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

MD. RASHEDUL HAQUE

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

DECEMBER, 2013

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

BY
MD. RASHEDUL HAQUE
REGISTRATION NO. : 07-02398

A Thesis
Submitted to the Faculty of Agribusiness Management
Sher-e-Bangla Agricultural University, Dhaka,
in partial fulfillment of the requirements
for the degree of

MASTER OF SCIENCE
IN
AGRICULTURAL ECONOMICS

SEMESTER: JULY-DECEMBER, 2012

Approved by:

____
(Dr. A. S. M. Anwarul Huq)
Member Director
Agricultural Economics &
Rural Sociology Division
Bangladesh Agricultural Research Council, Dhaka-1215
Supervisor

____
(Monoj Kumar Majumder)
Assistant Professor
Department of Agricultural Economics
Sher-e-Bangla Agricultural University
Dhaka-1207
Co-supervisor

____
Professor Gazi M. A. Jalil
Chairman
Examination Committee
Department of Agricultural Economics
Sher-e-Bangla Agricultural University, Dhaka-1207

Bangladesh Agricultural Research Council
Farm Gate, New Airport Road
Dhaka-1215, Bangladesh.

G.P.O BOX : 3041
PHONE : 9119906
PABX NO. : 9132214-18
FAX : 88- 02- 8113032
WEB : www.barc.gov.bd

CERTIFICATE

This is to certify that thesis entitled, "**TECHNICAL EFFICIENCY AND PROFITABILITY OF ONION PRODUCTION IN SELECTED AREAS OF BANGLADESH**" submitted to the faculty of Agribusiness Management, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE IN AGRICULTURAL ECONOMICS**, embodies the result of a piece of *bona fide* research work carried out by **MD. RASHEDUL HAQUE** bearing Registration No. **07-02398** 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 course of this investigation has duly been acknowledged.

31 May, 2015
Dhaka, Bangladesh

...……………………………………..
Dr. A. S. M. Anwarul Huq)
Member Director
Agricultural Economics &
Rural Sociology Division
Bangladesh Agricultural Research Council
Dhaka-1215
Supervisor

Dedicated to
My Beloved
Parents

ABSTRACT

The present study was designed to measure technical efficiency of onion farmers and to estimate the profitability of onion production in selected areas of four villages namely Vitbila and Bonkhola under Sujanagar upazila in Pabna district and Haturiya and Loskorkandhi under Faridpur Sadar upazila in Faridpur district. Primary data were collected from 150 farmers which constituted 75 farmers from each upazilas respectively. A random sampling was followed. Both tabular and statistical analyses were applied in this study. The major findings of the study reveal that onion production is profitable. Total cost of production was Tk. 40643.03 per hectare. Gross returns was Tk. 380423.04 and net returns was Tk. 174759.75. Per hectare yields of onion bulb was found 13704.00 kg. Per hectare human labour was used 362 man-days. Benefit Cost Ratio (BCR) was found to be 1.85 which implies that one taka investment in onion production generated Tk. 1.85.

The Cobb-Douglas stochastic frontier production function was used for this study to measure technical efficiency of onion farmers. The coefficients of parameters like human labour, seed, fertilizers, insecticides and irrigation were positive where human labour, fertilizers and insecticides were highly significant and indicated positive effect on onion production. In the technical inefficiency effect model, experience, farm size, extension service and training have negative coefficients indicating that this helps in reducing technical inefficiency of onion farmers. The γ-parameter associated with the variance in the stochastic frontier model is to be estimated at 0.6818, indicates that inefficiency effects have a significant contribution in determining the level and variability of output of onion farms. The significant value of γ and σ^2 indicates that there are significant technical inefficiency effects in the production of onion.

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 onion production. The study also identified some problems and constraints faced by the onion farmers and suggested some recommendations to improve the present production situation so that per hectare yield of onion would possibly be increased.

ACKNOWLEDGEMENT

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

Now, I would like to pay ineffable gratitude to my supervisor Dr. A. S. M. Anwarul Huq, Member Director, Agricultural Economics & Rural Sociology Division, Bangladesh Agricultural Research Council, New Airport Road, Farm gate, Dhaka-1215, for his ever inspiring guidance, keen interest, scholarly comments and scholastic and constructive suggestions throughout the research work and preparation of thesis. I am deeply indebted to and grateful for his prompt comprehensive feedback, encouragement and patience throughout the duration of the research undertaken for this thesis. Despite an enormous workload because of his teaching and research and many others responsibilities, Dr. Huq has always been extremely generous without limits in giving his time and assistance. Dr. Huq repeatedly read earlier draft of this thesis and provide me useful guidance and helped to clear my perceptions about the complex issues related to my thesis. Without his valuable intellectual advice, precise constructive comments and help this work would never have come to life.

I am especially grateful to my respected Co-supervisor, Monoj Kumar Majumder, Assistant Professor, Department of Agricultural Economics, Sher-e-Bangla Agricultural University, Dhaka, for his proper guidance, inspiring co-operation and encouragement during the research work and preparation of thesis.

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

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

I would like to express my gratitude to 150 farmers who actively participate in this survey and most importantly help me to understand their initiatives and activities related to onion farming in general and in particular. They provided important data upon which different models were employed to evaluate the efficiency of farming activities. Their invaluable cooperation during my data collection process is highly acknowledged.

I would like to express my sincere appreciation to my dear friends Md. Rakibur Rahman, Lecturer, Department of Agricultural Economics, Sher-e-Bangla Agricultural University, Dhaka, who was always with me. I also want to express special thanks to F. M. Shamim and Md. Mehedi Kabir Rupom for their help during data collection process.

I would also like to express my sincere thanks and respect to my sisters especially Dr. Tamanna, my brother, friends and well-wishers for their support, love and understanding.

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

May, 2015

Md. Rashedul Haque

CONTENTS

CONTENTS (Continued)

CONTENTS (Continued)

CONTENTS (Continued)

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
t	: Ton
TC	: Total Cost
TFC	: Total Fixed Cost
Tk.	: Taka
TSP	: Triple Super Phosphate
TVC	: Total Variable Cost
US	: United States
USDA	: United States Department of Agriculture
$	: Dollar

CHAPTER 1

INTRODUCTION

CHAPTER 1

INTRODUCTION

1.1 Background of the Study

Bangladesh is predominantly an agro-based country. Agriculture is the key driver of the growth of Bangladesh economy. The economic development is inextricably linked with the performance of this sector. The performance of this sector has an overwhelming impact on major macroeconomic objectives like employment generation, poverty alleviation, human resources development and food security. Agriculture in Bangladesh is heavily dependent on the weather, and the entire harvest can be wiped out in a matter of hours when cyclones hit the country. Farms are usually very small due to heavily increasing population, uneven distribution of land ownership, and inheritance regulations. In Bangladesh, food security of the vast population is associated with the development of agriculture. Besides this, agriculture has a direct link to the issues like poverty alleviation, improved standard of living and employment generation. In order to ensure long-term food security for the people, a profitable, sustainable and environment-friendly agricultural system is critical. Broad agriculture sector and rural development sector have been given the highest priority in order to make Bangladesh self-sufficient in food.

The country has a vast delta with a population of 155.8 million encompassing an area of 147570 sq km (BER, 2015). About 76.75 percent of total population of this country lives in rural areas (BBS, 2014). Agriculture provides employment to nearly about 47.33 percent of its total labor forces (BER, 2015). Agriculture occupies a key position in the overall economic sphere of the country in terms of its contribution to Gross Domestic Product (GDP). Figure 1.1 represents the sectoral share of GDP at constant prices (Base Year: 2005-06). Broad agriculture sector which includes crops, livestock, fisheries and forestry contributes 16.33 percent to the gross domestic product (GDP) as a whole in the FY 2013-14 (BER, 2015).

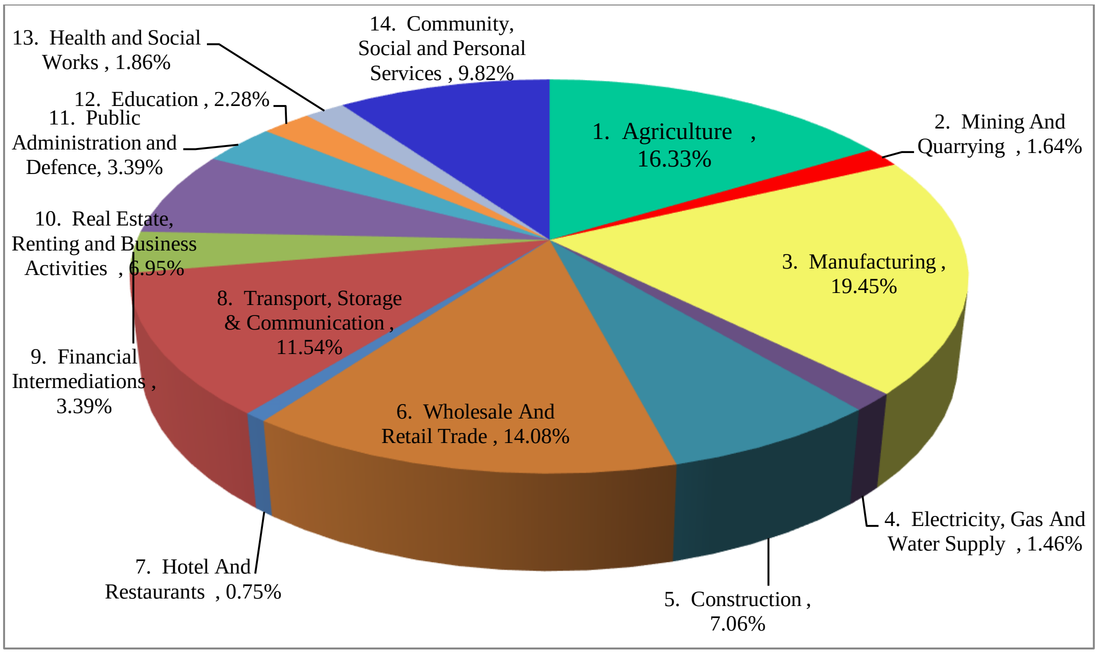


Fig 1.1: Sectoral Share of GDP at Constant Prices

Source: BER, 2015

Despite increase in the shares of fisheries, livestock, and forestry, crop sub-sector alone accounts for 55.82 percent share of agricultural GDP in FY 2013-14 (BER, 2015) (Fig 1.2). Although the contribution of crop sub-sector in GDP marginally decreased from 9.49 percent in FY 2012-13 to 9.11 percent in FY 2013 -14.

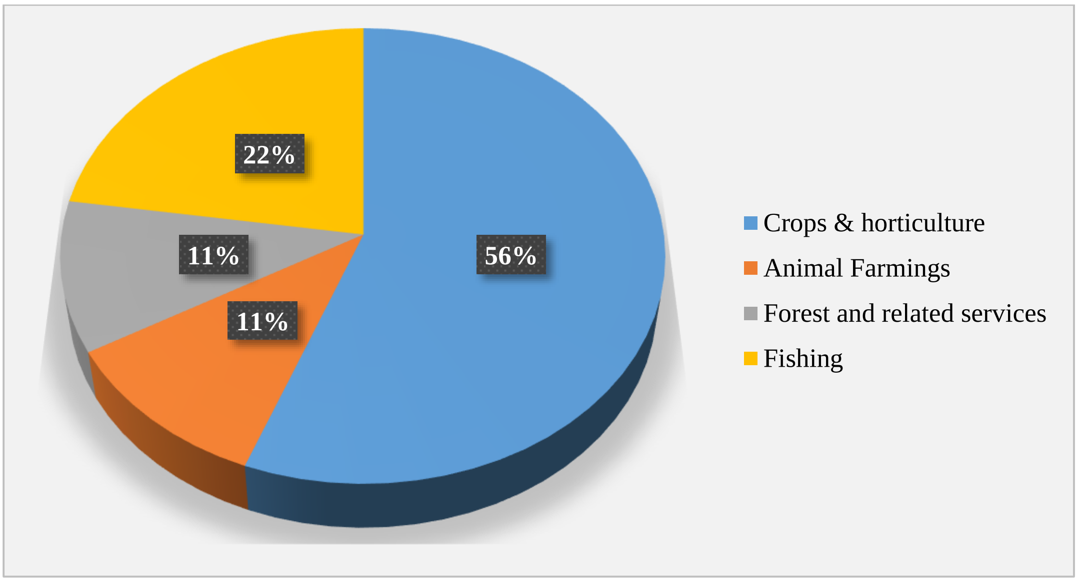


Fig 1.2: Sub-Sectoral Share of Broader Agricultural GDP in 2013-14

Source: BER, 2015

Crop agriculture in Bangladesh is constrained by a number of challenges every year. Major challenges include loss of arable land, population growth, climate changes, inadequate management practices (fertilizer, water, and pests & diseases), lack of quality seeds, and inadequate credit support to farmers, unfair price of produces, and insufficient investment in research. Besides, crop agriculture in Bangladesh has become regularly vulnerable to the hazards of climate change–flood, drought, and salinity in particular. In addition, poor management practices, especially those of pests and diseases, fertilizer, water and irrigation have largely contributed to significant decline in crop productivity. Small and marginal farmers that constitute majority of farm population are constrained by poor financial resources and cannot, therefore, afford high management costs of high input technology.

The scenarios of growth rates in agricultural subsectors indicate that the decline in overall growth in agriculture is mainly due to fall in the growth of crop production. While the growth of livestock and forestry is witnessing an increasing trend, the growth in crops is substantially declining. As a result, the share of agriculture in GDP is largely declining, since the crop production that renders the major contribution to national income from agriculture sector is growing at a decelerating rate over the recent periods. The growth rate of crops sub-sector GDP has drastically decreased from 6.17 percent in 2005-06 to 1.91 percent in 2013-2014 (Fig 1.3). Within the period 2005-06 to 2013-2014, growth rate of crops sub-sector GDP was highest (7.57 percent) in 2009-10 and lowest (0.59 percent) in 2012-13. Given the importance of agriculture in the national economy and due to existence of vital linkage effects of agriculture is a crucial pre-condition accelerating overall economic growth of Bangladesh. Fig 1.3 shows the crops and agricultural sector growth rates of GDP over the years.

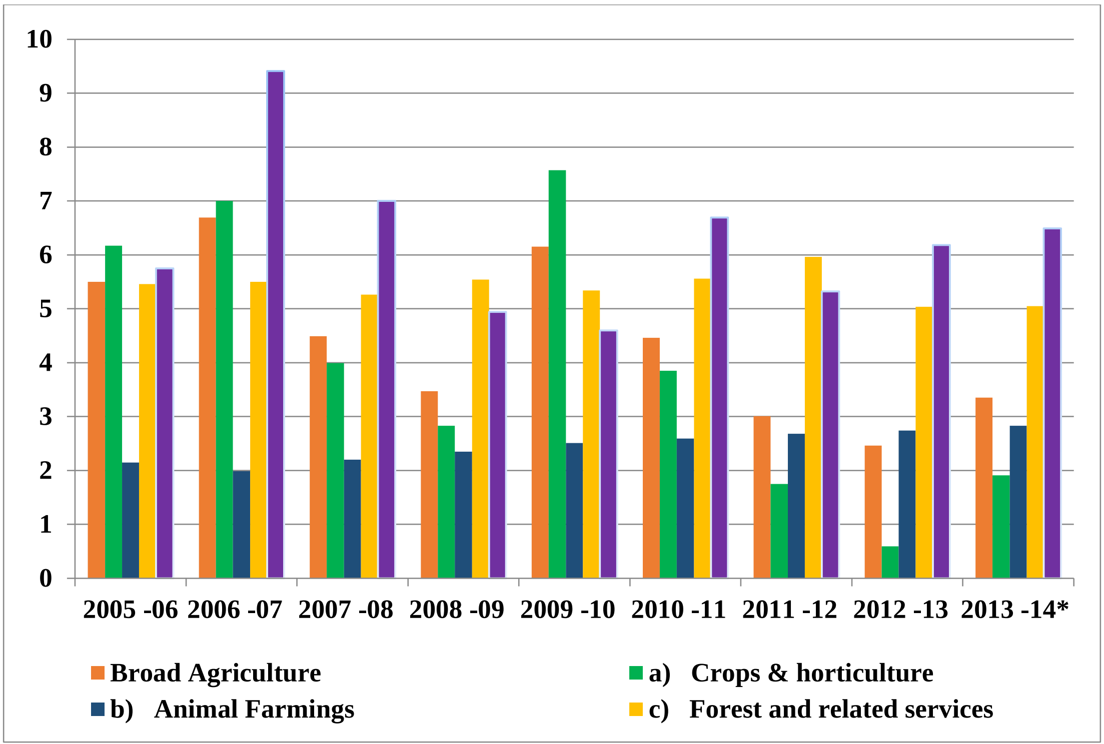


Fig 1.3: Sub-Sectoral Growth Rate of Agricultural GDP at Constant Prices

Source: BER, 2015

1.2 Present Status of Spices in Bangladesh

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

Spices are the plant parts may be the whole plant, bark, stem, leaf, root, rhizome, flower, fruit, and seed. Spices contain alkaloids, flavor-proteins, carotenoids, oleoresins, steroids, and oils etc., which are the sources of flavor, color and stimuli. Oils extract from some types of spices are used as ingredients of cosmetics and scented items of goods. For instance, onion, garlic, ginger, pepper and mustard have demonstrated antimicrobial activity against several types of bacteria. In injured stomach, cumin and coriander increase gastric secretion, and red pepper has an inhibitory effect. In FY 2011-12, total area under spices is 3.25 lakh hectares with the total production of about 17.55 lakh metric tons in our country (BBS, 2014). Spices covers almost 2.16 percent of total cropped area in Bangladesh (BBS, 2014). Now-a-days, spices are valuable trade commodities in the world. They are expensive but widely used, the gap between demand and supply is also increasing. Although a proper statistics of production and consumption is not available but it is true that a good quantity of spices is being imported every year to meet the huge demand of people of the country at the cost of foreign currency. Import payments of spices during the period from 2000-01 to 2013-14 is shown in Figure 1.4. Due to increasing population, demand for cereal food increased significantly. To mitigate this demand, the land of spices crop is being diverted to cereal food crop cultivation. Spices become agenda for politics by creating crisis in the market during the festivals like Ramadan, Eid, Puja and Christmas etc. Due to decreasing production and increasing demand for spices a big gap was observed between production and demand now. To lessen the pressure on the foreign currency, the spices production need be increased to meet up the country's demand.

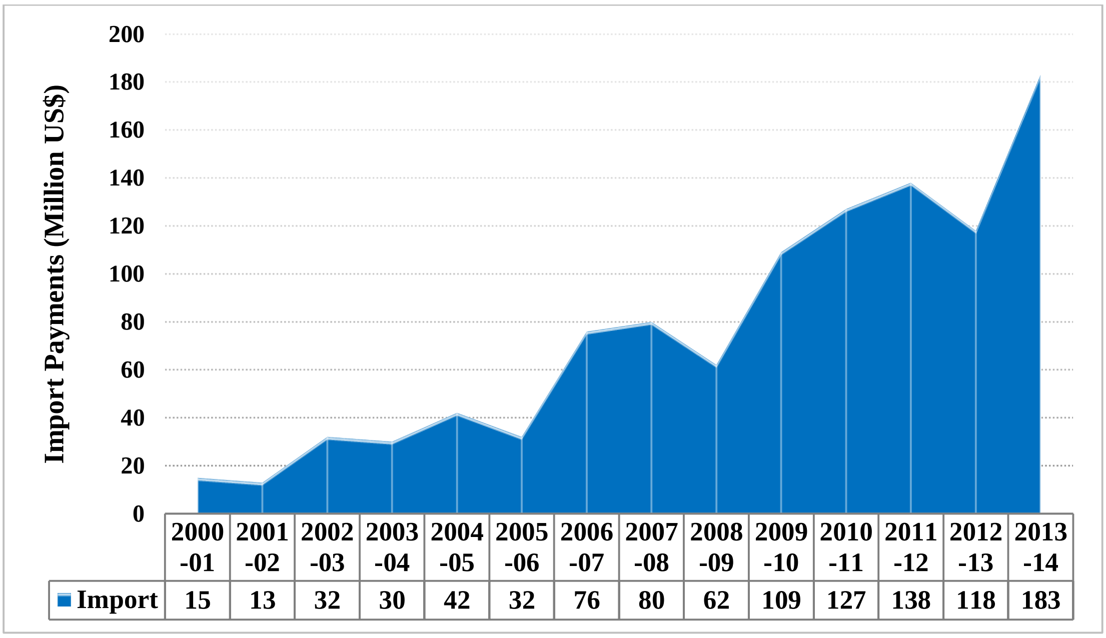


Fig 1.4: Import Payments of Spices

Source: Bangladesh Bank, 2014

Table 1.1 Area And Production of Spices and Condiments in Different Years, (2000-01 to 2011-12)

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

Source: BBS, 2014

1.3 Origin and Status of Onion

Onion (*Allium cepa* L.) is one of the oldest cultivated vegetables in our history, originating in central Asia from where it spread across entire world. Modern archeologist, botanist and historians are unable to determine exact time and place of their first cultivations (because this vegetable is perishable and its cultivation leaves little to no trace), however some written records enables us to paint a very interesting picture about its origins.

