PROFITABILITY AND TECHNICAL EFFICIENCY OF CHILI PRODUCTION IN SELECTED AREAS OF BANGLADESH

Suvro Basak

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

JUNE, 2018

PROFITABILITY AND TECHNICAL EFFICIENCY OF CHILI PRODUCTION IN SELECTED AREAS OF BANGLADESH

BY

Suvro Basak

REGISTRATION NO. : 11-04633

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: JANUARY- JUNE, 2018

Approved by:

Prof. Dr. Jahangir Alam Khan **Vice-Chancellor** **University of Global Village** **Barisal, Bangladesh** **Supervisor**	**Dr. Md. Sadique Rahman** **Associate Professor and** **Chairman** **Department of Management & Finance** **Sher-e-Bangla Agricultural University** **Dhaka-1207** **Co-supervisor**

Professor Gazi M. A. Jalil
Chairman
Examination Committee
Department of Agricultural Economics
Sher-e-Bangla A gricultural University

Department of Agricultural Economics
Sher-Bangla Agricultural University
Sher-e-Bangla Nagar, Dhaka-1207, Bangladesh.
Website: www.sau.edu.bd

CERTIFICATE

This is to certify that thesis entitled, ***"PROFITABILITY AND TECHNICAL EFICIENCY OF CHILI PRODUCTION IN SELECTED AREAS OF BANGLADESH"*** *submitted to the Faculty of Agribusiness Management, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of* ***MASTER OF SCIENCE IN AGRICULTURAL ECONOMICS,*** *embodies the result of a piece of bona fide research work carried out by* ***SUVRO BASAK****, Registration No.* ***11-04633*** *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.

Dated: 30 May, 2018
Place: Dhaka, Bangladesh

Professor Dr. Jahangir Alam Khan
Vice-Chancellor
University of Global Village
Barisal, Bangladesh

Supervisor


DEDICATED
TO
MY BELOVED PARENTS

ABSTRACT

The present study was designed to measure the profitability and technical efficiency of chili farmers in selected Shibgong, Shonatola, Sariakandi upzillas in Bogura district. Primary data were collected from randomly selected 100 farmers during December month. Both tabular and functional analyses were applied in this study. The major findings of the study reveal that chili production is profitable. Total cost of production was Tk. 399973 per hectare. Gross returns was Tk. 707546 per hectare and net returns was Tk. 307573 per hectare. Benefit Cost Ratio (BCR) was found to be 1.77 which implies that one taka investment in chili production generated Tk. 1.77. The Cobb-Douglas stochastic frontier production function was used for this study to measure technical efficiency of chili farmers. The coefficients of parameters like human labor, fertilizers and insecticides were positive where human labor and fertilizers are not significant but insecticides is significant and indicated positive effect on chili production. Others, Seed and irrigation were negative and significant indicated that negative effect on chili production. 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 chili farmers. The study also identified some problems like insect- pest and diseases, use of fertilizer & pesticide, Scarcity of High yielding seed variety mainly faced by the chili farmers and suggested some recommendations to improve the present production situation so that per hectare yield of chili would possibly be increased.

ACKNOWLEDGEMENT

I start in the name of God-who has bestowed upon me all the physical and mental attributes that I possess and skill to cut through and heal a fellow human. I take the golden opportunity to express my heartfelt, humble and deepest sense of gratitude to those who helped me to complete my research. These words are small acknowledgement but never fully recompensed for their great help and co- operation.

It is my privilege to study and conduct my research under **Professor Dr. Jahangir Alam Khan**, Vice-Chancellor, University of Global Village, Barisal, Bangladesh, who provided me the research insight, illuminating and meticulous guidance, calm endurance, continuous and unfailing encouragement, scholarly suggestions, unique supervision, constructive criticisms, sympathetic attitude, plausible appreciation and sustained support during the entire course of investigation and preparation of manuscript. I am highly indebted to him for his invaluable painstaking efforts made towards my study while devoting his precious time. I owe a profound debt to him for providing me his intellectual resources, reading materials and other all necessary facilities during my study period. His scientific approach and generosity without any reservation have my privileges to work under his supervision, knowledge and enthusiastic interest, which he provided me throughout my post-graduation and research investigation despite his busy schedule of work.

I emphatically and gratefully acknowledge my co-supervisor **Dr. Md. Sadique Rahman**, Associate Professor and Chairman, Department of Management and Finance, Sher-e-Bangla Agricultural University. He inspired me to undertake such a study and assisted me to build the foundation of this research. He provided creative suggestions, proper guidelines, helpful comments and cordial co-operation throughout the period of this research program.

I would 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 would like to express my gratitude to 100 farmers who actively participated in this survey and most importantly helped me to understand their initiatives and activities related to chili farming in general. 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 Asma Yeasmin Sampa, Lecturer, Department of Agricultural Economics, Sher-e-Bangla Agricultural University, Dhaka and Md. Hydar Khan Sujon, Lecturer, Department of Development and poverty studies, Sher-e-Bangla Agricultural University, Dhaka, who were always with me. I also want to express special thanks to Rebeka Sultana Supti for her help during data collection.

Last but not the least; I would like to convey my cordial thanks to all the teachers and well-wishers from my schooling days onwards who have directly or indirectly helped me to reach up to this level in my life.

How can I express my thanks to "God" because there is no any word to express it? So, dear lord, please realize and accept my feelings.

May, 2019
Suvro Basak

CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABBREVIATIONS AND ACRONYMS

BARI	: Bangladesh Agricultural 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	: Hectare
HIES	: Household Income and Expenditure Survey
HYV	: High Yielding Variety
IOC	: Interest on Operating Capital
kg	: Kilogram
MoP	: Muriate of Potash
mt	: Metric Ton
NGO	: Non-Government Organization
SRC	: Spices Research Center
t	: Ton
TC	: Total Cost
TFC	: Total Fixed Cost
Tk.	: Taka
TSP	: Triple Super Phosphate
TVC	: Total Variable Cost
US	: United States
USDA	: United States Department of Agriculture
$	: Dollar

CHAPTER-1

INTRODUCTION

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

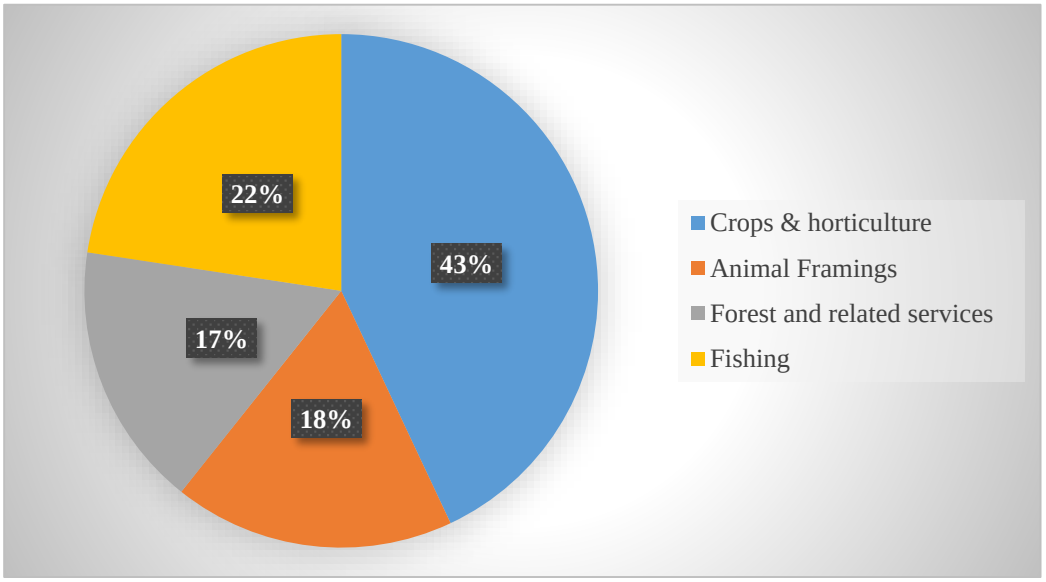

Figure 1.1: Sub-Sectorial Share of Broader Agricultural GDP in 2017-18
Source: BER, 2018

Bangladesh by birth possesses very fertile land in which diversified crops grow vereasily. Various types of crops are produced in this country. Chili is a valuable spice and also one of the most important cash crops grown in Bangladesh. It is available and used in the form of green, dried and powdered. It has become an essential ingredient in Bangladeshi meals. Most of our households always keep a stack of fresh hot green chilies at hand, and use them to flavor most curries and dry dishes. It is typically lightly fried with oil in the initial stages of preparation of the dish.

It has diversified uses. The peoples of Bangladesh are usually using chilies in all curry preparation like meat, fish, vegetables, pulses etc. for its typical color, taste and flavor. Red chilies contain large amounts of vitamin-C and small amounts of carotene (provitamin-A). Green chilies (unripe fruit) contain a considerably lower amount of both substances. In addition, peppers are a good source of most vitamin-B and vitamin-B6 in particular. They are very high in potassium, magnesium and iron. Part of the capsicum family, chilies come in scores of varieties and colors (from green through to yellow, orange and red) and are one of the most popular spices in the world. The level of heat of chili varies from type to type, from sweet and mellow to blisteringly hot as a general rule, the smaller the chili, the hotter the taste. But it's not all about heat -each type has its own distinct flavor.

Chili is the most essential and important spices crops in Bangladesh. The production of chili largely depends on the use of fertilizers, irrigation, pesticide etc. The Government of Bangladesh has, therefore, provided priority to the agriculture sector to increase the production of chili by giving subsidy to the farmers on different inputs such as seeds, fertilizer, irrigation etc. to achieve self-sufficiency in chili production.

Poverty cannot be reduced to a desired level excepting increasing productivity of agriculture sector and at the same time it is to be assured that farmers get fair price of the crops. Natural calamities like draught, flood, cyclone, tornado etc. are a very regular phenomenon which hinders the production of agriculture to a great extent. Cultivable land is being decreased due to the pressure of massive population. As a result, food security is being threatened and the risk of poor people is being increased.

Bangladesh government is remarkably concerned about this agriculture sector. Notable portion of annual budget has consistently been allocated for the last couple of years for the development of the sector. Government has also been launching many programmes one after another in order to boost up the agriculture production

1.1 Present Status of Spices in Bangladesh

Flavoring food and making it tasty by adding different plant parts during cooking or making paste or salad is a very common practice everywhere. Spices are the symbol for aristocracy, health, tonic, immunity, vigor and stimuli. The people of Bangladesh cannot think a meal without use of spice. Most of the spices are high value crops. Net returns of major spices are also profitable. It can contribute a vital role to increase the farmers' income, generate employment, alleviate poverty, ensure food security, empower women and increase social development of Bangladesh. Underneath the taste and flavor the spices possess immense nutritional and medicinal value which is proved by the today's scientists. Since ancient times, spices have also been used in traditional treatment of a number of diseases. The widely used spices are onion, garlic, ginger, turmeric, chili, pepper, cinnamon, cardamom, clove, coriander, cumin, mints, fenugreeks, fennel and tamarind etc. Besides these, there are many more spices being used by the people of different localities.

