A STUDY ON FINANCIAL PROFITABILITY AND FACTORS CONTRIBUTING TO THE YIELD OF OFF- SEASON VEGETABLE CULTIVATION IN SOME SELECTED AREAS OF BANGLADESH

FAIROZE GOUHAR EBTIDA

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

JUNE, 2021

A STUDY ON FINANCIAL PROFITABILITY AND FACTORS CONTRIBUTING TO THE YIELD OF OFF- SEASON VEGETABLE CULTIVATION IN SOME SELECTED AREAS OF BANGLADESH

BY

FAIROZE GOUHAR EBTIDA

REGISTRATION NO.:14-05844

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

MASTER OF SCIENCE
IN
AGRICULTURAL ECONOMICS

SEMESTER: JANUARY-JUNE, 2021

Approved by:

(Md Rakibur Rahman) Associate Professor Department of Agricultural Economics Sher-e-Bangla Agricultural University Supervisor	(Dr Md Sadique Rahman) Associate Professor Department of Management and Finance Sher-e-Bangla Agricultural University Supervisor

(Dr. Ripon Kumar Mondal)
Chairman
Examination Committee
Department of Agricultural Economics
Sher-e-Bangla Agricultural University, Dhaka

CERTIFICATE

This is to certify that thesis entitled, **“A STUDY ON FINANCIAL PROFITABILITY AND FACTORS CONTRIBUTING TO THE YIELD OF OFF-SEASON VEGETABLE CULTIVATION IN SOME SELECTED AREAS OF BANGLADESH”** submitted to the Department of Agricultural Economics, 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 *hona fide* research work carried out by **FAIROZE GOUHAR EBTIDA** bearing Registration No. **14-05844** 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.

(Md Rakibur Rahman)
Associate Professor
Department of Agricultural Economics
Sher-e-Bangla Agricultural University
Supervisor

A STUDY ON FINANCIAL PROFITABILITY AND FACTORS CONTRIBUTING TO THE YIELD OF OFF-SEASON VEGETABLE CULTIVATION IN SOME SELECTED AREAS OF BANGLADESH

ABSTRACT

Brahmanbaria and Kishoregonj districts have been selected purposively as study area. The study was confined to only summer tomato and cauliflower. Simple random sampling technique has been used for collecting cross sectional data and information from a total of 100 farmers (summer tomato-50 and off-season cauliflower-50). All the collected data were summarized and scrutinized carefully to eliminate all possible errors. Data were presented mostly in the tabular form. Descriptive statistics like average, percentage etc. were followed to analyze the data to achieve the objectives of the study. Functional analysis was also adopted in a small scale to arrive at expected findings. A Cobb-Douglas production function was used to estimate the factors affecting the yield of vegetables. Cost items were identified as land preparation, human labour, seed, urea, TSP, MoP, manure, irrigation, insecticide, interest on operating capital and land use cost. All these cost were accounted for one production period of selected vegetables. Per hectare gross return of summer tomato and cauliflower were calculated at Tk. 1099395.00 and Tk. 615360.00, respectively. Net returns of summer tomato and cauliflower were calculated at Tk. 994353.40 and Tk. 455278.13 per hectare, respectively. Benefit Cost Ratios (BCRs) were found to be 10.47 and 3.84 for summer tomato and cauliflower, respectively. The net returns of summer tomato and cauliflower were found to be positive and the BCRs were greater than one, which showed that the cultivation of summer tomato and cauliflower were profitable. Production function analysis suggested that land preparation cost, human labour cost, seed, urea and TSP had a positive and significant effect on the yield of summer tomato and cauliflower. MoP and irrigation cost had insignificant effect on the yield of both crops and irrigation cost had a positive and significant effect on the yield of cauliflower. Cost of insecticides had negative but significant effect on the yield of summer tomato, and had a positive and significant effect on the yield of cauliflower. The Adjusted R^2s were found to be 0.772752, and 0.853164 for summer tomato and cauliflower, respectively. The F-values of the estimated production functions of summer tomato and cauliflower were found to be significant at one percent level which implies good fit of the models.

