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

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BY

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CERTIFICATE

This is to certify that the research work entitled, **"PROFITABILITY AND TECHNICAL EFFICIENCY OF CHILI PRODUCTION IN SOME SELECTED AREAS OF BOGURA DISTRICT IN BANGLADESH"** conducted by **MD. AL IMRAN** bearing **Registration No. 13-05385** under my supervision and guidance in the partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE (MS) IN DEVELOPMENT AND POVERTY STUDIES** in the Faculty of Agribusiness Management, Sher-e-Bangla Agricultural University, Dhaka 1207, Bangladesh. No part of this thesis has been submitted for any other degree or diploma.

I further certify that any help or source of information received during this study has been dully acknowledgement by her/him.

Dated: June, 2020
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DEDICATED

TO

MY BELOVED PARENTS

ABSTRACT

The study aims to assess profitability and technical efficiency of chili. Hundred cultivators of chili from three upazila namely Kahaloo, Shonatola, Sariakandi under Bogura district were selected for study purpose. A structured questionnaire was constructed for data collection. The results are as descriptive statistics and interpreted based on farmer feedbacks. Findings include that total cost (TC) for chili is Tk. 131450.01; gross return (GR) of green chili is Tk. 191800; gross margin (GM) for green chili is Tk. 82191.40. All the calculations are based on per hectare. Thus, producing chili net return (NR) is Tk. 60349.99. The chili is attractive for farmers to produce as its benefit cost ratio (BCR) shows 1.4591 in our study. The regression coefficients of Seed cost and Irrigation cost and Insecticide were negative but the coefficient of Human labour, Total fertilizer cost, Insecticide cost was found negative. In the technical inefficiency effect model experience, farm size, extension service and credit service have expected (negative) coefficients. Average estimated technical efficiencies for chili are 85 percent which indicate that chili production could be increased by 15 per cent with the same level of inputs without incurring any further cost. Increase of only managerial skills result in a substantial increase of output for chili. Lack of agricultural credit, lack of farmer's association and lack of crop insurance were the major problems for green chili cultivation. Farmers expect to avail sufficient credit facilities along with regular government extension services, strong market monitoring authority and better transportation facilities for assisting chili cultivation. Moreover, a farmers' association is needed to be formed in chili production area. The study revealed that a considerable improvement took place to increase household income of the farmers in the study area and to improve the socioeconomic conditions with the introduction of large-scale commercial chili production. The study also identified some problems and constraints 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.

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The Author

June, 2020

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ABBREVIATIONS AND ACRONYMS

BRRI	: Bangladesh Rice Research Institute
BBS	: Bangladesh Bureau of Statistic
BCR	: Benefit Cost Ratio
BDT	: Bangladeshi Taka
BER	: Bangladesh Economic Review
DAE	: Department of Agricultural Extension
et al.	: and others (at elli)
GR	: Gross Return
Gm	: Gram
Ha	: 100 chili
HIES	: Household Income and Expenditure Survey
HYV	: High Yielding Variety
IOC	: Interest on Operating Capital
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 I

INTRODUCTION

1.1 General background

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.

The peoples of Bangladesh are usually used 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, chilies 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.

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.

1.2 Present status of spices in bangladesh

Spices are very important crop as food and as medicine. Spices are commonly used for cooking and seasoning of foods. It also could be used to change the look of food to make it more attractive in color. They are so important in ancient times and still today almost all people are habituated to use spices in curries and other food. They are known in different flavors and aroma. As medicine or food, the importance of spices cannot be over emphasized. Almost all curries are popular and tasty which are made from a combination of several spices. Species are also used as natural food preservatives. Pharmaceutically they have been used to flavor medicines. Spices are a broad term used to describe herbal by-products that add flavor and aesthetic, aromatic and therapeutic treatments to food, drink and other items. (Kumar *et al.,* 2011). Spices have some medicinal value such as turmeric is useful for reducing blood sugar, garlic is helpful for preserving memory and removing heart disease and ginger is well known for digestive property. Spices and condiments play quite an important role in the national economies of several spice-producing, importing and exporting countries of the world. Presently 109 kinds of spices are cultivated in the world but in Bangladesh we use only 27 and produce 17. On the basis of area, yield, demand and availability, spices are divided into three categories viz. major, minor and exotic. Major spices are regularly used in daily diet at large amount such as chili, onion, garlic, turmeric and ginger (Islam *et al.*, 2011). In Bangladesh, the area under the spice's cultivation is 3.96 lakh hectares with annual production of 24.88 lakh metric tons (BBS, 2016) and the annual demand of spices seeds are 30 lakh metric tons. Spices cover almost 2.60 percent of total cropped area in Bangladesh (BBS, 2016). In recent year, the production rate of major spices like onion, garlic, chili, turmeric and ginger are 17.35, 3.82, 1.30, 1.40 and 0.77 lakh tons respectively (BBS, 2016). Now-a-days, spices are valuable trade commodities in the world. They are expensive but widely used. The average price of onion is 27180 taka/ton, garlic is 110910 taka/ton, chili is 195990 taka/ton, ginger is 74490 taka/ton and turmeric are 275850 taka/ton (BBS, 2016).

The average area and production of spice are increasing in Bangladesh. However, there are some reports we found that shrinkage of land resources there is a limited scope to increase production of spice (Noor *et al.*, 2008). Therefore, a proper statistic of production and consumption is not available. The gap between demand and supply is also increasing. 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 foreign currency. The imported cost of onion is 19300 taka/ton, garlic is 163980 taka/ton and ginger are 64460 taka/ton (BBS, 2016).

Table 1.1 Area and production of spices and condiments in different years, (2000-01 to 2019-20)

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
2015-16	430	1953
2016-17	580	2149
2017-18	997	2587
2018-19	995	2667
2019-20	1046	2998

Source: BBS, 2020

1.4 Area, production and productivity of chili in bangladesh

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 nightly temperature falls below 12°C. Growth will be inhibited if temperatures fall below 15°C. Chili plants is a type of seasonal crops (annual plant) which only live for one season then died. If cultivated this plant can grow and produce for several months after planting after which it will die.

Chilies plants should be watered regularly to avoid 'flooding' them at wide intervals. Overwatering on a regular basis will cause the roots to root. 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 every few weeks should be applied which are necessary for the plants fruiting heavily.

Chili are harvested when the chilies are either green or red. Red chilies are hotter than green chilies. If anyone wants to harvest green chilies, allow them to grow as large as possible. Harvesting of chilies should be done when they start to turn red. Clip the chilies 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 due to lack of high yielding variety and method of production practices followed by the local growers.

The area under chili production 252 thousand acres and the production 130 thousand ton and the average yield 1.32 ton/ha (BBS 2016). The area of cultivable land for chili production is decreasing day by day whereas the demand of 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 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 drops despite same area of cultivation.

1.5 Economic importance of the crop

Chili is an important cash crop. In our country, mainly chili is known as spice crop. It is in high demand both raw and cooked. Nutritious raw chilies are rich in vitamins A and C. Chili is an essential ingredient in everyday cooking to bring variety in color, taste and flavor. In our country, it is not possible to think of cooking any vegetable without chili. There is also a lot of demand for chili sauce to enhance the taste of different foods. Moreover, it also has medicinal properties. It is cultivated in almost all regions. However, chili production is higher in the char areas. Chili is considered as the main agricultural crop in different char areas of Bangladesh. Moreover, chili is cultivated on a commercial basis in North Bengal and Chittagong. According to a statistic, a total of 1.02 lakh hectares of land is cultivated and produced 1.03 lakh MT (dried chili) during Rabi and Kharif seasons in this country. Average yield 1.28 tons / ha. (Dried chili). Many farmers in Bangladesh make a living by producing only chili.