Spices are the plant parts may be the whole plant, bark, stem, leaf, root, rhizome, flower, fruit, and seed. Spices contain alkaloids, flavor-proteins, carotenoids, oleoresins, steroids, and oils etc., which are the sources of flavor, color and stimuli. Oils extract from some types of spices are used as ingredients of cosmetics and scented items of goods. For instance, onion, garlic, ginger, pepper and mustard have demonstrated antimicrobial activity against several types of bacteria. In injured stomach, cumin and coriander increase gastric secretion, and red pepper has an inhibitory effect. In FY 2015-16, total area under spices was 3.25 lakh hectares with the total production of about 17.55 lakh metric tons in our country (BBS, 2017).

Spices covers almost 2.16 percent of total cropped area in Bangladesh (BBS, 2017). Now-a-days, spices are valuable trade commodities in the world. They are expensive but widely used, the gap between demand and supply is also increasing. Although a proper statistics of production and consumption is not available but it is true that a good quantity of spices is being imported every year to meet the huge demand of people of the country at the cost of valuable foreign currency. Import payments of spices during the period from 2000-01 to 2015- 16 is shown in Figure 1.2. Due to increasing population, demand for cereal food increased significantly. To mitigate this demand, the land of spices crop is being diverted to cereal food crop cultivation. Spices become agenda for politics by creating crisis in the market during the festivals like Ramadan, Eid, Puja and Christmas etc. Due to decreasing production and increasing demand for spices a big gap was observed between production and demand. To lessen the pressure on the foreign currency, the spices production needs to be increased to meet up the country's demand.

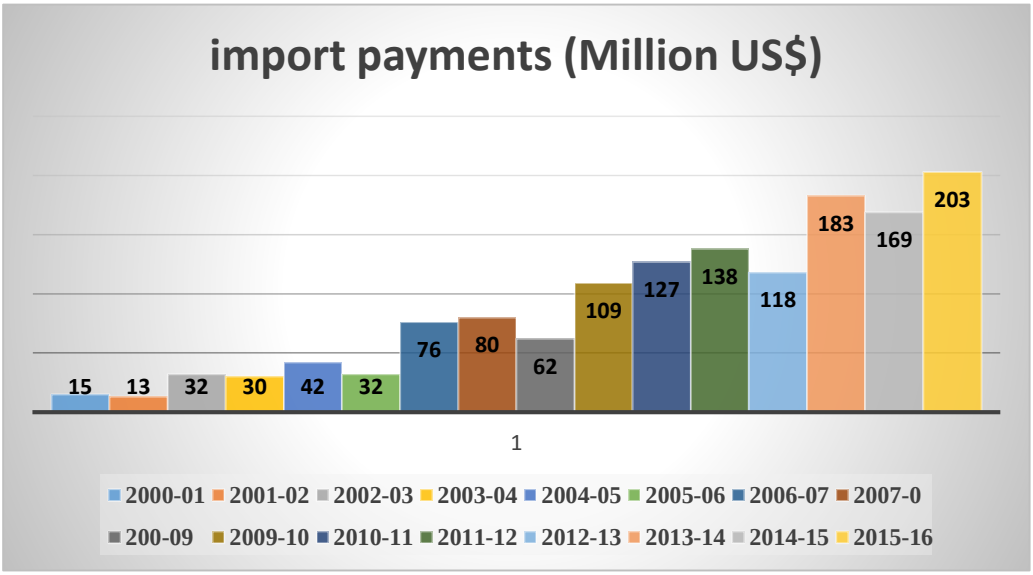

Figure 1.2: Import Payments of Spices,

Source: Bangladesh Bank, 2017

Table 1.1 Area and Production of Spices and Condiments in Different Years, (2000-01 to 2014-15)

Year	Area ('000' hectares)	Production ('000'metric tons)
2000-01	253	394
2001-02	252	418
2002-03	254	425
2003-04	270	609
2004-05	302	1000
2005-06	321	1182
2006-07	348	1405
2007-08	298	1369
2008-09	275	1213
2009-10	286	1350
2010-11	313	1617
2011-12	325	1755
2012-13	336	1796
2013-14	345	1805
2014-15	358	1814

Source: BBS, 2017

1.2 Production of Chili

The chili is a plant of tropical and sub-tropical region. It grows well in warm and humid climate. Deep, loamy, fertile soils rich in organic matter are preferred by the crop for satisfactory growth. Also need well drained soils with adequate soil moisture for the growth of the crop. Chili grows well in the dry and the intermediate part of the country. Chili plants should be in a position that receives a good amount of light. Chilies should not be in a position where the night temperature falls below 12°C. Growth will be inhibited if temperatures fall below 15°C.

Chili plant is a type of seasonal crop which only live for one season then die. If cultivated, this plant can grow and produce for several months after planting after which it will die.

Chilies plants should be watered regularly. Overwatering on a regular basis will cause the roots to rot. When flowers developing on the plants, leave them on and they will die after a few weeks and chilies will form. Once the plants are producing fruits, required amount of organic liquid fertilizer should be applied for few weeks which are necessary for the plants fruiting.

Chili are harvested when the chili are either green or red. Red chili are hotter than green chilies. If anyone wants to harvest green chili peppers, allow them to grow as large as possible. Harvesting of chilies should be done when they start to turn red. Clip the peppers from the plant by cutting the stems where they connect to the main branch. The chilies farmers of Bangladesh cultivate local cultivars which produce very low yields. The main reasons of low yield are lacking of high yielding varieties and limited availability of irrigation facilities. Though the area and production have been raised but per unit yield of Chili is very low. In Bangladesh, chilies are grown in all the districts but plenty of chilies are produced in the district of Bogura, Rangpur, Kurigram, Jamalpur, Natore and Jessore.

Farmers of Bangladesh are growing chilies following indigenous methods with the poor yield rate. The reasons behind such low yield are to lack of high yielding variety and traditional method of production practices followed by the local growers. The yield of chili can be increased by adopting improved production technology like proper plant spacing. Although chili is a major spice crop of Bangladesh, but its production technologies has not been standardized from the scientific and economic point of view. Therefore, research is needed to bring improvement in production technologies as well as economic return. If nature favors, farmers get moderately good harvest.

1.3 Crop situation in the world

In the world, area and production of chili is around 19.89 million hectares and 33.52 million tonnes respectively. Major chili growing countries are India, Myanmar, Bangladesh, Pakistan, Thailand, Vietnam, Romania, China, Nigeria and Mexico etc. The bulk share of chili production is with Asian countries. The largest producer of chilies in the world is India accounting for 13 million tonnes of production annually followed by China with a production of around 3 million tonnes. Out of the total (33.52 million tonnes) world chili production, 38.78 percent is contributed by India followed by China (8.65 percent). India also leads in the context of maximum area covered under chili cultivation. The world trade in chili account for 16 percent of the total spice trade in the world occupying second position after black pepper. The area, production and productivity of chili in major chili producing countries in the world are given in Table 1.2.

Table 1.2: Area, production and productivity of major chili producing countries

S. No.	COUNTRY	AREA ('000ha)	PRODUCTION ('000tons)	PRODUCTIVITY (tons/ha)
1.	India	794.00 (39.91)	1299.94 (38.78)	1.64
2.	Myanmar	132.00 (6.63)	128.00 (3.82)	0.97
3.	Bangladesh	99.00 (4.98)	172.00 (5.13)	1.74
4.	Pakistan	65.00 (3.27)	150.00 (4.47)	2.31
5.	Thailand	65.00 (3.27)	145.00 (4.33)	2.23
6.	Vietnam	64.00 (3.22)	93.00 (2.77)	1.45
7.	Romania	56.00 (2.81)	48.5 (1.45)	0.87
8.	China	43.00 (2.16)	290.00 (8.65)	6.74
9.	Nigeria	36.00 (1.81)	62.00 (1.85)	1.72
10.	Mexico	32.5 (1.63)	60.00 (1.79)	1.85
11.	Others countries	603.16 (30.31)	903.72 (26.96)	1.50
12.	**World**	**1989.66 (100.00)**	**3352.16 (100.00)**	**1.68**

Note – figures in the parenthesis indicate percentages contribution to total area, production and productivity of chili in the world.

Source: http://faostat.fao.org/site/567/DesktopDefault.aspx?PageID=567

1.4 Area, production and productivity of chili in Bangladesh:

The area under chili production is 252 thousand acres and the production is 130 thousand tons and the average yield is 1.32 ton/ha (BBS 2016).The area of cultivable land for chili production is decreasing day by day whereas the demand for chili is increasing. Unfortunately, the production cannot meet the demand. For meeting the demand of our country, we import large amount of chili each year. The main reason behind low yield is that we have no sufficient land for chili production. Another reason is the uses of low yielding variety that cannot produce good yield. We observe that the production of chili maintains the trend in area of cultivation each year except from 2010-11 to 2011-12 where production dropped despite same area of cultivation.

1.5 Economic importance of the crop:

The vegetable production has vital importance as it provides three to four times more calories of energy and cash incomes per hectare of land as compared to cereals. Vegetable crops hold a great promise for fostering economic growth and improving the diet of the people. Vegetable cultivation gives much higher returners per unit of land, labour and capital investment as compared to cereals crops. Chili crop is grown all over Bangladesh not only for a huge home market but also for export purposes. It has become indispensable in every Bangladeshi home. Chili is valued for its diverse commercial uses. Demand is increasing for value added products using chilies such as chili paste, curry powders and sauces for the convenience of food industry. It occupies an important place in Bangladesh economy.

1.6 Justification of the study:

The economic growth of an agro-based country like Bangladesh mainly depends on the development of agriculture sector. The agro-climatic conditions of Bangladesh are suitable for the cultivation of a wide variety of crops but 80 percent of the gross cropped areas are at present confined to the production of cereal crops mainly rice. Due to increasing population, demand for cereal food increased significantly.

In 1950s spices were exported outside the country. But their production and per capita availability had been decreasing since 1980s. To mitigate demand, the land of spices is being diverted to cereal food crop cultivation. Bangladesh is endowed with a favorable climate and soil for the production of spices. Chili is an important spice crop of Bangladesh widely grown in winter. Recently, Spices Research Centre (SRC, BARI, Bogura) has released two new varieties of chilies, which are grown in summer season. They hoped that chili production in the region would continue to increase due to the new impetus being given to the sector by various organizations and the crop is being cultivated twice a year during the summer and winter seasons in place of only once during the winter in the past.

Prior to giving emphasis on the production of chili, it requires relevant and adequate information on different aspects of production at the farm level. Such knowledge of production is also necessary to make appropriate decision by the growers especially when several alternatives are open to them. However, little systematic economic investigations on chili production have been undertaken by the government or private organizations in order to satisfy the demand of extension worker, policy makers, research personnel and the farmer. There are several factors like institutional, economic, physical and natural calamities that can limit agricultural production.

Production of chili can be increased by increasing the technical efficiency of chili using existing technology. It is generally assumed that farmers are inefficient at producing chili crop and there are significant inefficiency differences among farm groups. Agriculture production policy in Bangladesh is concerned by lack of information about the relative profitability of different agricultural production.

In the past so far the author's knowledge is concerned, there was no study on the technical efficiency or inefficiency as well as factors affecting the level of technical efficiency or inefficiency of chili producers. For this reason, the present study makes an attempt to analyze the profitability of chili production and to estimate the technical efficiencyof chili producing farmers which depends on the different socio-economic variables like farm size, age, education, experience and training of the farmers.

