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

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CERTIFICATE

This is to certify that thesis entitled, ***"Profitability and technical efficiency of Chili production in some selected upazila of Bogura District in Bangladesh"*** *submitted to the Faculty of Agribusiness Management, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of* ***MASTER OF SCIENCE*** *in* ***AGRICULTURAL STATISTICS,*** *embodies the result of a piece of bona fide research work carried out* ***MD. MASUDUR RAHMAN****, Registration No.* ***19-10315*** *under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.*

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

Dated: December, 2021

Place: Dhaka, Bangladesh

Hasan Mahammad Sammy
Associate Professor
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Supervisor

DEDICATED

TO

MY BELOVED PARENTS

ABSTRACT

Agriculture plays vital role and is taken as the most important sector of economy in Bangladesh. Bangladesh possesses very fertile land in which various types of crops are produced. Chili is one of the most important crops grown in Bangladesh. The goal of the current study was to measure the profitability and technical efficiency of chili farmers in selected Sariakandi, Gabtoli and Sonatola, upazilas in Bogura district. Primary data were collected from randomly selected 60 farmers during July month. Both tabular and functional analyses were applied in this study. The major findings of the study reveal that chili production is profitable Total cost of production was Tk. 353512 per hectare. Gross returns was Tk. 695263 per hectare and net returns was Tk. 341750 per hectare. Benefit Cost Ratio (BCR) was found to be 1.97 which implies that one taka investment in chili production generated Tk. 1.97. In this study, the technical efficacy of chili growers was evaluated using the Cobb-Douglas stochastic frontier production function. The coefficients of parameters like human labor, fertilizers and insecticides were positive where human labor and fertilizers are not significant but insecticides is significant and indicated positive effect on chili production. Others, Seed and irrigation were negative and significant indicated that negative effect on chili production. In the technical inefficiency effect model, experience, farm size, extension service and credit service have negative coefficients indicating that this helps in reducing technical inefficiency of chili farmers. The study also identified some issues, such as insect-pest and disease infestation, the use of fertilizer and pesticides, and the scarcity of high yielding seed varieties, which are primarily experienced by farmers of chili, and it made some recommendations for how to improve the current production situation so that the yield of chili per hectare might be increased.

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I'd want to convey my appreciation to the 60 farmers who participated actively in this survey and, more significantly, helped me understand their efforts and actions linked to chili production. Their amazing assistance throughout the data gathering procedure is much appreciated.

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Md. Masudur Rahman.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABBREVIATIONS AND ACRONYMS

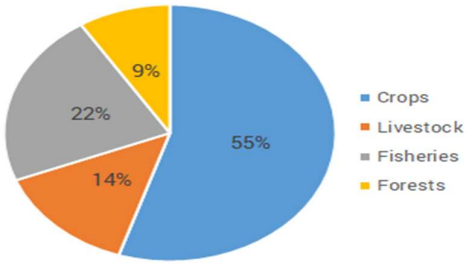
BARI	: Bangladesh Agricultural Research Institute.
BBS	: Bangladesh Bureau of Statistic
BCR	: Benefit Cost Ratio
BDT	: Bangladeshi Taka
BER	: Bangladesh Economic Review
DAE	: Department of Agricultural Extension
et al.	: and others (at elli)
GR	: Gross Return
gm	: Gram
ha	: Hectare
HIES	: Household Income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

CHAPTER- I

INTRODUCTION

1.1 General background

Bangladesh is an agricultural based country dominated by crop production. Most of the inhabitants directly or indirectly are involved in agricultural activities for their livelihood. Agriculture is the key driver of the growth of Bangladesh economy. The overall contribution of the agriculture sector was 11.63 percent in GDP during the year 2022 (BBS). One of Bangladesh's most significant revenue crops is chili, a desirable spice. It is offered and utilized in green, dried, and powdered forms. Chili is considered as one of the commercial spice crops. Different varieties are cultivated for various uses like vegetable, pickles, spice and condiments. In daily life, chilies are the most important ingredient in many different cuisines around the world as it adds pungency, taste, flavor and color to the dishes. Bangladeshi people frequently add chilies to all types of curries, including those made with meat, fish, vegetables, lentils, etc., because of their distinctive color, flavor, and aroma. Large quantities of vitamin C and little carotene are found in red chilies (provitamin-A).Green chilies (unripe fruit) contain a considerably lower amount of both substances. Additionally, chilies are a good source of most B vitamins, including specifically B6. They contain a lot of potassium, magnesium, and iron. Chilies, which are members of the capsicum family, are among the most widely used spices in the world. They come in a huge variety of colors, ranging from green to yellow, orange, and red. The degree of heat in chili varies from variety to variety, ranging from sweet and mellow to scorchingly hot. Generally speaking, the hotter the chili, the sweeter the flavor. But each type has a distinctive flavor, so it's not just about the heat. The use of fertilizers, irrigation, pesticides, and other agricultural inputs is crucial to the production of chili. In order to enhance chili production and attain self-sufficiency in the production of chili, the Bangladeshi government has given importance to the agricultural sector. To do this, subsidies are being provided to farmers for a variety of inputs, including seeds, fertilizer, irrigation, and others.



By birth, Bangladesh has exceptionally fertile ground where a variety of crops may thrive readily. This nation produces a wide range of crops. One of Bangladesh's most significant revenue crops is chili, a desirable spice. It is offered and utilized in green, dried, and powdered forms. It is now a necessary component in Bangladeshi cuisine. A stack of fiery, fresh green chilies is a staple in most of our homes, and they are used to season most curries and dry meals. In the early stages of making the dish, it is often lightly cooked in oil. Without boosting agricultural output and ensuring that farmers receive fair prices for their commodities, poverty cannot be reduced to the acceptable level. Natural disasters including droughts, floods, cyclones, tornadoes, etc. are a frequent occurrence that significantly reduce agricultural production. Due to the pressure of a large population, there is less land that can be used for agriculture. As a result, food security is being threatened and the risk of poor people is being increased.