Two types of chilies are cultivated in Bangladesh. Namely less salty or unsalted and salted chili. Salted chilies are used in pickles, green vegetables and salads. Salted chili is mainly used as the main spice. It is slender and long. Chili is bitter for a chemical called capsaicin and bright and red for a pigment called capsaicin. The yield of chili can be increased by adopting improve 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 needs to bring improvement in production technologies as well as considering economic return. If nature favors, farmers get moderately good harvest.

1.6 Statement of the problem

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 nightly temperature falls below 12°C. Growth will be inhibited if temperatures fall below 15°C. Chili plants is a type of seasonal crops (annual plant) which only live for one season then died. If cultivated this plant can grow and produce for several months after planting after which it will die. Chilies plants should be watered regularly to avoid 'flooding' them at wide intervals. Overwatering on a regular basis will cause the roots to root. 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 every few weeks should be applied which are necessary for the plants fruiting heavily. Chili are harvested when the chilies are either green or red. Red chilies are hotter than green chilies. If anyone wants to harvest green chilies, allow them to grow as large as possible. Harvesting of chilies should be done when they start to turn red.

Clip the chilies 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 due to lack of high yielding variety and method of production practices followed by the local growers. The yield of chili can be increased by adopting improve 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 needs to bring improvement in production technologies as well as considering economic return. If nature favors, farmers get moderately good harvest.

1.7 Objectives of the study

1. To assess the present socio-economic characteristics of chili growing farmers.
2. To estimate the profitability of chili cultivation.
3. To find out the technical efficiency of chili production.

4. To identify the constraints and to suggest some policy guidelines for efficient chili cultivation.

1.8 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 50 decades, spices were exported outside the country. But their production and per capita availability had been decreasing from 80 decades. To mitigate this 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.

The area of cultivable land for crop production as well as chili production is decreasing day by day. The demand for chili is increasing but production cannot meet up the existing demand. For meeting the deficit, the government of Bangladesh has to import a large volume of chili and some major crops at the cost of hard-earned foreign currency. To lessen the pressure on the foreign currency, the spices production must be increased to meet up the country's demand. 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 significance 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 efficiency of 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 the further research to the researchers. 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.

1.9 Organization of the study

The study consists of 9 chapters. Chapter 1 describes introduction of the study. Relevant review of literature, methodology, description of the study area, socioeconomic characteristics of the sample farmers, results and discussion, major factors affecting to the production processes of chili, problems of chili growers and summary, conclusion and recommendations are presented in Chapter 2, Chapter 3, Chapter 4, Chapter 5, Chapter 6, Chapter 7, Chapter 8 and Chapter 9, respectively.

CHAPTER II

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 Analysis of chili Production in Some Selected Areas of Bogura District in Bangladesh.”** A brief account of the work reported by the past researchers has been discussed under the following heads:

1. Studied on production.
2. Resource productivity and resource use efficiency
3. Studies on constraints.

2.1 Studied on production

Chili peppers originated in the lowlands of Brazil in a location called the “nuclear area” it has the greatest number of wild species of chili peppers in the world today. Scientists believe that birds are mainly responsible for the spread of wild chili peppers out of the area. They (birds) do not have the receptors in their mouths that feel the “heat” and a bird’s digestive system does not harm the chili pepper seed. So, while birds could go around gathering up the small fruits and consuming them with no adverse effects, dispersed seeds would grow into new plants (**Chile Pepper Institute, 2007**).

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.

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).

Rahman *et al.* (2014) studied about the technical efficiency of fresh water golda (Macro brachium 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.

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.* (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 & Ayinde (2013) designed the study to investigate the profitability in pepper production in Nigeria. The mean of different socio-economic characteristics were estimated such 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.

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, labour and capital cost was estimated to the positive values 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.

Jagtap *et al.* (2012) stated that chili (Capsicum annuum L.) is most widely used and universal spice of India. The study was conducted in Achalpurtahsil 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' were Rs. 19329.52, Rs. 24114.79 and Rs. 21400.51 per acre and input-output ratio at cost 'C' was 1**.**

Mohammad (2011) stated that 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.

Haque (2005) conducted a comparative economic analysis of onion and garlic production in a selected area in Sathia 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 efficiency 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.

2.2 Resource productivity and technical use efficiency

Adinarayan (1967) reported on the basis of production function analysis that only area under chilies and human labour was 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.

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.

Thakur *et al.* (1990) studied the resource use 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.

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

Kariem *et al.* (1999) carried out estimate the neutral technology, non-neutral technology and 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 appeared 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 labour, top dressing, animal power and weeding between large and small farms. Small farms were more productive than large farms.

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 inputs except nitrogenous and phosphatic fertilizers of which former found to bear a significant effect on output, while seeds and human labour in spite 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.

Hireematha and Hilli (2012) conducted frontline demonstrations were conducted 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 of 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 Byadagikaddi and Byadagidabbi 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 Byadagidabbi compared to Byadagikaddi. While the extension gap (1.60) was maximum in Byadagikaddi. The higher gross returns, net returns and B:C ratio were recorded in both varieties compared to their respective local/check plots.

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 to identify the constraints in production and suggest 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.

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 per cent, respectively, while as in case of irrigation, plant protection and training/ pruning one per cent additional investment could decrease the production by 0.011 per cent, 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.

Ovhar and Dhenge (2014) the sample constituted 90 Turmeric farmers drawn from10 villages from the Buldhana district of tow panchayatesamiti namely Lonar and Mehkar. The exploratory design of social research was used. Finding revealed that(72.22%) majority of turmeric growers faced with constraints like Low price of turmeric crop, one third of turmeric growers (63.33%) faced with constraints like Non availability of labour at the time of transplanting and harvesting, one third of turmeric growers (60.11%) faced with constraints like faced with constraints like Irregular supply of electricity and Non availability of storage facilities, majority of turmeric growers (50.56%) faced with constraints like Inadequate availability of improved seed, turmeric growers (40.00%) faced with constraints like High wages of labour,(38.89%) turmeric growers faced with constraints like Inadequate sources of finance for agriculture and (22.22%) turmeric growers faced with constraints like Inadequate availability of FYM.

Janailin *et al.* (2014) 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 14.7q/ha of semi-processed (dried) turmeric. The share of variable cost is 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 in disposal price of turmeric ranks first among the marketing constraints faced by farmers.

Asodiya *et al*. (2014) present study was designed to measure input use, cost structure, return and resource use efficiency in wheat production of South Gujarat division of Gujarat, India. In present investigation the sample of 240 Wheat farmers were 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. We were 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 increase by less than 1%.

Joshi *et al.* (2014) the present study was undertaken to find out the yield gap through FLDs on wheat crop. Krishi Vigyan Kendra, JAU, Amreli (Gujarat) conducted 100 demonstrations 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 DK. And Grover DK. (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 return 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.

Hiremath and Nagaraja (2014) studied Problems of onion production and their solution at farming situation were studied with the participation of this regard, under technology development and refinement, 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 years variety Arkakalyan performed superior over local check. The gross returns, net returns and B: C ratio (1:3.43) recorded highest in Arkakalyan 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 Arkakalyan have shown increased yield over local variety.

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.

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, 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 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 14.7q/ha of semi-processed (dried) turmeric.

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. Our analysis further 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, labour 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 elasticities 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.

2.3 Studies on constraints

Mutkule *et al.* (2001) reported that important constraints experienced by the chili growers were 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.

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 inadequate quantity (84.83 percent) and erratic 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, on-sufficient and timely credit, non-availability of seed of S-49 variety in time, improper market and non- availability of fertilizers and pesticides.

Shrivastava (2003) revealed that the problems of 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.

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.

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), 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.

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.

Singh (2012) studied on 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's. 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.

CHAPTER III

METHODOLOGY

3.1. Introduction

Farm management research depends on the proper methodology of the study. Proper methodology is a prerequisite of a good research. The design of any survey is predominantly determined by the nature, aims, and objectives of the study. It is 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 jute 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-District namely Kahaloo, 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) No study of this type was conducted previously in these areas;

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

e) 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 2020. 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 manner consistent with the theory of production function Cobb-Douglas type stochastic frontier production function will be used in the present study.