There are two schools of thoughts regarding the home of onion cultivation, and both look at the period 5,500 years ago in Asia. Some scientists believe that onion was first domesticated in central Asia and others in Middle East by Babylonian culture in Iran and West Pakistan. Those are of course based on ancient remnants of food cultivation that survived the tooth of time, but many believe that organized cultivation started much earlier, thousands of years before writing and sophisticated tools were created. Onions were grown in Ancient Egypt 5,500 years ago, in India and China 5,000 years ago, in Sumeria 4,500 years ago. With organized onion cultivation starting around 3,500 BC, ancient civilizations that used them soon became really dependent on this great vegetable. The major onion producing countries are China, India, USA, Iran, Russia, Egypt, Turkey, Pakistan, Brazil, Netherland, Nigeria, Mexico, Korea, Spain, Algeria, Bangladesh, Ukraine, Myanmar, Japan and Uzbekistan (FAOSTAT, 2013a). Onion stand first among the spice crops in Bangladesh both in area (3.25 lakh ha) and production (17.55 lakh metric tons) (BBS 2014). The special quality of onion is its smell (flavor) on account of which it is commonly used in food and masala preparation. It is an indispensable part of the Bangladeshi diet and is commonly used both by rich and poor but domestic production does not achieve the annual requirement. It is semi perishable in nature.

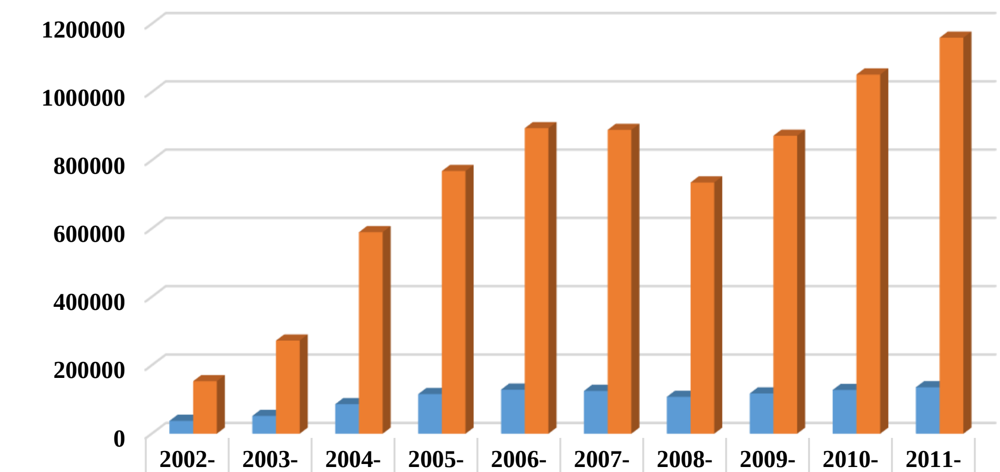
Traditionally, onion grows in winter. Recently Spices Research Centre of Bangladesh Agricultural Research Centre (BARI) has released two new varieties of onions, which are grown in summer season. The released varieties of onion are not yet available in the farmers' field in large scale. Bangladesh requires about 2.3 million tons of onion per annum to fulfill her demand. But Bangladesh produces only 1.9 million tons of onion and imported 0.50 million tons of onion (Alam, 2014). So, we have to increase the production of onion per year. The local winter variety usually grows at Faridpur, Pabna, Rajshahi, Manikganj, Narshingdi, Bogra and greater Rangpur, during the period of December to May. Total area under onion production in our country is 1.35 lakh hectares with the total production of about 11.59 lakh metric tons in the cropping year 2011-12. Among all districts of Bangladesh, Faridpur covers the highest area of land use for onion production (37163.90 hectares), the highest production (3.2 lakh metric tons) in the cropping year 2011-12 (BBS, 2014). It is grown almost in all districts of Bangladesh but the yield is very low (9.58 tons/ha) as compared to other leading onion producing countries of the world such as Ireland, Korea Republic, Australia, USA, Span and Japan where per hectare yield was reported as 75.78, 71.19, 60.39, 60.03, 59.18 and 46.8 tons, respectively (FAOSTAT, 2013b).

Onion is produced in Bangladesh by three different methods (Anonymous, 1991). In the first method, the crop is raised from small bulbs produced in the previous year that is called bulb to bulb production. This method is practiced to produce an early crop for bulbs well as for seed. But this method involves high cost mainly for maintaining good facilities for storing mother bulbs. In the second method, crop is grown by sowing seeds directly in the field usually in broadcast method and very seldom in lines. The third method involves remaining for seedlings in the seedbed and transplanting of such seedlings in the main field after 5-7 weeks. The maximum yield from local varieties like Faridpuri and Taherpuri averages between 7.48 and 8.98 tons per hectare. The varieties were also widely accepted by farmers who got higher returns from their investment compared to the yield from previous varieties. However, a large gap is prevailing in every year between the total requirement and the total production of onion in Bangladesh. The shortfall is met by imports mainly from India, Pakistan and China. Bangladesh needs to spend 183 million US$ annually in foreign currency to import onion, a politically sensitive item whose supply and price variations have reasons for the government's headache.

Table 1.2 Area And Production of Onion in Different Countries in 2013

Countries	Area (ha)	Production (tons)
China	1026250	22345000
India	1217000	19299000
Bangladesh	134354	3159400
USA	294668.8	3159400
Iran	70125	2381551
Russian Federation	85740	1984937
Turkey	63796	1904846
Egypt	52920	1903000
Pakistan	125900	1660800
Republic of Korea	20036	1294009

Source: FAOSTAT, 2013b



	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12
Area	37654	51968	86429	115741	128723	125171	107748	117560	127940	135721
Production	153455	272230	589410	768655	894255	889260	735140	872081	1051347	1159259

Fig 1.5: Area and Production of Onion in Bangladesh from 2002-03 to 2012-13

Source: BBS, 2014

Table 1.3 Area and Production of Onion by Regions from 2009-10 to 2011-12.

Region	2009-10		2010-11		2011-12	
	Area (ha)	Prod. (mt)	Area (ha)	Prod. (mt)	Area (ha)	Prod. (mt)
Bandarban	39.66	181	44.92	233	48.97	222
Chittagong	144.88	659	150.95	660	151.35	668
Comilla	1377.95	7623	1426.52	7372	1489.24	7864
Khagrachhari	14.97	52	14.16	49	14.57	49
Noakhali	424.52	1792	428.97	1788	432.20	1822
Rangamati	39.25	192	38.04	176	36.83	161
Sylhet	221.77	1034	256.57	1150	263.05	1109
Dhaka	6243.49	27240	6579.38	34343	6776.06	36863
Faridpur	28056.86	199772	31634.28	243834	37163.90	320079
Jamalpur	1958.68	12948	1986.60	13144	2035.97	13674
Kishoreganj	742.60	3655	714.27	3552	689.58	3345
Mymensingh	761.62	3760	730.05	3878	725.20	3767
Tangail	940.08	4578	963.96	4737	904.88	4473
Barisal	724.39	1973	793.99	3170	796.02	3134
Jessore	8736.76	70343	10331.22	96051	9317.89	85696
Khulna	795.61	3104	819.49	4861	771.74	4627
Kushtia	10407.30	89322	11247.43	159669	11913.54	148916
Patuakhali	99.15	267	99.15	266	94.70	256
Bogra	2061.47	12073	2154.95	13473	2171.14	13864
Dinajpur	3452.37	17963	3547.47	18872	3617.08	19439
Pabna	30614.87	252983	31427.89	257763	33322.22	305545
Rajshahi	15723.25	139868	18630.51	161913	18830.83	162164
Rangpur	3980.08	20663	3883.36	20393	4097.04	21522
Bangladesh	117561.58	872081	127904.13	1051347	135663.98	1159259

Source: BBS, 2014

1.4 Nutritive, Medical Value of Onion

Onion has many medicinal properties. It is diuretic and is applied on bruises and wounds. It also relieves head sensation and insect bites. Onion is very rich spice because it contains appreciable amount of various nutrients, which are readily available by human body. Onion contains vitamin B and a trace of vitamin C and also trace of iron and calcium. The outstanding characteristics of onion are its pungency which is due to a volatile oil known as allylpropyl-disulphide (Yawalkar 1985). An edible portion of 100 gm onion bulb contains 1.10 gm protein, 9.34 gm carbohydrate, 23 mg calcium and 40 kilocalories energy. Table 1.4 displays that the edible portion furnishes different kinds of bio-chemical substances (USDA, 2015).

Table 1.4 Biochemical Substances of Onion (Value per 100 gm)

Name of substances	Quantities
Water	89.11 gm
Energy	40 kcal
Protein	1.10 gm
Total lipid (fat)	0.10 gm
Carbohydrate	9.34 gm
Fiber, total dietary	1.7 gm
Sugars, total	4.24 gm
Calcium, Ca	0.023 gm
Potassium, K	0.146 gm
Iron, Fe	0.00021 gm
Vitamin C, total ascorbic acid	0.0074 gm
Vitamin B1, Thiamin	0.000046 gm
Vitamin B2, Riboflavin	0.000027 gm

Source: USDA, 2015

1.5 Statement of the Problem

Agriculture plays a vital role in the economic development of the country. Agricultural development is considered to be a prerequisite for the economic development of most Asian countries. In Bangladesh, agricultural (mainly crop) production has remained constant over the past few years whereas population increased several times. At present, the Government of Bangladesh has to import some major crops and industrial goods. Although Bangladesh exports many agricultural products, the export earnings from these products are unable to pay the import costs. Consequently, balance of trade is always negative. The excess import costs are paid by foreign currency retained in the country and by foreign loans. Production of agricultural crops including onion will have to increase to boost the economy.

As agriculture evolves, several factors ranging from institutional to economic, and from physical to natural calamities can limit agricultural development. An increase in onion production by increasing area is not possible since total cultivable area is decreasing day by day due to the increased use of land for non-agricultural purposes. Production can be increased by increasing the technical efficiency of onion using existing technology. If farmers are found to be technically inefficient, production can be increased to a large extent using the existing level of inputs and available technology. A decline in agricultural production could also be caused by sub-optimal utilization of the existing technology or due to productive inefficiency. Several studies in other countries have shown that there is significant potential for raising agricultural output or profitability by improving productive (technical and allocative) efficiency using existing resources. Moreover, these studies have also indicated that there may be significant efficiency differentials between different groups of farms and between different regions among all farms and it should be possible to improve the performance of the less efficient farms or regions without major investment from outside at least in the short run.

The possibilities of economic growth solely through the more efficient use of existing resources will obviously be exhausted when an efficient production technology is reached. In other words, the process of increasing output only by improving efficiency cannot continue indefinitely, since under perfect technically efficient conditions the frontier output level will be reached. Thus, other growth promoting strategies need to be considered when it is not possible to increase output only through efficient utilization of existing resources. The use of modern technology in agriculture to raise output per unit of input is one such strategy. In the case of technically efficient farmers, production can also be increased by substituting existing technology with more advanced technology. A sound and realistic agricultural policy is one of the most important instruments through which agricultural production can be increased.

1.6 Objectives of the Study

The present study was undertaken to achieve the following objectives:

1. To find out the technical efficiency of onion cultivation.
2. To estimate the profitability from onion cultivation.
3. To identify the problems facing by onion farmers and to suggest policy options to overcome them.

1.7 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. Onion is an important spice crop of Bangladesh widely grown in winter. Recently, Spices Research Centre (SRC, BARI, Bogra) has released two new varieties of onions, which are grown in summer season. They hoped that onion 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.

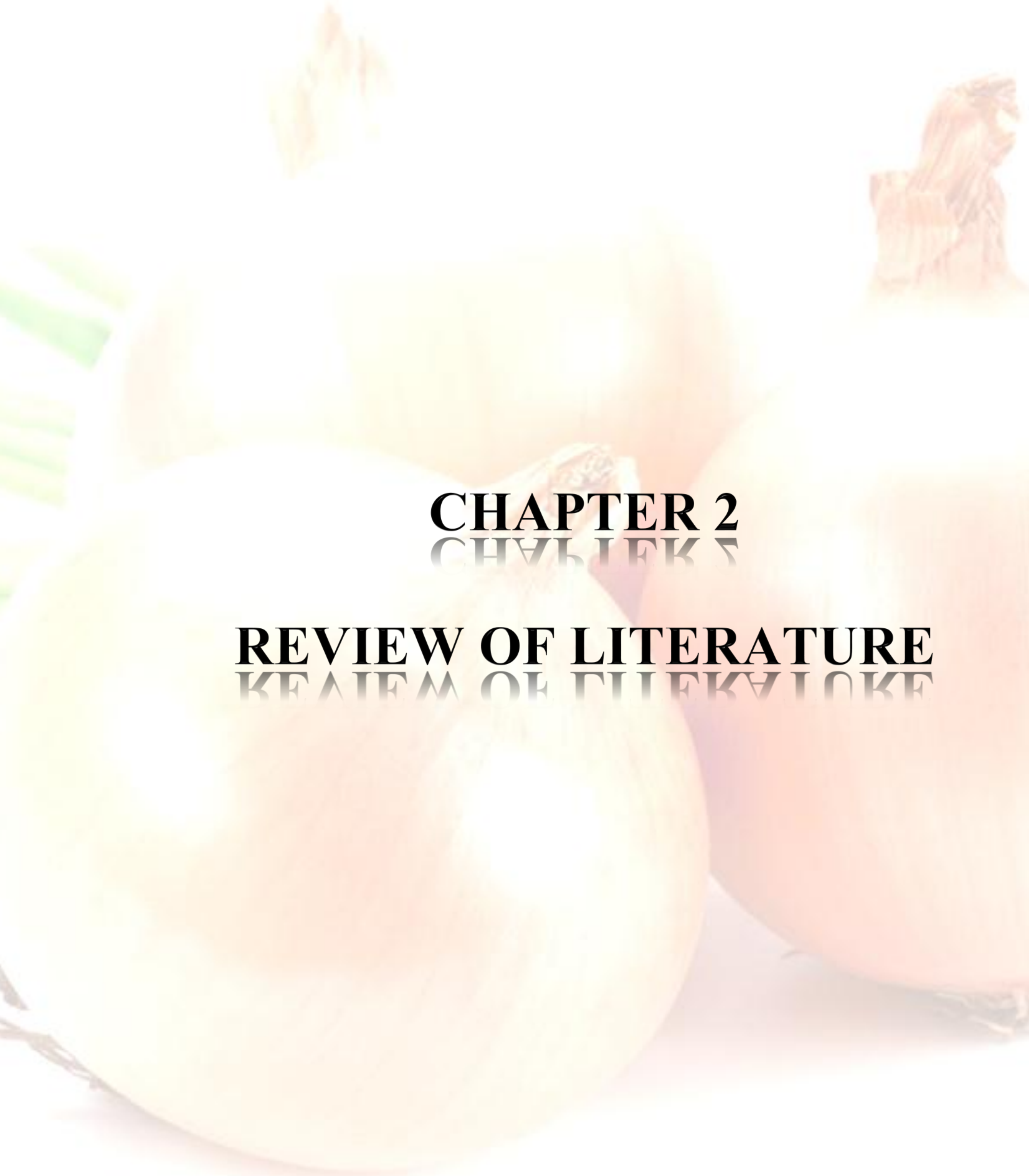
The area of cultivable land for crop production as well as onion production is decreasing day by day. The demand for onion is increasing but production cannot meet up the existing demand. For meeting the deficit, the government of Bangladesh has to import a large volume of onion and some major crops 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 onion, 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 onion 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 onion can be increased by increasing the technical efficiency of onion using existing technology. It is generally assumed that farmers are inefficient at producing onion 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 onion producers. For this reason, the present study makes an attempt to analyze the profitability of onion production and to estimate the technical efficiency of onion 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.

1.8 Outline of the Study

The study consists of 9 chapters. Chapter 1 explained introduction of the study. Relevant review of literature is briefly described in chapter 2. Methodology of the study is presented in chapter 3. A brief description of the study area is presented in chapter 4. Chapter 5 deals with the socioeconomic characteristics of the participant farmers. Technical efficiency of onion farmers are evaluated in chapter 6. Chapter 7 determined profitability of onion production. Chapter 8 is designed to identify different types of problems and constraints faced by the onion farmers. Finally, Chapter 9 deals with summary, conclusions and some policy recommendations.



CHAPTER 2

REVIEW OF LITERATURE

CHAPTER 2
REVIEW OF LITERATURE

The main purpose of this chapter is to review some related studies in connection with the present study. Only a few studies have so far conducted related to technical efficiency and profitability of onion in Bangladesh. Again, some of these studies may not entirely relevant to the present study, but their findings, methodology of analysis and suggestions have a great influence on the present study. Review of some research works relevant to the present studies, which have been conducted in the recent past, are discussed below.

Bevanthade *et al.* (1993) conducted a study on onion production in Amravati district under Maharastra State in India. Sixty-eight farmers were selected from 6 villages in the Amravati District. The holdings were classified according to their area of production. Average areas for Group I, II and III were 209.54, 241.07 and 255.3 ha, respectively. The production costs for A (running costs), B (A+ fixed costs) and C (B+ family labour input) were 13164.85, 19020. 23 and 19668.123 Rs/ha, respectively. On an average, the loss during harvest and storage was 73 percent, the yield was 2335.3 q/ha, and the gross return was 33878.44 Rs/ha. At cost C, the cost: benefit ratio was 1:1.70, the production cost was 83.61 Rs/q and the profit was 59.19 Rs/q, using the prevailing average price of 142.8 Rs/q.

Sabur and Mollah (1993) examined the trend, annual and seasonal variability and relative profitability of spices in Bangladesh. The result showed that all spices except turmeric and ginger show negative growth rates in production since independence. Production growth trend of all spices was lower compared with other food crops but it was reverse in case of nominal price trend. Real price remained more or less same during the study period. Production as well as price fluctuation were higher for onion and garlic and lower for ginger and turmeric. Price fluctuation is directly related to the production fluctuation. Seasonality mostly depends on the perishability of the product and seasonal price variation of spices decreased in the recent years. All the selected spices except coriander are more profitable compared with their competing crops except potato and lentil. On average, 82 percent of production, were sold during harvesting period.

Mahmood (1995) conducted a study on selected spices in Comilla district of Bangladesh. He showed the relative profitability of selected spices, compared with their competing crops. Onion was the most profitable crop among all competing crops like potato, lentil and garlic. The net return per hectare of onion was found to be Tk. 26673.7, which was allowed by potato Tk. 25875.30, lentil Tk. 20652.10 and garlic Tk. 16755.49.

Hossain (1997) studied effect of intercropping groundnut with onion at varying planting arrangement at agricultural research station, Shyampur, Rajshahi, Bangladesh during the Rabi season of 1993-94 and 1994-95. Six treatment viz., sole groundnut (1:0), sole onion (0:1), one row of onion in two rows of groundnut (1:1), two rows of groundnut altered with two rows of onion (2:2), three rows of groundnut altered with two rows of onion (3:2) and four rows of groundnut altered with two rows of onion were studied. The highest groundnut yield and onion bulb yield were obtained from their respective sole crop.

Rahman (1998) conducted an economic study of onion production in selected areas of Rajbari district. Gross returns for the corresponding farmers were Tk. 118765.50, Tk. 157606.75, Tk. 155627.25 and Tk. 145360.50 respectively and their net returns were Tk. 81280.15, Tk. 115376.84, Tk. 111553.04 and Tk. 103637.30, respectively. Per hectare yields of small, medium, large and all farmers were 9501.24 kg, 12608.54 kg, 12450.18 kg and 11628.84 kg. Per hectare human labour was used 309.65 man-days constituting 40.82 percent of total cost for all farmers which was the highest of all cost items. Compared to other farmers, resource use efficiency was higher in the medium size farmers and its BCR was 3.73. Variation in yield was greatly influenced by the number and magnitude of human labour, ploughing, manuring, irrigation and timely date of sowing, planting and harvesting.

Shrivastava (1998) studied on economics of agro-forestry in Indo-Gangetic alliums of Uttar Pradesh in India. Total profit from the first and second cycles was predicted as Rs.28363125 and Rs.75548135, respectively with cost/benefit ratio of 4.0 and 7.2. The system generated 112960 man-days of employment in the first rotation. The second was found to be more efficient in terms of better returns to the producer. Farmers faced some production problems such as inadequate water availability, lack of technical assistance and untimely supply of inputs.