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 colour. 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. Being one of the least developed nations in the world, Bangladesh has many economic issues. The bulk of its citizens rely on agriculture as their primary source of income. Bangladesh's economic development and agricultural development continue to be closely related. Therefore, every effort will be focused on giving agriculture the boost it needs to increase productivity. Therefore, the effective growth of our agricultural sector is highly dependent on the general economic development. Spices are frequently used in cooking and food seasoning. Additionally, it might be used to alter the appearance of food to give it a more appealing tint. Almost everyone uses spices in curries and other foods since they are so significant and have

been since ancient times. They are well-known for their various flavors and aromas. It is impossible to overstate the value of spices as either food or medicine. Nearly all curries, which are prepared using a variety of spices, are well-liked and delicious. 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 therapeutic value. For example, eating chili peppers dramatically cuts the risk of heart attack and stroke, turmeric helps lower blood sugar, garlic helps prevent heart disease and preserve memory, and ginger is well recognized for its digestive properties. Several spice-producing, -importing, and -exporting nations in the world see significant economic impact from spices and condiments.

Table 1.1 Area and Production of Spices and Condiments in Different Years, (2000-01 to 2020-21)

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
2020-21	1054	3072

Source: BBS, 2021

1.3 Production of Chili

The chili plant is native to tropical and subtropical climates. It thrives in warm, muggy climates. The crop prefers deep, loamy, fertile soils rich in organic matter for successful growth. Additionally required for the growth of the crop are well-drained soils with enough soil moisture. Chili does well in the country's middle and arid regions. Chili plants should be placed where they will receive plenty of light. Chilies shouldn't be kept in an area where the nighttime low is 12°C. If the temperature drops below 15°C, growth will be slowed. A particular kind of seasonal crop, the chili plant only survives for one season before dying. This plant can yield for several months after planting if it is cultivated before dying. Plants that produce chilies need regular watering. Regularly overwatering a plant will make the roots rot. Leave flowers that are forming on the plants alone; they will eventually die and be replaced with chilies. Applying the proper amount of organic liquid fertilizer for a few weeks after the plants start to produce fruit can help the plants fruit. When the chilies are either green or red, they are picked. Green chilies are not as fiery as red chilies. Allow green chili peppers to grow as big as they can if you wish to harvest them. When the chilies begin to turn red, they should be harvested. Cut the stems at the point where they join the main branch to remove the peppers from the plant. The native cultivars of chili that Bangladeshi farmers grow yield

relatively little. Lack of good yielding cultivars and restricted availability of irrigation facilities are the main causes of low yield. Despite increased area and output, chili has a very poor yield per unit. Although chilies are grown throughout Bangladesh, the districts of Bogura, Rangpur, Kurigram, Jamalpur, Natore, and Jessore produce a disproportionate amount of them. With a low yield rate, Bangladeshi farmers are cultivating chilies using traditional ways. Lack of high producing varieties and local growers' use of traditional methods of cultivation are to blame for the low yield. By implementing more advanced production techniques like optimal plant spacing, the productivity of chili can be boosted. Although chile is a significant spice crop in Bangladesh, from a scientific and economic perspective, its production technologies have not been standardized. Research is therefore required to improve industrial technology and increase economic output. Farmers should expect a fair harvest if the weather cooperates.

1.4 Crop situation in the world

Around 19.89 million hectares and 33.52 million tonnes of chili are produced globally, respectively. India, Myanmar, Bangladesh, Pakistan, Thailand, Vietnam, Romania, China, Nigeria, and Mexico are among the major nations that grow chilies. The majority of chili is produced in Asian nations. India, which produces 13 million tonnes of chilies yearly, is the world's top producer, followed by China, which produces about 3 million tonnes. India contributes 38.78 percent of the world's total chili production, which stands at 33.52 million tonnes, followed by China (8.65 percent). India is also the country with the largest area under chili farming. The world trade in chili account for 16 percent of the total spice trade in the world occupying second position after black pepper.

1.5 Area, production and productivity of chili in Bangladesh:

In Bangladesh the crop is grown in an area of about 66,235 ha and annual production amounts to about 52,215 m tons. It can be cultivated in both the summer and winter seasons; average yield of green chili is 5 to 6 m tons/ha. The area of cultivable land for chili production is decreasing day by day whereas the demand for chili is increasing. Unfortunately, the production cannot meet the demand. For meeting the demand of our country, we import large amount of chili each year. The main reason behind low yield

is that we have no sufficient land for chili production. The use of low yielding varieties that cannot provide high yields is another factor.

1.6 Economic importance of the crop:

Vegetable production is crucial because it generates three to four times as many calories of energy and money per hectare of land as cereals do. Vegetable crops have a lot of potential to stimulate economic growth and enhance human nutrition. In comparison to grain crops, vegetable farming yields substantially higher returns per unit of land, labor, and financial investment. All around Bangladesh, chili crops are grown for both domestic consumption and export. In every home in Bangladesh, it has become essential. Chili is prized for its variety of industrial applications. For the convenience food business, there is rising demand for value-added chili goods including chili paste, curry powders, and sauces. It holds a significant position in Bangladesh's economy.

1.7 Justification of the study:

An agro-based nation like Bangladesh depends heavily on the expansion of its agricultural sector for its economic prosperity. Although Bangladesh's agro-climatic conditions are favorable for growing a diverse range of crops, 80 percent of the country's total cropped land is currently used to grow cereal crops, primarily rice. The demand for cereal foods expanded dramatically as the population grew.

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

Prior to giving emphasis on the production of chili, it requires relevant and adequate information on different aspects of production at the farm level. Such knowledge of production is also necessary to make appropriate decision by the growers especially when several alternatives are open to them. However, little systematic economic investigations on chili production have been undertaken by the government or private

organizations in order to satisfy the demand of extension worker, policy makers, research personnel and the farmer. There are several factors like institutional, economic, physical and natural calamities that can limit agricultural production.