3.8.1. Economic profitability analysis

The net economic 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 variable cost items identified for the study were as follows-

- Land preparation
- Hired labour
- Family labour
- Seedlings
- Urea
- TSP
- Mop
- Insecticide
- Irrigation

Fixed costs are as follows

- Interest on operating capital
- Land use

3.8.1.1 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 ploughings varied from farm to farm and location to location.

3.8.1.2 Cost of human labour

Human labour 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 labour cost, the recorded man-days per hectare were multiplied by the wage per man-day for a particular operation.

3.8.1.3 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.

3.8.1.4 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.

3.8.1.5 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.

3.8.1.6 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.

3.8.1.7 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.

3.8.1.8 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 needed per hectare and how was its cost.

3.8.1.9 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 / 3
t = Total time period of a cycle

3.8.1.10 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.

3.8.1.11 Calculation of returns

3.8.1.11.1 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.

3.8.1.11.2 Gross margin

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

3.8.1.11.3 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

3.8.1.11.4 Undiscounted benefit cost ratio (bcr)

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

BCR = Total return (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) and Meeusen and van den Broeck (1977). It was later extended and elabourated by Schmidt and Lovell (1979; 1980) and 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

$$Y_i = f(X_i, \beta) \exp.(V_i - U_i) \qquad i = 1, 2, 3, \ldots\ldots\ldots, N \qquad (3.1)$$

Where the stochastic production frontier is f (X_i, β) 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, β) 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

$$Y = a \prod_{i=1}^{\lambda} X_i^{bi} \exp.(\mathcal{E}) \qquad (3.2)$$

Where Y is the frontier output, X is physical input, b the elasticity of Y with respect to X, a is intercept and $\mathcal{E}$ = V-U is a composed error term as defined earlier. For simplicity, we have ignored the subscript. The above model also can be expressed in the following logarithmic form;

$$\ln Y = b_o + \sum_{i=1}^{k} b_i \ln X_i + V - U \qquad (3.3)$$

Where b_0 = In a.

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:

$$Y = \beta_0 X_1^{\beta 1} X_2^{\beta 2} \ldots\ldots\ldots. X_6^{\beta 6} e^{Vi-Ui} \quad (3.4)$$

The above function is linearized double-log form:

$$\ln Y = \ln\beta_0 + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + \beta_4 \ln X_4 + \beta_5 \ln X_5 + V_i - U_i \quad (3.5)$$

Where,

Y = Output (Kg/ha)

X_1 = Human labour (Man days/ha)

X_2 = Irrigation cost (Tk./ha)

X_3= Seed (Kg/ha)

X_4 = Fertilizer (Kg/ha)

X_5 = Cost of insecticide (Tk./ha)

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

$$U_i = \delta_0 + \delta_1 Z_1 + \delta_2 Z_2 + \delta_3 Z_3 + \delta_4 Z_4 + \delta_5 Z_5 + \delta_6 Z_6 + W_i \quad (3.6)$$

Where,

Z_1 = Chili farming experience

Z_2 = Varity

Z_3 = Education

Z_4 = Training

Z_5 = Experience

Z_6 = Distance of Market

The equation can be written as:

$U_i = \delta_0 + \delta_1$chili farming experience + δ_2Education + δ_3Farm size + δ_4Contact with AEO + δ_5Training + δ_6Taking loan + W_i (3.7)

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

The β and δ coefficients are unknown parameters to be estimated together with the variance parameters which are expressed in terms of

$$\sigma^2 = \sigma_u^2 + \sigma_v^2 \text{ and } \gamma = \sigma_u^2/\sigma^2$$

Where γ parameter has value between zero and one.

CHAPTER IV

DESCRIPTION OF THE STUDY AREA

This section deals with various demography features like population, literacy rate urban and rural area and sex ratio in the study area. All these indicates are presented in the following sub section.

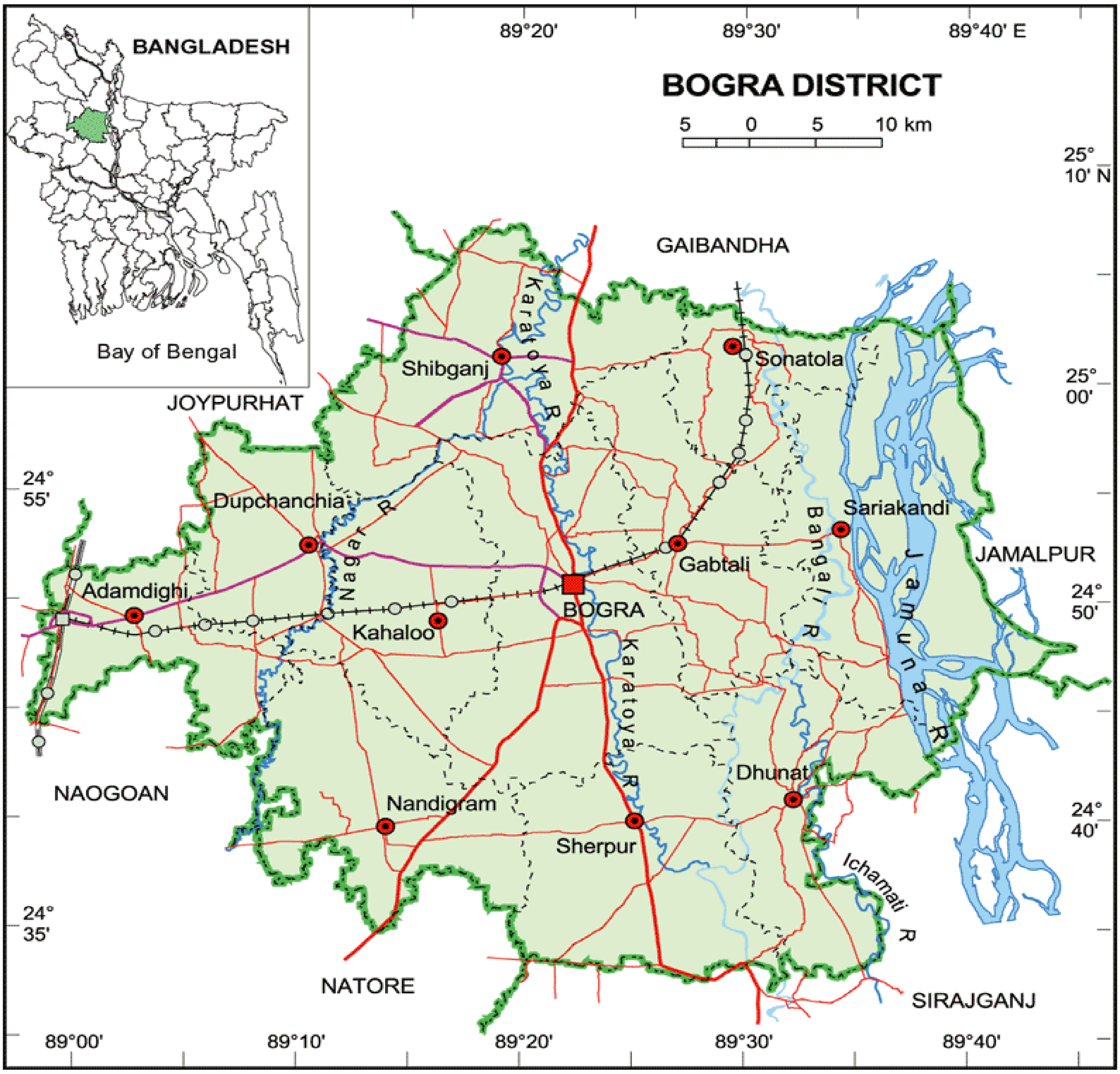

Figure 4.2: Map of Bogura District

4.2 Distribution of landholdings

The distribution of land holdings according to size and the total cultivated area falling in each category are given in table 3.6. It is clear from this table that concentration of marginal farmers are more as compare to small, medium and large groups, implying that the majority of land owners are in marginal categories in the district. The largest number of holdings falls under marginal farm size category. However, farmers in this category owned only a small proportion of the cultivated land. It is important to note here that about 54 percent marginal farmers depend on about 14 percent land only while remaining 46 percent farmers have 86 percent of total cultivated land.