The study may be informative in this field and may serve as a foundation for further research. Finally, it is expected that the findings of the study will be helpful for the individual farmers for increasing the productive efficiency by effective operation and management of their farms through pointing drawbacks and policy makers and extension workers to frame out a useful policy.

The present study is an attempt to examine the various aspects of production of Robi chilies in Bogura district with the following objectives

1. To access the socio economic characteristics of the chili growers in study area.
2. To determine the profitability of chili production.
3. To analyze technical efficiency of chili growers.
4. To draw conclusions and formulate some recommendations for necessary interventions with a view to increasing production of chili.

1.7 Setup of the study:

This thesis has been divided into eight chapters including the present chapter which consists of introduction and objectives of the study. A review of literature of work done in the past is given in Chapter- II, Chapter-III deals with material and methods, Chapter-IV has Socio-Demography Chapter-V consists Profitability Chapter-VI is Technical Efficiency, Chapter-VII deals with Problems and Chapter- VIII includes summary, conclusion and recommendations for future research work.

CHAPTER-2

REVIEW OF LITERATURE

In this chapter, an attempt has been made to review of pertinent literature keeping in view the problem entitled, "**Profitability and technical efficiency of Chili production in some selected areas of Bogura District in Bangladesh."**

Daundkar & Bairagi (2015) explored the economics of capsicum in India. Total cost was Rs. 125,260 with net returns (Rs. 273,388) and input-output ratio (3.11). Velayutham & Damodaran (2015) demonstrated the economic performance of chili production in India. Regression coefficients of Cobb-Douglas model were positive for labour man-days (0.406), manure (0.0778), fertilizer (0.368) and chemicals (0.251).

Haile (2015) explained the determinants of technical, allocative and economic efficiencies among small scale onion growers in the irrigation agriculture of Ethiopia. He found that land related factors described much of technical efficiencies and the socio-economic characteristics of the farmers (age, market access, training access, experience, farm income, responsibility and field visit) significantly and positively effect on both the technical and productive efficiencies. Age of households, plot distance, fertility, source of irrigation water, experience of the farmers, farm income and land fragmentation, and extension visit were treated as the major determinants of economic efficiency.

Umar and Abdulkadir (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. Tomato output was highly variable, ranging from 260 kg to a maximum of 17940.0 kg per household. Average fertilizer use was 69.5 kg ha -1. The empirical results show that from the estimates of the Cobb-Douglas production function model, the estimated elasticity's of mean tomato output with respect to land, labour, fertilizer, pesticide and seed at mean input values, are 0.130, -0.052 , 0.124, -0.001 and - 0.376, respectively, at the mean input value.

Asodiya *el al.* (2014) conducted a study to measure input use, cost structure, return and resource use efficiency in wheat production of South Gujarat division of Gujarat, India. A sample of 240 wheat farmers was selected from study area which input-output data collected based on *rabi* cropping season with a view to examine the input use, cost structure and returns in production and marketing of wheat and the resource use efficiency of wheat growers in year 2013-14. The studies used the log linear type Cobb-Douglas production function. The results of study revealed that the average total cost of cultivation of wheat was ` 45784.31. It was the highest on large farms followed by 45720.79 on medium farms, and 39016.69 on small farms. The average net profit per hectare over (Cost-C2) was ` 20017.55 and it increased with the increase in size of farms. The overall input-output ratio was 1:1.44 on the basis of total cost of cultivation. It was the highest (1: 1.48) on large farms, followed by medium farms (1:1.43), and small farms (1:1.35).The elasticity of production (Ep) of all the variables summed up to 0.66 meaning decreasing return to scale, implying that, if these resources are increased by 1%, the output would increases by less than 1%.

Hiremath and Nagaraja (2014) studied Problems of onion production and their solution at farming situation. Front line demonstrations on onion was conducted at different locations in Haveri district. These demonstrations focused on increased productivity of onion per unit area and get the feedback from farmers on the performances of onion variety. From the study it revealed that over the year's variety Arka kalyan performed superior over local check. The gross returns, net returns and B: C ratio (1:3.43) recorded highest in Arka kalyan compared to local. Arka kalian Variety potential yield (t/ha) 45.00, demonstration yield 20.90 (t/ha), technology gap (t/ha) 24.10, technology Index53.56 ,adoption Score by Respondent (Ai) 04, Possible maximum Score (Pi) 07, adoption index (%)57.1. variety Arka kalyan have shown increased yield over local variety.

Janailin *et al.* (2014) conducted a study on cultivation of turmeric in Meghalaya that provides supplementary income to the farmers. The average yield of fresh turmeric in the study area was 49q/ha which on drying gives an approximate yield of about 14.5q/ha of semi-processed (dried) turmeric. The share of variable cost was about 98 % of the total cost.

The total costs of cultivation (cost C2) for turmeric was estimated at `77,012/ha whereas the net income was worked out to be `6,475/ha for fresh turmeric and `28,109/ha for dried turmeric. About `12,719/ha of additional expenditure is incurred on post-harvest management of turmeric. It is observed that a higher net income is obtained when the farmers disposed off the product after drying which also gives the farmers the capacity to hold/store their product to avoid distress sale. The cost of production of turmeric is `15.68/kg, `60.93/kg and `/70.17/kg for fresh, semi-processed and processed (powdered) form, respectively. Lack of knowledge about pest management is the major constraint faced by farmers in production whereas the fluctuation indisposal price of turmeric ranks first among the marketing constraints faced by farmers.

Janailin *et al.* (2014) found that the cost of production of turmeric is `15.68/kg, `60.93/kg and `/70.17/kg for fresh, semiprocessed and processed (powdered) form, respectively. Lack of knowledge about pest management is the major constraint faced by farmers in production whereas the fluctuation in disposal price of turmeric ranks first among the marketing constraints faced by farmers. Cultivation of turmeric in Meghalaya provides supplementary income to the farmers. The average yield of fresh turmeric in the study area is 49q/ha which on drying gives an approximate yield of about 14.5q/ha of semi-processed (dried) turmeric.

Joshi *et al.* (2014) conducted a study to find out the yield gap through FLDs on wheat crop. Krishi Vigyan Kendra, JAU, Amreli (Gujarat) conducted 100 demonstration on wheat since 2006-07 to 2009-10 in different seven adopted villages. Prevailing farmers' practices were treated as control for comparison with recommended practices. The average four year data observed that an average yield of demonstrated plot was obtained 43.26 q/ha over control (36.59q/ha) with an additional yield of 6.67 q/ha and the increase average wheat productivity by 18.22 per cent. The average technology gap and index were found to be 6.74 and 13.48 percent. The extension gap ranging between 5.34 to 8.12 q/ha. During the period of study emphasis the need to educate the farmers through various techniques for adoption of improved agricultural production reverse the trend of wide extension gap.

Mahawar and Grover (2014) estimated the economics of turmeric cultivation for different categories of producers in Hoshiarpur, Nawashahar (Shaheed Bhagat Singh Nagar) and Gurdaspur districts of Punjab. The results revealed that on an overall basis the total cost incurred on use of physical input, machine labour and human labour use was '74438, '5227 and '29556 per hectare, respectively. The total variable cost was '121720, '108357 and '103569 per hectare for small, medium and large producers, respectively. On an overall basis returns over variable cost per hectare was '45380

which was highest for large producers ('68604) followed by medium producers ('48660) and small producers ('30822). Similarly, B-C ratio was also highest for large producers (1.66) followed by medium producers (1.45) and small producers (1.25). The overall benefit-cost (B-C) ratio was 1.40 denoting turmeric cultivation a profitable enterprise. The results of the study on economics of turmeric cultivation showed that the net returns per hectare received were quite high for all the categories of the farmers which clearly indicate the financial worthiness of turmeric crop.

Olayiwola (2014) performed the economic analysis of chili production in Nigeria. On per acre basis, total cost was estimated for small (34,225.05 Naira), medium (38,612.48 Naira) and large (42,086.84 Naira) farmers. The gross income was higher for large farmers (73,883.49 Naira) and less for small (49,104.38 Naira) farmer. Similarly, large farmers had higher benefit cost ratio (1.91) as compared with medium (1.87) and small (1.56) farmers.

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

Bhat et al. (2013) in his study made an in depth analysis of lemon being an important citrus crop by studying its resource use efficiency. The analysis of data on lemon indicated the overall values of regression coefficients as 0.451, 1.257, -0.011, -0.002 and -0.023 for human labour, manures + fertilizers, irrigation, plant protection and raining/ pruning, respectively, out of which human labour and manures + fertilizers were statistically significant, indicating that one per cent increase of expenditures on these two inputs could increase the returns to the extent of 0.45 per cent and 1.26

percent, respectively, while as in case of irrigation, plant protection and training/ pruning one per cent additional investment could decrease the production by 0.011 Percent, 0.002 per cent and 0.023 per cent, respectively. The marginal value productivities of human labour and manures + fertilizers were positive with their values at 0.111 and 0.882, respectively whereas that of irrigation (-0.020), plant protection (-59.710) and training/ pruning (-0.039) were negative thereby indicating that with an additional one rupee spent on these inputs could reduce the total returns and hence should be checked.

Karthik and Amarnath (2013) in his study estimated the costs and returns of turmeric cultivation in Dharampura district of Tamilnadu, along with resource use efficiency and technical efficiency of turmeric farms assessed the financial feasibility of starting a turmeric processing industry and identified the constraints to production and suggested measures for improvement. The cost of cultivation of turmeric per hectare was Rs. 119873.75. And the gross income realized was Rs. 247754.92. The net income was Rs. 127881.17 per ha. Coefficient of multiple determinations (R2) was 0.58 revealed that the production function model was a good fit. The coefficients of planting material, potash, harvesting and curing, machine hours, and irrigation were positive and significant at one percent level with the coefficient values of 0.29, 0.15, 0.24, 0.32 and 0.33 respectively which indicated that these were the significant operations in turmeric cultivation. The variable nitrogen was positive and significant at five per cent level with a coefficient value of 0.12. The positive value of NPV, BCR of greater than one and IRR of more than current bank rate revealed the financial feasibility of turmeric processing unit.

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

Sanusi and Ayinde (2013) made an attempt to investigate the profitability in pepper production in Nigeria. The mean of different socio-economic characteristics were estimated as age (43 years), pepper growing experience (12 years), family size (8 persons) and farm size (1.23 ha). On average, the variable and fixed cost were N 228,293.06 (US$ 1,521.95) and N 9,765.49 (US$ 65.10), respectively to receive the average revenue of N 622,847.56 (US$ 4,152.32). The return to investment ratio was 2.62.

Solomon and Korede (2013) used a cross sectional data obtained through a multistage sampling technique and estimated the technical efficiency of Ginger crop production in Jaba Local Government Area, Kaduna State, Nigeria and further examined the factors that determined the differential in efficiency index. A total of 78 Ginger crop farmers in the study area were randomly selected for the study. The stochastic frontier production model was used in the analysis to determine the relationship between output and the level of input used in the study area. The empirical results revealed that farm size, Planting materials, fertilizers and hired labour were statistically significant at 5% level while chemicals and family babour were not statistically significant. The estimated gamma parameters (γ) of 0.37 indicated that 37% of the total variation in total output was due to technical inefficiencies of the respondents. The mean technical efficiencies (χ) level was 0.68. It was therefore concluded that there is scope for increasing the technical efficiency of ginger crops production by 0.68% with the present technology. Therefore the study confirmed that increased land, planting material, fertilizer and hired labour can be used in the area by the farmers in ginger production.