Production of chili can be increased by increasing the technical efficiency of chili using existing technology. It is generally assumed that farmers are inefficient at producing chili crop and there are significant inefficiency differences among farm groups. Agriculture production policy in Bangladesh is concerned by lack of information about the relative profitability of different agricultural production. In the past so far the author's knowledge is concerned, there was no study on the technical efficiency or inefficiency as well as factors affecting the level of technical efficiency or inefficiency of chili producers. For this reason, the present study makes an attempt to analyze the profitability of chili production and to estimate the technical 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 further research. Finally, it is expected that the findings of the study will be helpful for the individual farmers for increasing the productive efficiency by effective operation and management of their farms through pointing drawbacks and policy makers and extension workers to frame out a useful policy.

1.8 Objectives of the study:

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

i. To access the socio economic characteristics of the chili growers in study area.
ii. To determine the profitability of chili production.
iii. To explore technical efficiency of chili growers.
iv. To draw conclusions and create some suggestions for necessary interventions in an attempt to increase chili production.

1.9 Setup of the study:

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

CHAPTER- 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 of Chili production in some selected upazila of Bogura District in Bangladesh."**

Ila *et al.* (2019) The study aims to assess financial profitability of green chili. Fifty producers of green chili from three upazila of Bogra 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 green Chili is Tk. 128011.13; gross return (GR) of Green Chili is Tk. 240864; gross margin (GM) for green Chili is Tk. 137698. All the calculations are based on per hectare. Thus, producing green Chili net return (NR) is Tk. 112852.87. The green chili is attractive for farmers to produce as its benefit cost ratio (BCR) shows 1.88 in their study.

Hossain (2016) The main objective of this study is to estimate the technical efficiency of chili production in Bogra district (the largest produced area) of Bangladesh. In order to estimate the level of technical efficiency in a manner consistent with the theory of production function, Cobb-Douglas type stochastic frontier production function was used in the present study. Among the elasticities, the elasticity for land used for chili production is the largest (31.1434) and for the cost on insecticide is the lowest (0.0401). The average technical efficiency for the sample is about 88 percent. The Government should provide priority by giving subsidy to the farmers on different inputs such as seeds, fertilizer, irrigation etc. to achieve self-sufficiency in chili production.

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.

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

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

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

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.

Islam et al. (2011) determined the productivity, profitability and resource use efficiency of four promising spices crops such as garlic, chili, ginger and turmeric. The data were collected from 480 farm households in the crop year 2010- 2011. Productions of all the crops were profitable as estimated by net returns and benefit cost ratios. The

average estimated technical efficiencies for garlic, chilies, ginger and turmeric were 88, 80, 69 and 79% respectively which indicated that garlic production could be increased by 12%, chili by 20%, ginger by 31% and turmeric by 21% with the same level of inputs without incurring any additional cost.

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.

Mutkule et al. (2011) reported that important constraints experienced by the chili growers include less adoption of chili cultivation technology costly insecticides and pesticides non awareness of concentration of pesticides, fluctuation of price of chili, non-timely availability of fertilizers, high cost of fertilizers, lack of disease resistant varieties, non-availability of transport facilities to city area, lack of cold storage and non-availability of sprayers on hire basis at the time of spraying.

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.

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

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

CHAPTER- III

METHODOLOGY

3.1. Introduction

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

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

The upazila is the second lowest tier of administrative government in Bangladesh. The districts of Bangladesh are divided into sub-districts called Upazilas (Sarker, 2010). Spatial variation of different household characteristics was found in the different studies in Bangladesh (Sarker, 2012).

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

Sariakandi, Sonatola and Gabtoli under of Bogura district were purposively selected for the study.

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

- Availability of a large number of Chili growers in the study area.
- These villages had some identical physical characteristics like topography, soil and climatic conditions for producing chili.
- Easy accessibility and good communication facilities in these villages. and
- 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 60 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 July to August in 2022. Data relating to inputs and outputs were collected by making time to time visit in the study area during this period.

3.6. Data Collection Methods

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

3.7. Processing, Tabulation and Analysis of Data

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

3.8. Analytical Techniques

Data were analyzed with a view to achieving the objectives of the study. Several analytical methods were employed in the present study. Tabular method was used for a substantial part of data analysis. This technique is intensively used for its inherent quality of purporting the true picture of the farm economy in the simplest form.

Relatively simple statistical techniques such as percentage and arithmetic mean or average were employed to analyze data and to describe socioeconomic characteristics of chili growers, input use, costs and returns of chili production and to calculate undiscounted benefit cost ratio (BCR).

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

3.8.1 Profitability Analysis

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

- Land preparation
- Human labor
- Seedlings
- Urea
- TSP
- MoP
- DAP
- Zink
- Land Preparation
- Transplanting
- Weeding
- Fertilizer apply
- Harvesting
- Transportation
- Manure

- Power tiller
- Insecticide
- Irrigation

Fixed costs are as follows

- Interest on operating capital
- Land use

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

Cost of Land Preparation

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

Cost of Human Labor

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

Cost of Seed

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

Cost of Urea

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

Cost of TSP

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

Cost of MoP

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

Cost of Insecticides

Farmers used different kinds of insecticides for 4-5 times to keep their crop free from pests and diseases. Cost of insecticides was calculated based on the market price of the insecticides which was used in the study areas per hectare.

Cost of Irrigation

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

Interest on Operating Capital

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

Hence, at the rate of 10 percent per annum interest on operating capital for four months was computed for chili. Interest on operating capital was calculated by using the following formula:

IOC= AIit Where,

IOC= Interest on operating capital

i= Rate of interest

AI= Total investment / 2

t = Total time period of a cycle

Land Use Costs

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

Calculation of Returns

Gross Return

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

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

Gross Margin

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

Per hectare gross margin was obtained by subtracting variable costs from gross return. That is, Gross margin = Gross return – Variable cost.