Table 4.2: Distribution of land holdings in bogura district, 2013-14

Sl .No.	Size of Holdings	Number of Holdings	Area (ha)
1.	Marginal (up to 1.00 ha)	98530 (53.78)	42538 (13.58)
2.	Small (1.0 – 2.00 ha)	38591 (21.06)	56878 (18.16)
3.	Medium (2.0 – 4.00 ha)	43251 (23.61)	169077 (53.99)
4.	Large (above 4.00 ha)	2844 (1.55)	44662 (14.27)
Total		183216 (100.00)	313155 (100.00)

Note: Figures in parentheses indicate percentage of total holdings and total area in the respective column.

Source: Department of Agriculture, Bogura.

4.3 Land use pattern

Bogura district has total geographical area of 670442 hectares. The permanent cropped area has 4535 hectares which is 22.93 percent of total geographical area. About 8 percent land is not available for cultivation while about 4 percent land under fallow of the total geographical area. The net and gross cropped area is about 42 percent and 47 percent respectively of the total geographical area of the district. The cropping intensity is 112.07 percent only. The detail information about the land use pattern is presented in table 3.3.

Table 4.3: Land use pattern in the study area (According to Census 2011)

Sl. No.	Particulars	Area (ha)
1.	Total area	670442
2.	Permanent cropped area	4535
3.	Temporary cropped area	551807
4.	Current fallow	2387
5.	Others	111713
6.	Net sown area	275905
7.	Gross sown area	309145
8.	Cropping intensity (%)	289

4.5 Source of irrigation

The different sources of irrigation in the Bogura district are shown in Table 3.9. The Table clearly point out that the maximum are irrigated by low lift pump (400286 acre.) which is the largest percent of the total irrigation in the Bogura district followed by Tube well (217010 acre.) Ponds and channels are other source of irrigation which are covering 20785.96 acre and 600 acres of total irrigated land respectively in Bogura district.

Table 4.5: Source-Wise Irrigated Area and Number of Sources in Bogura district (According to Census 2011)

Sl.No.	Source of Irrigation	Number	Area (acre)
1.	Tube well	2814	217010
2.	low lift pump	73995	400286
3.	Cannels	100	600
4.	Ponds	54106	20785.96
5.	Others	75	385

4.6 Administrative units

Bogura district is administratively divided into 12 sub-districts and 11 Municipality. Out of these, 113 wards in the district. The district consists 2618 villages. Bogura district is administratively divided into 1613 mauza. The whole information related to Bogura district is provided in Table (3.6)

Table 4.6 Administrative units of the bogura district (according to census 2011)

Sl. No.	Units	Number
1.	Sub-Division	12
2.	Municipality	11
3.	Ward (PSA)	113
4.	Mahalla	362
5.	Total Union	110
6.	Mauza	1613
7.	Village	2618

CHAPTER V

SOCIO-ECONOMIC PROFILE OF HOUSEHOLD POPULATION

5.1 Introduction

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

5.2 Composition of the family size

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

Table 5.1: Average family size and distribution of members according to sex of the sample farmers

Particulars	Kahaloo Upazila		Shonatola Upazila		Sariakandi Upazila		All Farmers		Natl. Avg. Family Size
	No.	%	No.	%	No.	%	No.	%	
Male	3.15	60.58	3.05	60.64	2.85	49.14	3.02	56.46	
Female	2.05	39.42	1.98	39.36	2.95	50.86	2.33	43.54	4.06
Total	5.20	100.00	5.03	100.00	5.80	100.00	5.34	100.00	

Source: Field Survey, 2020

5.3 Age

There are 30, 35, 35 samples are collected from three upazila named respectively Kahaloo, Shonatola and Sariakandi represented the total population. In Kahaloo upazila, 40percent of the sample populations were 20-40 years, 40 percent were 40-60 years and 20 percent were above 60 years old. In Shonatola upazila, 40 percent of the sample populations were 20-40 years, 30 percent were 40-60 years and have 18 percent found sample were above 60 years old. In Sariakandi upazila, 40 percent of the sample populations were 20-40 years, 40 percent were 40-60 years and 10 percent sample found who were above 60 (Figure 5.1). In this figure we saw most of the people age between 20 to 40 years in every upazila.

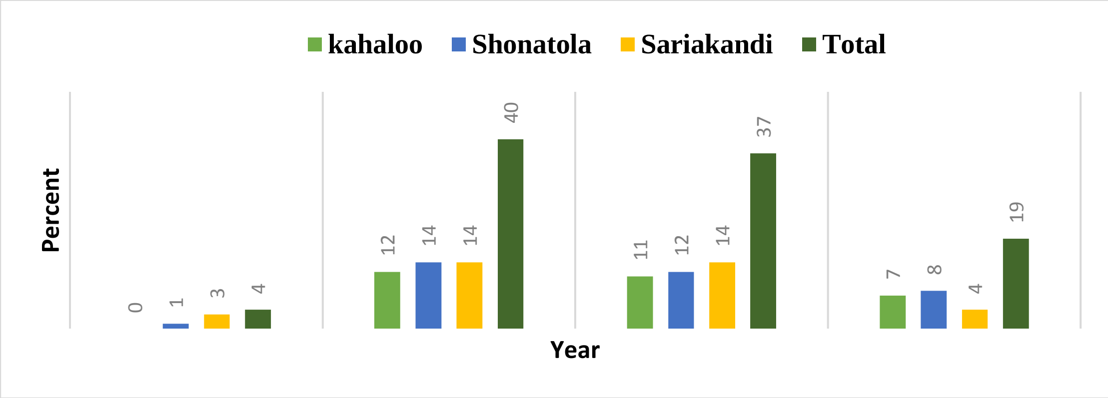

Figure 5.1: Age of the Respondent by Study Area
Source: Field survey, 2020

5.4 Education

Figure 5.2 showed that, in Kahaloo upazila, about 10 percent of the study population aged 5 years or more were found to have no education and/or read/write, about 27 percent were found to have primary level education, about 45 percent were found to have secondary and/or higher secondary level education and 10 percent people were found to have attained/completed graduation level of education. In Shonatola upazila, about 5 percent of the study population aged 5 years or more were found to have no education and/or read/write, about 30 percent were found to have primary level education, about 50 percent were found to have secondary and/or higher secondary level education and 7 percent people were found to have attained/completed graduation level of education. In Sariakandi upazila, about 8 percent of the study population aged 5 years or more were found to have no education and/or read/write, about 20 percent were found to have primary level education, about 45 percent were found to have secondary and/or higher secondary level education and 11 percent people were found to have attained/completed graduation level of education.