Saha (1999) examined comparative profitability of different varieties of onion in selected area of Pabna District. All the varieties studied were found profitable. But Faridpuri variety was found more profitable than other varieties. Gross returns per hectare for the taherpuri, Indian and Faridpuri varieties of onion were Tk. 112389.00, Tk. 106570.00, Tk. 135640.89, respectively; net returns were Tk. 46756.28, Tk. 50405.65 and Tk. 67945.41, respectively. It was found that variation in net returns was greatly influenced by the use of human labour, tillage, seed, fertilizer, insecticides and irrigation water.

Awal *et al.* (2001) were undertaken a study to examine the effect of various input uses and to determine the resource use efficiency in the production of onion. The results of the study indicated that the return of onion was positively related with the inputs, family labour, hired labour, ash, TSP, MP and irrigation except seeds, animal labour, cowdung, urea and insecticides. The findings also revealed that onion growers are not efficient in terms of resource allocation. Further, farmers have the scope to increase output by efficient utilization of family labour, cowdung, insecticides irrigation in the onion cultivation.

Alam (2003) carried out an experiment to study the effects of planting time and nitrogen on growth, yield and storability of summer onion. The highest yield of 11.32 t/ha was obtained from 11 April planting. Nitrogen also showed significant effect on the yield of summer onion. The highest percentage of weight loss (40.72 percent), rotting (19.13 percent), and sprouting (4.72 percent) were recorded from 12 May planting. The treatment combination of 11 April planting time x BARI Piaz-3 x 0 kg N/ha showed the lowest percentage of weight loss (22.89 percent), rotting (8.17 percent) and sprouting (1.33 percent).

Rahman (2004) studied effect of growth regulators on growth and yield of three varieties of onion grown from sets. The Taherpuri produced the highest bulb yield (14.99 t/ha). Application of all the growth regulators increased plant highest, number of leaves per plant, bulb diameter, mean bulb weight, and bulb yield compared to control plants of onion.

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

Alam (2007) examined the effects of planting time on vegetative growth, yield contributing traits, yield and quality of onion seed. Planting on October 30 gave the highest seed yield of 462.33 kg/ha compared to 443.00, 405.58 and 331.75 kg/ha obtained from October 15, November 15 and December 30 plantings, respectively. The highest seed yield per hectare was obtained from the second closest spacing 25x10 cm^2 (465.42 kg/ha), followed by that of the closest spacing 20x10 cm^2 (454.06 kg/ha).

Islam *et al.* (2007) were conducted a study on growth and yield response of onion (*Allium cepa* L.) genotypes to different levels of fertilizers. The study showed the influence of four levels of fertilizers viz. 0:0:0, 60:65:80, 120:130:160 and 240:260:320 kg/ha (N:P:K) on growth, yield and yield contributing characters of six onion genotypes viz. Thaherpuri Brown, BARI Onion 1, Faridpuri Bhati, Suksagar, Nasirbala and Pusa Red. The fertilizers at 120:130:160 kg/ha produced the maximum bulb yield (14.9 t/ha). Correlation studies revealed that bulb yield was positively related with different yield components, but it showed non-significant negative relation with bulb dry matter content (%). The regression analyses showed that the rate of change of bulb yield was dependent upon the rate of change of plant height, number of leaves and roots, and root length. Increase in number of roots per plant appears very important in increasing the yield.

Ullah (2008) carried out experiments at the Regional Agricultural Research Station, Rahmatpur, Barisal to study the impact of different sulphur levels on bulb yield, storability and economic return of onion. The highest bulb yields (19.75 t/ha and 19.88 t/ha) were obtained from sulphur levels between 60 kg/ha and 75 kg/ha in two consecutive years. Both the cumulative weight and rotten loss were significantly influenced by sulphur fertilization. The highest (9146 percent) marginal rate of return (MRR) with gross margin of Tk. 181844/ha was obtained from the sulphur level S_{60} kg/ha.

Haque *et al.* (2009) were conducted a study on economic assessment of onion and garlic under zero tillage and traditional methods of cultivation in major growing areas of Bangladesh. The study revealed that the cost of onion cultivation was Tk. 93517, Tk. 87696 and Tk. 72001 per hectare on full cost, variable cost and cash cost basis. The net return of onion cultivation was Tk. 64236 per hectare. The benefit cost ratio was 1.68, 1.80 and 2.19 for full cost, variable cost and cash cost basis, respectively. Human labor, seed/seedling, manures, urea, TSP irrigation and insecticide for onion and garlic had positive effect on yield. Non-availability of HYV seed at proper time, lack of technical knowledge, high price and non- availability of fertilizer in time, infestation of insects and diseases, low market price and lack of appropriate storage facility were the major problems of onion and garlic cultivation.

Hasan *et al.* (2009) were conducted a study on returns to investment in summer onion research and extension in Bangladesh. The results revealed that the growth of area and production of onion increased manifolds due to farm level adoption of summer onion. The summer onion adoption rate was found increasing trend over the period. The yield of summer onion was 57.04 percent higher than the local variety. The internal rate of return (IRR), net present value (NPV), and benefit cost ratio (BCR) were estimated to be 25 percent, Tk. 35.29 million and 3.09 respectively. Sensitivity analysis revealed that under various assumptions IRR ranged from 20 percent to 41 percent, NPV from Tk. 18.37 to Tk. 64.05 million, and BCR from 2.31 to 5.95. The results indicated that investment in research and development of summer onion was a good investment.

Hasan (2010) was conducted an economic study on onion production in selected area of Bangladesh. The major findings of the study reveal that onion production is profitable. Gross returns for small, medium and large farmers were Tk. 218989, Tk. 189880 and Tk. 164129 respectively and their corresponding net returns were Tk. 94350, Tk. 78098 and Tk. 67545 respectively. Per hectare yields of onion bulb those of produced were 14217 kg, 12202 kg and 10637 kg respectively. Per hectare human labour was used 292 man-days. Compared to other farmers BCR was highest in the case of small farmers and it was 1.77. The coefficients of parameters like cropped area, seed, inorganic and inorganic fertilizer and training of the farmers were significant and indicated positive effect on onion production. In the technical inefficiency effects model farm size was significant and showed negative sign which mean that farmers with larger farm holdings are technically more efficient than farmers with smaller farm holdings.

Baree *et al.* (2011) were conducted a study on comparative study of technical efficiency of onion producing farms in Bangladesh. The coefficients of experience were significant with negative sign in small and medium farms. The coefficients of education were negative in small and medium farms and it was positive for large farm. The farm-specific technical efficiencies of onion producing small, medium and large farms varied from 55 percent to 99 percent, 57 percent to 99 percent and 56 percent to 99 percent with a mean technical efficiency of 77 percent, 87 percent and 84 percent respectively, which meant that without incurring any additional costs there was a scope to increase output per hectare of onion by 23 percent, 13 percent and 16 percent for small, medium and large farms respectively through the efficient use of existing production technology.

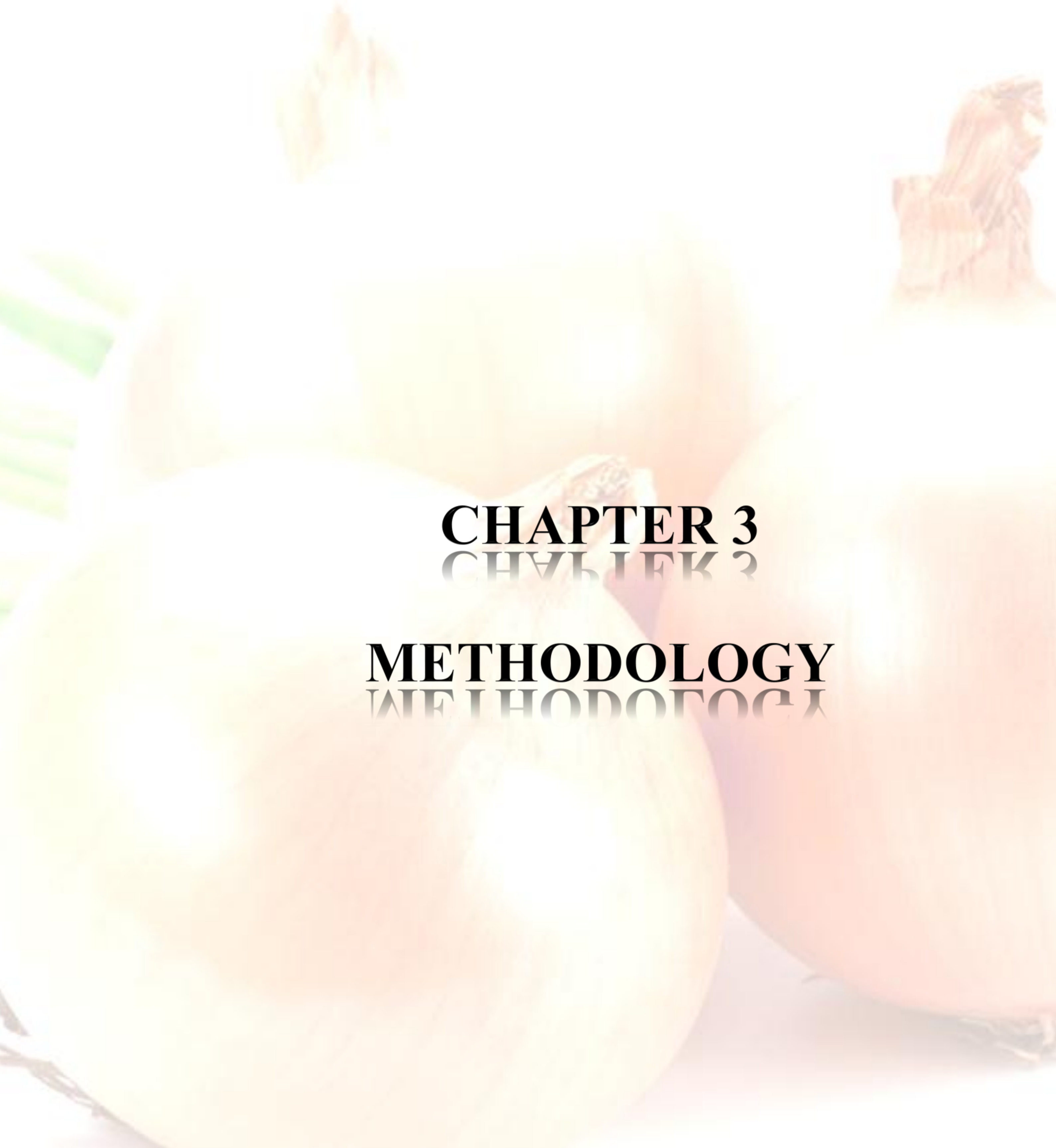
Haque *et al.* (2011) were conducted a study on profitability of onion cultivation in some selected areas of Bangladesh. The yield of onion was found 9869 metric tons per hectare. The gross margin and net return were found to be Tk. 85308 and Tk. 79487 per hectare, respectively. The benefit cost ratio was found 1.85. Inputs like human labour, seedling, manures, urea, TSP, irrigation, and insecticide had positive effect on the yield of onion. The profit obtained from onion cultivation was found higher than that of other competitive crops like mustard, groundnut, and cabbage. Non-availability of HYV onion seed at proper time, lack of technical knowledge, high price and non-availability of fertilizer in time, lack of appropriate storage facility were the major problems of onion cultivation in the study areas and needs immediate attention to solve these problems.

Ibrahim *et al* (2011) were conducted a study on evaluation of herbicides on weed control, performance and profitability of onion (*Allium cepa*) in the forest zone of Nigeria. The results revealed that all the weed control methods significantly ($P<0.05$) decreased weed population. Similarly, survival percentage of onion was affected by the use of chemical. Bulb diameter, number of bulbs and onion yield were affected by the application of chemicals. The use of oxyflorfen gave the best performance in all the parameters measured. It can be concluded that the profitability of producing onion is higher in the Guinea savannah than in the Forest zone and the profitability in the Forest zone can be increased by the use of selective herbicides (Oxyflorfen) at the recommended rate.

Shah *et al.* (2011) were conducted a study on onion production potential, limitations and its prospects for improvement in the farming system of Punjab, Pakistan. Area under onion crop has been increasing even up-to 17 percent of jump from the previous year but the productivity is declining monotonically due to number of threats including pest and diseases attack, lack of improved varieties and quality seed and in conjunction of high costs of all purchased inputs. The main reasons appraised in yield reduction were low quality seed, insects/pests and diseases attack, water stress, marketing and costly inputs (Urea, DAP) in order of priority ranking. All these reasons have adverse impact on the quality and profitability of the onion due to which Pakistan has not been able to earn significant foreign exchange and exploit full export potential.

Baree (2012) was conducted a study on measuring technical efficiency of onion (*Allium cepa* L.) farms in Bangladesh. The elasticity of output with respect to land, labour, and capital cost was estimated to be positive values of 0.3026, 0.0718, and 0.0442, respectively, and also significant. With respect to seed and irrigation, it was found to be insignificant with negative values of 0.0045 and 0.0007. The coefficients of age, experience, and farm size were significant with expected negative signs, which means that the inefficiency effects in onion production decreases with increase in age, experience, and farm size. The technical efficiency of onion farms varied from 58 percent to 99 percent with mean value of 83 percent. It denotes that there is a scope to increase output per hectare of onion farm by 17 percent through the efficient use of production technology without incurring any additional costs.

The above review indicates that a few studies have been conducted on technical efficiency of onion production. The result of these studies varies widely in different reasons. The present study aims to gather information on profitability of onion production and the level of technical efficiency and inefficiencies of onion farmers. The result of the present study would help researchers, related farmers and policy makers in taking necessary steps for increasing onion production in our country.



CHAPTER 3

METHODOLOGY

CHAPTER 3

METHODOLOGY

3.1 Introduction

Methodology is an indispensable and integral part of any study. The reliability of a specific study finding depends to a great extent on the appropriate methodology used in the study. Improper methodology very often leads to misleading result. So, careful considerations are needed by an author to follow a scientific and logical methodology for carrying out the study. The author has great responsibility in describing clearly what sorts of method and procedure is to be followed in selecting the study areas, the sources of data and the analyses as well as interpretations to arrive at a meaningful conclusion. This study was carried out by using a primary data collection from selected onion producers in selected areas of Bangladesh for estimation of technical efficiency and profitability of onion production. The methodological framework is presented in this chapter, which consists of three main sub-sections. The first section describes sampling procedure, sample frame, sample size and survey design. Second section describes data collection procedure, formal and informal survey, and primary and secondary data. Data analysis techniques are described in detail in the third section.

3.2 Sampling Procedure

In an empirical investigation it is impossible to collect information from the whole population. Therefore, researchers are often forced to make inferences based on information derived from a representative sample of the population. The size of the sample, and amount of variation, usually affect the quantity and quality of information obtained from the survey. Using appropriate sampling methods, both factors can be controlled (Scheaffer, 1979). The aim is to devise a sampling scheme, which is economical and easy to operate, and provides unbiased estimates with small variance (Barnett, 1991). The main characteristics of sampling theory applied in this study are discussed below.

3.2.1 Sampling Method

The selection of a sample from the population is commonly used in economics, marketing and other disciplines because of limitations of covering the whole population (Barnett, 1991; Kinnear and Taylor, 1987). The authors consider that cost is the main constraint to carrying out interview of the whole population. Given limitations in terms of money, time, efforts and data management, a sample is a more appropriate method. They argue that sampling not only saves cost and time but can also give more accurate results than a census. In a census survey more staff is required to carry out the task, therefore, supervision of staff and management problems will arise. Sampling theory provides an opportunity to minimize cost and to achieve acceptable results (Casley and Kumar, 1988; Kinnear and Taylor, 1987). However, a sampling procedure involves the following steps: defining the population, sample frame, sample size and sample selection procedure.

3.2.2 Defining the Population

Classification of the population is the first step in the sampling procedure, namely, the sector or element under investigation, the sampling unit, the area or extent of investigation, and the duration of investigation (Kinnear and Taylor, 1987). The sector under investigation was vegetable sector with crop including onion. The sampling units were onion producers of Pabna, and Faridpur districts respectively.

3.2.3 Sampling Frame

The farm management research requires some fundamental information in relation to the objectives of the study. The sampling frame for the present study were selected purposively as to select the area where the onion cultivation was intensive. On the basis of higher concentration of onion crop production, four villages namely Loskorkandi and Haturiya under Faridpur Sadar upazila in Faridpur district and Vitbila and Bonkhola under Sujanagar upazila in Pabna district were selected for the study. The main considerations in selecting the study areas were as follows-

i. A large number of onion growers are available and onion grows well and farmers use a good portion of their land for producing onion in these study areas.
ii. These villages had some identical characteristics like topography, soil and climatic conditions for producing onion.
iii. Easy accessibility and good communication facilities in these villages.
iv. The researcher was familiar with the local language and other socio- economic characteristics of the farmers in the selected villages and the anticipated cooperation from respondents was high which indicated the likelihood of obtaining a reasonably accurate set of data.
v. To conduct a socioeconomic study in these study areas.

3.2.4 Sample Size

In a sample survey, a first question that commonly arises is "how large should the sample be?" Casley and Kumar (1988) and Kinnear and Tayler (1987) suggested that a good survey sample should have both a small sampling error and minimum standard error. This can be obtained if one has unlimited resources. However, given constraints, such as finance, time and data management, compromises have to be made in selecting the sample size.

As a rule, the larger the sample size the higher the reliability, the lower the error and the greater the confidence one can place on the findings reflecting the characteristics of the population as a whole. But, faced with the inevitable constraints of time and money, the researcher invariably has to compromise between optimum and acceptable levels of confidence, reliability and error. Simple guidelines to determine the sample size provided by Poate and Daplyn (1993) were considered for selecting a representative sample size of onion producers. 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). A total of 150 (75 from each districts) farmers who were cultivating different varieties of onion in the selected areas were selected as samples.

3.2.5 Sample Selection Procedure

The investigator wishes to avoid bias in the sample selection process to achieve accuracy in the estimates, which is to have a small standard error (Kinnear and Taylor, 1987). The best way to avoid bias in the sample selection process is use of simple random sampling in which each unit of the population has an equal chance for selection (Scheaffer, 1979). Either increasing the sample size or imposing various restrictions and modifications on the simple random sampling procedure can achieve an increase in precision of the sampling procedure. At first, onion dominated upazila was selected purposively from each district. Then two villages were selected from each of the upazila by simple random sampling method and the ultimate sampling units (Households) were selected by random sampling method. The procedure was comprehensive and representative of the whole population.

3.3 Data Collection Procedure

Primary data has been collected by conducting survey of onion producers from the selected areas. The fieldwork also involved gathering data on onion production practices, input use, labor utilization, natural and socio-economic constraints, prices and market activities. The methodology consisted of field survey, review of previous studies, and interviews with knowledgeable onion producers, and also direct observation by the researchers. In the direct observation, emphasis was placed to assess the existing management practices, input use and marketing system of onion producers.

3.3.1 Informal Survey

An informal survey was carried out to achieve the stated objectives. The purpose of this survey was to gather quick information on various aspects of the study, organize fieldwork plan, testing the validity of the questionnaire and estimating the various cost components such as financial costs, travel time, interview time etc. This preliminary survey provided an opportunity to understand the existing labour use, input and output costs. During the informal survey, interviews were held with a producer or group of producers on one or more aspects of the study and field notes prepared. Based on this preliminary information the investigator developed the questionnaire for further in-depth investigations.

3.3.2 Formal Sample Survey

Gaining the farmers' confidence and obtaining accurate information was a key during the fieldwork. To achieve these objectives, producers were assured absolute privacy, interviews were held in places of their choice and they were assured that the researchers are not related to any government tax agency and information would be used for academic purposes. Most of the interviews were held at the farm or in the farmer's house. The interview usually started with an introduction about the background of the researcher, the objectives of the study and the way in which the respondent was chosen. The discussion started with general topics of interest of the farmers, such as social life, family and the onion production and contracting system etc. This method has been found useful in establishing confidence with producers; its only disadvantage was increasing the time of the interview. Gradually, the researcher converted the discussion to the related issues of onion production practices and problems. Then specific questions from the questionnaire were asked and the answers were recorded.

3.3.3 Design of Questionnaire

Design of questionnaire is a difficult exercise at the planning stage of a survey (Casely and Lury, 1981). During the development of a questionnaire, two main problems are commonly noted:

a) the questionnaire tends to be long or too many topics are covered
b) the sequence of question has not been well organized.

Thus time and money are wasted for collecting, checking and entering data in a computer, which are not required. The poor sequences of questions also make it difficult at the time of data analysis. As the survey mainly depends upon the preparation of the survey schedule, therefore, a draft schedule was prepared for pre-testing to verify the relevancy of the questions and nature of response of the farmers. After making necessary correction, modification and adjustment, a final survey schedule was developed.

In this study the questionnaires were designed with the following heads-

i. General information of the sample farmers;
ii. Family composition of the sample farmers;
iii. Occupational and educational status of sample farmers;
iv. Information about land;
v. Production cost of onion;
vi. Source of capital;
vii. Amount of yield obtained from onion and
viii. Problem faced by the farmers in producing onion.

The questionnaires were in English but questions were asked in the local languages from the respondents.