Net Return

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

Undiscounted Benefit Cost Ratio (BCR)

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

3.8.2 Technical Efficiency Analysis

Technical efficiency refers to the ability of a firm to produce the maximum possible output from a given set of inputs and given technology. A technically efficient farm will operate on its frontier production function. Given the stated relationship the firm is technically efficient if it produces on its outer-bound production function to obtain the maximum possible output which is feasible under the current technology. Putting it differently a firm is considered to be technically efficient if it operates at a point on an isoquant rather than interior to the isoquant. The homogeneity of inputs is a vital factor for achieving technically efficient output.

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

3.8.2.1 The Stochastic Frontier Models

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

elaborated by Jondrow et al. (1982). The notion of a deterministic frontier shared by all farms ignores the very real possibility that a farm's performance may be affected by factors entirely outside its control (such as poor machine performance, bad weather, input supply breakdowns, and so on), as well as by factors under its control (inefficiency). But stochastic frontiers consider all the factors while estimating the model and accordingly it separates firm- specific efficiency and random error effect. Thus the efficiency measurements as well as the estimated parameters are unbiased.

3.8.2.2 The Stochastic Frontier with Cobb-Douglas Production Function

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

Logarithmic form it is linear in parameters; it is parsimonious in parameters (Beattie and Taylor, 1985).

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

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

Where the stochastic production frontier is $f(Xi,\beta)\exp.(Vi)$, Vi having some symmetric distribution to capture the random effects of measurement error and exogenous shocks which cause the placement of the deterministic kernel $f(Xi,\beta)$ to vary across firms.

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

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

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

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

3.8.2.3 Specification of Production Model

We have specified the Cobb-Douglas Stochastic Frontier Production Function in order to estimate the level of technical efficiency. The functional form of stochastic frontier is as follows: Yi = β0 X1β1 X2β2 …….X5β5 eVi-Ui

The above function is linearized double-log form:

lnY = lnβ0 + β1lnX1 + β2lnX2 + β3lnX3 + β4lnX4+ β5lnX5+ Vi-Ui

Where, Y = Output (kg/ha)

X1 = Human labour (man days/ha)

X2 = Seed (Kg/ha),

X3= Fertilizer (kg/ha)

X4 = Cost of insecticide (Tk./ha)

X5 = Irrigation cost (Tk./ha). i= Number of variable

The model of the technical inefficiency effects in the stochastic production

frontier equation is defined by

Ui = δ0 + δ1Z1+ δ2Z2+ δ3Z3+ δ4Z4+ δ5Z5+ + Wi

Where,

Z1 to Z5 are explanatory variable

The equation can be written as:

Ui = δ0 + δ1 Chili farming experience + δ2 Farm size + δ3 Extension service + δ4 Training + δ5Taking loan + Wi

V is two-sided uniform random variable beyond the control of farmer having N (0, σ 2) distribution, U is one-sided technical inefficiency effect under the control of farmer having a positive half normal distribution {Ui~|N (0, σu2)|} and Wi is two-sided uniform random variable. W is unobservable random variable having a positive half normal distribution. The model was estimated simultaneously using STATA.

CHAPTER- IV

SOCIO-DEMOGRAPHY PROFILE OF HOUSEHOLD POPULATION

4.1 Introduction

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

4.2 Age

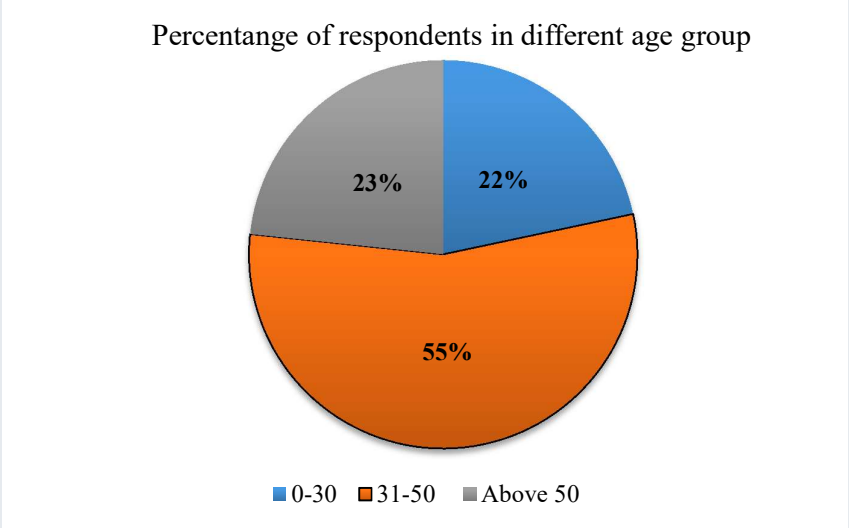
The sample of 20, 20, and 20 are respectively covering Sariakandi, Gabtoli, Shonatola sub-district and represented the total population. In Sariakandi upazila, 21.66 percent of the sample populations were 0-30 years, 55 percent were 31-50 years and 23.34 percent were above 50 years old. (Table 4.1).

