a broad - based study with large samples; A further study can be undertaken by taking into account different farm sizes to assess the impacts on income generation through other horticultural crops cultivation.

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