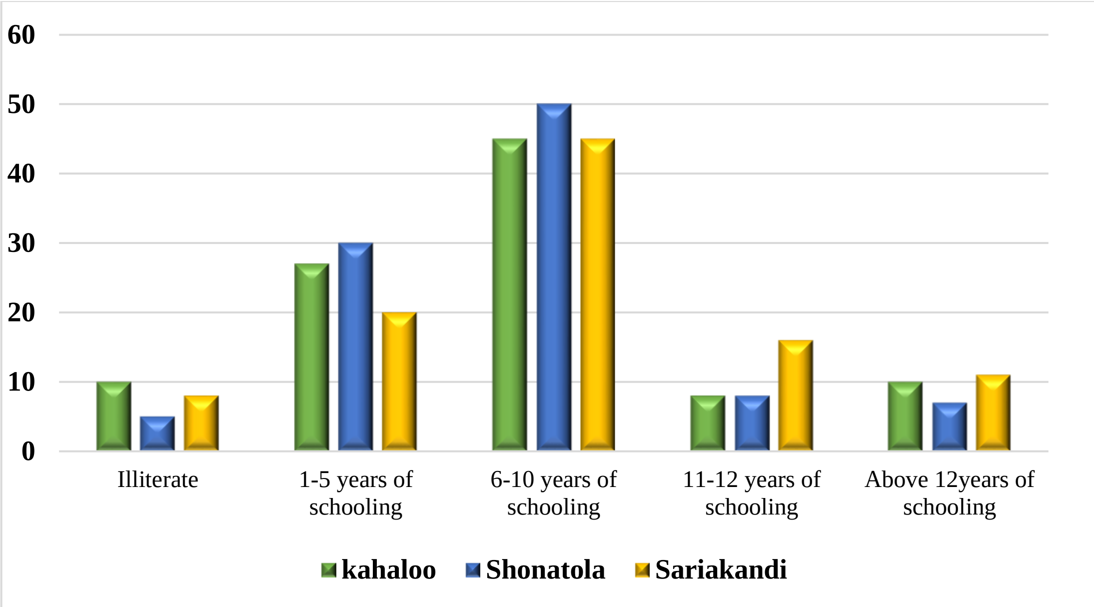

Figure 5.2: Education of the Household Members by Study Area
Source: Field survey, 2020

5.5 Annual family income

a) Agricultural work

Table 5.2: Agricultural work

Sector	Average Annual Income (Tk)	Mean
Crops	85600	206380
Poultry	65780	
Livestock	35000	
Fisheries	20000	

Crops, poultry, livestock and fisheries are the main agricultural income source of the sample. Most of the framer generate income by agriculture sector. Crop production was the main source of income among them average yearly income from crop production found TK 85600. Now a day's poultry and dairy farm have been developed in the study area. Farmers Tk. 65780yearly income from poultry. The mean value of annual family income by agriculture was Tk. 206380.

b) Non-agriculture work

Main non agriculture was found day labour, Auto driver, Truck driver, domestic worker, small business, foreign remittance, services. Annual average income by non-agriculture source was found Tk130900. The total average annual income was found Tk337280.

5.6 Annual family expenditure

Sample farmer, annual average expenditure was found Tk. 295850. Main family expenditure was use for food consumption. Others main cost were child's education cost, clothing cost, medicine cost transportation, festival cost, entrainment cost etc. Average annual family savings was found Tk41430.

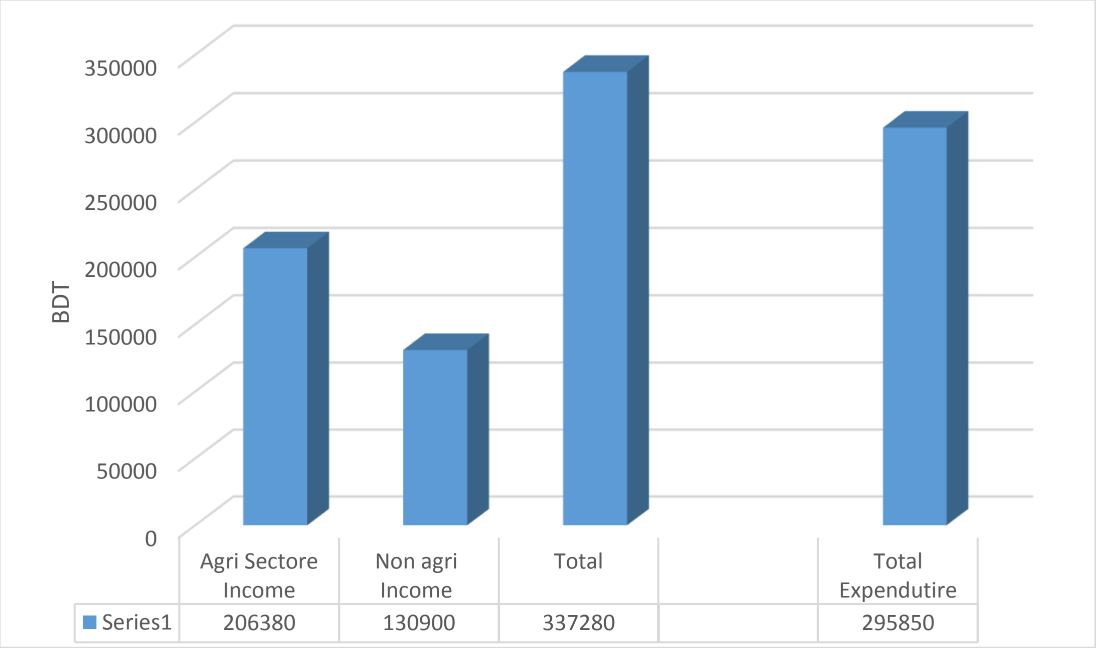

Figure 5.3: Annual Family Income and Expenditure by Study Area
Source: Field survey, 2020

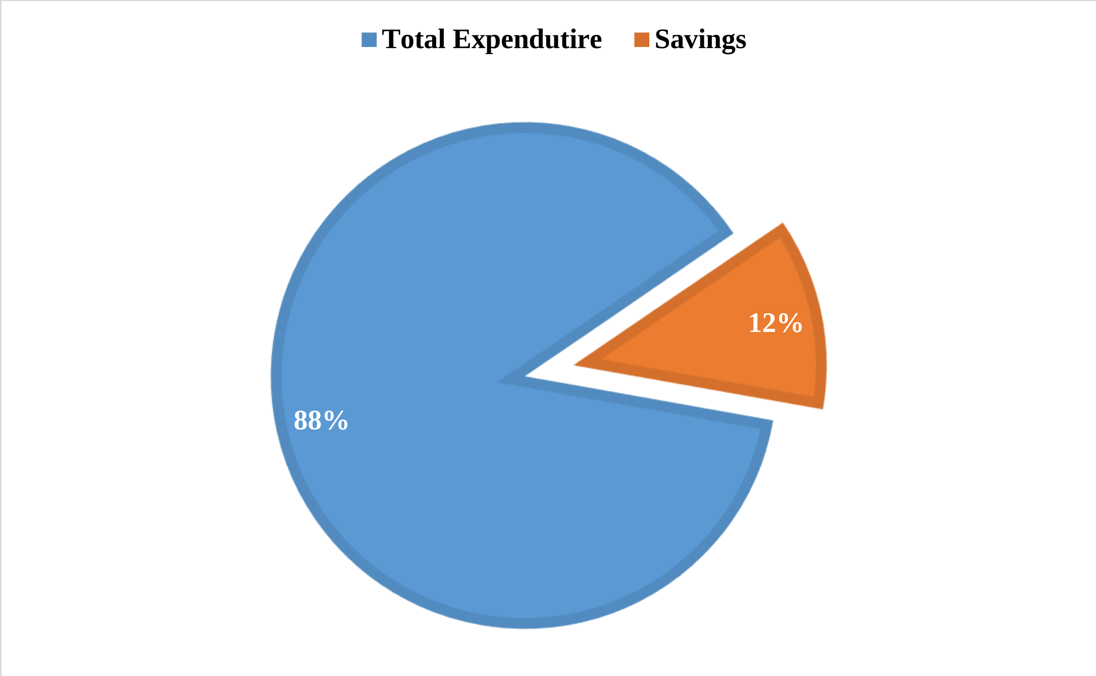

Figure 5.4: Annual Family Expenditure and Savings by Study Area
Source: Field survey, 2020

5.7 Agricultural training

Among the respondent farmers in Kahaloo upazila, only 73.3 percent farmers got training on chili cultivation whereas, about 86 percent farmers got training in Shonatola upazila, and 86 percent farmers got training in Sariakandi upazila (Table 5.3). These training have improved their perceptions of good seed use, use of resistant varieties, application of insecticides and pesticides, water management, and so on. Most of the training by Spices Research Center (SRC) on hybrid chili cultivation method.