Table 4.1: Age of the respondent by Study Area

Area	Age			Total
	0-30	31-50	Above 50	
Sariakandi	3	12	5	20
Gabtoli	4	12	4	20
Shonatola	6	9	5	20
Total	13	33	14	**60**
Mean ± SD				40.62 ± 8.93

Source: Field survey, 2022

Figure 4.1: percentange of respondents in different age group



Source: Field survey, 2022

4.3 Education

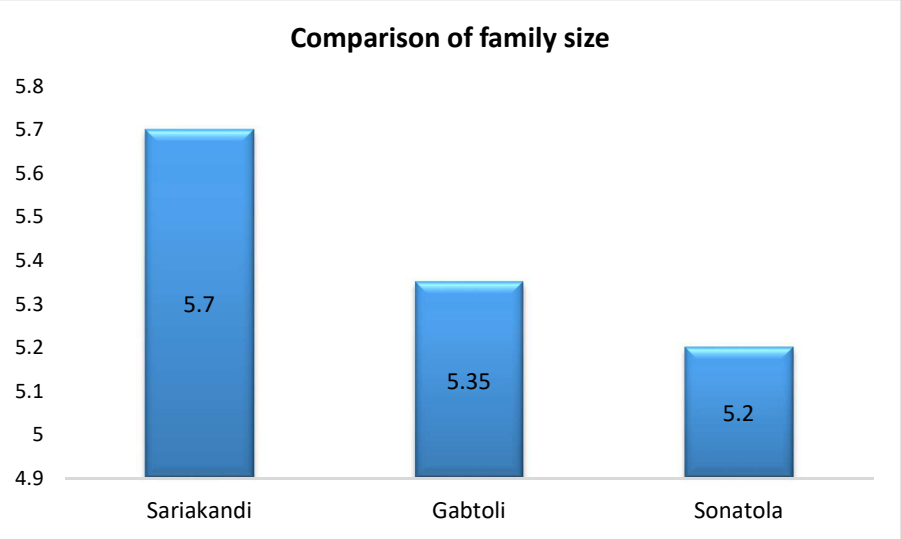
In Sariakandi upazila, 55 percent of the sample populations have completed primary education, 30 percent were secondary passed and 10 percent were at higher secondary and above higher secondary level were 5 percent. In Gabtoli upazila, 60 percent of the sample populations have completed primary education, 30 percent were were secondary passed and 10 percent were higher secondary and above higher secondary were 0 percent. In shonatola upazila, 55 percent of the sample populations have completed primary education, 25 percent were secondary passed and 15 percent were higher secondary and above higher secondary were 5 percent. (Table 4.2).

Table 4.2: Education of the respondent by Study Area

Area	Education level				Total
	Primary	Secondary	Higher secondary	Above	
Sariakandi	11	6	2	1	20
Gabtoli	12	6	2	0	20
Shonatola	11	5	3	1	20
Total	34	17	7	2	**60**

Source: Field survey, 2022

Figure 4.2: Family size of the respondent by Study Area



Source: Field survey, 2022

4.4 Family size:

The average family size was 5.7, 5.35 and 5.2 respectively for Sariakandi ,Gabtoli and Shonatola upzillas. (Figure 4.1)

4.5 Agricultural Training

Among the respondent farmers in Sariakandi upazila, 45 percent farmer's got training of chili farming whereas, 60 percent farmers got training in Gabtoli upazila, 35 percent farmers got training in Shonatola upazila (Table 4.3). These training have improved their perceptions of good seed use, use of resistant varieties, application of insecticides and pesticides, water management, and so on.

Table 4.3: Agricultural Training of the respondent by Study Area

Training received	Sariakandi		Gabtoli		Shonatola	
	No.	**%**	**No.**	**%**	**No.**	**%**
Yes	9	45	12	60	7	35
No	11	55	8	40	13	65
Total	20	100	20	100	20	100

Source: Field survey, 2022

4.6 Membership of any social organization

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

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

Membership in any organization	Sariakandi		Gabtoli		Shonatola	
	No.	**%**	**No.**	**%**	**No.**	**%**
Yes	8	40	10	50	13	65
No	12	60	10	50	9	45
Total	20	100.00	20	100.00	20	100.00

Source: Field survey, 2022

CHAPTER–V

PROFITABILITY OF CHILI PRODUCTION

5.1 Variable Costs

Cost of Land Preparation

Land preparation is the most important component in the production process. Land preparation included ploughing, laddering and other activities needed to make the soil suitable for chili cultivation. For land preparation in chili production, no. of tiller was required 3 with Tk. 3922.33 per tiller. Thus, the average land preparation cost of chili production was found to be Tk. 11766.99 per hectare, which was 3.33percent of total cost (Table 5.1).

Cost of Human Labor

Human labor cost is one of the major cost components in the production process. It is one of the most important and largely used inputs for producing chili. It is generally required for different operations such as land preparation, sowing, weeding, fertilizer and insecticides application, irrigation, harvesting and carrying, cleaning, drying, storing etc. The quantity of human labour used in chili production was found to be about 378 man-days per hectare and average price of human labour was Tk. 500 per man-day. Therefore, the total cost of human labor was found to be Tk. 153710 representing 43.48 percent of total cost (Table 5.1).

Cost of Seed

Cost of seed varied widely depending on its quality and availability. Per hectare total cost of seed for chili production were estimated to be Tk. 8522, which constituted 2.41 percent of the total cost (Table 5.1).

Cost of Urea

In the study area, farmers used different types of fertilizers. On an average, farmers urea 713 kg used per hectare. Per hectare cost of urea was Tk. 14279, which represents 3.53 percent of the total cost (Table 5.1).

Cost of TSP

Among the different kinds of fertilizers used, the rate of application of TSP (566 kg) was similar to urea fertilizers. The average cost of TSP was Tk. 14168 which representing 3.50 percent of the total cost (Table 5.1).

Cost of MoP

The application of MoP per hectare (62 kg) was found lower than other fertilizers. Per hectare cost of MoP was Tk. 997.12, which represents 0.25 percent of the total cost (Table 5.1).

Cost of DAP

On an average, farmers used DAP 171 kg per hectare. Per hectare cost of dap was Tk. 5986.05, which represents 1.48 percent of the total cost (Table 5.1).

Cost of Zink

On an average, farmers used Zink 16 kg per hectare. Per hectare cost of zink was Tk. 3030, which represents 0.75 percent of the total cost (Table 5.1).