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 endeavor 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 Md Rakibur Rahman, Assistant Professor, Dept. of Agricultural Economics, Sher-e-Bangla Agricultural University, Dhaka, for his ever inspiring guidance, keen interest, scholarly comments and scholastic and constructive suggestions throughout the research work and preparation of thesis.

I am especially grateful to my respected Co-supervisor, Dr Md Sadique Rahman, Associate Professor, Department of Management and Finance, Sher-e-Bangla Agricultural University, Dhaka, for his proper Guidance, inspiring co-operation and encouragement during the research work and preparation of 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 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.

August, 2022

Fairoze Gouhar Ebtida

CONTENTS

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
CGPRT	: Coarse Grains, Pulses, Roots and Tubers
CIF	: Cost, Insurance and Freight
DAE	: Department of Agricultural Extension
DRC	: Domestic Resource Cost
EPC	: Effective Protection Coefficient
ESC	: Effective Subsidy Coefficient
et al.	: and others (at elli)
GR	: Gross Return
ha	: Hectare
HIES	: Household Income and Expenditure Survey
HYV	: High Yielding Variety
IOC	: Interest on Operating Capital
kg	: Kilogram
MFC	: Marginal Factor Cost
MoP	: Muriate of Potash
MPP	: Marginal Physical Product
mt	: Metric Ton
MVP	: Marginal Value Product
NGO	: Non Government Organization
NPC	: Nominal Protection Coefficient
RUE	: Resource Use Efficiency
SFYP	: Sixth Five Year Plan
t	: Ton
TC	: Total Cost
TFC	: Total Fixed Cost
Tk.	: Taka
TSP	: Triple Super Phosphate
TVC	: Total Variable Cost
US	: United States
$	: Dollar

CHAPTER 1
INTRODUCTION

1.1 Background of the Study

Bangladesh, a country of 16.1 million people and covers an area of 147,570 square kilometer, is one of the predominantly agro-based developing countries in the world (WB, 2019). Since her independence in 1971, agriculture has been the core sector of Bangladesh economy, which is still contributing around 13.60 percent of the GDP and also providing employment to 40.6 percent labor force (MoF, 2019 and BBS, 2018). Agriculture is one of the predominant driving forces for the economy of Bangladesh and its contribution to fulfilling the national macroeconomic targets such as employment of labor force, reduction of hunger rate, extinction of poverty and industrialization are remarkable. For instance, Agriculture captures 14.10 % GDP and absorbs 40.7 % of total manpower in Bangladesh (BBS, 2019). Agriculture sector plays an important role in overall economic development of the country. The overall contribution of the agriculture sector is 13.75 percent to Gross Domestic Product (GDP) at current price (GOB, 2017-18). The main agricultural commodities of our country are rice, wheat, pulse, jute and different vegetables. Vegetable are considered as one of the most important food crops due to their high nutritive value, relatively higher yield and higher return (Sharmin, 2015).

The production of agriculture sector has experienced the tremendous growth due to introduction of improved variety seed, hybrid seed, chemical fertilizers, pesticides, easing the irrigation facilities. Beside food grain like rice, wheat, maize etc. the government of Bangladesh has emphasized to increase the production of vegetables considering the nutritional value and higher return in the country for achieving the food self-sufficiency. Still per capita consumption of vegetable is 166.1 g daily instead of 200 g required (Hoque et al., 2019). This indicated that we must increase the vegetables production for meeting up the domestic demand and exporting the vegetables for earning the foreign currency which will create an employment opportunity and ultimately reduce the poverty in Bangladesh. Vegetables are the cheapest source of vitamins and minerals and are considered as protective food. In Bangladesh, more than 70 varieties of vegetable are grown round the year in varied seasons. Vegetable production is one form of intensive cultivation that can be opted in all seasons (Shaheen et al., 2011). Apart from nutritional importance, it helps to employment generation, increase income and reduce poverty in developing countries like Bangladesh (Mitra &Yonus, 2018).