Baree (2012) focused a study on the overall farm-specific technical efficiency or inefficiency of onion farms in Bangladesh. The elasticity of output with respect to land, labor and capital cost was estimated to the positive and also significant. On the other hand, seed and irrigation was found to be insignificant. The efficiency of onion farms varied from 58% to 99% with mean value of 83% which implies that there is a scope to increase output per hectare of onion by 17% through the efficient use of production technology.

Hireematha and Hilli (2012) conducted frontline demonstrations in Haveri district of Karnataka with objective of study on yield gap analysis in chili production technology. Chili is one of the important commercial crops in Karnataka, which plays a major role in supplementing the income to small and marginal farmers of Haveri district in Northern Karnataka. One of the major constraints to traditional chili farming is low productivity due to non-adoption of recommended package of practices and inferior seeds. To solve these problems frontline demonstrations on chili were conducted in adopted villages of Krishi Vigyan Kendra, Hanumanamatti in Haveri district. The impact of varieties on yield data indicates the Byadagi kaddi and Byadagi dabbi varieties recorded 22.80 and 19.91 per cent increased yield over local, respectively. The technology gap (5.77) and technology index (92.77) was highest in Byadagi dabbi compared to Byadagi kaddi. While the extension gap (1.60) was maximum in Byadagi kaddi. The higher gross returns, net returns and B: C ratio were recorded in both varieties compared to their respective local/check plots.

Jagtap et al. (2012) observed that chili (capscicum annuam L.) is most widely used and universal spice of India. The study was conducted in Achalpur tahsil of Amravati district of Maharashtra in India. Total four villages and twenty farmers from each village ie, total 80 farmers were selected randomly as sample size. Data used were pertaining to the period 2009-10. Economic analysis of data indicated that Cost 'C' was found to Rs. 40541.72, Rs. 42811.07 and Rs. 53421.29 per acre for small, medium and large farmers respectively. Net returns over cost 'C' was Rs. 19329.52, Rs. 24114.59 and Rs. 21400.51 per acre and input-output ratio at cost 'C' was 1**.**

Piya et al. (2012) conducted a case study in Nepal to compare the technical efficiency of rice farming in urban and rural areas. The study estimated production function using maximum likelihood method and calculated the efficiency score of individual household by using stochastic frontier analysis. The result suggested that the degree of commercialization, farmers' age, education, share of agriculture in total household

income and share cropping had significant impact on the efficiency of rice farming. The mentioned studies used the stochastic frontier approach to measure the efficiency of various crop farming. Some studies also analyzed the efficiency of rice farming in Bangladesh. However, this study was designed to show the impact of controlling saline water intrusion into the rice field in the coastal area of Bangladesh on the basis of profitability and technical efficiency of rice farming.

Singh (2012) studied on the extent of adoption of recommended chili production technology. The data were collected from 160 chili growers in Abhanpur block of Raipur district of Chhattisgarh during 2011-12 using an interview schedule.Overall findings of adoption showed that majority of respondents (73.12 percent) had medium level of adoption in case of selected practices. Majority of the respondents reported incidences of more pest and diseases followed by high cost of pesticides, non-availability of fertilizers and pesticides locally, inadequacy of labour at the time of picking, complicated techniques of seed treatment, poor germination and lack of skill about use of pesticides and equipment. Chili growers suggested that pest and disease resistant variety of chili should be available, fertilizers and pesticides should be available locally in subsidized rate and storage facility should be provided to the chili growers.

Islam et al. (2011) determined the productivity, profitability and resource use efficiency of four promising spices crops such as garlic, chili, ginger and turmeric. The data were collected from 480 farm households in the crop year 2010- 2011. Productions of all the crops were profitable as estimated by net returns and benefit cost ratios**.**The average estimated technical efficiencies for garlic, chilies, ginger and turmeric were 88, 80, 69 and 79% respectively which indicated that garlic production could be increased by 12%, chili by 20%, ginger by 31% and turmeric by 21% with the same level of inputs without incurring any additional cost**.**

Mohammad (2011) stated the concept of yield gaps originated from the studies conducted by IRRI in the seventies. The yield gap discussed in this paper is the difference between the potential farm yield and the actual average farm yield. In Bangladesh, yield gaps exist in different crops ranging up to 60%. According to the recent study conducted by BRRI, the yield gap in rice was estimated at 1.74 t/ha. The existence of yield gaps was as well observed in rice, mustard, wheat and cotton in India. In India, yield gap varied from 15.5 to 60% with the national average gap of 52.3% in irrigated ecosystem.

Venkataramalu *et al.* (2010) revealed that the majority of the respondents (95.83 percent) faced problems of water scarcity for irrigation and 82.50 percent faced constraints of high incidence of pests and diseases. Whereas 68.33 percent and 48.53 percent respondents faced problems of price fluctuation and lack of technical guidance respectively as important constraints in chili cultivation.

Rajput *et al*. (2007) revealed that the following factors were responsible for the declining of chili area. These constraints were technical aspects (85.14 percent) and economic aspect (85.33 percent). Lack of information sources (70.00 percent), non-availability of labour (67.32 percent), and erratic climatic condition (94.66 percent), were the important constraints.

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

Hanumanaikar *et al.* (2006) revealed that cent percent (100 percent) of the respondents expressed the problems of increased pest and disease infestation to the chili crop which forced them to use the excess pesticide doses. Ninety percent of the respondents expressed their inability to read the instructions given by the manufactures on the label of containers about the right uses of pesticides due to illiteracy and language problem.

Haque (2005) conducted a comparative economic analysis of onion and garlic production in a selected area in Santhia Upazila of Pabna district. Both onion and garlic were profitable. Onion cultivation was more profitable than garlic cultivation.Per hectare average yield of onion and garlic was 8412 kg. and 4510 kg., respectively. Per hectare total cost of production, gross margin and net return of onion were Tk. 49437, Tk. 101230 and Tk. 93567, respectively. On the other hand, the corresponding figures for producing garlic were Tk. 49386, Tk. 43693 and Tk. 36304 respectively.

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

Shrivastava (2003) revealed that the problems include high cost of fertilizers followed by high cost of plant protection chemicals and insecticides (98.33 percent), insects and diseases attack (96.67 percent), unavailability of irrigation facility (67.00 percent), lack of proper guidance by RAEOs about recommended chili production technology (56.67 percent) and effect of climate (55.00 percent) were important constraints.

Prajapati *et al*. (2002) reported that the important constraints experienced by the chili growers in adoption of recommended chili cultivation practices were lack of knowledge pertaining to recommended variety (85.00 percent), non-availability of fertilizers in time and in adequate power supplies (83.16 percent) in the rural areas.

Shrivastava *et al.* (2002) reported that constraints experienced by the chili growers in adoption of chili cultivation technology were high price of chemical fertilizers, insecticides and pesticides, incidents of pest and diseases, lack of technical guidance from village level workers, adverse effect of climate and lack of knowledge about technology, poor economic condition of the farmers, non-availability of plant protection chemicals, insufficient use of credit, non-availability of seed of S-49 variety in time, improper market and non- availability of fertilizers and pesticides.

Mutkule *et al*. (2001) reported that important constraints experienced by the chili growers include less adoption of chili cultivation technology costly insecticides and pesticides non awareness of concentration of pesticides, fluctuation of price of chili, non-timely availability of fertilizers, high cost of fertilizers, lack of disease resistant varieties, non-availability of transport facilities to city area, lack of cold storage and non-availability of sprayers on hire basis at the time of spraying.

Korikanthimath *et al.* (2000) conducted a study to evaluate the efficient' utilization of cash input resources and made an attempt to draw optimality in' the use of these resources in chili + cotton system in Dharwad district, in Karnataka. A total sample of 30 farmers following the system was selected randomly interviewed through survey method using well-structured schedules. It revealed that there existed an indiscriminate use of almost all cash external inpts except nitrogenous and phosphatic fertilizers of which former found to bear a significant effect on output, while seeds and human labor inspite of their excess utilization had significant effect on the yield indicating irrational

behavior of the farmers for the same. It was evident that about 92% of the variation in yield was explained by those variables which were included in the function representing a significant goodness in fitting the regression.

Kariem *et al.* (1999) carried out a study to estimate the neutral technology, non-neutral technology and observed that input use contributed differences between large and small farms producing summer chili (Capsicum). Decomposition technique was used to achieve the objectives. Only the neutral technology contribution was in favour of large farms. The non-neutral technologies and input use contributed differences in small farms and to perform better than large farms in summer chili production. The study revealed that the highest input use contributing factor differences were seen for fertilizers followed by seedling, insecticide, manure, human labor, top dressing, animal power and weeding between large and small farms. Small farms were more productive than large farms.

Mishra *et al.* (1999) studied on production and marketing of chilies. The study was conducted in Ahraula block of Azamgarh district of Uttar Pradesh. The study was undertaken to work out the cost of cultivation and cost of production of chilies and the price spread in the marketing of chilies. The study was based on 60 randomly selected farmers in the study area. On average, input cost of chilies came ₹ 22439.22 which varied from ₹ 22782.67 at marginal farms to ₹ 22498.79 atsmall farms and to ₹ 21848.87 at medium and other farms. The chili cost was higher in case of marginal and small farms due to more use of the manure and fertilizers at these farms. Producer's share in consumer's rupee was only 70.14 percent in channel- II and 90.85 percent in channel – I. The total marketing cost was estimated as 25.83 percent while the whole seller and retailer margin was 7.75 percent and 8.56 percent respectively.The yield of onion was found 9869 metric ton per hector. The gross margin and gross return were found to be Tk. 85308 and 79487 per hectare respectively. They found out the non-availability of HYV onion seed at the proper

time, lack of technical knowledge of onion growers, high price in the cultivation time and non-availability of qualified fertilizer in time as the major problems of onion cultivation in the study areas and finally they suggested that both governmental and nongovernmental organizations should come forward and take proper steps to solve these problems.

Mahmood (1995) examined the relative profitability of selected spices, compared with their competing crops. Among all competing crops onion was the most profitable crop with net profit of Tk. 26673, which was followed by potato (Tk. 25875.30), lentil (Tk. 20652.1) and garlic (Tk. 16755.49) in respect of net return per hectare.

Hiremath (1994) studied on Production and marketing of dry chilies in Karnataka. The study has analysed the cost and returns of dry chilies in Dharwad district. Per acre cost of cultivation of chili was estimated as ₹ 5942.64 while cost A and cost B was ₹ 3865.90 and ₹ 5110.39 respectively. The value of gross output was observed as ₹ 5531.72. The farm business income and family labour income was estimated as ₹ 1466.08 per acre and ₹ 221.33 per acre respectively.

Sharma *et al.* (1992) reported on the basis of regression equation that keeping bullock labour and working capital fixed at their geometric mean levels. 1 percent increase in human labour will lead to 0.67 per cent increase in income from chilies.