3.3.4 Data Collection Techniques

Primary data was collected through conducting field survey, while secondary data was gathered from publications and statistical bulletins. Due to the absence of producers' records regarding farm activities, data collection depended on a combination of methods, which rely on memory recall for basic information such as labor use, wages, input costs.

3.3.4.1 Primary Data Collection

Since farming is seasonal one, a farm business survey should cover a whole crop year in order to have a complete sequence of crops. The researcher must determine to what extent the information for a particular year represents normal or average conditions, particularly for crop yields, annual production and price level. Farmers generally plant onion from mid-December to January and harvest after three months. Data for the present study collected during the period of March to April 2015. Primary data were collected from primary producers. Selected respondents were interviewed personally with the help of pre-tested questionnaires. Farmers' fields were also visited in order to get clear understanding, observations and perceptions about the production and marketing systems in the study area. Primary, secondary and terminal markets were also visited for primary data collection, field perception and observation. Primary data collected from producers has been used in estimating production function.

3.3.4.2 Secondary Data Collection

Secondary data had been collected from various research documents and papers like-

- Statistical Yearbook of Bangladesh,
- Yearbook of Agricultural Statistics
- Bangladesh Economic Reviews
- The national and international journals, articles and publications and
- Internet

3.4 Accuracy of the Data

Adequate measures were taken during the period of data collection to minimize the possible errors. The measures taken were-

- Built-in-check in the interview schedule;
- Field checking; and
- Independent re-interviewing of the respondents.

In case of any inconsistency and lapses, the neighboring farmers were asked for necessary verification and data were checked and corrected through repeated visits. In order to ensure consistency and reliability of the parameters being generated out of the data, follow up visits were also made to the field to obtain supplementary information.

3.5 Processing, Editing and Tabulation of Data

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 were presented mostly in the tabular form, because it was of simple calculation, widely used and easy to understand. Besides, functional analysis was also adopted in a small scale to arrive at expected findings. Data entry was made in computer and analysis was done using the concerned software Microsoft Excel and statistical package FRONTIER 4.1 (Coelli, 1996).

3.6 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 onion growers, input use, costs and returns of onion 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 will be used in the present study.

3.6.1 Economic Profitability Analysis

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

- Land preparation
- Human labour
- Seedlings
- Urea
- TSP
- Mop
- Insecticide
- Irrigation

- Interest on operating capital
- Land use

The returns from the crops were estimated based on the value of main products. In this study variable cost, fixed cost and total cost had been described. Total variable cost (TVC) included land preparation, human labour, 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.

3.6.1.1 Cost of Land Preparation

Land preparation considered one of the most important components in the production process. Land preparation for onion 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.

3.6.1.2 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.

3.6.1.3 Cost of Seed

Cost of seed varied widely depending on its quality and availability. Market prices of seeds of respected onion 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.

3.6.1.4 Cost of Urea

Urea was one of the important fertilizers in onion 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.

3.6.1.5 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.

3.6.1.6 Cost of MoP

Among the three main fertilizers used in onion 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.

3.6.1.7 Cost of Insecticides

Farmers used different kinds of insecticides for 2-3 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.

3.6.1.8 Cost of Irrigation

Water management helps to increase onion 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.

3.6.1.9 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 onion. 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

3.6.1.10 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.

3.6.1.11 Calculation of Returns

3.6.1.11.1 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.

3.6.1.11.2 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

3.6.1.11.3 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

The following profit equation was used to assess the profitability of onion production at the farm level:

$$\Pi = P_rQ_r + P_bQ_b - \sum_{i=1}^{n} (P_{xi}.X_i) - TFC$$

Where,

Π = Profit per hectare for producing onion

P_r = Per unit price of onion (bulb) (Tk. /Kg)

Q_r = Quantity of onion (bulb) (Kg/ha)

P_b= Per unit price of onion flower stalk (Tk. /kg)

Q_b= Quantity of onion flower stalk (Kg/ha)

P_{xi}= Per unit price of the i^{th} (Variable) inputs (Tk. /kg)

X_i = Quantity of the i^{th} inputs (Kg/ha)

i = 1, 2, 3………..n and

TFC = Total fixed cost

3.6.1.11.4 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.

$$BCR = \frac{\text{Total Return (Gross Return)}}{\text{Total Cost}}$$

3.6.2 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. If these differences in quality are physically measurable, it may be possible to reduce this effect by defining a large number of relatively homogeneous factors of production, but in practice it is never likely to be possible to completely eliminate it (Farrell 1957).

3.6.2.1 Farrell's Approach

Farrell illustrated his ideas using a simple example involving firms which use two inputs (X_1 and X_2) to produce a single output (Y), under the assumption of constant returns to scale. Knowledge of the unit isoquant of fully efficient firms, represented by SS' in Figure 3.1, permits the measurement of technical efficiency. If a given firm uses quantities of inputs, defined by the point P, to produce a unit of output, the technical inefficiency of that firm could be presented by the distance QP, which is the amount by which all inputs could be proportionally reduced without reduction in output. This is expressed as a percentage by the ratio QP/OP, which represents the percentage by which all inputs need to be reduced to achieve technically efficient production. The technical efficiency (TE) of a firm is most commonly measured by the ratio

$$TE_i = OQ/OP \quad (3.1)$$

Which is equal to one minus QP/OP. It will take a value between zero and one, and hence provides an indicator of the degree of technical inefficiency of the firm. A value of one indicates that the firm is fully technically efficient. For example, the point Q is technically efficient because it lies on the efficient isoquant.

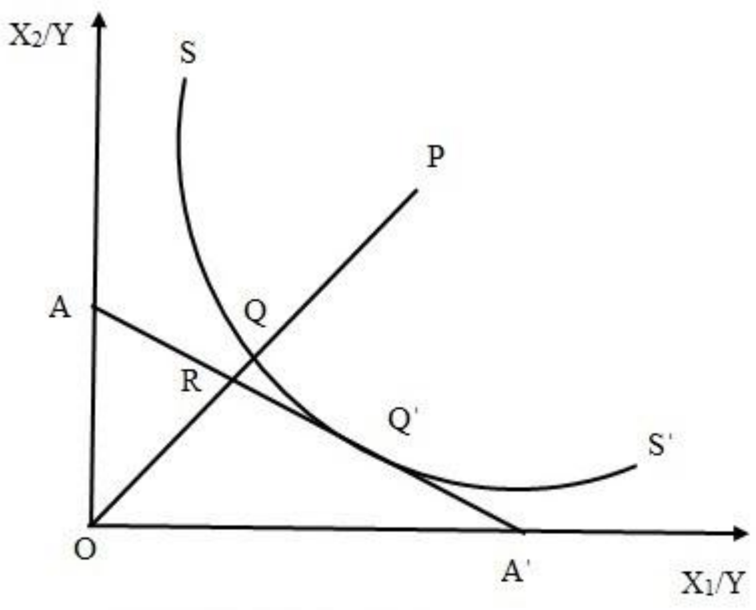


Fig 3.1: Technical Efficiency

3.6.2.2 Frontier Efficiency Models

The text book definition of a production function holds that it gives the maximum possible output which can be produced from given quantities of a set of inputs. Similarly, a cost function gives the minimum level of cost at which it is possible to produce the same level of output, given input prices. Finally, a profit function gives the maximum profit that can be attained, given output price and input prices.

For each of the above functions, the concept of maximality or minimality is important. The word frontier may meaningfully be applied in each case because the function sets a limit on the range of possible observations. Thus one may, for example, observe points below the production frontier (firms producing less than maximal possible output) but no points can lie above the production frontier; similar comments apply to suitably defined cost and profit frontiers.

The amount by which a firm lies below its production and profit frontiers, and the amount by which it lies above its cost frontier, can be regarded as measures of inefficiency. The measurement of inefficiency has been the main motivation for the study of frontiers.

The conventional production function approach is the most widely used measure in the analysis of the production efficiency of farmers. The traditional approach is to estimate an average production function by a statistical technique such as least squares. The average production functions have received far more attention for the simple statistical reason that the mean of the error terms is zero. This is, however, not consistent with the definition of the production function.

Thus finding a measure of production efficiency that is consistent with the definition of production function has been a major concern for many researchers. The production technology is represented by the transformation (production) function that defines the maximum attainable outputs from different combinations of inputs. Alternatively, if considered from an input orientation side, it describes the minimum amount of input required to achieve the given output level. In other words the production function describes a boundary or a frontier.

Given the definition of a production function, interest has now centered more on specifying and locating the production frontier. Alternatively, production models have often been proposed and the frontier model, which is based on the concept of maximality and minimality is one of these models. There seems to be a consensus in the recent literature on production function estimation that the production frontier rather than the average production function corresponds to the theoretical notion of the production function. Farrell was the pioneer who introduced the frontier measure of efficiency which reflects actual firm performances and can include all relevant factors of production. This is consistent with the textbook definition of the production function.

The frontier production function approach has some obvious advantages over the traditional methodologies and its use is, therefore, becoming increasingly widespread. The primary advantage of the method is that it is more closely related to the theoretical definition of a production function which relates to the maximum output attainable from a given set of inputs and which is consistent with the underlying economic theory of optimizing behaviour. The second advantage of the method lies in the fact that estimates of technical or production efficiency of a firm in the sample may be obtained by comparing the observed output with the predicted (or attainable) output. Deviations from the frontier have acceptable interpretations as measures of the inefficiency which economic units have attained. This approach provides a benchmark against which one can measure the relative efficiency of a firm. Finally, information about the structure of the frontier and about the relative efficiency of economic units has many policy applications. The production frontier is, however, unknown and it has to be empirically constructed from observed data in order to compare the position of a firm or a farm relative to the frontier.

Thus, it is the task of the econometrician to recast the theoretical treatment into a framework that permits estimation of the various frontiers, and allows calculation of the magnitudes and costs of the various types of inefficiency relative to these frontiers. Although work has been progressing on this task for over three decades, it has only recently attracted widespread attention. Several methods have been developed for the empirical estimation of the frontier models. These different methods to estimate the frontier efficiency models can be categorized according to:

I. the way the frontier is specified; the frontier may be specified as a parametric function of inputs or as a deterministic nonparametric function;
II. the way the frontier is estimated; the frontier may be estimated either through programming techniques or through the explicit use of statistical procedures;
III. the way the deviation from the frontier are interpreted; deviations may be interpreted simply as inefficiencies or they could ne treated as mixtures of inefficiency and statistical noise; that is, frontier may be deterministic or stochastic;
IV. the way the frontier is optimized (dual approach); the frontier may be production frontier or cost frontier.

3.6.2.3 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 elaborated 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.

3.6.2.3.1 The Stochastic Frontier Production Function

Aigner, Lovell and Schmidt (1977) and Meeusen and van den Broeck (1977) independently proposed the stochastic frontier production function, in which an additional random error, V_i, is added to the non-negative random variable, U_i, in equation (3.2) to provide

$$Y_i = f(X_i, \beta) + \varepsilon_i \qquad (3.2)$$

Or

$$Y_i = f(X_i, \beta) + V_i - U_i \qquad (3.3)$$

where Y_i = output for observation i, β = vector of parameters, ε_i = error term for observation i. The error term ε_i is made up of two independent components,

$$\varepsilon_i = V_i - U_i \qquad (3.4)$$

Where V_i is the two-sided symmetric, normally distributed random error $\{V_i \sim N(0, \sigma_v^2)\}$ representing the usual statistical noise found in any relationship and $U_i \geq 0$ is one-sided error term representing technical inefficiency with a half normal distribution $\{U_i \sim |N(0, \sigma_u^2)|\}$. That is, U_i is distributed as the absolute value of a $N(0, \sigma_u^2)$ variable. One may note that U_i measures technical inefficiency in the sense that it measures the shortfall of output (Y_i) from its maximum possible value given byb the stochastic frontier $[f(X_i, \beta) + V_i]$. The maximum likelihood estimation of equation (3.2) provides estimators for β, λ and σ, where β was defined earlier, $\lambda = \sigma_u / \sigma_v$ and $\sigma^2 = \sigma_u^2 + \sigma_v^2$. For notational simplicity, we have dropped the observation subscript (i).

When a model of this form is estimated, one readily obtains residuals $\tilde{\varepsilon}_i = Y_i - f(X_i, \tilde{\beta})$, which can he regarded as estimates of the error terms ε_i. However the problem of decomposing these estimates into separate estimates of the components V_i and U_i remained unsolved for some time until Jondrow *et al.* (1982) produced a method for decomposing the total error term. Of course, the average technical inefficiency - the mean of the distribution of the U_i - is easily calculated. For example, in the half-normal case of U_i the mean technical inefficiency is $\sigma_u \sqrt{(\frac{2}{\pi})}$, and this can be evaluated given one's estimate of σ_u, as in Aigner, Lovell and Schmidt (1977) or Schmidt and Lovell (1979). On average technical inefficiency can be estimated by the average of $\tilde{\varepsilon}_i$. It is also clearly desirable to be able to estimate the technical inefficiency U_i for each observation or farm. Indeed this was Farrell's (1957) original motivation for introducing production frontiers, and the ability to compare levels of efficiency across observations or farms remains the most compelling reason for estimating frontiers.

Intuitively, this should be possible because $\varepsilon_i = V_i - U_i$ can be estimated and it obviously contains information on U_i. Now we can show the conditional distribution of U_i given ε_i as presented by Jondrow *et al.* (1982). This distribution contains whatever information ε_i yields about U_i. Either the mean or the mode of this distribution can be used as a point estimate of U_i. Jondrow *et al.* (1982) have shown that the assumptions made on the statistical distributions of V and U, as mentioned above, make it possible to calculate the conditional mean of U given ε as:

$$E\,(U/\varepsilon) = \sigma\left(\frac{f\left(\frac{\varepsilon\lambda}{\sigma}\right)}{1-F\left(\frac{\varepsilon\lambda}{\sigma}\right)} - \frac{\varepsilon\lambda}{\sigma}\right) \qquad (3.5)$$

Where f and F are, respectively, the standard normal density and distribution functions, evaluated at $\varepsilon\lambda/\sigma$ and $\sigma.^2 = \sigma^2 \sigma_v^2/\sigma_u^2$. Thus, equations (3.2) and (3.5) provide estimates for U and V after replacing ε, $\sigma.$ and λ by their estimates.

Equation (3.5) measures the firm-specific technical inefficiency. We may recall that the technical efficiency of i-th farm is defined by TE_i = exp. ($-U_i$), which is inversely related to technical inefficiency effect U_i. This firm-specific technical inefficiency effect U_i is unobservable. Even if the true value of the parameter vector, β, in the stochastic frontier production function (3.2) was known, only the difference $\varepsilon_i = V_i - U_i$ could be observed. The best predictor for U_i is the conditional expectation of U_i, given the value of ε_i, which is shown in equation (3.5). The measure of the individual technical efficiency is then computed as TE_i = exp. $\{-E(U_i/\varepsilon_i)\}$. This measure represents the technical efficiency of the farmer relative to the practice of the efficient frontier.

The second point estimator for U, the mode of the conditional distribution, is the minimum of $\mu^\cdot$ ($\mu^\cdot = -\varepsilon\lambda\sigma^\cdot/\sigma$) and zero, which can be written as

$$M(U/\varepsilon) = -\varepsilon\,(\sigma_u^2/\sigma_v^2) \qquad \text{if } \varepsilon \leq 0,$$

$$= 0 \qquad \text{if } \varepsilon > 0 \qquad (3.6)$$

The mode M (U/ε) can be given an appealing interpretation as a maximum likelihood estimator; it can be derived by maximizing the joint density of U and V with respect to U and V, subject to the constraint that $V-U= \varepsilon$. Incidentally, it is easily verified that the expressions in (3.5) and (3.6) are non-negative, and monotonic in ε. Of courses, $\mu^\cdot$ and $\sigma^\cdot$ are unknown, and thus in using any of the above results we will have to replace $\mu^\cdot$ and $\sigma^\cdot$ by their estimates $\bar{\mu}^\cdot$ and $\bar{\sigma}^\cdot$ respectively.

As with the specifications of stochastic frontier production functions, estimation of them is also important. The direct estimates of the parameters of the stochastic frontier production function can be obtained using either the maximum-likelihood (ML) method or by using a variant of the COLS method, suggested by Richmond (1974). The COLS approach is not as computationally demanding as the ML method, which requires numerical maximization of the likelihood function. However, this distinction has lessened in recent years with the availability of computer software, such as the LIMDEP econometrics package (Greene 1992) and the Frontier Version 4.1 programme (Coelli, 1996), both of which automatically estimate the parameters of stochastic frontier models using ML method.

The ML estimator is asymptotically more efficient that than the COLS estimator. Coelli (1995a) investigated the finite-sample properties of the half- normal frontier model in a Monte Carlo experiment showed that ML estimator was significantly better than the COLS estimator when the contribution of the technical inefficiency effects to the total variance term is large.

The above discussion deals with the case of the half-normal distribution for the technical inefficiency effects, because it has been most frequently assumed in empirical investigations. Aigner, Lovell and Schmidt (1977) derived the log- likelihood function for the model, defined by equation (3.2), in which the U_is are assumed to be i.i.d. truncations (at zero) of a $N(0, \sigma_u^2)$ random variable, independent of the V_is which are assumed to be i.i.d. $N(0, \sigma_v^2)$. Assuming a random sample of N observations and using a joint density function of U_i and V_i of the aforesaid form. Aigner, Lovell and Schmidt (1977) have shown that the log- likelihood function is given as:

$$\text{Ln } L(Y/\beta\lambda\sigma^2) = N \ln \frac{\sqrt{2}}{\pi} + N \ln \sigma^{-1} + \sum_{i=1}^{N} ln\ [1\text{-}F\ (\varepsilon_i\lambda\sigma^{-1})] - (1/2\sigma^2) \sum_{i=0}^{n} \varepsilon_i^2 \qquad (3.7)$$

The maximum likelihood estimator is then obtained by the numerical maximization of the above likelihood equation with respect to the parameters (β, σ^2, λ).

As with the specifications and estimation of the stochastic frontier production functions, the appropriate and competent explanation of different parameter characters is also necessary. Aigner, Lovell and Schmidt (1977), Jondrow *et al.* (1982), Bravo-Ureta and Rieger (1991) and others expressed the likelihood function in terms of the two variance parameters, $\sigma^2 = \sigma_u^2 + \sigma_v^2$ and $\lambda = \sigma_u/\sigma_v$. They interpreted λ to be an indicator of the relative variability of the two sources of the random error that distinguishes farms from one another. Here $\lambda = \sigma_u/\sigma_v$, is the ratio of the standard deviation of the non-negative error term U_i to the standard deviation of the two-sided symmetric error term V_i. If λ approaches 0 then it implies σ_v very large or σ_u is close to zero, i.e. the symmetric error dominates in the determination of ε and the density function of ε becomes the density of a N (0, σ^2) random variable. In other worlds, the discrepancy between the observed and the frontier output is dominated by random factors beyond the control of the farmer. Similarly, when σ_v is close to zero (i.e. $\sigma_v \rightarrow 0$), λ becomes very large (i.e. $\lambda \rightarrow \alpha$) and the one side error becomes the dominant source of random variation in the mode and hence the production process in characterized by technical inefficiency, where density of ε takes on the form of a negative half-normal. Some other authors (Battese and Corra

1977; Coelli and Battese 1996a; Kalirajan 1981, 1984; Kalirajan and Flinn 1983; Kalirajan and Shand 1985) have used different parameter $\gamma = \sigma_u^2/\sigma^2$ to explain the discrepancy between the frontier output level and the actual output. Battese and Corra (1977) suggested that the parameter, $\gamma = \sigma_u^2/\sigma^2$, be used because it has a value between zero and one, whereas the λ parameter could be any non-negative value. They also suggested that the γ parameterization has advantages in seeking to obtain the ML estimates because the parameter space for γ can be searched for a suitable starting value for the iterative maximization algorithm involved.

The most important advantage of the stochastic frontier model is the introduction of a two sided symmetric random error which accounts for statistical noise, measurement error and exogenous shocks that are beyond the control of the production until in addition to one-sided inefficiency component to be the model. The second important advantage of this model is that it provides a method of separating the error term into its two components for each observation of firm.

This enables one to estimate the level of technical inefficiency for each observation in the sample, and largely removes what had been viewed as a considerable disadvantage of the stochastic frontier model relative to other models (so-called deterministic frontiers) for which technical inefficiency is readily measured for each observation. Since it separates technical inefficiency effects from other random effects, the estimated efficiency measurement is unbiased and competent.

Nevertheless, the stochastic frontier model is not without problems. The main criticism is that there is generally no a priori justification for the selection of any particular distributional form for the U_is. The specifications of more general distributional forms, such as the truncated-normal (Stevenson 1980) and two- parameter gamma (Greene 1990), have partially alleviated this problem, but the resulting efficiency measures may still be sensitive to distributional assumptions.