Vegetable production has experienced remarkable growth in last 40 years in Bangladesh. Winter vegetables of Bangladesh are tomato, water gourd, cauliflower, cabbage, rabi brinjal, rabi pumpkin, radish, bean, green spinach etc. Supply of vegetables increases in a large extent in the winter season. Surplus vegetables in winter reduce the market price and farmer’s faces economic loss. For year around availability of fresh vegetables off season vegetable production is necessary. Off-season (also called counter-season) vegetable cultivation is the growing of vegetables under adverse climatic or economic conditions crops beyond the normal and regular crop calendar when demand is high, supply is low and prices are higher. The agricultural cropping season in Asia is generally divided into two main seasons: Kharif season—often referred to as spring, summer, rainy or simply monsoon season—is characterized by high temperatures, high rainfall and high humidity. Over 85% of the annual rainfall typically falls in this period, which generally lasts from May to November. Typical summer crops are rice, soybean, mungbean, and summer vegetables such as okra, amaranth, Indian spinach and gourds. The rabi season—also referred to as autumn or winter—has much cooler and drier conditions and lasts from November to March. Typical rabi crops are wheat, maize, potatoes, mustard, and winter vegetables such as cabbage, eggplant, and tomato. Previous studies have suggested that farmers growing tomatoes during the kharif season have received high profits. Off-season vegetable production can create dramatic income improvement (Schreinemachers et al., 2016). Off-Season vegetable production technology can create better environment of income improvement and motivates farmers toward commercial cultivation. It is performed by planting at different climatic zones, altering time, different structures, hormones etc.

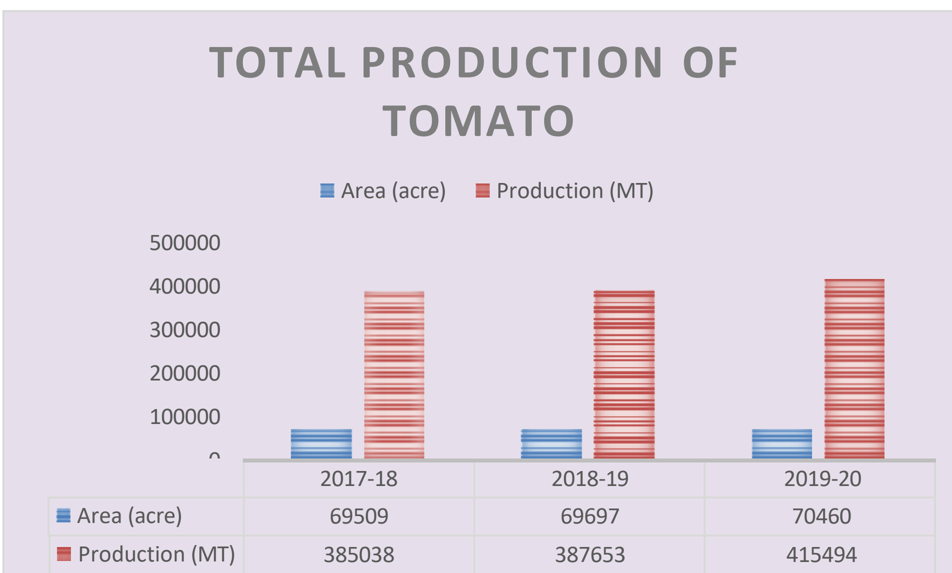
1.2 Importance of Off-season Vegetable Cultivation

Vegetables are being an important component of agricultural production of Bangladesh in terms of area, production, value addition to GDP and export earnings. Vegetables cultivation is getting importance from 1984-85 because it has immense scope of earning foreign currency through export. That is why there was a positive structural change in the production of different types of vegetables (Kamurzzaman & Takeya, 2008). Vegetable production has more than doubled in just over a decade, making Bangladesh one of the fastest-growing vegetable producers in the world.