Thakur *et al.* (1990) studied the resource use by farm size and return to scale on tribal farms of Himachal Pradesh. The total sample size was of 150 farmers and data were collected by survey method for the year 1983-84.. The analysis revealed that elasticity coefficient of inputs particularly labour did not differ significantly between marginal, small and large farms and hence the hypothesis that farm size is an important factor to influence the productivity of inputs at farm level could not be supported.

Vyas (1989) studied resource use and productivity in dry land Agriculture in Nagpur district of and Rajasthan for 1977-78 to 1979-80 for three farm size groups by employing a production function approach. All the components of input-mix excepting human labour need additive adjustment for enhancement of value productivity of crop output mix on dry land farms.

Sharma and Pant (1988) studied marketing of vegetables in south Saurashtra zone of Gujarat. They found that per quintal marketing cost incurred by the producer was the highest in highly perishable vegetables, namely tomato (₹ 108.04) followed by chilies (₹ 101.84), brinjal (₹61.75), cabbage (₹ 50.44) and bottle gourd (₹ 45.74). The commission paid to the commission agent formed the major component of total marketing cost. At the retailers level, the per quintal expenditure incurred was also the highest in the case of tomato (₹ 139.76) followed by chilies (₹65.98), brinjal (₹ 61.12), cabbage (₹ 45.82) and bottle gourd (₹ 33.32). Among the different items of expenditure at retail level, the spoilage cost formed major component of total retail cost in all the vegetables. The producer's share in consumer's rupee was found to be lower in brinjal (56.87 percent) and tomato (56.89 percent) as compared to cabbage (62.30 percent), chilies (61.01percent) and bottle gourd (59.65 percent).

Adinarayan (1967) reported on the basis of production function analysis that only area under chilies and human labour were positively contributing to the yield of chilies. Plant protection charges and size of holding were negatively significant. The elasticity of land, human labour, plant. Protection charges and size of holding were worked out to be 1.95, 3.45, 0.82 and 0.19 respectively.

CHAPTER 3
METHODOLOGY

3.1. Introduction

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

i. Survey enables quick investigations of large number of cases; and
ii. Its results have wider applicability.

The major disadvantage of the survey method is that the investigator has to rely upon the memory of the farmers. To overcome this problem, repeated visits were made to collect data in the study area and in the case of any omission or contradiction the farmers were revisited to obtain the `missing and/or correct information. The design of the survey for the present study involved the following steps.

3.2. Selection of the Study Area

Selection of the study area is an important step for farm management study. The selection of an area fulfilled the particular purpose which was set for the study and also the possible cooperation from the farmer. Although chili is grown all over Bangladesh, the district Bogura is one of the important districts where it is grown quite extensively. So, on the basis of higher concentration of Chili production, 3 Sub-Districts namely Shibgong, Shonatola, Sariakandi under of Bogura district were purposively selected for the study.

The main reasons in selecting the study area were as follows:

a) Availability of a large number of Chili growers in the study area;
b) These villages had some identical physical characteristics like topography, soil and climatic conditions for producing chili;
c) Easy accessibility and good communication facilities in these villages; and
d) Co-operation from the respondents was expected to be high so that the reliable data would be obtained.

3.3. Sampling Technique and Sample Size

In selecting samples for a study two factors need to be taken into consideration. The sample size should be as large as to allow for adequate degrees of freedom in the statistical analysis. On the other hand, administration of field research, processing and analysis of data should be manageable within the limitation imposed by physical, human and financial resources (Mannan 2001). However, because of diversity in the technical and human environment, it is necessary to sample several numbers of the population before any conclusion can be drawn. Therefore, the purpose of sampling is to select a sub-set of the population that is representative of the population (Rahman 2000).

It was not possible to include all the farmers of the study area due to limitation of time, money and personnel. In total 100 farmers were randomly selected. A purposive random sampling technique was followed in the present study for minimizing cost, time and to achieve the ultimate objectives of the study.

3.4. Preparation of the Survey Schedule

A draft questionnaire was prepared for collecting information from the sample farmers. Keeping the objectives of the study in mind, the questionnaire was pre-tested by interviewing some farmers who cultivated Chili and necessary modifications, additions and alternations were made and then draft questionnaire was finalized.

The final questionnaire contained three categories of information. The purpose of the first category was to obtain information about the socioeconomic conditions of the selected farmers. The second category contained information related to costs and returns. The third category of information was related to constraints and problems faced by the farmers in producing chili.

3.5. Period of the Study

Data were collected during the period from November to December in 2018. Data relating to inputs and outputs were collected by making time to time visit in the study area during this period.

3.6. Data Collection Methods

For the present study, data were collected from the Chili growing farmers through field survey. The researcher himself collected the relevant data from the selected Chili growers. Before interviewing, the selected farmers were contacted so that they could be interviewed according to their convenience of time. At the time of interview, the researcher asked questions systematically and explained the aims and objectives of the study whenever it was felt necessary. It was explained to the farmers that the study was purely academic. Farmers were also explained the usefulness of the study in their farm business context. Each time, when interview was over, the interview schedule was checked to be sure that information to each of the item was properly recorded. If there were such items which were overlooked or contradictory, they were corrected through a revisit. In addition to survey, observation method was also applied to collect information by the researcher.

3.7. Processing, Tabulation and Analysis of Data

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

3.8. Analytical Techniques

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

3.8.1 Profitability Analysis

The net returns of chili 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 chili production included ploughing, laddering and other activities needed to make the soil suitable for planting seedling. It was revealed that the number of ploughing varied from farm to farm and location to location.

Cost of Human Labor

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

Cost of Seed

Cost of seed varied widely depending on its quality and availability. Market prices of seeds of respected chili 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 chili 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 chili 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 chili 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 10 percent per annum interest on operating capital for four months was computed for chili. Interest on operating capital was calculated by using the following formula:

IOC= AIit

Where,

IOC= Interest on operating capital

i= Rate of interest

AI= Total investment / 2

t = Total time period of a cycle

Land Use Costs

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

Calculation of Returns

Gross Return

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

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

Gross Margin

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

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

Gross margin = Gross return – Variable cost

Net Return

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

Net return = Total return – Total production cost.

Undiscounted Benefit Cost Ratio (BCR)

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

BCR = Total return (Gross return)/ Total cost

3.8.2 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.

3.8.2.1 The Stochastic Frontier Models

The most widely discussed, theoretically reasonable and empirically competent method of measuring efficiency is the stochastic frontier model. It is an improvement on the traditional average production function and on all types of deterministic frontiers in the sense that it introduces in addition to one-sided error component a symmetric error term to the model. This permits random variation of the frontier across farms, and captures the effects of measurement error, other statistical noise arid random shocks outside the firm's control. A one-sided component captures the effects of inefficiency relative to the stochastic frontier. The stochastic frontier model is also called the 'composed error' model introduced by Aigner, Lovell and Schmidt (1977). It was later extended and elaborated by Jondrow *et al*. (1982). The notion of a deterministic frontier shared by all farms ignores the very real possibility that a farm's performance may be affected by factors entirely outside its control (such as poor machine performance, bad weather, input supply breakdowns, and so on), as well as by factors under its control (inefficiency). But stochastic frontiers consider all the factors while estimating the model and accordingly it separates firm- specific efficiency and random error effect. Thus the efficiency measurements as well as the estimated parameters are unbiased.

3.8.2.2 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 $f(X_i,\beta)\exp.(V_i)$, V_i having some symmetric distribution to capture the random effects of measurement error and exogenous shocks which cause the placement of the deterministic kernel $f(X_i,\beta)$ to vary across firms.

The technical inefficiency relative to the stochastic production frontier is then captured by the one-sided error component $U_i \geq 0$.

The explicit form of the stochastic Cobb-Douglas production frontier is given by

$$Y = a \prod_{i=1}^{\lambda} X_i^{bi} \exp.(\varepsilon)$$

Where Y is the frontier output, X is physical input, b the elasticity of Y with respect to X, a is intercept and $\varepsilon = V-U$ is a composed error term as defined earlier. For simplicity, we have ignored the subscript. The estimation of the model and derivation of technical efficiency is the same as described earlier.

3.8.2.3 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:

$$Yi = \beta 0\ X1^{\beta 1}\ X2^{\beta 2}\ \ldots\ldots\ldots X5^{\beta 5}\ e^{Vi-Ui}$$

The above function is linearized double-log form:

$$\ln Y = \ln\beta 0 + \beta 1 \ln X1 + \beta 2 \ln X2 + \beta 3 \ln X3 + \beta 4 \ln X4 + \beta 5 \ln X5 + Vi - Ui$$

Where,

Y = Output (kg/ha)

X1 = Human labour (man days/ha)

X2 = Seed (Kg/ha),

X3= Fertilizer (kg/ha)

X4 = Cost of insecticide (Tk./ha)

X5 = Irrigation cost (Tk./ha).

i= Number of variable

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

$$Ui = \delta 0 + \delta 1 Z1 + \delta 2 Z2 + \delta 3 Z3 + \delta 4 Z4 + \delta 5 Z5 + + Wi$$

Where,

Z1 to Z5 are explanatory variable

The equation can be written as:

$$Ui = \delta 0 + \delta 1 \text{ Chili farming experience} + \delta 2 \text{ Farm size} + \delta 3 \text{ Extension service} + \delta 4 \text{ Training} + \delta 5 \text{Taking loan} + Wi$$

V is two-sided uniform random variable beyond the control of farmer having N $(0, \sigma^2)$ distribution, U is one-sided technical inefficiency effect under the control of farmer having a positive half normal distribution $\{Ui \sim |N\ (0, \sigma u^2)|\}$ and Wi 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

SOCIO-DEMOGRAPHY PROFILE OF HOUSEHOLD POPULATION

4.1 Introduction

The point of this part is to present a brief description of the socio-economic characteristics of the growers delivering chili. Socioeconomic l 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.

4.2 Age

The sample of 30, 35, and 35 are respectively covering Shibgong, Shonatola, Sariakandi sub-district and represented the total population. In shibgong upazila, 23.33 percent of the sample populations were 0-35 years, 63.33 percent were 35-60 years and 13.34 percent were above 60 years old. In shonatola upazila, 5.71 percent of the sample populations were 0-35 years, 77.14 percent were 35-60 years and 17.15 percent were above 60 years old. In sariakandi upazila, 17.14 percent of the sample populations were 0-35 years, 60 percent were 35-60 years and 22.86 percent were above 60 (Table 4.1**)**.

Table 4.1: Age of the respondent by Study Area

Area	Age			Total
	0-35	35-60	Above 60	
Shibgong	7	19	4	30
Shonatola	2	27	6	35
Sariakandi	6	21	8	35
Total	15	67	18	**100**

Source: Field survey, 2018

4.3 Education

In shibgong upazila, 33.33 percent of the sample populations have completed primary education, 36.67 percent were secondary passed and 20 percent were at higher secondary and above higher secondary level were 9 percent. In shonatola upazila, 2.57 percent of the sample populations have completed primary education, 4.57 percent were were secondary passed and 26.66 percent were higher secondary and above higher secondary were 0 percent. In sariakandi upazila, 37.14 percent of the sample populations have completed primary education, 42.86 percent were secondary passed and 17.14 percent were higher secondary and above higher secondary were 2.86 percent. (Table 4.2**)**.