3.6.2.3.2 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

$$Y_i = f(X_i,\beta)\ \exp.(V_i - U_i) \qquad i = 1, 2, 3, \ldots\ldots\ldots., N \qquad (3.8)$$

Where the stochastic production frontier is $f(X_i,\beta)\exp.(V_i)$, V_i having some symmetric distribution to capture the random effects of measurement error and exogenous shocks which cause the placement of the deterministic kernel $f(X_i,\beta)$ to vary across firms. The technical inefficiency relative to the stochastic production frontier is then captured by the one-sided error component $U_i \geq 0$.

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

$$Y = a \prod_{i=1}^{\lambda} X_i^{bi}\ \exp.\ (\mathcal{E}) \qquad (3.9)$$

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;

$$\ln Y = b_o + \sum_{i=1}^{k} b_i \ln X_i + V - U \qquad (3.10)$$

Where $b_0 = \text{In } a$.

The estimation of the model and derivation of technical efficiency is the same as described earlier.

3.6.2.3.3 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:

$$Y = \beta_0\ X_1^{\beta 1}\ X_2^{\beta 2} \ldots\ldots\ldots. X_6^{\beta 6}\ e^{Vi-Ui} \qquad (3.11)$$

The above function is linearized double-log form:

$$\ln Y = \ln\beta_0 + \beta_1\ln X_1 + \beta_2\ln X_2 + \beta_3\ln X_3 + \beta_4\ln X_4 + \beta_5\ln X_5 + \beta_6\ln X_6 + V_i - U_i \qquad (3.12)$$

Where,

Y = Output (kg/ha)

X_1 = Human labour (man days/ha)

X_2 = Land preparation cost (Tk./ha)

X_3= Seed (Kg/ha),

X_4 = Fertilizer (kg/ha)

X_5 = Cost of insecticide (Tk./ha)

X_6 = Irrigation cost (Tk./ha).

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

$$U_i = \delta_0 + \delta_1 Z_1 + \delta_2 Z_2 + \delta_3 Z_3 + \delta_4 Z_4 + \delta_5 Z_5 + \delta_6 Z_6 + W_i \qquad (3.13)$$

Where,

Z_1…….. Z_6 are explanatory variables.

The equation can be written as:

$U_i = \delta_0 + \delta_1$Onion farming experience + δ_2Education + δ_3Farm size + δ_4Contact with AEO + δ_5Training + δ_6Taking loan + W_i (3.14)

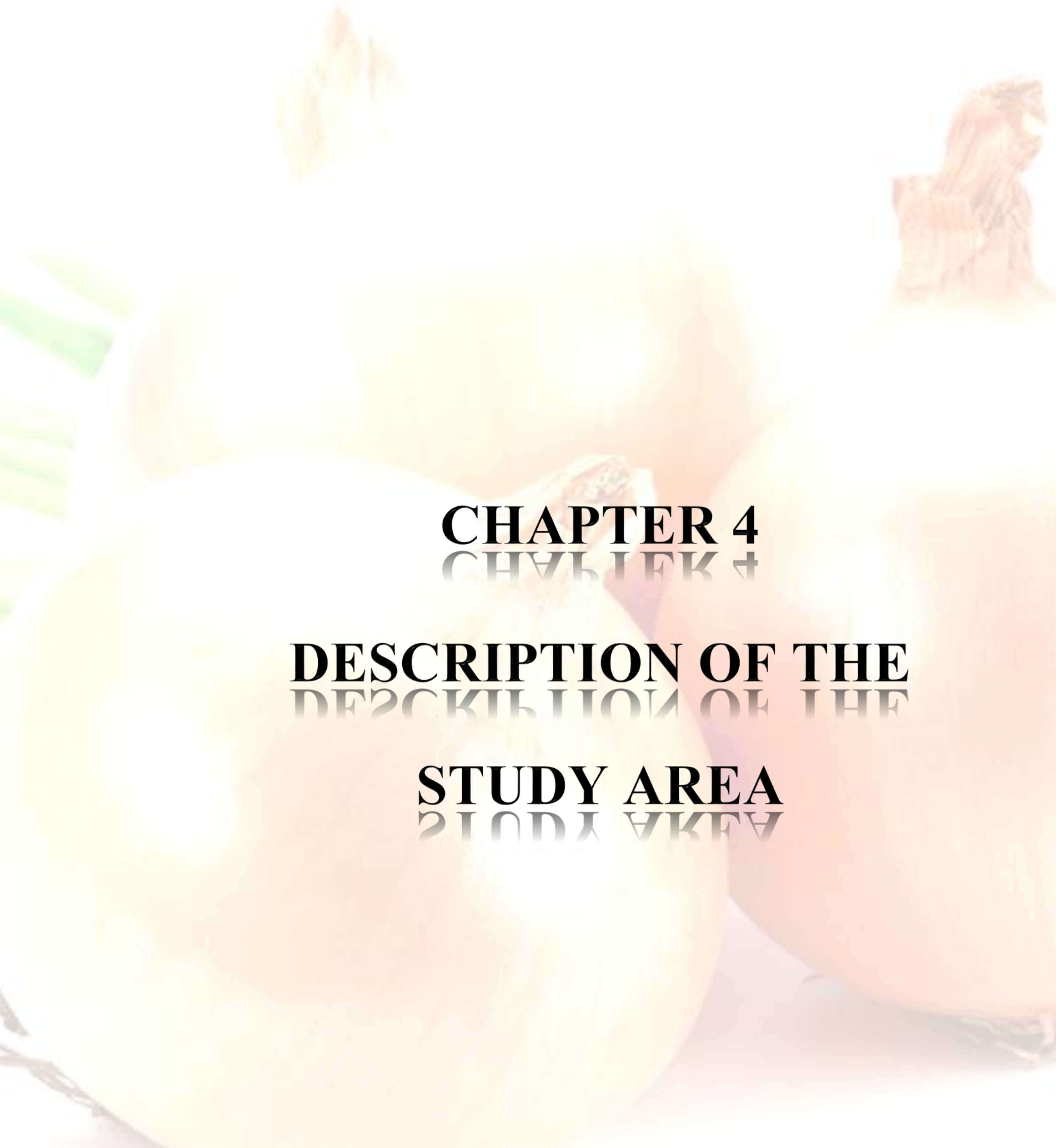
V is two-sided uniform random variable beyond the control of farmer having $N(0, \sigma_v^2)$ distribution, U is one-sided technical inefficiency effect under the control of farmer having a positive half normal distribution $\{U_i \sim |N(0, \sigma_u^2)|\}$ and W_i is two-sided uniform random variable. W is unobservable random variable having a positive half normal distribution. The model was estimated simultaneously using frontier package 4.1.

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

$\sigma^2 = \sigma_u^2 + \sigma_v^2$ and

$\gamma = \sigma_u^2/\sigma^2$

Where γ parameter has value between zero and one.



CHAPTER 4

DESCRIPTION OF THE STUDY AREA

CHAPTER 4

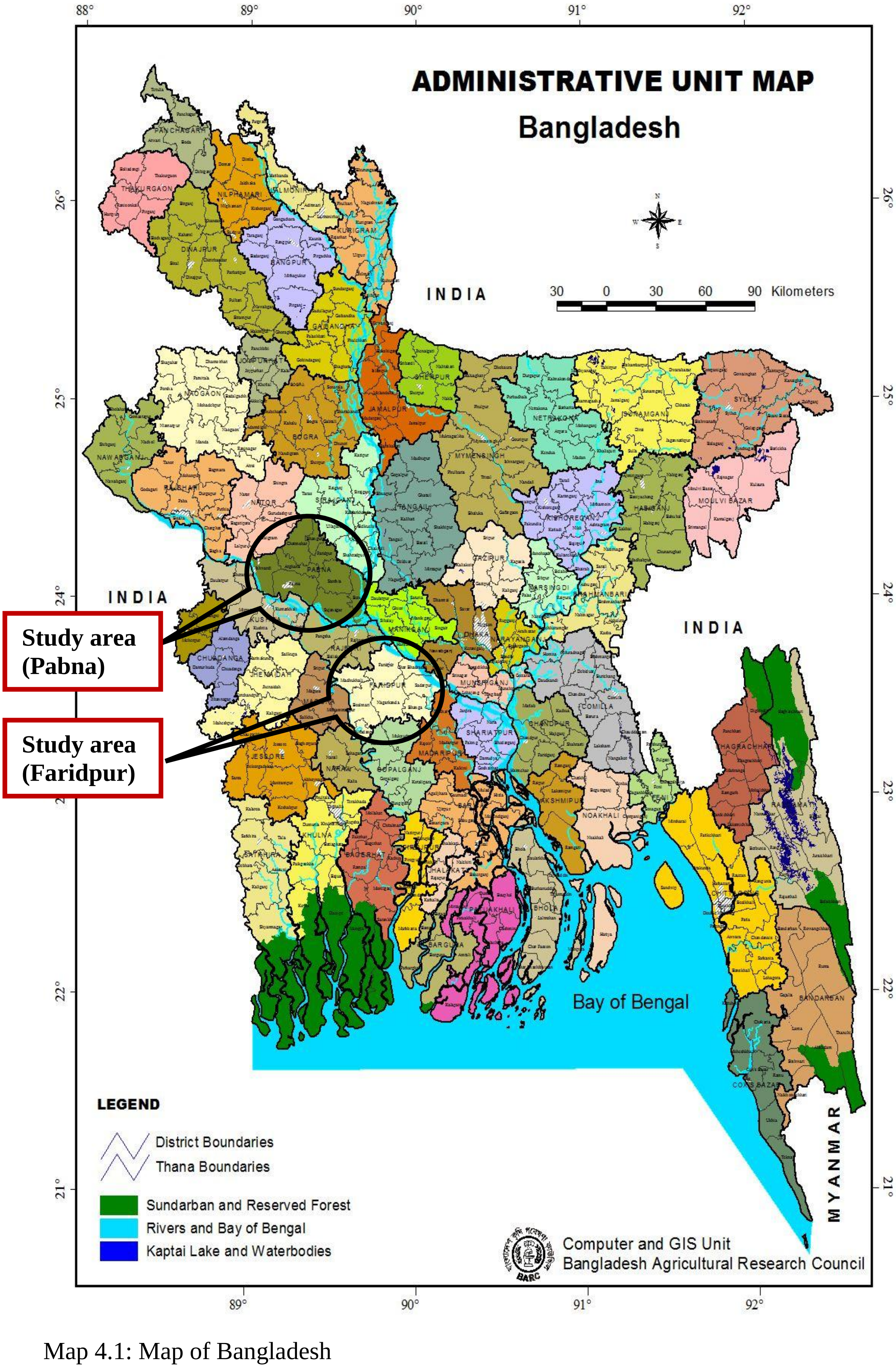
DESCRIPTION OF THE STUDY AREA

4.1 Introduction

A short description has been presented in this chapter to know the overall features of the study area. It is essential to know the agricultural activities, possible development opportunities and potentials of the study area. Location, area, population, monthly average temperature and rainfall, agriculture, occupation, cropping patterns, communication and marketing facilities of the study area are discussed in this chapter. However, for the production of onion, it is very essential to know the climate and topography of the study areas.

4.2 Location

The selected sample farmers are located in four villages namely Vitbila, Bonkhola, Loskorkandi and Haturiya under Sujanagar and Faridpur Sadar upazila respectively. Sujanagar is under the Pabna district and Faridpur Sadar is under the Faridpur district. These four villages are located from 10 to 15 km of the upazila headquarters. The locations of the upazila are presented in the Map 4.2 and 4.3 respectively.



Map 4.1: Map of Bangladesh

Figure 4.2: Map of Sujanagar Upazila

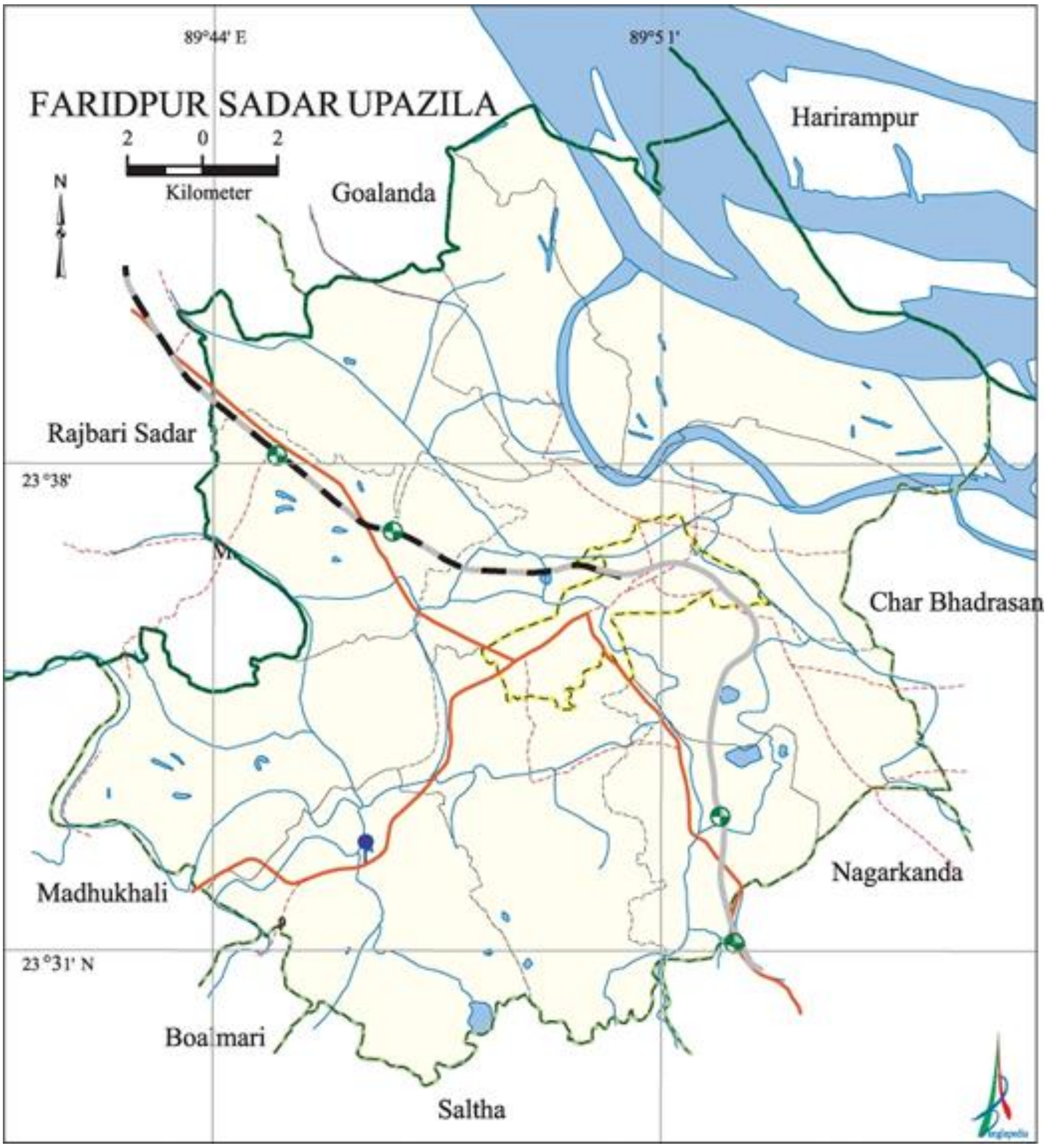


Figure 4.3: Map of Faridpur Sadar Upazila

4.3 Physical Features, Topography and Soil Condition

Pabna district includes the region of both High Ganges River Floodplain and Lower Ganges River Floodplain whereas Faridpur district includes Lower Ganges River Floodplain region. High Ganges River Floodplain (13205 sq km) includes the western part of the Ganges river floodplain which is predominantly highland and medium highland. General soil types predominantly include calcareous dark grey floodplain soils and calcareous brown floodplain soils. Organic matter content in the brown ridge soils is low but higher in the dark grey soils. Soils are slightly alkaline in reaction. General fertility level is low. Lower Ganges River Floodplain (7968 sq km) comprises the eastern half of the Ganges river floodplain which is low-lying. Soils of this region are silt loams and silty clay loams on the ridges and silty clay loam to heavy clays on lower sites. General soil types predominantly include calcareous dark grey and calcareous brown floodplain soils. Organic matter content is low in ridges and moderate in the basins. General fertility level is medium. Onion can be grown in any type of soil, ranging from sandy loam to heavy clay. It was evident from the study that medium highland with clay soil and high land with silty loam soil at Pabna and Faridpur were mostly used for onion bulb production (Table 4.1). The soil texture and structure of the study areas are almost similar to the other parts of the district. Soils are calcareous within a depth of 1.2 m below of the surface. Clays are highly cracking when dry, drought, prone and have heavy consistence. The soil of the study area is very fertile and suitable for cultivating the various crops.

Table 4.1 Land Topography in Survey Areas

Study areas	**Land type**					
	High Land	Medium High land	Medium Low Land	Low land	Very Low land	Total
Pabna	55082 (23)	52890 (22)	43060 (18)	32836 (14)	6010 (3)	238795
Faridpur	23309 (11)	63768 (31)	63381 (31)	13251 (6)	299 (0.14)	208569

Source: BBS, 2013

4.4 Area and Population

The total area, population and density of population of the selected upazilas are presented in Table 4.2 .The highest population density (1137 per sq.km) is Faridpur Sadarpur and the lowest population density (821 sq. km) is in Sujanagar Upazilla.

Table 4.2 Population Size of Upazilas under the Study Areas

Upazila	Area (sq. km)	Population	Male %	Female %	Population density
Sujanagar	338.65	2,89,031	49.82	50.18	821
Faridpur Sadar	412.86	4,89,017	50.23	49.77	1137

Source: BBS, 2012.

4.5 Climate, Temperature and Rainfall

The climate, temperature and rainfall are very important factors for production of onion and other crops. There was no local arrangement of meteorological center for recording temperature and rainfall in the study area. It is basically warm and humid in Pabna and Faridpur region. Maximum temperature of the study areas varies from 30.7°C to 32.5°C and minimum temperature varies from 20.2°C to 22.01°C (Table 4.3). The annual total rainfall of the study areas varies from 893mm to 2040mm (Table 4.4). The monthly rainfall of the study areas in 2013 presented in Table 4.5.

Table 4.3 Average Maximum and Minimum Temperature (°C) in Selected Station

Name of Station	2008		2009		2010		2011		2012	
	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
Ishwardi	31.0	21.3	31.9	20.8	32.5	21.1	30.8	20.2	31.3	21.1
Faridpur	30.8	22.1	31.67	21.7	31.9	22.0	30.7	21.2	30.9	21.4

Source: BBS, 2014

Table 4.4 Annual Total Rainfalls in Millimeter in Selected Station

Name of Station	2006	2007	2008	2009	2010	2011	2012
Ishwardi	1286	1573	1304	1292	893	1736	1062
Faridpur	1649	2040	1443	1584	1409	1509	1279

Source: BBS, 2014

Table 4.5 Monthly Rainfalls in Millimeter by Station, 2013

Name of Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ishwardi	0	0	1	68	187	267	140	233	104	129	0	0
Faridpur	0	0	13	53	388	285	196	264	230	185	0	0

Source: BBS, 2014a

4.6 Land and Agriculture

Total cultivable land in two districts is 25000 hectares and 25504 hectares respectively. Onion is the main crop grown in the study areas. Besides, paddy, jute, wheat, sugarcane, garlic, pulse, groundnut, brinjal are also grows well in the areas. It is evident from the study that, cropping pattern in the study areas are almost same and it was jute- fellow-onion, jute-short crops-onion, jute- onion- jute and fellow-amon-onion. Land under cropped in the study areas are given in Table 4.6. It is evident from the table that almost half of the lands are utilized as double cropped land in the study areas. It also cleared from the table that near about half of the cultivated lands are under irrigation in the study areas.

Table 4.6 Information of Land under the Study Areas

Upazillas	Distribution of land (%)			
	Single crop	Double crop	Treble crop	Under irrigation
Sujanagar	15.62	46.54	37.84	43.1
Faridpur Sadar	12.13	48.69	39.18	47.1

Source: Banglapedia, 2015

4.7 Occupations

The major occupations of the peoples under study areas are agriculture, non-agricultural labourer, wage labourer, industrial labourer, service holder and others. Average wage rate of agricultural labour varies in different areas. Day labours were charged with high wage rate and they became scarce during harvesting period. Major types of occupations of the peoples in the study areas are given in Table 4.7.

Table 4.7 Types Of Occupation in the Study Areas

Upazilas	Types of occupation (%)						
	Agriculture	Non-Agri. Labour	Industry	Commerce	Transport	Service	Others
Sujanagar	61.17	2.89	5.95	12.73	2.71	6.3	8.25
Faridpur Sadar	39.72	4.03	1.65	17.49	9.19	15.79	12.13

Source: Banglapedia, 2015

4.8 Transportation, Communication and Marketing Facilities

Transportation and communication is the pre-condition for the development of a particular region or a country. The selected areas for the study are well communicated with the different places of Bangladesh. The road network of this area facilitates the local people to market their agricultural as well as other products to the nearby and distance market places. Most of the roads in the study areas are concreted and some of the roads are muddy. Due to well communication with the different markets, usually farmers do not deceive from having good prices of their produced commodities. The modes of transportation of this area are rickshaw, van, bullock carts, truck, by-cycle, motorcars and boats. There are many hats, which are sit on more than one day in a week and the local bazars are held on every morning and afternoon.