Table 5.3: Agricultural Training of the Respondent by Study Area

Training Received	Kahaloo Upazila		Shonatola Upazila		Sariakandi Upazila		All farmer	
	No.	%	No.	%	No.	%	No.	%
Yes	22	73.3	30	85.71	30	85.71	82	82.00%
No	8	26.7	5	14.29	5	14.29	18	18.00%
Total	30	100	35	100	35	100	100	100

Source: Field survey, 2020

5.8 Membership of any social organization

Among the respondent farmers in Kahaloo upazila, 93.3 percent chili growers were found to have membership in different NGOs and/or farmers' organizations whereas Shonatola upazila 80 percent of chili grower's farmers had membership in different NGOs and/or farmers' organizations and 91.4 percent of cotton farmers had membership in different social organization in Sariakandi upazila (Table 5.4).

Table 5.4: Membership in any organization of the respondent by study area

Member ship	Kahaloo Upazila		Shonatola Upazila		Sariakandi Upazila		All farmer	
	No.	%	No.	%	No.	%	No.	%
Yes	28	93.3	28	80.00	32	91.4	88	88.0%
No	2	6.7	7	20.00	3	8.6	12	12.0%
Total	30	100	35	100	35	100	100	100

Source: Field survey, 2020

5.9 Concluding remarks

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

CHAPTER VI

PROFITABILITY OF CHILI PRODUCTION

6.1 Introduction

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

6.2 Profitability of chili production

6.2.1 Variable costs

6.2.1.1 Cost of land preparation

Land preparation is the most important components in the production process. Land preparation included ploughing, laddering and other activities needed to make the soil suitable for chili cultivation. For land preparation in chili production, no. of tiller was required 3 times with Tk. 1500 per tiller. Thus, the average land preparation cost of chili production was found to be Tk. 4500.00 per hectare, which was 3.42 percent of total cost (Table 6.1).

6.2.1.2 Cost of hired human labour

Human labour cost is one of the major cost components in the production process. It is one of the most important and largely used inputs for producing 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 average hired human labour used in chili production was found to be about 105 man-days per hectare and average price of human labour was Tk. 400 per man-day. Therefore, the total cost of hired human labour was found to be Tk. 42000 representing 31.95 percent of total cost (Table 6.1).

6.2.1.3 Cost of family labour

Human labour cost is one of the major cost components in the production process. It is one of the most important and largely used inputs for producing 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 average family supply labour (Without hired labour) used in chili production was found to be about 54 man-days per hectare and average price of human labour was Tk. 400 per man-day. If we pay those labour it was found to be Tk. 21600 representing 16.43 percent of total cost (Table 6.1).

6.2.1.4 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. 3500, which constituted 2.66 percent of the total cost (Table 6.1).

6.2.1.5 Cost of urea

In the study area, farmers used different types of fertilizers. On an average, farmers used urea 252.5 kg per hectare. Per hectare cost of urea was Tk. 4545, which represents 3.45 percent of the total cost (Table 6.1).

6.2.1.6 Cost of tsp

Among the different kinds of fertilizers used, the rate of application of TSP (180 kg). The average cost of TSP was Tk. 4500 which representing 3.42 percent of the total cost (Table 6.1).

6.2.1.7 Cost of mop

The application of MoP per hectare (130 kg) per hectare cost of MoP was found Tk. 2210, which represents 1.68 percent of the total cost (Table 6.1).

6.2.1.8 Cost of liam

Among the different kinds of fertilizers used Liam to remove acidic soil condition. The average rate of Liam (10.00 kg). The average cost of Liam was found Tk. 2500 which representing 1.90 percent of the total cost (Table 6.1).

6.2.1.9 Cost of insecticides

Farmers used different kinds of insecticides to keep their crop free from pests and diseases. The average cost of insecticides for chili production was found to be Tk. 2298.60 which was 1.75 percent of the total cost (Table 6.1).

6.2.1.10 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 helps to increase bulb diameter, number of cloves, and number of leaves and plant height. As a result, yield per hectare is being increased. The average cost of average irrigation was found 4 times in survey area and Tk 3200 to be per hectare, which was found Tk.3200 per heater that represents 2.43 percent of the total cost (Table 6.1).

Table 6.1: Per Hectare Costs of chili

Cost Items	Quantity	Price Per Unit (Tk.)	Costs/Returns (Tk ha-1)	% Of Total
A. Gross Return				
Main product (Green chili)	10500	18	189000.00	98.54
By-product				1.46
Total return			189000.00	100.00
B. Gross Cost				
C. Variable Cost				
Seed	7 packet of 25 gm	500	3500.00	2.66
Irrigation	4 times	800	3200.00	2.43
Power tiller	3 times	1500	4500.00	3.42
Hired labour	105 persons	400	42000.00	31.95
Family labour	54 persons	400	21600.00	16.43
Urea	252.5 kg	18	4545.00	3.46
TSP	180 kg	25	4500.00	3.42

MOP	130 kg	17	2210.00	1.68
Liam	10 kg	250	2500.00	1.90
Fertilizer's cost			13755.00	10.46
Manure	1000 kg	5	5000.00	3.80
Insecticides			2298.60	1.75
Total variable cost (TVC)			74253.60	83.38
D. Fixed Cost				
Land use cost			6500.00	14.07
Interest on operating capital			3341.41	2.54
Total Fixed cost (TFC)			31441.41	16.61
E. Total costs			105695.01	100.00

Source: Field survey, 2020

6.2.1.11 Cost of manure

It was observed in the present study area that farmers used cow dung for producing their enterprises. They bought a large portion of cow dung from the milk producers. It was found about Tk. 5000 per hectare.

6.2.1.12 Total variable cost

Therefore, from the above different cost items it was clear that the total variable cost of chili production was Tk. 109608.6 per hectare, which was **83.38** percent of the total cost (Table 6.1).

6.2.2 Fixed cost

6.2.2.1 Rental value of land

Rental value of land was calculated on the basis of opportunity cost of the use of land per hectare for the cropping period of four months. Cash rental value of land has been used as cost of land use. On the basis of the data collected from the chili farmers the land use cost was found to be Tk. 18500 per hectare, and it was 14.07 percent of the total cost (Table 6.1).

6.2.2.2 Interest on operating capital

It may be noted that the interest on operating capital was calculated by taking in to account all the operating costs incurred during the production period of chili. Interest on operating capital for chili production was estimated @ 9% as bank rate and calculated Tk. 3341.41 per hectare, which represents 2.54 percent of the total cost (Table 6.1).

6.2.3 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. **109608.6** (Table 6.1).

Table 6.2: Per hectare cost and return of chili production

Cost Item	Cost/Returns (Tk/ha)
A. Gross Return	191800.00
B. Variable Cost	109608.60
C. Fixed Cost	21841.41
D. Total costs	131450.01
E. Gross Margin (A-B)	82191.4
F. Net Return (A-D)	60349.99
G. Undiscounted BCR (A/D)	1.4591

6.2.4 Return of chili production

6.2.4.1 Gross return

Return per hectare of chili cultivation is shown in table 6.2. Per hectare gross return was calculated by multiplying the total amount of product with respective per unit price. It is evident from table that the average yield of chili per hectare was 10500 kg and the average price of chili was Tk. 18. By product from one hectare of land was 700 kg and the average of per kg by product was tk. 4. Therefore, the gross return was found to be Tk. 191800 per hectare (Table 6.2).

6.2.4.2 Gross margin

Gross margin is the gross return over variable cost. Gross margin was calculated by deducting the total variable cost from the gross return. On the basis of the data, gross margin was found to be Tk. 82191.4 per hectare (Table 6.2).

6.2.4.3 Net return

Net return or profit was calculated by deducting the total production cost from the gross return. On the basis of the data the net return was estimated as Tk. 60349.99 per hectare (Table 6.2).

6.2.5 Benefit cost ratio (undiscounted)

Benefit Cost Ratio (BCR) is a relative measure, which is used to compare benefit per unit of cost. Benefit Cost Ratio (BCR) was found to be 1.4591 which implies that one taka investment in chili production generated Tk. 1.4591 (Table 6.2). From the above calculation it was found that chili cultivation is profitable in Bangladesh.