Cost of Manure

On an average, farmers used manure 1186 kg per hectare. Per hectare cost of manure was Tk. 2372, which represents 0.67 percent of the total cost (Table 5.1).

Cost of Insecticides

Farmers used different kinds of insecticides to keep their crop free from pests and diseases. The average cost of insecticides for chili production was found to be Tk. 46940 which was 13.28 percent of the total cost (Table 5.1).

Cost of Irrigation

Cost of irrigation is one of the most important costs for chili production. Production of chili largely depends on irrigation. Right doses application of irrigation water help to increase bulb diameter, number of cloves, and number of leaves and plant height. As a result yield per hectare is being increased. The average cost of irrigation was found to be Tk. 15645 per hectare, which represents 4.43 percent of the total cost (Table 5.1).

Table 5.1: Per hectare labour cost of Chili Production

Operation	Labour (man-days)/hec		Total (man-days)	Unit cost	Total cost (Tk)	%of Total Labour Cost
	Family	Hired				
Land Preparation	7.90	18.05	25.95	500	12975	8.44
Transplanting	7.84	26.64	34.48	500	17240	11.22
Weeding	7.85	86.14	93.98	500	46990	30.57
Fertilizer Apply	45.29	2.63	47.92	500	23960	15.58
Harvesting	11.38	163.77	175.15	300	52545	34.18
Total	80.26	297.23	377.48	2300	153710	100.00

Source: Field survey, 2022

Table 5.2: Per hectare seed and fertilizer cost of Chili Production

Various Inputs	Units	Quantity	Unit Price	Total Cost
Seed	Kg	0.17	50133.33	8522.66
Fertilizer	Kg			
Urea	Kg	713.95	20	14279
TSP	Kg	566.74	25	14168
MOP	Kg	62.32	16	997.12
Dap	Kg	171.03	35	5986.05
Zink	Kg	15.15	200	3030
Manure	Kg	1186.11	2	2372.22
Total Fertilizer	Tk			40832.39
Power Tiller	Tk			11767
Irrigation	Tk			15644.80
Pesticide	Tk			46940
Total				115184.19

Source: Field survey, 2022

Table 5.3: Per Hectare Cost of Chili Production

Item	Total Cost	% of total cost
Variable Cost		
Human labor cost	153710	43.48
Seed cost	8522	2.41
Fertilizer cost	40832.39	11.55
Power Tiller cost	11766.99	3.33
Pesticide	46940	13.28
Irrigation	15644.80	4.43
Total Variable Cost	277416.18	78.47
Fixed Cost		
Interest on operating	11096.64	3.14
Land use cost	65000	18.39
Total Fixed Cost	76096.64	21.53
Total Cost (A+B)	353512.8	100.00

Source: Field survey, 2022.

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

Table 5.4: Per hectare chili production

Name of Crop	Value of main product		
	Quantity (Kg/ha)	Price (Tk./kg)	Value (Tk.)
Chili	32950.86	21.10	695263.15

Interest on Operating Capital

It may be noted that the interest on operating capital was calculated by taking in to account all the operating costs incurred during the production period of chili. Interest

on operating capital for chili production was estimated at Tk. 11096.64 per hectare, which represents 3.14 percent of the total cost (Table 5.1).

Total Variable Cost

From the above different cost items it was clear that the total variable cost of chili production was Tk. 277416.18 per hectare, which was 78.47 percent of the total cost (Table 5.1).

5.2 Fixed Cost

Rental Value of Land

Rental value of land was calculated on the basis of opportunity cost of the use of land per hectare for the cropping period of three months. Cash rental value of land has been used as cost of land use. On the basis of the data collected from the chili farmers the land use cost was found to be Tk. 65000 per hectare, and it was 18.39 percent of the total cost (Table 5.1).

5.3 Total Cost (TC) of Chili Production

Total cost was calculated by adding all the cost of variable and fixed inputs. In the present study per hectare total cost of producing chili was found to be Tk. 353512.8 (Table 5.1).

5.4 Return of Chili Production

Gross Return

Return per hectare of chili cultivation is shown in Table 4.6. Per hectare gross return was calculated by multiplying the total amount of product with respective per unit price. It is evident from table that the average yield of chili per hectare was 32950.86 kg and the average price of chili was Tk. 21.10 Therefore, the gross return was found to be Tk. 695263.15 per hectare (Table 5.2).

Gross Margin

Gross margin is the gross return over variable cost. Gross margin was calculated by deducting the total variable cost from the gross return. On the basis of the data, gross margin was found to be Tk. 417846.97 per hectare (Table 5.2).

Net Return

Net return or profit was calculated by deducting the total production cost from the gross return. On the basis of the data the net return was estimated as Tk. 341750.35 per hectare (Table 5.2).

Table 5.5: Per Hectare Cost and Return of Chili Production

Measuring Criteria	**Cost (Tk./ha)**
Main Product Value	695263.15
Gross Return (GR)	695263.15
Total Variable Cost (TVC)	277416.18
Total Cost (TC)	353512.8
Gross Margin (GR-TVC)	417846.97
Net Return (GR-TC)	341750.35
BCR (undiscounted)(GR/TC)	**1.97**

Source: Field survey, 2022

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 1.97 which implies that one taka investment in chili production generated Tk. 1.97 (Table 5.2). From the above calculation it was found that chili cultivation is profitable in Bangladesh.

CHAPTER-VI

TECHNICAL EFFICIENCY OF THE CHILI FARMERS

6.1 Interpretation of ML Estimates of the Stochastic Frontier Production Function:

Maximum likelihood estimation begins with writing a mathematical expression known as the Likelihood Function of the sample data. The likelihood of a set of data is the probability of obtaining that particular set of data, given the chosen probability distribution model. This expression contains the unknown model parameters. The values of these parameters that maximize the sample likelihood are known as the Maximum Likelihood Estimates or MLE's. 6.1

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

Human Labor (X1)

The regression coefficients of Human labor (X1) was was positive and significant at 10 percent level of significance, which implied that if the expenditure on Human labour was increased by 1 unit then the yield of chili would be increased by 0.086 percent, other factors remaining constant (Table 6.1).