CHAPTER 5

SOCIO-ECONOMIC PROFILE OF HOUSEHOLD POPULATION

CHAPTER 5

SOCIO-ECONOMIC PROFILE OF HOUSEHOLD POPULATION

5.1 Introduction

The aim of this chapter is to present a brief description of the socio-economic characteristics of the farmers producing onion. Socioeconomic aspects of the farmers can be looked upon from different points of view depending upon a number of variables related to their level of living, the socio-economic environment in which they live and the nature and the extent of the farmers' participation in national development activities. It was not possible to collect all the information regarding the socio-economic characteristics of the sample farmers due to limitation of time and resources. Socioeconomic condition of the sample farmers is very important in case of research planning because there are numerous interrelated and constituent attributes characterizes an individual and profoundly influences development of his/her behavior and personality. People differ from one another for the variation of socioeconomic aspects. However, for the present research, a few of the socioeconomic characteristics have been taken into consideration for discussion.

5.2 Age and Sex

The sample of 75 household in each study area comprised a total population of 390 and 394 in Sujanagar upazila, Pabna and Faridpur Sadar upazila, Faridpur, respectively. In Sujanagar upazila, 52.30 percent of the sample populations were male and 47.70 percent were female. About 27 percent of household populations were below 15 years of age, about 67 percent of the populations were under 15-64 years age group and only 6 percent were of 65 years or above (Figure 5.1**)**. On the other hand, in Faridpur Sadar upazila, 51.02 percent and 48.98 percent were male and female, respectively. About 30 percent of household populations were below 15 years of age, about 68 percent of the populations were under 15-64 years age group and only 2 percent was of 65 years or above (Figure 5.1). The sex ration in Sujanagar and Faridpur Sadar were found 110 and 105 male per 100 women (Figure 5.2**)**, respectively, which were remarkably higher than the national figure (105) (BBS, 2014a), possibly because of the sample framework used for the survey. The dependency ratios of the study population were estimated at 48.52 and 46.21 (Figure 5.2**)** which were significantly lower than that reported in HIES-2010 survey (65.30) (BBS, 2011). For details also see in appendices (Table A.5.1).

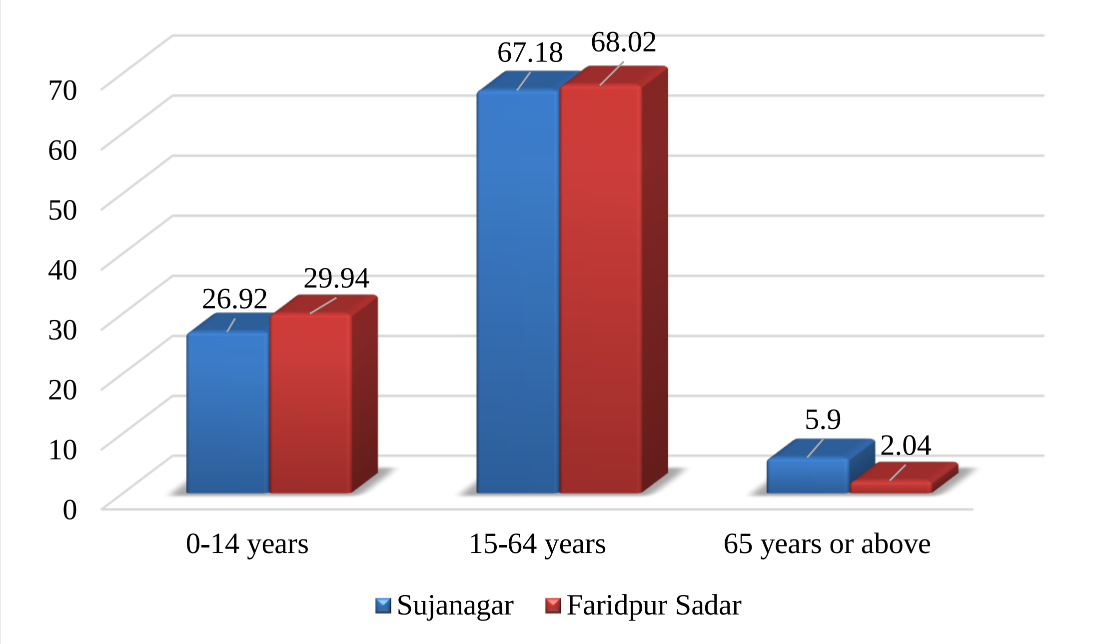


Figure 5.1: Age of the Household Members by Study Area

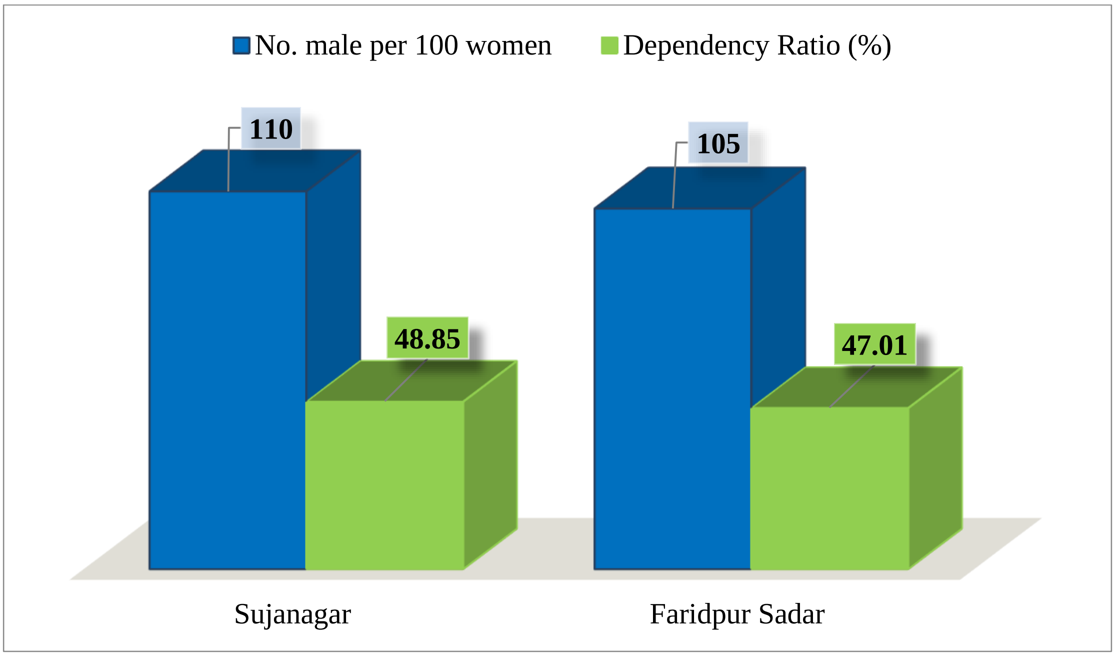


Figure 5.2: Sex Ratio and Dependency Ratio of the Household Members by Study Area

5.3 Marital Status

In Sujanagar upazila, marital status of the household population aged 16 years or more (at the time of survey) indicated that about 30 percent were married and about 68 percent were unmarried (Figure 5.3**)**. The proportion of unmarried people was found lower for female population in comparison with that of male population. On the other hand, in Faridpur Sadar upazila, marital status of the household population aged 16 years or more (at the time of survey) clearly indicated that about 33 percent were married and about 65 percent were unmarried. Here, the proportion of unmarried people was found lower for male population in comparison with that of female population. For details also see in appendices (Table A.5.2).

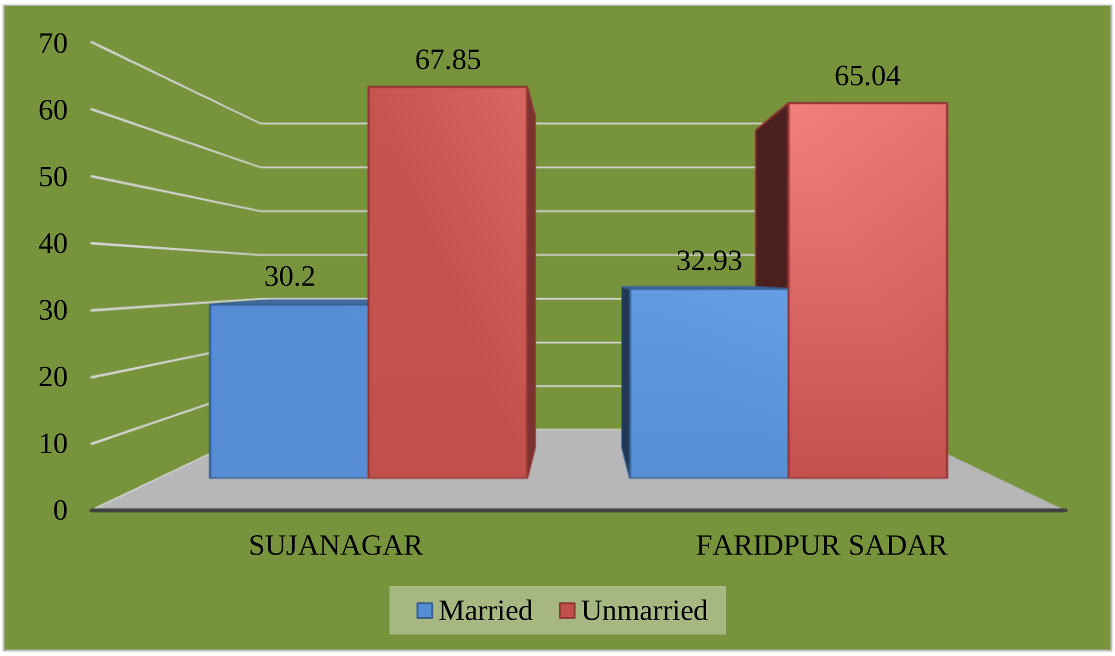


Figure 5.3: Marital Status of the Household Members by Study Area

5.4 Education

Figure 5.4 showed that, in Sujanagar upazila, about 19 percent of the study population aged 5 years or more were found to have no education and/or read/write, about 42 percent were found to have primary level education, about 35 percent were found to have secondary and/or higher secondary level education and only 3.53 percent people were found to have attained/completed graduation level of education. In Faridpur Sadar upazila, about 17 percent of the study population aged 5 years or more were found to have no education and/or read/write, about 41 percent were found to have primary level education, about 38 percent were found to have secondary and/or higher secondary level education and only 2.85 percent people were found to have attained/completed graduation level of education. The proportion of attainment of post-secondary or higher level of education was relatively higher for men than women in both study areas, partly due to gender discrimination against female (Table A.5.3).

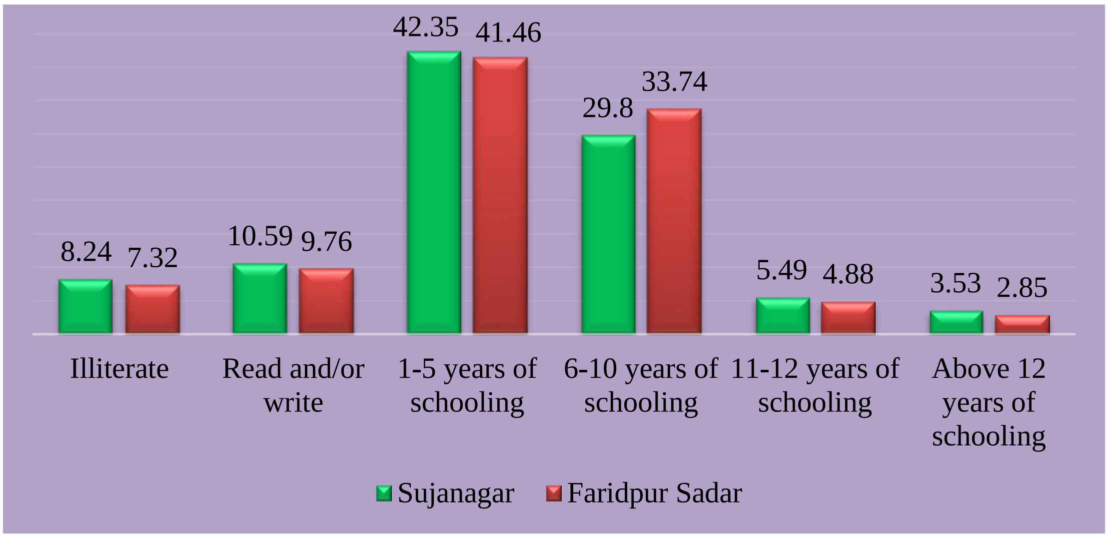


Figure 5.4: Education of the Household Members by Study Area

5.5 Occupation

The occupation of the study population aged 16 years or more showed that, in Sujanagor, about 38 percent (out of 255) were engaged in agriculture as a main occupation and about 46 percent (out of 74) were engaged in agriculture as a subsidiary occupation. On the other hand, in Faridpur Sadar, about 35 percent (out of 246) were engaged in agriculture as a main occupation and about 38 percent (out of 79) were engaged in agriculture as a subsidiary occupation (Figure 5.5**)**. In Sujanagar and Faridpur Sadar, respectively, 36.86 percent and 36.18 percent were engaged in domestic work as household activities and, 11.37 percent and 13.41 percent were engaged in study. Household activities and study are not directly included in Gross Domestic Product (GDP). For details also see in appendices (Table A.5.4).

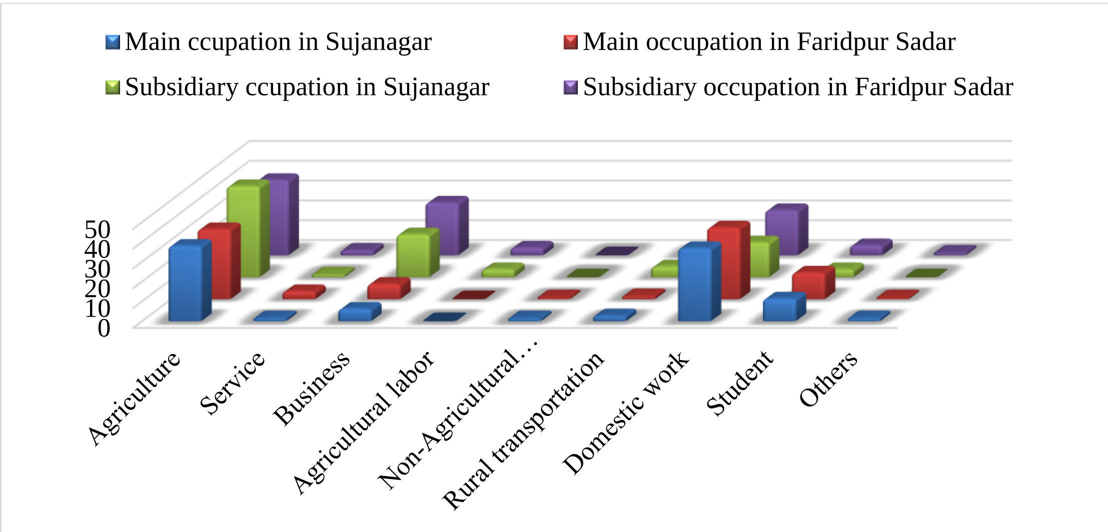


Figure 5.5: Occupation of the Household Members by Occupational Category

5.6 Agricultural Training

Among the respondent farmers in Sujanagar upazila, 61.33 percent farmers got training on different agricultural technologies of onion farming whereas, 84 percent farmers got training on different agricultural technologies of others crops. On the other hand, 52 percent of respondent farmer got training on onion production whereas, 76 percent farmers got training on different agricultural technologies of others crops in Faridpur Sadar upazila (Table 5.1). These training have improved their perceptions of good seed use, use of resistant varieties, application of insecticides and pesticides, water management, and so on.

Table 5.1: Agricultural Training of the Respondent Farmers by Crop

Training received	Sujanagar, Pabna				Faridpur Sadar, Faridpur			
	Onion		Others		Onion		Others	
	No.	%	No.	%	No.	%	No.	%
Yes	46	61.33	63	84.00	39	52.00	57	76.00
No	29	38.67	12	16.00	36	48.00	18	24.00
Total	75	100.00	75	100.00	75	100.00	75	100.00

Source: Field survey, 2015.

5.7 Membership

Among the respondent farmers in Sujanagar upazila, 56.00 percent onion producers were found to have membership in different NGOs and/or farmers' organizations whereas 48 percent of onion farmers had membership in different NGOs and/or farmers' organizations in Faridpur Sadar upazila (Table 5.2).

Table 5.2: Membership of the Respondent Farmers by Crop

Membership in any organization	Sujanagar, Pabna		Faridpur Sadar, Faridpur	
	No.	%	No.	%
Yes	28	56.00	24	48.00
No	22	44.00	26	52.00
Total	50	100.00	50	100.00

Source: Field survey, 2015.

5.8 Concluding Remarks

From the above discussions it is clear that there are some variations in socioeconomic characteristics between the onion farmers of two upazilas, Sujanagar and Faridpur Sadar. But the magnitude of the variations was not large. There are substantial indications suggesting that onion farmers of both areas were progressive.

CHAPTER 6

TECHNICAL EFFICIENCY OF THE ONION FARMERS

CHAPTER 6

TECHNICAL EFFICIENCY OF THE ONION FARMERS

6.1 Introduction

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

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

6.2 Interpretation of ML Estimates of the Stochastic Frontier Production Function

Maximum likelihood estimation begins with writing a mathematical expression known as the Likelihood Function of the sample data. The likelihood of a set of data is the probability of obtaining that particular set of data, given the chosen probability distribution model. This expression contains the unknown model parameters. The values of these parameters that maximize the sample likelihood are known as the Maximum Likelihood Estimates or MLE's. The maximum likelihood estimates for parameters of the Cobb-Douglas stochastic frontier production function and technical inefficiency effect model for onion production for all farmers are presented in Table

6.1. Asides from estimates of coefficients in the model, the output also provides other variance parameters such as sigma square (σ^2), gamma (γ) and log-likelihood function.

6.2.1 Human Labour (X_1)

The regression coefficients of Human labour (X_1) was positive and significant at 1 percent level of significance. The regression coefficients of human labour (X_1) was 0.1932, which implied that, other factors remaining the same, if expenditure on human labour was increased by 1 percent then the yield of onion would be increased by 0.1932 percent (Table 6.1).

6.2.2 Land Preparation Cost (X_2)

The regression coefficients of land preparation cost was found to be negative and significant at 5 percent level for onion (Table 6.1). Co-efficient of land preparation cost (X_2) was -0.0529. The result of the analysis indicated that, keeping other factors constant, a 1 percent increase in additional expenditure on land preparation would decrease the yield of onion by 0.0529 percent.

6.2.3 Seed (X_3)

The regression coefficients of seed was 0.0032 (not significant), which implied that, holding other factors constant, 1 percent increase in the amount of seed would increase the yield of onion by 0.0032 percent (Table 6.1).

6.2.4 Fertilizer (X_4)

The regression coefficients of fertilizer (X_4) was positive and significant at 1 percent level of significance (Table 6.1). The regression coefficients of fertilizer (X_4) was 0.5192, which implied that, other factors remaining the same, if amount of fertilizer was increased by 1 percent then the yield of onion would be increased by 0.5192 percent.

6.2.5 Cost of Insecticide (X_5)

The regression coefficient of insecticides cost (X_5) of onion production was positive and significant at 1 percent level of significance, which implied that if the expenditure on insecticides was increased by 1 percent then the yield of onion would be increased by 0.1088 percent, other factors remaining constant (Table 6.1).

6.2.6 Irrigation (X_6)

The magnitudes of the coefficients of irrigation cost was positive and insignificant for onion production (Table 6.1). 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 onion by 0.0682 percent.

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

Variables	Parameter	Coefficients	T-ratio
Stochastic Frontier:			
Constant (X_0)	β_0	3.9786***	5.90052
Human Labour (X_1)	β_1	0.1932***	5.4551
Land Preparation (X_2)	β_2	-0.0529**	-2.6319
Seed (X_3)	β_3	0.0032	0.1021
Fertilizer (X_4)	β_4	0.5192***	8.5626
Insecticide (X_5)	β_5	0.1088***	4.4448
Irrigation (X_6)	β_6	0.0682	1.0114
Inefficiency Model			
Constant	δ_0	0.2177***	3.2118
Experience (Z_1)	δ_1	-0.0013	-0.6310
Education (Z_2)	δ_2	0.0099	0.7594
Farm size (Z_3)	δ_3	-0.1280	-1.4043
Extension service (Z_4)	δ_4	-0.3569***	-6.8707
Training (Z_5)	δ_5	-0.1215*	-2.3364
Credit service (Z_6)	δ_6	0.1046*	2.2929
Variance Parameters			
$\sigma^2_s = \sigma^2_v + \sigma^2_u$		0.0123***	4.8915
$\gamma = \sigma^2_u / \sigma^2_s$		0.6818***	7.8338
Log-likelihood Function		173.71	

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

Source: Field survey, 2015.