6.3 Concluding remarks

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

CHAPTER VII

MAJOR FACTORS AFFECTING AND TECHNICAL EFFICIENCY OF CHILI CULTIVATION

7.1 Introduction

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

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

7.2 Interpretation of ml estimates of the stochastic frontier cultivation function

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

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

Table 7.1: ML estimates for parameters of cobb-douglas stochastic frontier cultivation function and technical inefficiency model for chili farmers.

Variables	Parameter	Coefficients	T-ratio	Standard error
Stochastic Frontier:				
Constant (X_0)	β_0	6.42**	2.02	3.186
Human Labour Cost (X_1)	β_1	0.5054***	3.27	0.399
Seed Cost (X_2)	β_2	-0.6230***	-3.29	0.189
Total Fertilizer cost (X_3)	β_3	0.01129*	1.73	0.304
Irrigation Cost (X_4)	β_4	-0.4258**	-2.28	0.187
Insecticide Cost (X_5)	β_5	0.3955***	3.26	0.121
Inefficiency Model				
Constant	δ_0	0.2808	0.17	1.684
Farm Size (Z_1)	δ_1	-0.1782***	-2.61	0.683
Varity (Z_2)	δ_2	0.8944	1.07	1.690
Education (Z_3)	δ_3	0.8853	0.96	1.470
Training (Z_4)	δ_4	-0.3493	-0.26	1.341
Experience (Z_5)	δ_5	-0.0554*	-1.82	0.030
Distance of Market (Z_6)	δ_6	0.5145**	2.15	0.374
Log-likelihood Function		54.08		

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

Human labour (x_1)

The regression coefficient of labour cost (X_1) of chili cultivation was positive and significant at 1 percent level of significance, which implied that if the expenditure on labour was increased by 1 percent, then the yield of chili would be increased by 0.5054 percent, other factors remaining constant (Table 7.1).

Seed cost (x_2)

The regression coefficient of seed cost (X_2) of chili cultivation was negative and significant at 1 percent level of significance, which implied that if the expenditure on chili seed was increased by 1 percent, then the yield of chili would be decreased by 0.6230 percent, other factors remaining constant (Table 7.1).

Total fertilizer cost (x_3)

The regression coefficient of Total fertilizer cost (X_3) of chili cultivation was positive and significant at 10 percent level of significance, which implied that if the expenditure on fertilizer was increased by 1 percent, then the yield of chili would be increased by 0.01129 percent, other factors remaining constant (Table 7.1).

Irrigation cost (x_4)

The regression coefficient of irrigation cost (X_4) of chili cultivation was negative and significant at 5 percent level of significance, which implied that if the expenditure on irrigation was increased by 1 percent, then the yield of chili would be decreased by 0.4258 percent, other factors remaining constant (Table 7.1).

Insecticide cost (x_5)

The regression coefficient of insecticide cost (X_5) of chili cultivation was positive and significant at 1 percent level of significance, which implied that if the expenditure on insecticide was increased by 1 percent, then the yield of chili would be increased by 0.3955 percent, other factors remaining constant (Table 7.1).

7.3 Interpretation of technical inefficiency model

In the technical inefficiency effect model Farm size, experience, and training have expected (negative) coefficients. The negative and significant (1 percent, and 10 percent respectively) coefficient of experience implies that experienced farmers are technically more efficient than non-experienced farmers. The negative coefficient of training postulates that trained farmer are more efficient than others. (Table 7.1)

The negative coefficient of Farm Size postulates that if farm size being large then farmer are technically more efficient than others. (Table 7.1)

The coefficients of farmer's age education and chili variety is positive and insignificant 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. (Table 7.1)

The positive coefficient of Market distance meaning that distance of chili market have no impact on the technical inefficiency. (Table 7.1)

Table 7.2: Frequency distribution of technical efficiency of chili farms

Efficiency (%)	No. of farms	Percentage of farms
0-60	5	5.00
61-80	26	26.00
81-90	40	40.00
91-99	29	29.00
Total number of farms	100	100
Minimum	0.10	
Maximum	0.99	
Mean	0.83	
SD	0.16	

7.4 Technical efficiency and its distribution

Table 7.2 shows frequency distribution of farm-specific technical efficiency for chili farmers. It reveals that average estimated technical efficiencies for chili are 83 percent which indicate that chili cultivation could be increased by 17 percent with the same level of inputs without incurring any further cost. Increase of only managerial skills result a substantial increase of output for chili. It was observed that about 30 percent of sample farmers were found to have received outputs which were very close to the maximum frontier outputs maintaining the efficiency level. On the other hand, 70 per cent of sample farmers obtained up to 80 percent technical efficiency level. The minimum and maximum technical efficiencies were observed to be 10 and 99 percent respectively.

7.5 Concluding remarks

From the above discussion on the maximum likelihood estimates for parameters of the Cobb-Douglas stochastic frontier cultivation function and technical inefficiency effect model for chili cultivation. It is easy to understand about the different the regression coefficients of Seed cost (X2) and Irrigation cost (X4) and Insecticide (X5) were negative but the coefficient of Human labor (X1), Total fertilizer cost (X3), and Insecticide cost (X4) was found negative. Average estimated technical efficiencies for chili are 85 percent which indicate that chili production could be increased by 15 per cent with the same level of inputs without incurring any further cost. Increase of only managerial skills result in a substantial increase of output for chili.

CHAPTER VIII

PROBLEMS AND CONSTRAINTS TO CHILI PRODUCTION

8.1 Introduction

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

8.2 Lack of operating capital

The farmers of the study area had capital constraints. For cultivation of chili, a huge amount of cash money was needed to purchase various inputs like, human labour, seed, fertilizers, pesticides, etc. about 93 percent chili farmers reported that they did not have sufficient amount of money for purchasing the required quantity of inputs for the relevant enterprises and marked this as high problem. (Table 8.1).

8.3 High price of quality seed

High price of quality seed was also one of the most important limitations of producing chili in the study area. From Table 8.1 it is evident that about 90 percent chili growers reported this as high problem.

8.4 High cost of irrigation water

Irrigation is the leading input for crop production. Yield of chili varies with the application of irrigation water. Most of the farmers had no shallow tube well or deep tube well of their own in the study areas and for this they had to pay a higher amount of money to the water supplier. But farmers reported that they had to pay higher charge for irrigation water. Table 8.1 shows that about 85 percent chili growers reported this as high problem. (Table 8.1).

8.5 Low price of output

Most of the farmers had to sell a large portion of their product at the harvesting period to meet various obligations like, household's expenditure and repayment of loan. But harvest time price of chili remained low because of ample supply. So, they could not get reasonable return for their products. It can be seen from Table 8.1 that 84 percent chili growers reported this as high problem.

8.6 Attack of pest and disease

The growers of chili were also affected by the problem of attack of pests and diseases. Pests and diseases attack reduce crop yield and increase cost of production. About 80 percent chili growers reported this as high problem (Table 8.1).

8.7 Inadequate extension service

During the investigation some farmers complained that they did not get any extension services regarding improved method of chili cultivation from the relevant officials of the Department of Agricultural Extension (DAE). As an agricultural extension personnel block supervisor, the main advisor of technical knowledge to the farmers about their farming problems. About 76 percent chili growers reported this as high problem (Table 8.1). Farmers of both areas marked that they hardly ever got help from the block supervisor and Agricultural Extension Officer.

8.8 Lack of quality seed

Lack of quality seed was one of the most important limitations of producing chili in the study area. From Table 8.1 it is evident that about 70.00 percent chili growers reported this as high problem. Farmers in both Upazilla’s told that they were cheated by buying so called hybrid seeds from the local markets and from the seed dealers.