Seed (X2)

The regression coefficient of seed cost (X2) of chili production was negative and significant at 1 percent level of significance, which implied that if the expenditure on seed was increased by 1 percent then the yield of chili would be decreased by 0.119 percent, other factors remaining constant (Table 6.1).

Fertilizer (X3)

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

Cost of Insecticide (X4)

The regression coefficient of insecticides cost (X4) of chili production was not significant. (Table 6.1).

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

Variables	**Parameter**	**Coefficients**	**T-ratio**
Stochastic Frontier:			
Constant (X0)	β0	7.73	4.19
Human Labour (X1)	β1	0.086*	1.10
Seed (X2)	β2	-0.119***	-0.810
Fertilizer (X3)	β3	0.213	1.22
Insecticide (X4)	β4	0.242	2.25
Irrigation (X5)	β5	0.048**	0.433
Power Tiller (X6)	B6	0.061*	0.545
Inefficiency Model			
Constant	δ0	0.625*	0.55
Experience (Z1)	δ1	-0.060*	1.80
Farm size (Z2)	δ2	-0.122***	-2.42
Extension service (Z3)	δ3	-0.483	-0.56
Training (Z4)	δ4	0.525	0.288

Source: Field survey, 2022.

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

Irrigation (X5)

The magnitudes of the coefficients of irrigation cost was positive and significant at 5 percent level of significance. The result of the analysis indicated that, keeping other factors constant, a 1 percent increase in additional expenditure on irrigation would increase the yield of chili by 0.048 percent (Table 6.1).

Power Tiller (X6)

The regression coefficient of power tiller cost (X6) of chili production was positive and significant at 10 percent level of significance, which implied that if the expenditure on Power tiller was increased by 1 unit then the yield of chili would be increased by 0.061 percent, other factors remaining constant (Table 6.1).

6.2 Interpretation of Technical Inefficiency Model

In the technical inefficiency effect model experience, farm size and extension service have expected (negative) coefficients. The negative and significant (1 percent) coefficient of experience implies that experienced farmers are technically more efficient than non-experienced farmers. The negative coefficient and significant at10 percent level of significance of farm size implies that large farm households are technically more efficient than small farm households. The negative coefficient of extension service postulates that farmers having contacts with extension officers are technically more efficient than others. Although this coefficient is not statistically significant. The negative coefficient of credit service postulates that farmers taking loan for producing chili are technically more efficient than others. Although this coefficient is not statistically significant. (Table 6.2)

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

6.3 Technical Efficiency and Its Distribution

Here frequency distribution of farm-specific technical efficiency for chili farmers. It reveals that average estimated technical efficiencies for chili are 81 percent which indicate that chili production could be increased by 19 percent with the same level of inputs without incurring any further cost. Increase of only managerial skills result a substantial increase of output for chili. It was observed that 27 percent of sample farmers were found to have received outputs which were very close to the maximum frontier outputs maintaining the efficiency level more than 95 per cent. On the other hand, 32 per cent of sample farmers obtained 81 to 100 percent technical efficiency level. The minimum and maximum technical efficiencies were observed to be 4 and 99 per cent respectively, where standard deviation was maintained at 0.16.

Table 6.2: Frequency Distribution of Technical Efficiency of Chili Farms

Efficiency (%)	**No. of farms**	**Percentage of farms**
0-50	4	6.67
51-60	6	10.00
61-70	8	13.33
71-80	10	16.66
81-90	14	23.33
91-100	18	30.00
Total number of farms	60	100
Minimum	0.4	
Maximum	0.99	
Mean	0.81	
Standard Deviation	0.16	

Source: Field survey, 2022

6.4 Concluding Remarks

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

CHAPTER– VII

PROBLEMS IN PRODUCTION OF CHILI

In this section, an attempt has been made to analyze the constraints responsible for lower yield at the farmer's field. The major problems faced by the farmers in the production and marketing of chilies in this district are presented in Table 7.1 Irrespective of farm size, most of the farmers reported that insect- pests and diseases are the major problems, specially leaf curl, and powdery mildew and fruit borers. Fifty, out of 60 farmers faced the problems of insect-pests and diseases in the study area. These Farmer's suggested that diseases and insect pest resistant varieties must provide to the farmers. Another important aspect perceived by about 85 percent farmers is imbalance use of fertilizers and pesticide at all categories of farms. Lack of latest technical know-how may be a reason for this imbalanced use of fertilizers and pesticide. Therefore, it is needed that the department of agriculture should arrange periodically training programmes to aware the farmers about balanced use of fertilizers, pesticide and other technical knowledge. Problem faced by 50 percent farmers is lack of sufficient soil testing facilities. Farmers perceived that the soil testing equipment's should be available at least at block level along with recommended dose of fertilizer and manure according to the soil test. The other most important constraint is non availability of seed during peak season faced by chili growers of Bogura district. The scarcity of High yielding seed is reported to be serious problem faced by 75 percent of the farmers. About 50 percent farmers do not have any institutional support in chili production like supply of seed, supply of plant protection chemical and technical support. However, certain problems like lack of regulated and co-operative markets are reported by about 40 percent farmers of the study area.