Table 4.2: Education of the respondent by Study Area

Area	Education level				Total
	Primary	Secondary	Higher secondary	Above	
Shibgong	10	11	6	3	30
Shonatola	10	17	8	0	35
Sariakandi	13	15	6	1	35
Total	33	43	20	4	**100**

Source: Field survey, 2018

4.4 Family size:

The average family size was 5.2, 4.51 and 4.63 respectively for Shibgong, Shonatola, Sariakandi upzillas. (Figure 4.1)

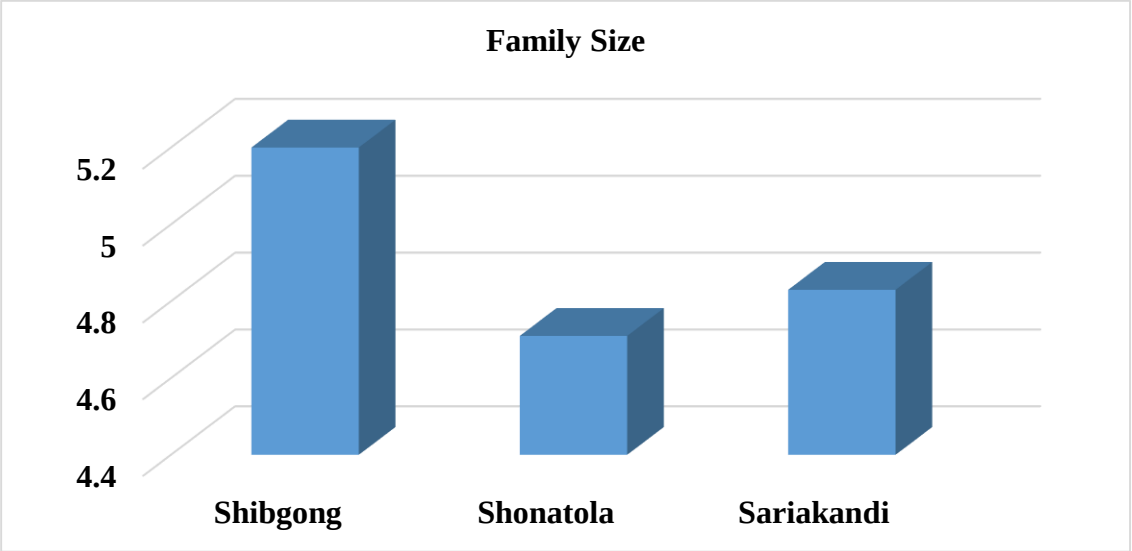

Figure 4.1: Family size of the respondent by Study Area

Source: Field survey, 2018

4.5 Agricultural Training

Among the respondent farmers in Shibgong upazila, only 6.67 percent farmer's got training of chili farming whereas, 54.29 percent farmers got training in Shonatola upazila, 14.29 percent farmers got training in Sariakandi upazila (Table 4.3). 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 4.3: Agricultural Training of the respondent by Study Area

Training received	Shibgong		Shonatola		Sariakandi	
	No.	%	No.	%	No.	%
Yes	2	6.67	19	54.29	5	14.29
No	28	93.33	16	45.71	30	85.71
Total	30	100.00	35	100.00	35	100.00

Source: Field survey, 2018

4.6 Membership of any social organization

Among the respondent farmers in Shibgong upazila, 70.00 percent chili producers were found to have membership in different NGOs and/or farmers' organizations whereas Shibgong upazila 68.57 percent of chili farmers had membership in different NGOs and/or farmers' organizations and 74.28 percent of chili farmers had membership in different social organization in sariakandi upazila (Table 4.4).

Table 4.4: Membership in any organization of the respondent by Study Area

Membership in any organization	Shibgong		Shonatola		Sariakandi	
	No.	%	No.	%	No.	%
Yes	21	70.00	24	68.57	26	74.28
No	9	30.00	11	31.43	9	25.72
Total	30	100.00	35	100.00	35	100.00

Source: Field survey, 2018

CHAPTER –5

PROFITABILITY OF CHILI PRODUCTION

5.1 Variable Costs

Cost of Land Preparation

Land preparation is the most important component in the production process. Land preparation included ploughing, laddering and other activities needed to make the soil suitable for chili cultivation. For land preparation in chili production, no. of tiller was required 3 with Tk. 3737.76 per tiller. Thus, the average land preparation cost of chili production was found to be Tk. 11213 per hectare, which was 2.80 percent of total cost (Table 5.1).

Cost of Human Labor

Human labor 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 chili. 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 chili production was found to be about 462 man-days per hectare and average price of human labour was Tk. 400 per man-day. Therefore, the total cost of human labor was found to be Tk. 184800 representing 46.20 percent of total cost (Table 5.1).

Cost of Seed

Cost of seed varied widely depending on its quality and availability. Per hectare total cost of seed for chili production were estimated to be Tk. 3434, which constituted 0.86 percent of the total cost (Table 5.1).

Cost of Urea

In the study area, farmers used different types of fertilizers. On an average, farmers urea 250 kg used per hectare. Per hectare cost of urea was Tk. 4250, which represents 1.06 percent of the total cost (Table 5.1).

Cost of TSP

Among the different kinds of fertilizers used, the rate of application of TSP (149.57 kg) was similar to urea fertilizers. The average cost of TSP was Tk. 3589 which representing 0.90 percent of the total cost (Table 5.1).

Cost of MoP

The application of MoP per hectare (128.45 kg) was found lower than other fertilizers. Per hectare cost of MoP was Tk. 2055, which represents 0.51 percent of the total cost (Table 5.1).

Cost of Insecticides

Farmers used different kinds of insecticides to keep their crop free from pests and diseases. The average cost of insecticides for chili production was found to be Tk. 87804.54 which was 21.95 percent of the total cost (Table 5.1).

Cost of Irrigation

Cost of irrigation is one of the most important costs for chili production. Production of chili 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. 31237 per hectare, which represents 7.81 percent of the total cost (Table 5.1).

Table 5.1: Per Hectare Cost of Chili Production

Items of Cost	Quantity (kg/ha)	Rate (Tk./Kg)	Cost (Tk./ha)	% of Total cost
Land preparation	3	3737.76	11213	2.80
Human labour	462	400	184800	46.20
Seed			3434	0.86
Urea	250	17	4250	1.06
TSP	149.57	24	3589	0.90
MoP	128.45	16	2055.2	0.51
Cost of Insecticides			87804	21.95
Cost of Irrigation			31237	7.81
A. Total Operating Cost (TOC)			**328384**	**82.10**
Interest on operating capital @ of 10% for month			10946	2.74
B. Total Variable Cost (TVC)			**339330**	**84.64**
Rental value of land			60643.03	15.16
C. Total Fixed Cost (TFC)			**60643.03**	**15.16**
D. Total cost (B+C)			**399973**	**100.00**

Source: Field survey, 2018.

Note: Quantity and rate for land preparation are expressed in no. of tiller perhectare and Tk. per tiller units, respectively. Quantity and rate of human labour are expressed in man-days per hectare and Tk. per man-days units, respectively.

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 chili. Interest on operating capital for chili production was estimated at Tk. 10946 per hectare, which represents 2.74 percent of the total cost (Table 5.1).

Total Variable Cost

From the above different cost items it was clear that the total variable cost of chili production was Tk. 343669 per hectare, which was 85 percent of the total cost (Table 5.1).

5.2 Fixed Cost

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 chili farmers the land use cost was found to be Tk. 60643.03 per hectare, and it was 15 percent of the total cost (Table 5.1).

5.3 Total Cost (TC) of Chili 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 chili was found to be Tk. **399973** (Table 5.1).

5.4 Return of Chili Production

Gross Return

Return per hectare of chili cultivation is shown in Table 4.6. 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 chili per hectare was 35377.31 kg and the average price of chili was Tk. 20. Therefore, the gross return was found to be Tk. 707546 per hectare (Table 5.2).

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. 363877 per hectare (Table 5.2).

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. 307573 per hectare (Table 5.2).

Table 5.2: Per Hectare Cost and Return of Chili Production

Measuring Criteria	**Cost (Tk./ha)**
Main Product Value	707546
Gross Return (GR)	707546
Total Variable Cost (TVC)	343669
Total Cost (TC)	399973
Gross Margin (GR-TVC)	363877
Net Return (GR-TC)	307573
BCR (undiscounted)(GR/TC)	**1.77**

Source: Field survey, 2018.

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 1.77 which implies that one taka investment in chili production generated Tk. 1.77 (Table 5.2). From the above calculation it was found that chili cultivation is profitable in Bangladesh.

CHAPTER 6

TECHNICAL EFFICIENCY OF THE CHILI FARMERS

6.1 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. 6.1

The maximum likelihood estimates for parameters of the Cobb-Douglas stochastic frontier production function and technical inefficiency effect model for chili production for all farmers are presented in Table 6.1. Asides from estimates of coefficients in the model, the output also provides other variance parameters such as sigma square (σ^2), gamma (γ) and log-likelihood function.

Human Labor (X1)

The regression coefficients of Human labor (X1) was not significant.

Seed (X2)

The regression coefficient of seed cost (X2) of chili production was negative 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 chili would be decreased by 0.5988 percent, other factors remaining constant (Table 6.1).

Fertilizer (X3)

The regression coefficients of fertilizer (X3) was not significant.

Cost of Insecticide (X4)

The regression coefficient of insecticides cost (X4) of chili production was positive and significant at 1 percent level of significance, which implied that if the expenditure on insecticides was increased by 1 percent then the yield of chili would be increased by 0.4039 percent, other factors remaining constant (Table 6.1).

Table 6.1: ML Estimates for Parameters of Cobb-Douglas Stochastic Frontier Production Function and Technical Inefficiency Model for Chili Farmers.

Variables	Parameter	Coefficients	T-ratio
Stochastic Frontier:			
Constant (X_0)	β_0	5.8889*	1.82
Human Labour (X_1)	β_1	0.5811	1.46
Seed (X_2)	β_2	-0.5988***	-3.41
Fertilizer (X_3)	β_3	0.0124	0.04
Insecticide (X_4)	β_4	0.4039***	3.40
Irrigation (X_5)	β_5	-0.4069**	-2.14
Inefficiency Model			
Constant	δ_0	0.7222*	0.63
Experience (Z_1)	δ_1	-0.0623*	1.90
Farm size (Z_2)	δ_2	-0.1480***	-2.48
Extension service (Z_3)	δ_3	-0.0298	-0.22
Training (Z_4)	δ_4	0.7348	-0.64
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 respectively**.

Source: Field survey, 2018.

Irrigation (X5)

The magnitudes of the coefficients of irrigation cost was negative and significant at 5 percent level of significance. The result of the analysis indicated that, keeping other factors constant, a 1 percent increase in additional expenditure on irrigation would decrease the yield of chili by 0.4069 percent (Table 6.1).

6.2 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 at10 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 chili are technically more efficient than others. Although this coefficient is not statistically significant. (Table 6.2)

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 chili.