6.3 Interpretation of Technical Inefficiency Model

In the technical inefficiency effect model, experience, farm size, extension service and training have expected (negative) coefficients. The negative coefficient of experience implies that experienced farmers are technically more efficient than non-experienced farmers. Although this coefficient is not statistically significant.

The negative coefficient of farm size implies that large farm households are technically more efficient than small farm households. This coefficient was, however, not statistically significant.

The negative and significant (1 percent) coefficient of extension service postulates that farmers having contacts with extension officers are technically more efficient than others.

The negative and significant (10 percent) coefficient of training indicates that training of farmers helps reduce technical inefficiency (Table 6.1).

The coefficients of education and credit service are positive meaning that these factors have no impact on the technical inefficiency. Although the coefficient of credit service is significant at 5 percent level of significance. That is, these factors do not reduce or increase technical inefficiency of producing onion.

The γ-parameter associated with the variance in the stochastic frontier model is to be estimated at 0.6818, which is significantly different from zero. It indicates that inefficiency effects have a significant contribution in determining the level and variability of output of onion farms. The significant value of γ (gamma) and σ^2 indicates that there are significant technical inefficiency effects in the production of onion.

6.4 Technical Efficiency and Its Distribution

Table 6.2 shows frequency distribution of farm-specific technical efficiency for onion farmers. It reveals that average estimated technical efficiencies for onion are 93 per cent which indicate that onion production could be increased by 7 per cent with the same level of inputs without incurring any further cost. Increase of only managerial skills result a substantial increase of output for onion. It was observed that 40.67 per cent 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. 14 per cent of sample farmers obtained 65 to 85 per cent technical efficiency level. The minimum and maximum technical efficiencies were observed to be 68 and 99 per cent respectively, where standard deviation was maintained at 7.27.

Table 6.2 Frequency Distribution of Technical Efficiency of Onion Farms

Efficiency (%)	**No. of farms**	**Percentage of farms**
0-65	0	0.00
65-70	3	2.00
70-75	5	3.33
75-80	8	5.33
80-85	5	3.33
85-90	18	12.00
90-95	50	33.33
95-100	61	40.67
Total number of farms	150	100
Minimum	0.68	
Maximum	0.99	
Mean	0.93	
Standard Deviation	7.27	

Source: Field survey, 2015.

CHAPTER 7

PROFITABILITY OF ONION PRODUCTION

CHAPTER 7
PROFITABILITY OF ONION PRODUCTION

7.1 Introduction

The main purpose of this chapter is to assess the costs, returns and profitability of growing onion. 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.

7.2 Profitability of Onion Production

7.2.1 Variable Costs

7.2.1.1 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 onion cultivation. For land preparation in onion production, no. of tiller was required 3 with Tk. 2727.67 per tiller. Thus, the average land preparation cost of onion production was found to be Tk. 8183.00 per hectare, which was 3.98 percent of total cost (Table 7.1).

7.2.1.2 Cost of Human Labour

Human labour cost is one of the major cost components in the production process. It is one of the most important and largely used inputs for producing onion. It is generally required for different operations such as land preparation, sowing, weeding, fertilizer and insecticides application, irrigation, harvesting and carrying, threshing, cleaning, drying, storing etc. The quantity of human labour used in onion production was found to be about 362 man-days per hectare and average price of human labour was Tk. 226.86 per man-day. Therefore, the total cost of human labour was found to be Tk. 82123.32 representing 39.93 percent of total cost (Table 7.1).

7.2.1.3 Cost of Seed

Cost of seed varied widely depending on its quality and availability. Per hectare total cost of seed for onion production were estimated to be Tk. 25975.00, which constituted 12.73 percent of the total cost (Table 7.1).

7.2.1.5 Cost of Urea

In the study area, farmers used different types of fertilizers. On an average, farmers used urea 213.85 kg per hectare. Per hectare cost of urea was Tk. 3447.98, which represents 1.68 percent of the total cost (Table 7.1).

7.2.1.6 Cost of TSP

Among the different kinds of fertilizers used, the rate of application of TSP (210.42 kg) was similar to urea fertilizers. The average cost of TSP was Tk. 6759.40 which representing 3.29 percent of the total cost (Table 7.1).

7.2.1.7 Cost of MoP

The application of MoP per hectare (125.64 kg) was found lower than other fertilizers. Per hectare cost of MoP was Tk. 1996.33, which represents 0.97 percent of the total cost (Table 7.1).

Table 7.1: Per Hectare Cost of Onion Production

Items of Cost	Quantity (kg/ha)	Rate (Tk./Kg)	Cost (Tk./ha)	% of Total Cost
Land preparation	3.00	2727.67	8183.00	3.98
Human labour	362	226.86	82123.32	39.93
Seed			25975.00	12.63
Urea	213.85	16.12	3447.98	1.68
TSP	210.42	32.12	6759.40	3.29
MoP	125.64	15.89	1996.33	0.97
Cost of Insecticides			6335.00	3.08
Cost of Irrigation			24877.00	12.10
A. Total Operating Cost (TOC)			**159697.03**	**77.65**
Interest on operating capital @ of 10% for months			5323.23	2.59
B. Total Variable Cost (TVC)			**165020.26**	**80.24**
Rental value of land			40643.03	19.76
C. Total Fixed Cost (TFC)			**40643.03**	**19.76**
D. Total cost (B+C)			**205663.29**	**100.00**

Source: Field survey, 2015.

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

7.2.1.8 Cost of Insecticides

Farmers used different kinds of insecticides to keep their crop free from pests and diseases. The average cost of insecticides for onion production was found to be Tk. 6335.00 which was 3.08 percent of the total cost (Table 7.1).

7.2.1.9 Cost of Irrigation

Cost of irrigation is one of the most important costs for onion production. Production of onion largely depends on irrigation. Right doses application of irrigation water help to increase bulb diameter, number of cloves, 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. 24877.00 per hectare, which represents 12.10 percent of the total cost (Table 7.1).

7.2.1.10 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 onion. Interest on operating capital for onion production was estimated at Tk. 5323.23 per hectare, which represents 2.59 percent of the total cost (Table 7.1).

7.2.1.11 Total Variable Cost

Therefore, from the above different cost items it was clear that the total variable cost of onion production was Tk. 165020.26 per hectare, which was 80.24 percent of the total cost (Table 7.1).

7.2.2 Fixed Cost

7.2.2.1 Rental Value of Land

Rental value of land was calculated on the basis of opportunity cost of the use of land per hectare for the cropping period of three months. Cash rental value of land has been used as cost of land use. On the basis of the data collected from the onion farmers the land use cost was found to be Tk. 40643.03 per hectare, and it was 19.76 percent of the total cost (Table 7.1).

7.2.3 Total Cost (TC) of Onion 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 onion was found to be Tk. 205663.29 (Table 7.1).

7.2.4 Return of Onion Production

7.2.4.1 Gross Return

Return per hectare of onion cultivation is shown in table 7.2. 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 onion per hectare was 13704.00 kg and the average price of onion was Tk. 27.76. Therefore, the gross return was found to be Tk. 380423.04 per hectare (Table 7.2).

7.2.4.2 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. 215402.78 per hectare (Table 7.2).

7.2.4.3 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. 174759.75 per hectare (Table 7.2).

Table 7.2: Per Hectare Cost and Return of Onion Production

Measuring Criteria	**Quantity (kg/ha)**	**Rate (Tk./kg)**	**Cost (Tk./ha)**
Main Product Value	13704.00	27.76	380423.04
Gross Return (GR)			380423.04
Total Variable Cost (TVC)			165020.26
Total Cost (TC)			205663.29
Gross Margin (GR-TVC)			215402.78
Net Return (GR-TC)			174759.75
BCR (undiscounted)(GR/TC)			**1.85**

Source: Field survey, 2015.

7.2.5 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 1.85 which implies that one taka investment in onion production generated Tk. 1.85 (Table 7.2). From the above calculation it was found that onion cultivation is profitable in Bangladesh.

7.3 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 onion cultivation. Onion 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 onion is a profitable. Cultivation of onion would help farmers to increase their income earnings.

CHAPTER 8

PROBLEMS AND CONSTRAINTS TO ONION PRODUCTION

CHAPTER 8

PROBLEMS AND CONSTRAINTS TO ONION PRODUCTION

8.1 Introduction

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

8.2 Lack of Quality Seed

Lack of quality seed was one of the most important limitations of producing onion in the study area. From Table 8.1 it is evident that about 47 percent onion growers in Sujanagar Upazila reported this as high problem whereas about 42 percent onion farmers in Faridpur Sadar Upazila reported this as high problem. Farmers in both Upazilas told that they were cheated by buying so called hybrid seeds from the local markets and from the seed dealers. About 95 percent of farmers in both Upazilas reported this problem (Table 8.2).

8.3 Inadequate Extension Service

During the investigation some farmers complained that they did not get any extension services regarding improved method of onion cultivation from the relevant officials of the Department of Agricultural Extension (DAE). As an agricultural extension personnel block supervisors, the main advisor of technical knowledge to the farmers about their farming problems. But in Sujanagar Upazila about 44 percent onion growers reported this as high problem whereas about 46 percent of onion farmers in Faridpur Sadar Upazila mentioned 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. About 94 percent of farmers in both Upazilas reported this problem (Table 8.2).

8.4 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. In Sujanagar upazila near 12 percent onion growers were encountered this problem highly whereas about 16 percent of onion farmers in Faridpur Sadar Upazila marked this as high problem (Table8.1). About 93 percent of farmers in both Upazilas reported this problem (Table 8.2).

8.5 High Cost of Irrigation Water

Irrigation is the leading input for crop production. Yield of onion 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 36 percent onion growers in Sujanagar Upazila reported this as high problem whereas this was reported as high problem by 41 percent of farmers in Faridpur Sadar Upazila. About 95 percent of farmers in both Upazilas reported this problem (Table 8.2).

8.6 Attack of Pest and Disease

The growers of onion were also affected by the problem of attack of pests and diseases. Pests and diseases attack reduce crop yield and increase cost of production. In Sujanagar Upazila about 46 percent onion growers reported this as high problem whereas 39 percent farmers in Faridpur Sadar Upazila marked this as high problem (Table 8.1). About 94 percent of farmers in both Upazilas reported this problem (Table 8.2).

8.7 Lack of Operating Capital

The farmers of the study area had capital constraints. For cultivation of onion, a huge amount of cash money was needed to purchase various inputs like, human labour, seed, fertilizers, pesticides, etc. In Sujanagar Upazila about 39 percent onion 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 whereas near 47 percent of onion growers in Faridpur Sadar Upazila reported this as high problem (Table 8.1). About 98 percent of farmers in both Upazilas reported this problem (Table 8.2).

Table 8.1 Problems and Constraints of Onion Production by Study Areas

Type of Problems	Sujanagar, Pabna								Faridpur Sadar, Faridpur							
	No Problem		Low Problem		Medium Problem		High Problem		No Problem		Low Problem		Medium Problem		High Problem	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Lack of quality seed	2	2.67	12	16.00	26	34.67	35	46.67	6	8.00	15	20.00	23	30.67	31	41.33
Inadequate extension service	4	5.33	11	14.67	27	36.00	33	44.00	5	6.67	11	14.67	25	33.33	34	45.33
Lack of scientific knowledge of farming	6	8.00	24	32.00	36	48.00	9	12.00	4	5.33	28	37.33	31	41.33	12	16.00
High cost of irrigation water	4	5.33	14	18.67	30	40.00	27	36.00	4	5.33	15	20.00	25	33.33	31	41.33
Attack of pest and disease	1	1.33	6	8.00	31	41.33	34	45.33	5	6.67	6	8.00	35	46.67	29	38.67
Lack of operating capital	1	1.33	13	17.33	32	42.67	29	38.67	2	2.67	13	17.33	25	33.33	35	46.67
High price of quality seed	2	2.67	8	10.67	37	49.33	28	37.33	2	2.67	6	8.00	35	46.67	32	42.67
Natural calamities	8	10.67	22	29.33	20	26.67	25	33.33	4	5.33	29	38.67	23	30.67	19	25.33
Low price of output	12	16.00	26	34.67	19	25.33	18	24.00	6	8.00	22	29.33	19	25.33	28	37.33
Shortage of human labour	1	1.33	13	17.33	30	40.00	31	41.33	12	16.00	13	17.33	27	36.00	23	30.67
High price of fertilizers	9	12.00	18	24.00	23	30.67	25	33.33	11	14.67	21	28.00	19	25.33	24	32.00
Adulteration of fertilizer, insecticide, and pesticide	4	5.33	14	18.67	35	46.67	22	29.33	16	21.33	18	24.00	27	36.00	14	18.67
Lack of quality tillage	23	30.67	27	36.00	13	17.33	12	16.00	21	28.00	23	30.67	17	22.67	14	18.67
Poor storage facilities in house	16	21.33	28	37.33	22	29.33	9	12.00	11	14.67	30	40.00	18	24.00	16	21.33

Source: Field Survey, 2015

Table 8.2 Problems and Constraints of Onion Production by no. of Farmers

Type of Problems	No. of farmers	Percentage of farmers	Rank
Lack of operating capital	147	98.00	1
High price of quality seed	146	97.33	2
High cost of irrigation water	142	94.67	3
Lack of quality seed	142	94.67	4
Attack of pest and disease	141	94.00	5
Inadequate extension service	141	94.00	6
Lack of scientific knowledge of farming	140	93.33	7
Natural calamities	138	92.00	8
Shortage of human labour	137	91.33	9
Low price of output	132	88.00	10
Adulteration of fertilizer, insecticide, and pesticide	130	86.67	11
High price of fertilizers	130	86.67	12
Poor storage facilities in house	123	82.00	13
Lack of quality tillage	106	70.67	14

Source: Field Survey, 2015

8.8 High Price of Quality Seed

High price of quality seed was also one of the most important limitations of producing onion in the study area. From Table 8.1 it is evident that about 37 percent onion growers in Sujanagar Upazila reported this as high problem whereas in Faridpur Sadar Upazila about 43 percent farmers had high problem with this. About 97 percent of farmers in both Upazilas reported this problem (Table 8.2).

8.9 Natural Calamities

It was found that onion 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 onion. Table 8.1 shows that almost 33 percent onion growers in Sujanagar upazila reported this as high problem whereas in Faridpur Sadar Upazila about 25 percent onion farmers mentioned this as high problem. About 92 percent of farmers in both Upazilas reported this problem (Table 8.2).

8.10 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 onion 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 24 percent onion growers in Sujanagar Upazila reported this as high problem whereas in Fridpur Sadar Upazila about 37 percent onion farmers mentioned this as high problem. About 88 percent of farmers in both Upazilas reported this problem (Table 8.2).

8.11 Shortage of Human labour

Most of the human labour is being used during seed/seedling plantation and harvesting period of onion. Onion 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 41 percent of onion growers in Sujanagar Upazila reported this as high problem whereas about 31 percent of onion farmers in Faridpur Sadar Upazila marked this as high problem. About 91 percent of farmers in both Upazilas reported this problem (Table 8.2).

8.12 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 33 percent onion growers in Sujanagar Upazila reported this as high problem whereas in Faridpur Sadar Upazila 32 percent of farmers reported this as high problem. Farmers told that they had to purchase fertilizers at a high price during the production period. But the present government provides fertilizers to the farmers at a subsidized price with a view to help farmers and also actively maintain and regulate supply of all kinds of fertilizer. About 87 percent of farmers in both Upazilas reported this problem (Table 8.2).

8.13 Adulteration of Fertilizer, Insecticide, and Pesticide

Chemical fertilizers, insecticides and pesticides are the most important inputs of onion production. They were being intensively used in onion 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 29 percent onion growers in Sujanagar Upazila faced this problem highly whereas in Faridpur Sadar

Upazila about 19 percent of onion farmers mentioned this as a high problem. About 87 percent of farmers in both Upazilas reported this problem (Table 8.2).

8.14 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 16 percent onion growers in Sujanagar Upazila reported this as high problem whereas in Faridpur Sadar Upazila about 19 percent onion farmers marked this as high problem. About 71 percent of farmers in both Upazilas reported this problem (Table 8.2).

8.15 Poor Storage Facilities in House

Usually most of the fanners used to store their onion in their house. Lack of trained manpower was a great deal of spoilage of onion in the harvest and the post-harvest period. For this, they had to face some losses like losing weight and rotten of onion. It appears from Table 8.1 that only 12 percent of sample farmers in Sujanagar Upazila faced the problem of poor storage facilities highly whereas about 21 percent of onion farmers mentioned this as high problem in Faridpur Sadar Upazila. About 82 percent of farmers in both Upazilas reported this problem (Table 8.2).

8.16 Concluding Remarks

The above mentioned discussions as well as the results presented in Table 8.1 indicates that onion growers in the study area have currently been facing some major problems in conducting their onion farming. These are the major constraints for the producers of onion in the study area. Public and private initiatives should be taken to reduce or eliminate these problems for the sake of better production of onion.

CHAPTER 9

SUMMARY, CONCLUSION AND RECOMMENDATIONS

CHAPTER 9

SUMMARY, CONCLUSION AND RECOMMENDATIONS

9.1 Introduction

This chapter focuses on the summary in the light of the discussions made in the earlier chapters. Conclusion has been made on the basis of empirical result. Policy recommendations are drawn for improvement of the existing inefficiency of onion production in Bangladesh. Section 9.2 presents a summary of the major findings of the study, conclusion, policy recommendations, limitation of the study and scope for further study are given in Section 9.3, 9.4, 9.5 and 9.6, respectively.

9.2 Summary

Agriculture is the key driver of the growth of Bangladesh economy. The economic development is inextricably linked with the performance of this sector. The performance of this sector has an overwhelming impact on major macroeconomic objectives like employment generation, poverty alleviation, human resources development and food security. Agriculture provides employment to nearly about 47.33 percent of its total labor forces (BER, 2015). Agriculture occupies a key position in the overall economic sphere of the country in terms of its contribution to Gross Domestic Product (GDP). Broad agriculture sector which includes crops, livestock, fisheries and forestry contributes 16.33 percent to the gross domestic product (GDP) as a whole in the FY 2013-14 (BER, 2015). Flavoring food and making it tasty by adding different plant parts during cooking or making paste or salad is a very common practice everywhere. Most of the spices are high value crops. Net returns of major spices are also profitable. It can contribute a vital role to increase the farmers' income, generate employment, alleviate poverty, ensure food security, empower women and increase social development of Bangladesh. In FY 2011-12, total area under spices is 3.25 lakh hectares with the total production of about 17.55 lakh metric tons in our country (BBS, 2014). Spices covers almost 2.16 percent of total cropped area in Bangladesh (BBS, 2014).

Traditionally, onion grows in winter. Recently Spices Research Centre of Bangladesh Agricultural Research Centre (BARI) has released two new varieties of onions, which are grown in summer season. The released varieties of onion are not yet available in the farmers' field in large scale. Bangladesh requires about 2.3 million tons of onion per annum to fulfill her demand. But Bangladesh produces only 1.9 million tons of onion and imported 0.50 million tons of onion (Alam, 2014). So, we have to increase the production of onion per year. The local winter variety usually grows at Faridpur, Pabna, Rajshahi, Manikganj, Narshingdi, Bogra and greater Rangpur, during the period of December to May. Total area under onion production in our country is 1.35 lakh hectares with the total production of about 11.59 lakh metric tons in the cropping year 2011-12. Among all districts of Bangladesh, Faridpur covers the highest area of land use for onion production (37163.90 hectares), the highest production (3.2 lakh metric tons) in the cropping year 2011-12 (BBS, 2014).

The sampling frame for the present study were selected purposively as to select the area where the onion cultivation was intensive. On the basis of higher concentration of onion crop production, four villages namely Loskorkandi and Haturiya under Faridpur Sadar upazila in Faridpur district and Vitbila and Bonkhola under Sujanagar upazila in Pabna district were selected for the study. 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). A total of 150 (75 from each districts) farmers who were cultivating different varieties of onion in the selected areas were selected as samples. Farmers generally plant onion from mid-December to January and harvest after three months. Data for the present study collected during the period of March to April 2015. 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 statistical package FRONTIER 4.1 (Coelli, 1996).