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

SL. No	Particulars	No. of farmers	Percentage of total No. of farmers
A	**Production problems**		
1	Problem of insect- pest and diseases	51	85
2	Imbalance use of fertilizer & pesticide	48	80
3	Scarcity of High yielding seed variety	45	75
4	Lack of soil testing facility	30	50
5	Lack of institutional support	30	50
6	Lack of latest technical know-how about chili production	24	40
B	**Marketing problem**		
1	Lack of regulate market and co-operative market	24	40

Source: Field survey, 2022

CHAPTER- VIII

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

8.1 Summary

Nowadays Chili is one of the most important commercial crops of Bangladesh; it is a crop of tropical and sub-tropical regions and requires a warm humid climate. Number of varieties of chilies are grown, which can be used as vegetable, condiments and pickles. Chili occupies an important place in Bangladeshi diet and it is an indispensable item in the kitchen, as it is consumed daily as a condiment in one or other form. Chili is rich in vitamin A and C and has many medicinal properties. The world area and production of chili is around 19.89 million hectares and 33.52 million tons respectively. The largest producer of chilies in the world is Bangladesh accounting for 13 million tons of production annually. Bangladesh also leads in the context of maximum area covered under chili cultivation. In Bangladesh, chilies are grown in almost all districts of the country and the major growing district in terms of production are Bogura. The total area under spices is 92769 hectares in the Bogura district with a production of 632031 metric tons. Chili is the important vegetable, spice crop of the Bogura district with area and production of 22359 hectares and 19804 tons respectively and productivity was 6 metric tons (green chili) per hectare during 2020-21. Chilies are grown all over Bangladesh, not only for a huge home market but also for export purposes. Production of chilies plays an important role in improving the economic conditions of farmer's specially marginal and small farmers and meeting the nutritional requirements of the people of Bangladesh. The present study will give the answers of some of the important questions regarding the aspects like growth of this crop, cost of cultivation, returns from this crop and constraints to its production and marketing. Therefore, a systematic research work was required to carry out for this crop in order to make available complete information to the farmers who want to grow this crop.

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

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

The sampling frame for the present study were selected purposively as to select the area where the chili cultivation was intensive. On the basis of higher concentration of chili crop production, three upazila namely Sariakandi, Gabtoli and Shonatola, in Bogura district was selected. A sample size of 60 is generally regarded as the minimum requirement for larger population that will yield a sufficient level of certainty for decision-making (Poate and Daplyn, 1993). In this case, who were cultivating different varieties of Robi chili in the selected areas were selected as samples. Farmers generally plant Robi chili from mid- August to November and harvest after four months. Data for the present study have collected during the period of July to August 2022 . 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. 11767 per hectare. . The quantity of human labor used in chili production was found to be about 378 man-days per hectare and average price of human labor was Tk. 500 per man-day. Therefore, the total cost of human labor was found to be Tk. 153710 representing 43.48 percent of total cost. Per hectare total cost of seed for chili

production was estimated to be Tk. 8522. On average, farmers used Urea, TSP, MoP 713 Kg, 566 kg and 62.32 kg respectively, per hectare. The average cost of insecticides for chili production was found to be Tk. 46940. Whereas the average cost of irrigation was found to be Tk. 15644 per hectare. The total variable cost of chili production was Tk. 277416 per hectare, which was 78.48 percent of the total cost. The average yield of chili per hectare was total price of chili was Tk. 695263. The gross return, gross margin and net return were found to be Tk. 695263, Tk. 417846 and Tk. 341750 per hectare. Benefit Cost Ratio (BCR) was found to be 1.97 which implies that one taka investment in chili production generated Tk. 1.97.

Technical efficiency reflects the ability of a farmer to obtain the maximum possible output from a given level of inputs and production technology. Technical efficiency is then measured as the deviation of a farmer from the best-practice frontier. The regression coefficients of Human labor (X1), Fertilizer (X3),Insecticides cost (X4),Irrigation cost (X5) and Power tiller (X6) were positive but the coefficient of Seed (X2) was found negative. It indicates that if Human labor (X1), Fertilizer (X3), Insecticides cost (X4), Irrigation cost (X5) , Power tiller (X6) were increased by one percent, the production of chili would be increased by 0.086, 0.213, 0.242, 0.048, 0.061 percent of sample farmers respectively.

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

The negative coefficient of extension service postulates that farmers having contacts with extension officers are technically more efficient than others. The negative credit service coefficient indicates that taking loan by farmers helps reduce technical inefficiency. The coefficients of training are positive meaning that these factors have no impact on the technical inefficiency. Average estimated technical efficiencies for chili are 81 percent which indicate that chili production could be increased by 19 per cent with the same level of inputs without incurring any further cost. Increase of only managerial skills result in a substantial increase of output for chili. Farmers faced a lot of problems in producing chili. The problems were social and cultural, financial and

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

8.2 Conclusion

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

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

8.3 Recommendations

On the basis of the finding of the study it was evident that chili was profitable enterprises and it can generate income earnings and employment opportunity to the rural people of Bangladesh. But some problems and constraints bared to attain the above mentioned objectives. The policy makers should, therefore, take necessary

measures. According to the findings of the study; some policy recommendations may be advanced which are likely to be useful for policy formulation. The following specific recommendation may be made for the development of chili sector.

- As most of the chili farmers are technically efficient at present production technology, improved method of production technology with sufficient storage ability should be introduced.
- As chili is a profitable enterprise, government and concern institutions should provide adequate extension programme to expand its area and production.
- Chili based cropping pattern should be developed and disseminated to those areas of Bangladesh where their production is suitable.
- Government should take necessary measures to lower the price of inputs which have positive significant impact on yield. It will increase the net benefit of chili producers.
- Adequate training on recommended fertilizer doses, insecticides, use of good seed, intercultural operations, etc., should be provided to the chili farmers which will enhance production as well as technical efficiency by improving the technical knowledge of the farmers.
- Chili farmers had to sell their product at low price during harvesting or just after harvest. An appropriate storage scheme should be developed so that the farmers are not forced to sell their product at low price during the harvest period.

8.4 Limitations of the Study

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

a. Most of the data were collected through interview of the farmers and sometimes they did not well-cooperate with the interviewer.

b. The information were gathered mostly through the memories of the farmers which were not always correct.

c. Due to resource and time constraints, broad based and in-depth study was hampered to some extent.

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