Supply of quality vegetable seeds particularly the high-yielding and hybrid varieties. Farmers now can grow vegetables during off season and all seasons because of the development of varieties suitable for yearlong production.

Increasing off-season vegetable production is part of the effort to diversify the rice-reliant agriculture in Bangladesh. Farmers who produce tomatoes, cauliflower and other high-value crops during the hot and humid kharif season, traditionally when rice is grown, can see dramatic improvements in their crop output, land productivity, profitability, and net income (Ahmad, 2019). Diversification into vegetables can lead to dramatic increases in land productivity, farm profits and per capita incomes. Production of fresh vegetable after or before their normal season is called off-season vegetable production. The objective is to produce and supply vegetables to the market during their lean period of supply. Agriculture in Bangladesh is in the process of diversifying from subsistence rice production into higher value crops such as vegetables (Schreinemachers et al., 2016). On the farm level, farmers sell vegetables at a fairly low price during peak season. But the prices spike manifold by the time they enter the urban markets, consumers are paying but growers are not getting the money because of illegal tolls in the whole chain. The cultivation of crops outside the regular cropping calendar when supply is low and prices are high can give farmers better profits and consumers more choice . Nearly all the trained farmers said that their main constraint was the high incidence of pests and diseases. They felt that they had to spend a lot of money on pesticides and some were concerned about the impact on their health. Farmers also mentioned the high investment costs on rain shelters and lack of access to quality tomato seed (Schreinemachers et al., 2016). The present study will be undertaken to assess the profitability, efficiency and impact of off-season vegetables cultivation in Bangladesh focused on Tomato and cauliflower production on Brahmanbaria and Khiroganj districts. In this study offseason cultivation of tomato and cauliflower will be focused.

Tomato (*Solanum lycopersicum*) is one of the most important vegetables of Bangladesh and the world wide, too. It is the second most important world consumable vegetable after potato, ranks first among the processing crops (FAO, 2008) and belongs to Solanaceae family. It is cultivated all over the country due to its adaptability to wide range of soil and climate. In Bangladesh congenial amosphere remains for tomato production during low temperature winter season that is early November is the best time for tomato planting in our country Although tomato plants can grow under a wide range of climatic conditions, they are extremely sensitive to hot and wet growing conditions, the weather which prevails in the summer to rainy season in Bangladesh. The growing demand and importance of tomato, Bangladesh Agricultural Research Institute (BARI) has take n initiative to develop off-season summer and rainy season tomatoes. So far BARI has developed and released 2 hybrid tomato varieties i.e. BARI hybrid tomato-3 and 4 which can be grown during summer and rainy season under polytunnel (Zaman et al,2006). Summer tomato cultivation in Bangladesh is mainly constrained by the seasonality and frequent attack of diseases. During the summer, fruit settings were disrupted due to high daytime temperatures above 26°C and at night temperatures above 20°C. To overcome this problem, Bangladesh Agricultural Research Institute (BARI) has developed few hybrid varieties of heat tolerant tomato, known as off-season summer tomato. High to medium land is required for summer tomato cultivation. Tomato may be grown on a wide range of soil from sandy to clay. The raised bed planting can be adopted in low land tropics and high rainfall areas. Transparent poly tunnel with a height of 120-180 cm was built on the raised beds to protect the tomato plants from rain. Approximately 75 cm wide drainage channel need must be constructed between tunnels to facilitate irrigation, drainage, and other intercultural operations.