6.3 Technical Efficiency and Its Distribution

Table 4.8 shows frequency distribution of farm-specific technical efficiency for chili farmers. It reveals that average estimated technical efficiencies for chili are 81 percent which indicate that chili production could be increased by 19 percent with the same level of inputs without incurring any further cost. Increase of only managerial skills result a substantial increase of output for chili. It was observed that 33 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, 45 per cent of sample farmers obtained 71 to 90 percent technical efficiency level. The minimum and maximum technical efficiencies were observed to be 10 and 99 per cent respectively, where standard deviation was maintained at 0.17.

Table 6.2: Frequency Distribution of Technical Efficiency of Chili Farms

Efficiency (%)	No. of farms	Percentage of farms
0-50	5	5.00
51-60	7	7.00
61-70	10	10.00
71-80	15	15.00
81-90	30	30.00
91-100	33	33.00
Total number of farms	100	100
Minimum	0.10	
Maximum	0.99	
Mean	0.81	
Standard Deviation	0.17	

Source: Field survey, 2018

6.4 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 chili cultivation. Chili production is a 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 chili is a profitable. Cultivation of chili would help farmers to increase their income earnings.

CHAPTER – 7

PROBLEMS IN PRODUCTION OF CHILI

In this section, an attempt has been made to analyze the constraints responsible for lower yield at the farmer's field. The major problems faced by the farmers in the production and marketing of chilies in this district are presented in Table 4.9.

Irrespective of farm size, most of the farmers reported that insect- pests and diseases are the major problems, specially leaf curl, and powdery mildew and fruit borers. Ninety, out of 100 farmers faced the problems of insect-pests and diseases in the study area. These Farmer's suggested that diseases and insect pest resistant varieties must provide to the farmers. Another important aspect perceived by about 76 percent farmers is imbalance use of fertilizers and pesticide at all categories of farms. Lack of latest technical know-how may be a reason for this imbalanced use of fertilizers and pesticide. Therefore, it is needed that the department of agriculture should arrange periodically training programmes to aware the farmers about balanced use of fertilizers, pesticide and other technical knowledge. Problem faced by 50 percent farmers is lack of sufficient soil testing facilities. Farmers perceived that the soil testing equipment's should be available at least at block level along with recommended dose of fertilizer and manure according to the soil test. The other most important constraint is non availability of seed during peak season faced by chili growers of Bogura district. The scarcity of High yielding seed is reported to be serious problem faced by 74 percent of the farmers. About 50 percent farmers do not have any institutional support in chili production like supply of seed, supply of plant protection chemical and technical support. Table 4.9 reveals that there is no serious problem in marketing of chili by the chili growers due to highly demand of this crop.

However, certain problems like lack of regulated and co-operative markets are reported by about 31 percent farmers of the study area.

Table 7.1: Production and marketing problems faced by the chili growers

S. No.	Particulars	No. of farmers	Percentage of total No. of farmers
A.	**Production problems**		
1.	Problem of insect- pest and diseases	89	89
2.	Imbalance use of fertilizer & pesticide	76	76
3.	Scarcity of High yielding seed variety	74	74
4.	Lack of soil testing facility	50	50
5.	Lack of institutional support	50	50
6.	Lack of latest technical know-how about chili production	24	24
B.	**Marketing problem**		
1.	Lack of regulate market and co-operative market	31	31

Source: Field survey, 2018

CHAPTER-8

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

8.1 Summary

Nowadays Chili is one of the most important commercial crops of Bangladesh; it is a crop of tropical and sub-tropical regions and requires a warm humid climate. Number of varieties of chilies are grown, which can be used as vegetable, condiments and pickles. Chili occupies an important place in Bangladeshi diet and it is an indispensable item in the kitchen, as it is consumed daily as a condiment in one or other form. Chili is rich in vitamin A and C and has many medicinal properties. The world area and production of chili is around 19.89 million hectares and 33.52 million tons respectively. The largest producer of chilies in the world is Bangladesh accounting for 13 million tons of production annually. Bangladesh also leads in the context of maximum area covered under chili cultivation.

In Bangladesh, chilies are grown in almost all districts of the country and the major growing district in terms of production are Bogura. The total area under spices is 92769 hectares in the Bogura district with a production of 632031 metric tons. Chili is the important vegetable, spice crop of the Bogura district with area and production of 41359 hectares and 280312 tons respectively and productivity was 26.77 metric tons (green chili) per hectare during 2016-17.

Chilies are grown all over Bangladesh, not only for a huge home market but also for export purposes. Production of chilies plays an important role in improving the economic conditions of farmer's specially marginal and small farmers and meeting the nutritional requirements of the people of Bangladesh. The present study will give the answers of some of the important questions regarding the aspects like growth of this crop, cost of cultivation, returns from this crop and constraints to its production and marketing. Therefore, a systematic research work was required to carry out for this crop in order to make available complete information to the farmers who want to grow this crop.

This context, the present study was taken under in Bogura district of Rajshashi division with the following specific objectives.

1. To access the socio economic characteristics of the chili growers in study area
2. To estimate the compound growth rate of area, production and productivity of chilies in the district.
3. To workout the cost of cultivation and returns of chilies at sample farms in Bogura district.
4. To identify the constraints faced by the producers in the production and marketing of chilies and to suggest some measures to improve them.

The sampling frame for the present study were selected purposively as to select the area where the chili cultivation was intensive. On the basis of higher concentration of chili crop production, three upzillas namely Shibgong, Shonatola, Sariakandi in Bogura was selected. A sample size of 60 is generally regarded as the minimum requirement for larger population that will yield a sufficient level of certainty for decision-making (Poate and Daplyn, 1993). In this case, who were cultivating different varieties of Rbi chili in the selected areas were selected as samples. Farmers generally plant Robi chili from mid- September to November and harvest after three months. Data for the present study have collected during the period of November to December 2018. Primary data were collected from primary producers. Selected respondents were interviewed personally with the help of pre-tested questionnaires. The collected data were checked and verified for the sake of consistency and completeness. Editing and coding were done before putting the data in computer. All the collected data were summarized and scrutinized carefully to eliminate all possible errors. Data entry was made in computer and analysis was done using the concerned software Microsoft Excel and STATA.

Economic profitability is a major criterion to make decision for producing any crop at farm level. It can be measured based on net return, gross margin and ratio of return to total cost. The average land preparation cost of chili production was found to be Tk. 11213 per hectare. . The quantity of human labor used in chili production was found to be about 462 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. 184800 representing 46.20 percent of total cost. Per hectare total cost of seed for chili production was estimated to be Tk. 3434. On average, farmers used Urea, TSP, MoP 250. Kg, 149.57 kg and 128.45 kg respectively, per hectare. The average cost of insecticides for chili production was found to be Tk. 87804. Whereas the average cost of irrigation was found to be Tk. 31284 per hectare. The total variable cost of chili production was Tk. 339330 per hectare, which was 84.84 percent of the total cost. The average yield of chili per hectare was total price of chili was Tk. 707546. The gross return, gross margin and net return were found to be Tk. 707546, Tk. 363877 and Tk. 307573 per hectare. Benefit Cost Ratio (BCR) was found to be 1.77 which implies that one taka investment in chili production generated Tk. 1.77.

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 Human labor (X1), Fertilizer (X3) and Insecticides cost (X4) were positive but the coefficient of Seed (X2) and Irrigation (X5) was found negative. It indicates that if Human labor (X1), Fertilizer (X3), Insecticides cost (X4) were increased by one percent, the production of chili would be increased by 0.5811, 0.0.0124, 0.4039, 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. Average estimated technical efficiencies for chili are 81 percent which indicate that chili production could be increased by 19 per cent with the same level of inputs without incurring any further cost. Increase of only managerial skills result in a substantial increase of output for chili.

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

8.2 Conclusion

Chili is one of the important spice crops grown by farmers mainly for market purpose. The study areas have tremendous potential for chili cultivation. The findings of the present study indicate that chili production is highly profitable and it would help to improve the socioeconomic condition of sample farmers in the study areas. As chili is a labour intensive crop, it would help to create employment opportunities. In Bangladesh, it is difficult to increase chili production by increasing the area of land under cultivation due to the limitation of land. But, there is an opportunity to increase production of chili by improving the existing production technology. Farmers are relatively inefficient due to land fragmentation, less experience, illiteracy, etc. The present study indicate that farmers are technically efficient that means there is an opportunity to increase production to a large extent using the existing level of agricultural inputs, the agricultural extension services and the available technology.

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

8.3 Recommendations

On the basis of the finding of the study it was evident that chili was profitable enterprises and it can generate income earnings and employment opportunity to the rural people of Bangladesh. But some problems and constraints bared to attain the above mentioned objectives. The policy makers should, therefore, take necessary measures. According to the findings of the study; some policy recommendations may be advanced which are likely to be useful for policy formulation. The following specific recommendation may be made for the development of chili sector.

- As most of the chili farmers are technically efficient at present production technology, improved method of production technology with sufficient storage ability should be introduced.
- As chili is a profitable enterprise, government and concern institutions should provide adequate extension programme to expand its area and production.
- Chili based cropping pattern should be developed and disseminated to those areas of Bangladesh where their production is suitable.
- Government should take necessary measures to lower the price of inputs which have positive significant impact on yield. It will increase the net benefit of chili producers.

- Adequate training on recommended fertilizer doses, insecticides, use of good seed, intercultural operations, etc., should be provided to the chili farmers which will enhance production as well as technical efficiency by improving the technical knowledge of the farmers.
- Chili farmers had to sell their product at low price during harvesting or just after harvest. An appropriate storage scheme should be developed so that the farmers are not forced to sell their product at low price during the harvest period.

8.4 Limitations of the Study

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

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

REFERENCES

Adinarayan, L. (1967). A study of production and marketing of chilli in Bapatala block. Unpublished thesis, A.P. Agril.University:58.

Aigner,D.J., Lovell, C.A.K. and Schmidt, P.J. (1977). Formulation and Establishment of Stochastic Frontier Production Function Models. Journal of Econometrics. 6:21-37.

Asodiya P, Suresh kumar, Kashinath S, Parth S, Parmar K. (2014) Input use, coststructure, return and resource use efficiency analysis of wheat crop in south Gujarat, India. *International Journal Agriculture Extension.*2 (1) 5-12

Banglapedia (2015). National Encyclopedia of Bangladesh. Asiatic Society of Bangladesh, Dhaka Bangladesh.

Baree, M,A. (2012).Measuring technical efficiency of onion (allium cepa L.) Farms in Bangladesh‖. *Bangladesh J. Agril. Res.* 37(1): 171-178, March 2012.

BB (2017). Annual Review of Import Payments, Bangladesh Bank, Head Office, Bangladesh Bank, Motijheel, Dhaka.

BBS (2011). Household Income and Expenditure Survey-2010, Bangladesh Bureau of Statistics, Ministry of Planning, Government of the People's Republic Bangladesh, Dhaka.

BBS (2012). Community Report, Population and Housing Census, Bangladesh Bureau of Statistics, Ministry of Planning, Government of the People's Republic Bangladesh, Dhaka.

BBS (2013). Statistical Yearbook of Bangladesh, Bangladesh Bureau of Statistics, Ministry of Planning, Government of the People's Republic Bangladesh, Dhaka.

BBS (2014). Yearbook of Agricultural Statistics, Bangladesh Bureau of Statistics, Ministry of Planning, Government of the People's Republic Bangladesh, Dhaka.