8.9 Lack of scientific knowledge of farming

Although modern agricultural technologies have been using in the study area, a large number of farmers have no adequate knowledge of right doses and methods of using modern inputs and technologies of producing their enterprises. Near 70.00 percent chili growers were encountered this problem. (Table 8.1).

8.10 Shortage of human labour

Most of the human labour is being used during seed/seedling plantation and harvesting period of chili. Chili are labour intensive spices. Non-availability of human labour was found in different stages of production such as planting, intercultural operations and harvesting. Table 8.1 shows that near 70.00 percent of chili growers reported this as high problem.

8.11 Lack of quality tillage

Deeply ploughing is essential for successful crop production. Most of the farmers, who use hired power tiller, reported that hired power tiller owners did not till deeply. Never the less, they did not use all the tines when they till others land. Table 8.1 shows that 68 percent chili growers reported this as high problem.

8.12 Adulteration of fertilizer, insecticide, and pesticide

Chemical fertilizers, insecticides and pesticides are the most important inputs of chili production. They were being intensively used in chili production in the study area. Many farmers reported to have been cheated by applying adulterate fertilizers and pesticides in their crop field. It can be seen from Table 8.1 that near 65 percent chili growers faced this problem highly.

8.13 High price of fertilizers

Farmers claimed that non-availability of fertilizers at fair price was a problem in the way of producing enterprise. It appears from the table 8.1 that about 62 percent chili growers reported this as high problem.

8.14 Space shortage in the cold storages

Usually most of the fanners used to store their chili in their house. Lack of trained manpower was a great deal of spoilage of chili in the harvest and the post-harvest period. For this, they had to face some losses like losing weight and rotten of chili. It appears from Table 8.1 that only 50 percent of sample farmers faced the problem of poor storage facilities highly.

Table 8.1 Problems and constraints of chili production by no. of farmers

Type of Problems	No. of Farmers	Percentage of Farmers	Rank
Lack of operating capital	93	93.00	1
High price of quality seed	90	90.00	2
High cost of irrigation water	85	85.00	3
Low price of output	84	84.00	4
Attack of pest and disease	80	80.00	5
Inadequate extension service	76	76.00	6
Lack of quality seed	70	70.00	7
Lack of scientific knowledge of farming	70	70.00	8
Shortage of human labour	70	70.00	9
Lack of quality tillage	68	68.00	10
Adulteration of fertilizer, insecticide, and pesticide	65	65.00	11
High price of fertilizers	62	62.00	12
Poor storage facilities in house	50	50.00	13
Natural calamities	50	50.00	14

Source: Field survey, 2020

8.15 Natural calamities

It was found that chili growers faced some acute problems relating to the nature in their production process. Natural calamities like drought, hailstorm, excessive rainfall, caused substantial damage to the crop in the field. Farmers said that excessive rainfall during the harvesting period reduces both the quantity and storability of chili. Table 8.1 shows that almost 50 percent chili growers in reported this as high problem.

8.16 Concluding remarks

The above-mentioned discussions as well as the results presented in Table 8.1 indicates that chili growers in the study area have currently been facing some major problems in conducting their chili farming. 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.

CHAPTER IX

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

9.1 Summary

Bogura farmers are eying bumper production of chili every year. Sources of the Department of Agricultural Extension (DAE) said chili grew well as there was favorable weather throughout the season, and the farmers got proper advice on cultivating chili from the DAE officials. Farmers of Sariakandi, Sonatala, Gabtoli and Dhunat upazillas of the district see a good yield of chili on the river basins of Jamuna and Bangalee, according to the DAE. The Department of Agriculture Extension (DAE) has taken initiative for commercial chili cultivation in the district. Over 670 hectares of land in all the 12 upazilas have been brought under the farming of the vegetable. The DAE sources said a total of 1590 hectares of land were brought under the farming of the vegetable and the total production was 3220 tonnes in the district. The production of chilies is increasing gradually in Bangladesh, and so is the surplus, according to data from DAE. We should focus more on markets in Asia and the Middle East.

Chili are grown all over Bangladesh, not only for a huge home market but also for export purposes. Production of chili plays an important role in improving the economic conditions of farmer's especially marginal and small farmers and meeting the nutritional requirements and food safety 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.

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 upazillas namely Kahaloo, Shonatola and Sariakandi in Bogura was selected. A sample size of 100 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 chili in the selected areas were selected as samples. Farmers generally plant chili from mid- December to January and harvest after three months. Data for the present study have collected during the period of December 2019 to January 2020. Primary data were collected from primary producers. Selected respondents were interviewed personally with the help of pre-tested questionnaires. The collected data were checked and verified for the sake of consistency and completeness. Editing and coding were done before putting the data in computer. All the collected data were summarized and scrutinized carefully to eliminate all possible errors. Data entry was made in computer and analysis was done using the concerned software Microsoft Excel and STATA.

Economic profitability is a major criterion to make decision for producing any crop at farm level. It can be measured based on net return, gross margin and ratio of return to total cost. The average land preparation cost of chili production was found to be Tk. 4500 per hectare. The quantity of hired human labour used in chili production was found to be about 105 man-days per hectare and average price of human labour was Tk. 400 per man-day. Therefore, the total cost of hired human labour was found to be Tk. 42000 representing 39.74 percent of total cost. Per hectare total cost of seed for chili production was estimated to be Tk. 3500. On average, farmers used Urea, TSP, MoP and Gypsum was 252.5 Kg, 180 kg and 130 kg, per hectare. The average cost of insecticides for chili production was found to be Tk. 2298.60. Whereas the average cost of irrigation was found to be Tk. 3200 per hectare. The total variable cost of chili production was Tk. 109608.60 per hectare, which was 83.38 percent of the total cost. The average yield of chili per hectare was 10500 kg and total price of chili was Tk. 189000.00 and by product was tk 2800. The gross return, gross margin and net return were found to be Tk. 191800.00, Tk. 82191.4 and Tk. 60349.99 per hectare. Benefit Cost Ratio (BCR) was found to be 1.4591 which implies that one-taka investment in chili production generated Tk. 1.4591.

Technical efficiency reflects the ability of a farmer to obtain the maximum possible output from a given level of inputs and production technology. Technical efficiency is then measured as the deviation of a farmer from the best-practice frontier. The regression coefficients of Seed cost (X2) and Irrigation cost (X4) and Insecticide (X5) were negative but the coefficient of Human labour (X1), Total fertilizer cost (X3), Insecticide cost (X4) was found negative.

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 positive coefficient of extension service is positive meaning that these factors have no impact on the technical inefficiency. That is, these factors do not reduce or increase technical inefficiency of producing chili.

Average estimated technical efficiencies for chili are 85 percent which indicate that chili production could be increased by 15 per cent with the same level of inputs without incurring any further cost. Increase of only managerial skills result in a substantial increase of output for 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 labour 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.

9.2 Conclusion

Finally, we have concluded that the production of chili in Bangladesh is increasing day by day. The soil and weather condition of our country is good for chili cultivation. From this analysis, it is clear that the quantity supplied is responsive to its price. Economic theory suggests that the coefficient of the price for supply equation is positive. That is, as expected price rises, the corresponding supply rises. This indicates that there is a direct relationship between expected price of chili and the quantity supplied.

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. Chili are only produced in winter season. But now the BARI introduced some verities of summer chili. However, farmers in the study areas, to some extents 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.

9.3 Recommendations

It has diversified uses. The peoples of Bangladesh are usually used 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. From our data analysis, we found that in the context of production and export chili has a great prospect in Bangladesh. However, it is a matter of great regret that our farmers fail to get back even their production cost. Cost of productions becomes higher, but the price of chili becomes lower at the time of harvest. So, farmers become looser.

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

a) 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.
b) Chili based cropping pattern should be developed and disseminated to those areas of Bangladesh where their production is suitable.
c) Government should establish such a monitor cell which may ensure the proper utilization of government incentives and other facilities provided to farmers.
d) Adequate training on recommended fertilizer dose, 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.

9.4 Limitations of the study

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

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

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