Socioeconomic condition of sample household considered composition of family size and household earning members, educational status, occupational status, and sources of income of the sample farmers. The sample of 75 household in each study area comprised a total population of 390 and 394 in Sujanagar upazila, Pabna and Faridpur Sadar upazila, Faridpur, respectively. In Sujanagar upazila, 52.30 percent of the sample populations were male and 47.70 percent were female. The sex ration in Sujanagar and Faridpur Sadar were found 110 and 105 male per 100 women (Figure

5.2), respectively, which were remarkably higher than the national figure (105) (BBS, 2014a), possibly because of the sample framework used for the survey. The dependency ratios of the study population were estimated at 48.52 and 46.21 (Figure 5.2) which were significantly lower than that reported in HIES-2010 survey (65.30) (BBS, 2011). In Sujanagar upazila, about 19 percent of the study population aged 5 years or more were found to have no education and/or read/write and only 3.53 percent people were found to have attained/completed graduation level of education. . In Faridpur Sadar upazila, about 17 percent of the study population aged 5 years or more were found to have no education and/or read/write and only 2.85 percent people were found to have attained/completed graduation level of education. The occupation of the study population aged 16 years or more showed that, in Sujanagor, about 38 percent (out of 255) were engaged in agriculture as a main occupation and about 34 percent (out of 74) were engaged in agriculture as a subsidiary occupation. On the other hand, in Faridpur Sadar, about 35 percent (out of 246) were engaged in agriculture as a main occupation and about 38 percent (out of 79) were engaged in agriculture as a subsidiary occupation.

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 onion production was found to be Tk. 8183.00 per hectare. . The quantity of human labour used in onion production was found to be about 362 man-days per hectare and average price of human labour was Tk. 226.86 per man-day. Therefore, the total cost of human labour was found to be Tk. 82123.32 representing 39.93 percent of total cost. Per hectare total cost of seed for onion production were estimated to be Tk. 25975.00. On an average, farmers used Urea, TSP, MoP 213.85 kg, 210.42 kg and 125.64 kg respectively, per hectare. The average cost of insecticides for onion production was found to be Tk. 6335.00 whereas the average cost of irrigation was found to be Tk. 24877.00 per hectare. the total variable cost of onion production was Tk. 165020.26 per hectare, which was 80.24 percent of the total cost. The average yield of onion per hectare was 13704.00 kg and the average price of onion was Tk. 27.76. The gross return, gross margin and net return were found to be Tk. 380423.04, Tk. 215402.78 and Tk. 174759.75 per hectare. Benefit Cost Ratio (BCR) was found to be 1.85 which implies that one taka investment in onion production generated Tk. 1.85.

Technical efficiency reflects the ability of a farmer to obtain the maximum possible output from a given level of inputs and production technology. Technical inefficiency is then measured as the deviation of a farmer from the best-practice frontier. The regression coefficients of Human labour (X_1), Seed (X_3), Fertilizer (X_4), Insecticides cost (X_5) and Irrigation (X_6) were positive but the coefficient of Land use cost (X_2) was found negative. It indicates that if Human labour (X_1), Seed (X_3), Fertilizer (X_4), Insecticides cost (X_5) and Irrigation (X_6) were increased by one per cent, the production onion would increase by 0.1932, 0.0032, 0.5192, 0.1088 and 0.0682 per cent of sample farmers respectively.

In the technical inefficiency effect model, experience, farm size, extension service and training 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 and significant (1 percent) coefficient of extension service postulates that farmers having contacts with extension officers are technically more efficient than others. The negative and significant (10 percent) coefficient of training indicates that training of farmers helps reduce technical inefficiency. The coefficients of education and credit service are positive meaning that these factors have no impact on the technical inefficiency. Average estimated technical efficiencies for onion are 93 per cent which indicate that onion production could be increased by 7 per cent with the same level of inputs without incurring any further cost. Increase of only managerial skills result a substantial increase of output for onion.

Farmers faced a lot of problems in producing onion. The problems were social and cultural, financial and technical. Lack of quality seed was one of the most important limitations of producing onion 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 onion in the study area. Public and private initiatives should be taken to reduce or eliminate these problems for the sake of better production of onion.

9.3 Conclusion

Onion is one of the important spice crops grown by farmers mainly for market purpose. The study areas have tremendous potential for onion cultivation. The findings of the present study indicate that onion production is highly profitable and it would help to improve the socioeconomic condition of sample farmers in the study areas. As onion is a labour intensive crop, it would help to create employment opportunities. In Bangladesh, it is difficult to increase onion production by increasing the area of land under cultivation due to the limitation of land. But, there is an opportunity to increase production of onion 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 inefficient that means there is an opportunities 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, products of this crop might be increased which could help them in alleviating rural poverty in many areas. Onions are only produced in winter season. But now the BARI introduced some verities of summer onion. However, farmers in the study areas, to some extent started to produce summer onion. 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 lead to viable production practices and sustainable income from onion cultivation.

9.4 Recommendations

On the basis of the finding of the study it was evident that onion was profitable enterprises and they 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. On the basis of the findings of the study, the following specific recommendation may be made for the development of onion sector.

a) As most of the onion farmers are technically efficient at present production technology, improved method of production technology with sufficient storage ability should be introduced.
b) As onion are profitable enterprise, government and concern institutions should provide adequate extension programme to expand their area and production production.
c) Onion based cropping pattern should be developed and disseminated to those areas of Bangladesh where their production is suitable.
d) 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 onion producers.
e) Adequate training on recommended fertilizer dose, insecticides, use of good seed, intercultural operations, etc., should be provided to the onion farmers which will enhance production as well as technical efficiency by improving the technical knowledge of the farmers.
f) Onion 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 in harvest period.

9.5 Limitations of the Study

There are some limitations of the study as the study conducted on the farmers of the country through interview schedules.

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

9.6 Scope for Further Study

Although the present study is intended to provide some valuable information for the guidance of farmers, extension workers, policy makers as well as researchers, it is not free from criticisms. Due to limitation of time and resources this study could not cover some important areas. The weaknesses of the present study, of course, open avenues for further research which are given below:

a) A broad based study in this line may be undertaken for better understanding not only to study relative profitability of onion but also with other crops.

b) A further study can be undertaken by taking into account different farm sizes to assess the impact of profitability of onion on income and employment opportunity.

c) The study of other varieties of onion may be conducted individually to assess their comparative profitability.

d) Acreage response, growth and instability of onion can be studied with respect to Bangladesh.

REFERENCES

REFERENCE

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

Alam, M.J. (2007). A Study on the Seed Production from Stored Bulb of Summer Onion. M.S. thesis, Bangladesh Agricultural University, Mymensingh, Bangladesh.

Alam, M.S. (2003). Effect of Planting Time and Nitrogen on Growth, Yield and Storability of Summer Onion. M.S. thesis, Bangladesh Agricultural University, Mymensingh, Bangladesh.

Anonymous, 1991. Homestead Vegetable Production. Training manual. On-Farm Research Division, Bangladesh Agricultural Research Institute, Joydebpur Gazipur.

Asad, A. (2014, July 03). Onion Prices May Rise. *Bdnews24.com*. Retrieved from http://bdnews24.com/business/2014/07/03/onion-prices-may-rise

Awal, M.A., Saha, S.R. and Islam, M.I. (2001). Onion Cultivation at Farm Level: Input Use, Productivity and Resource Use Efficiency. *SAARC Journal of Agriculture*. 2: 61-71.

Awghad, P.R., Bevanthade, T.L., Hedau, G.B., Rithe, S.K. and Nawlakhe, S.M. (1993). Economics of Raising Onion Nursery in Daryapur Tahasil of Amravati District. *Journal of Soils and Crops.* 4(1): 38-40.

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

Barakade, A.J. (2014). Agricultural Price Policy and Farm Profitability of Onion in Satara District of Maharashtra. *European Academic Research*. II(2).

Baree, M.A. (2012). Measuring Technical Efficiency of Onion (*Allium Cepa* L.) Farms in Bangladesh. *Bangladesh J. Agril. Res*. 37(1): 171-178.

Baree, M.A., Rahman, M.A., Rashid, M.H.A., Alam, M.N. and Rahman, S. (2011). A Comparative Study of Technical Efficiency of Onion Producing Farms in Bangladesh. *Progress. Agric.* 22(1 & 2): 213-221.

Barnett, V. (1991). *Sample Survey Principals and Methods*. London. Edward Arnold Publishers Ltd.

Battese, G.E. and Corra, G.S. (1977). Estimation of a Production Frontier Model: with Application to the Pastoral Zone of Eastern Australia. *Australian Journal of Agricultural Economics.* 21: 169-179.

BB (2014). *Annual Review of Import Payments*, Bangladesh Bank, Head Office, Bangladesh Bank, Motijheel, Dhaka.

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

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

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

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

BBS (2014a). *Statistical Pocketbook of Bangladesh*, Bangladesh Bureau of Statistics, Ministry of Planning, Government of the People's Republic Bangladesh, Dhaka.

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

BER (2015). *Bangladesh Economic Review*, Department of Finance, Ministry of Finance, Government of the People's Republic of Bangladesh, Dhaka.

Bevanthade, T.L., Awghad, P.R., Hedau, G.B., Rithe, S.K. and Nawlakhe, S.M. (1993). Economics of Raising Onion Nursery in Daryapur Tahasil of Amravati District. *Journal of Soils and Crops.* 3(1): 41-44.

Bravo-Ureta, B.E. and Rieger, L. (1991). Dairy Farm Efficiency Measurement Using Stochastic Frontiers and Neoclassical Duality. *American Journal of Agricultural Economics.* 73(2): 421- 428.

Casely, D. and Kumar, K. (1988). The Collection Analysis and Use of Monitoring and Evaluation Data. Baltimore, The Hohns Hopkins University Press.

Casely, D. and Lury, D.A. (1981). Data Collection in Developing Countries. Oxford Clarendon Press.

Chadha, K.I. (1990). Onion and Garlic Research in India. *Alternatives Appropriate Technologies in Agriculture.* 4(4): 40-50.

Coeli, T.J. (1996). A Guide to Frontier Version 4.1: A Computer Program for Stochastic Frontier Production and Cost Function Estimation. CEPA Working Paper 7. Center for Efficiency and Productivity Analysis. University of New England, Armidale.

Coelli, T.J. (1992). A Computer Programme: for Frontier Production Function Estimation: FRONTIER, Version 2.0. *Economics Letters.* 39: 29-32.

Coelli, T.J. (1995a). Estimators and Hypothesis Tests for a Stochastic: A Monte Carlo Analysis. *Journal of Productivity Analysis.* 6: 247-268.

Coelli, T.J. and Battese, G.E. (1996a). Identification of Factors which Influence the Technical Inefficiency of Indian Farmers. *The Australian Journal of Agricultural Economics.* 40(2): 103-128.

Debreu, G. (1951). The Coefficient of Resource Utilization. Econometria, 19:273- 92.

FAOSTAT (2013a). Food and Agricultural Commodities Production, FAOSTAT data, Food and Agricultural Organization of the United Nations, Rome, Italy. http://faostat3.fao.org/browse/rankings/countries_by_commodity/E (Retrieved on 27 May, 2015).

FAOSTAT (2013b). Food and Agricultural Commodities Production, FAOSTAT data, Food and Agricultural Organization of the United Nations, Rome, Italy. http://faostat3.fao.org/download/Q/QC/E (Retrieved on 27 May, 2015).

Farrell, M.J. (1957). The Measurement of Productive Efficiency. *Journal of Royal Statistics Society*. 120: 253-281.

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

Greene, W.H. (1992). LIMDEP version 6.0: User's Manual and Reference Guide. Econometrics Software Inc., New York.

Haque, M.A., Miah, M.A.M., Hossain, S. (2009). Economic Assessment of Onion and Garlic under Zero Tillage and Traditional Methods of Cultivation in Major Growing Areas of Bangladesh. Annual Research Report, Agricultural Economics Division, BARI, Gazipur, Bangladesh.

Haque, M.A., Miah, M.A.M., Hossain, S., Rahman, M.S. and Moniruzzaman. (2011). Profitability of Onion Cultivation in Some Selected Areas of Bangladesh. *Bangladesh J. Agril. Res.* 36(3): 427-435.

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

Hasan, M.K. and Uddin, M.Z. (2011). Marketing and Post-Harvest Practices of Onion in Some Selected Areas of Bangladesh. *J. Agrofor. Environ*. 5(1): 67-72.

Hasan, M.K., Islam, M.S. and Miah, M.A.M. (2009). Returns to Investment in Summer Onion Research and Extension in Bangladesh. *Bangladesh J. Agric. Econs.* 32(1&2): 49-61.

Hasan, S. (2010). Economic Study of Onion Production in Selected Areas of Bangladesh. M.S. thesis, Bangladesh Agricultural University, Mymensingh, Bangladesh.

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

Hossain, M.A. (1979). An Economic Study of the Practice of Intercropping in Some Selected Areas under Shayampur Sugar Mills Zone in the District of Rangpur. M.S. thesis, BAU, Mymensingh, Bangladesh.

Hossain, M.A. (1997). Effect of Intercropping Groundnut with Onion at Varying Planting Arrangement. *Bangladesh Journal of Agricultural Research*. 22(1): 23-29.

Ibrahim, U., Oluwatosin, O.J., Ayinde, B.T. and Mahmoud, B.A. (2011). Evaluation of Herbicides on Weed Control, Performance and Profitability of Onion (A*llium Cepa*) in the Forest Zone of Nigeria. *Middle-East Journal of Scientific Research.* 9(5): 611-615.

Islam, M.K., Alam, M.F. and Islam, A.K.M.R. (2007). Growth and Yield Response of Onion (A*llium Cepa* L.) Genotypes to Different Levels of Fertilizers. *Bangladesh J. Bot.* 36(1): 33-38.

Islam, M.S., Rahman, K.M.M. and Hasan, M.H. (2011). Profitability and Resource Use Efficiency of Producing Major Spices in Bangladesh. *Bangladesh J. Agric. Econs*. 34(1&2): 1-13.

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

Kalirajan, K. (1984). Farm Specific Technical Efficiencies and Development Policies. *The Journal of Economic Studies*. 11: 3-13.

Kalirajan, K.P. (1981). On Measuring Absolute Technical and Allocative Efficiencies. *The Indian Journal of Statistics*. 47: 385-400.

Kalirajan, K.P. and Flinn, J.C. (1983). The Measurement of Farm Specific Technical Efficiency. *Pakistan Journal of Applied Economics.* 2: 167-180.

Kalirajan, K.P. and Shand, R.T. (1985). Types of Education and Agricultural Productivity: A Quantitative Analysis of Tamil Nadu Rice Farming. *Journal of Economic Development*. 11: 147-160.

Kinnear, J. and Taylor, J. (1987). *Marketing Research: An Applied Approach* Singapore, McGraw- Hill Book Co.

Koopmans, T.C. (1951). An Analysis of Production as an Efficient Combination of Activities: Activity Analysis of Production and Allocation. Ed. T.C. Koopmans Monograph No. 13. Wilej, New York. Cowles Commission for Research in Economics.

Mahmood, S.M.Q. (1995). Marketing of Selected Spices in Comilla District of Bangladesh. M.S. thesis, BAU, Mymensingh, Bangladesh.

Meeusen, W. and Broeck, J.V.D. (1977). Efficiency Estimation from Cobb-Douglas Production Functions with Composed Error. *International Economic Review*. 18:435-444.

Miah, A.M. (1992). An Economic Study of Sugarcane Cultivation with Several Intercrops in Joypurhat Sugar Mills Areas. M.S. thesis, BAU, Mymensingh, Bangladesh.

Poate, C.D. and Daplyn, P.F. (1993). Data for Agrarian Development. Cambridge University Press.

Rahman, M.M. (1998). An Economic Study of Onion Production in Selected Areas of Rajbari District. M.S. thesis, BAU, Mymensingh, Bangladesh.

Rahman, M.M. (2004). Effects of Growth Regulators on Growth and Yield of Three Varieties of Onion Grown From Sets. M.S. thesis, Bangladesh Agricultural University, Mymensingh, Bangladesh.

Richmond, J. (1974). Estimating the Efficiency of Production. *International Economic Review*. 15(2): 515-521.

Sabur, S.A. and Mollah, A.R. (1993). Trend, Variability and Relative Profitability of Spices in Bangladesh. *Bangladesh Journal of Agricultural Economics*. 16(1): 1 15.

Saha, P.K. (1999). An Economic Analysis of Production of Different Varieties of Onion in a Selected Area of Pabna District. M.S. thesis, BAU, Mymensingh, Bangladesh.

Scheaffer, R. (1979). Elementary Survey Sampling. Massachusetts, USA, Duxbury Press.

Schmidt, P. and Lovell, C.A.K. (1979). Estimating Technical and Allocative Inefficiency Relative to Stochastic Production and Cost Frontier. *Journal of Econometrics*. 9: 343-366.

Shah, N.A., Saeed, I., Afzal, M. and Farooq, A. (2011). Onion Production Potential, Limitations and its Prospects for Improvement in the Farming System of Punjab, Pakistan. *Agricultural Science Research Journal*. 1(9): 202-212.

Srivastava, M.B. (1998). Economics of Agro-Forestry in Indo-Gangetic Alluvium of Uttar Pradesh. *Indian Journal of Forestry*. 11(4): 265-272.

Stevenson, R.E. (1980). Likelihood Function for Generalized Stochastic Frontier Estimation, *Journal of Econometrics*. 13: 57-66.

Ullah, M.H. (2008). Impacts of Sulphur Levels on Yield, Storability and Economic Return of Onion. *Bangladesh Journal of Agricultural Research*. 33(4): 539-548.

USDA, 2015. *Basic Report 11282, Onions, Raw*, USDA National Nutrient Database for Standard Reference Release 27, The National Agricultural Library, United States Department of Agriculture, Washington, DC.

Yawalker, K.S. (1985). Vegetables Crops in India. Agri-Horticultural Publishing House, Nagpur. pp. 288-563.

APPENDICES

APPENDICES

Table A.5.1: Age Distribution of the Household Members by Sex

Age Group	Sujanagar, Pabna						Faridpur Sadar, Faridpur					
	Male		Female		Total		Male		Female		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
0-14 years	57	27.94	48	25.81	105	26.92	59	29.36	59	30.57	118	29.94
15-64 years	138	67.64	124	67.67	262	67.18	139	69.15	129	66.84	268	68.02
65 years or above	9	4.42	14	7.52	23	5.90	3	1.49	5	2.59	8	2.04
Total	204	100.00	186	100.00	390	100.00	201	100.00	193	100.00	394	100.00
Sex Ratio	110 male per 100 women						105 male per 100 women					
Dependency Ratio	48.85						47.01					

Source: Field survey, 2015.

Table A.5.2: Marital Status of the Household Members by Sex and Study Area

Maritral Status (Age>15 years)	Sujanagar, Pabna						Faridpur Sadar, Faridpur					
	Male		Female		Total		Male		Female		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Married	38	28.57	39	31.97	77	30.20	42	33.60	39	33.05	81	32.93
Unmarried	94	70.68	79	64.75	173	67.85	81	63.28	79	66.95	160	65.04
Others	1	0.75	4	3.28	5	1.96	5	3.12	0	0	5	2.03
Total	133	100.00	122	100.00	255	100.00	128	95.54	118	100.00	246	100.00

Source: Field survey, 2015.

Table A.5.3: Education of the Household Members by Sex and Study Area

Educational status (Age>5 years)	Sujanagar, Pabna						Faridpur Sadar, Faridpur					
	Male		Female		Total		Male		Female		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Illiterate	8	6.02	13	10.66	21	8.24	7	5.47	11	9.32	18	7.32
Read and/or write	19	14.29	8	6.56	27	10.59	15	11.72	9	7.63	24	9.76
1-5 years of schooling	57	42.86	51	41.80	108	42.35	54	42.19	48	40.68	102	41.46
6-10 years of schooling	35	26.32	41	33.61	76	29.80	40	31.25	43	36.44	83	33.74
11-12 years of schooling	9	6.77	5	4.10	14	5.49	7	5.47	5	4.24	12	4.88
Above 12 years of schooling	5	3.76	4	3.28	9	3.53	5	3.91	2	1.69	7	2.85
Total	133	100.00	122	100.00	255	100	128	100.00	118	100.00	246	100.00

Source: Field survey, 2015.

Table A.5.4: Occupation of the Household Members by Occupational Category

Occupation (Age>15 years)	Sujanagar, Pabna				Faridpur Sadar, Faridpur			
	Main		Subsidiary		Main		Subsidiary	
	No.	%	No.	%	No.	%	No.	%
Agriculture	97	38.04	34	45.95	87	35.37	30	37.97
Service	4	1.57	1	1.35	10	4.07	2	2.53
Business	16	6.27	16	21.62	19	7.72	21	26.58
Agricultural labor	0	0.00	3	4.05	0	0.00	3	3.80
Non-Agricultural labor	4	1.57	0	0.00	2	0.81	0	0.00
Rural transportation	7	2.75	4	5.41	4	1.63	0	0.00
Domestic work	94	36.86	13	17.57	89	36.18	18	22.78
Student	29	11.37	3	4.05	33	13.41	4	5.06
Others	4	1.57	0	0.00	2	0.81	1	1.27
Total	255	100.00	74	100.00	246	100.00	79	100.00

Source: Field survey, 2015