BBS (2016). Statistical Pocketbook of Bangladesh, Bangladesh Bureau of Statistics, Ministry of Planning, Government of the People's Republic Bangladesh, Dhaka.

Beattie, B.R. and Taylor, C.R. (1985). The Economics of Production. Montana State University, John Wiley & Sons, New York.

BER (2017). Bangladesh Economic Review, Department of Finance, Ministry of Finance, Government of the People's Republic of Bangladesh, Dhaka.

Bhat A, Kachroo J, RIzvi SE, Sharma M, Singh SP (2013) Resource use efficiency of lemon cultivation in Jammu region of J&K state. *India Journal of Applied Research* 3(12): 2249-555.

Chile Pepper Institute (2007). The Story of chili pepper, Chile Pepper Institute News Letter, Las Cruces, New Mexico State University.

Daundkar KS, Bairagi SK (2015) Economics of production of capsicum in Akola district. *International Journal of Commerce, Business and* Management 8: 81-83. DOI: 10.15740/HAS/IJCBM/8 .1 /81-83.

Dillon, J.L. and Hardaker, J.B. (1993), Farm Management Research for Small Farmer Development, Food and Agricultural Organization, Rome.

Fuss, M. and Mcfadden,D. (1978). Production Economics: A Dual Approach to Theory and Application. North Holland, Amsterdam.

Haile, B.T. (2015). Determinants of Technical, Allocative and Economic Efficiencies among Onion Producing Farmers in Irrigated Agriculture. Vol. 10(20), pp. 2180-2189, 14 may 2015 DOl:10.5897/AJAR2015.9564 Article Number. 741D66D53034 ISSN 1991-637X.

Hanumanaikar, R.H., Rajeshwari, N. and Nimbal, M.F. (2006). Socio-economic status, constraints Faced and suggestions expressed by Chili growers in optimum use of pesticide in Tunga Bhadra project area of Bellary district. *Mysore Journal of AgriculturalScience.* 40(2):261-266.

Haque, M. Z. (2005). Comparative Economic Analysis of Onion and Garlic Production in a Selected Area in Santhia Upazila of Pabna District. M. S. Thesis, Department of Agricultural Economics, BAU, Mymensingh.

Heady, E.O. and Dillon (1969). Agricultural Production Functions. Iowa State University Press, Ames.

Hill et al. (2001), employed it in studying the profitability of incremental generic promotion of Australian dairy products in Australia.

Hill, D. J., Piggott, R.R and Griffith, G. R. (2001). Profitability of Incremental Generic Promotion of Australian Diary Products. *Journal of Agricultural Economics.* 26: 253- 266.

Hiremath et al., (2007). The increment in yield ranged between 25.80 to 32.20 percent. The percent increase in yield over local check was highest (32.20) during 2005-06 compared to local.

Hiremath SM and Hill. (2014). Yield gap analysis in onion under front line demonstration in Haveri District. *International Journal of science research,* 3 (10) 2277-8179.

Jagtap PP, Shingane UU, Kulkarni KP. (2012). Economics of chili production in India. *African Journal of Basic & Applied Sciences,* 4 (5): 161-164.

Janailin et al. (2014). found that the cost of production of turmeric is `15.68/kg, `60.93/kg and `/70.17/kg for fresh, semiprocessed and processed (powdered) form, respectively. Lack of knowledge about pest management is the major constraint faced by farmers in production whereas the fluctuation in disposal price of turmeric ranks first among the marketing constraints faced by farmers. Cultivation of turmeric in Meghalaya provides supplementary income to the farmers. The average yield of fresh turmeric in the study area is 49q/ha which on drying gives an approximate yield of about 14.5q/ha of semi-processed (dried) turmeric.

Jondrow, J., Lovell, C.A.K., Masterov, L.S. and Schmidt, P. (1982). On the Estimation of Technical Efficiency in the Stochastic Frontier Production Function Model. *Journal of Economics.* 19: 233-238.

Joshi NS, Bariya MK, Kunjadia BB. (2014). Yield gap analysis through front line demonstration in Wheat crop. *International Journal of Scientific and Research Publications,* 4 (9): 2250-3153.

Kariem, M.R.; M. Ahmed; A.K.M.H. Haqque and A.S.H.M. Talukdar (1999). Contribution of factors to summer chilli productivity differential between large and small farms in Bangladesh. *Thai J.Agric. Sci.,* 32(3): 377-383.

Karthik V and Amarnath JS (2013) an economic analysis of turmeric production in Tamil Nadu, *India Direct Research Journal of Agriculture and Food Science,* Vol.2 (6): 66-76.

Korikanthinath,V.S.; Govardhan Rao; G.M. Hiremath; K.V. Peter and G. Rao (2000). Resource productivities and their optimum utilization pattern in chilli based mixed cropping system — An Economic analysis, 57(1):83-86.

Mahawar DK, Grover DK. (2014) Economics of turmeric cultivation in Punjab. *Indian Journal of economics and Development,* 10(4):1- 25.

Mahmood, S. M. Q. (1995). Marketing of Selected Spices in Comilla District of Bangladesh. M. S. Thesis, Department of Agricultural Economics, BAU, Mymensingh.

Mannan,S.A. (2001). An analysis of agro-economic potentials of jute production in Bangladesh, Ph. D. thesis, Bangladesh Agricultural University. Mymensingh.

Mishra J.P.,Vishwakaram R.S. and Rawat K. (1999). Production and marketing of chillies. *The Bihar journal of Agricultural Marketing* 7(1): 36-43.

Mohammad H and Mondal (2011). Causes of yield gaps and strategies for minimizing the gaps in different crops of Bangladesh. *Bangladesh J. Agril. Res.* 36(3): 469-476.

Mutkule, S. R., Wattamwar, V. T., Narkar, G. S. and Geete, M. H. (2001). Constraints in adoption of chili technology. *Maharashtra Journal of Extension Education* 20: 85-87.

Olayiwola (2014). An economic analysis of chili crop production in Ilora area of Oyo State. *International Monthly Refereed Journal of Research,* Management & Technology 3: 47-53.

Ovhar ND and Dhenge SA. (2014). Constraints faced by turmeric growers about improved cultivation practices. Trends in Biosciences7 (19): 2999-3000.

Prajapati, M.R., Patel, V.T., Chaudhary, N.V. and Soni, M.C. (2002). Constraints experienced by chili growers in adoption of recommended chili technology. *Gujarat journal of Extension Education.* 12-13: 55-58.

Rahman, A.B. Siddique, M.A. Salam, M.F. Kabir and M.S. Mahamud (2003). Farm Level Evaluation of T. Aman Rice Cultivation in Selected Saline and Non-Saline Areas of Bangladesh, *IOSR Journal of Agriculture and Veterinary Science,* 4(4), 2013a, 91-98.

Rahman, A.B. Siddique, M.A. Salam, M.A. Islamand M.S. Al-faisal (2014). Assessment of Technical Efficiency of Rice Farmers in a Selected Empoldered Area of Bangladesh, *European Journal of Agricultural Sciences,* 10, 2013b, 102 110.

Rahman, M.Z. (2000), Effect of spacing on the growth, yield and storability of some garlic germplasm, M.S. in Horticulture thesis, Bangladesh Agricultural Universim, Mymensingh.

Rahman, M.A. Bashar, M.F. Kabir, M.I. Kaysar and K. Fatema, (2013). Estimating the Technical Efficiency of Maize Production in A Selected Area of Bangladesh. *International Journal of Innovative Research & Development*, 2(11), 2013, 449-456.

Rahman, T.H. Miah and M.H. Rashid (2013). Technical Efficiency of Fresh Water Golda Farming in Empoldered Area of Bangladesh, *Asian Academic Research J ournal of Multidisciplinary,* 1(25), 2014, 246-259.

Rajput, H.D., Supe, S.V. and Chinchmalatpure, U.R. (2007). Factors association for declining Chili area and its diversification. *Indian Research Journal of Extension Education* 7(2): 76-78.

Piya, A. Kiminami and H. Yag (2012). Comparing the Technical Efficiency of Rice Farms in Urban and Rural Areas: A Case Study from Nepal. Trends in Agricultural Economics, 5(2), 2012, 48-60.

S. Rahman, (2003). Profit Efficiency among Bangladesh Rice Farmers, Proceedings of the International Conference of Agricultural Economists, Durban, South Africa, 2003, 591-604.

Sanusi MM, Ayinde IA (2013) Profitability of pepper production in derived Savannah zone of Ogun State, Nigeria. *International Journal of Agriculture and Food Security* 4: 401- 410.

Serajul Islam, Mostafizur Rahman kM, Kamrul Hasan. (2011) profitability and resource use efficiency of producing major spices in Bangla-desh. *Bangladesh Journal Agricultural Economics*, 56 (1-2) 1-13.

Sharma, A.K.; T.V. Moorthy and R.C. Oberoi (1992). Economics of vegetable farming in mid hills of Himachal Pradesh. *Agricultural Situation in India*, XLVII (1):11

Sharma, R.C. and D.C. Pant (1988). Impact of regulation on marketing of vegetables, *Indian Journal of Marketing*, 2(1): 91-92.

Shrivastava, K.K. (2003). Constraints of chili cultivation and their suggestions in Kheda district of Gujrat. Krishi Vistar Samiksha. 13(1):18-21.

Shrivastava, K.K., Trivedi, M.S. and Lakhera, M.L. (2002). Knowledge and adoption behaviour of Chili growers. Agricultural Extension Review. 7(8): 22-25.

Singh Moorat (2012). A study on extent of adoption of recommended chili production technology among the farmers of Abhanpur block of Raipur district of Chhattisgarh state.MSc. (Ag.) Thesis submitted to Indira Gandhi Krishi Vishwavidyalaya Raipur (C.G.).

Singh Moorat (2012). A study on extent of adoption of recommended chilli production technology among the farmers of Abhanpur block of Raipur district of Chhattisgarh state.MSc. (Ag.) Thesis submitted to Indira Gandhi Krishi Vishwavidyalaya Raipur (C.G.).

T.S. Hyuha, (2007). Analysis of Profit Inefficiency in Rice Production in Eastern and Northern Uganda, *African Crop Science Journal*, 15(4), 2007, 243-253.

Thakur, D.R.; T.V. Moorthi and H.R. Sharma (1990). Resource productivity and resource use efficiency in dryland agriculture. *Maharashtra J.Agril.Economics*, 2(1):38.

Umar AS and Abdulkadir MB. (2015). Analysis of resource-use efficiency and productivity of tomato Production in Kaduna State, Nigeria. *International Letters of Social and Humanistic Sciences* 5 (4):152-157.

Umoh, G.S. (2006). Resource use Efficiency in Urban Farming: An Application of Stochastic Frontier Production Function. *International Journal of Agriculture and Biology*.8 (1): 38-44.

Venkataramulu, M., Hanchinal, S.N. and Hirevenkanagoudar, L.V. (2010). Adoption of improved cultivation practices among chili growers. *Karnatak Journal of Agricultural Science* 22(5):722-725.

Vyas, D.L. (1989). Resource use and productivity in dry land agriculture in Nagpur district. Annual of Arid Zone, 28(1/2):37-45.