	2017-18	2018-19	2019-20
Area (acre)	69509	69697	70460
Production (MT)	385038	387653	415494

Figure 1.1: Production of Tomato (BBS 2020)

Cauliflower (Brassica oleracea var. botrytis) is one of the popular vegetables mainly cultivated in winter season in Bangladesh. It is cultivated more or less over the country prevailing the suitable climate of cool daytime temperatures 21-29 °C. According to Bangladesh Bureau of Statistics (BBS, 2019), annual production of vegetables was 12.912 million metric tons of which 0.274 million metric tons was cauliflower. Thus, the production of cauliflower captures a remarkable share of the total vegetable production in Bangladesh (Hoque et al.,2021). Although cauliflower can grow under a wide range of climatic conditions, now a day's farmers have become very interested in cultivating off-season cauliflower on their due to high price of offseason cauliflower. According to Bangladesh Bureau of Statistics (BBS, 2019), annual production of vegetables was 12.912 million metric tons of which 0.274 million metric tons was cauliflower.

Thus, the production of cauliflower captures a remarkable share of the total vegetable production in Bangladesh. About 100 types of fresh horticultural crops are being exported from Bangladesh to more than 40 countries in the world. Export earnings from fresh fruits and vegetables have significantly increased from $ 51 million in FY2008-09 to $ 125 million in FY2015-16). Hence the government of Bangladesh is emphasizing on the year-round production, processing, storing

and export of high value agro-commodities especially horticultural crops through diversification of produces and market expansion. Since, the demand of the cauliflower is increasing day by day in domestic and foreign market, the Government of Bangladesh has prioritized to increase the production of cauliflower by providing subsidy to the farmers on different inputs such as seeds, fertilizer, irrigation etc. to achieve self-sufficiency in cauliflower production.

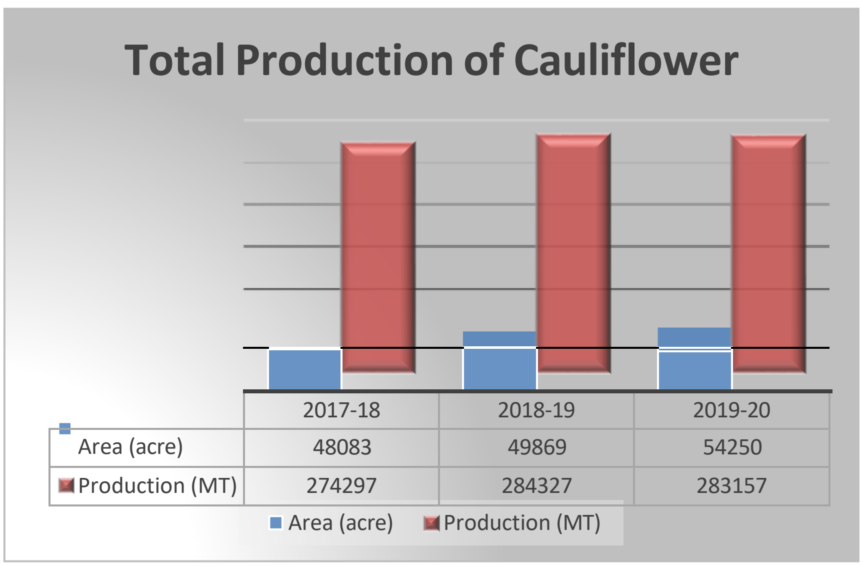


Figure 1.2 Production of cauliflower (BBS, 2020)

Both figure 1.1 and 1.2 showed that area and production of both the vegetables remain almost same over last five years.

1.3 Objectives of the Study

The present study will be undertaken:

- To examine the socio-demographic profile of off-season vegetable producer in Bangladesh.
- To estimate the profitability of off-season vegetable cultivation.
- To identify the factors constraining to yield and profitability of off-season vegetable producers in Bangladesh.

1.4 Justification of the Study

The outcomes of this research will be helpful to the planners, policy makers and extension workers for better understanding the current scenario and for taking strategies to accelerate regional development programs specifically in rural agricultural sector. Understanding the limiting factors of smallholder cultivators in technology adoption will help development workers to ascertain the type of strategy needed to encourage technology uptake and sustain their livelihood. With the information, NGOs, donor agencies and other local organizations involved in improving the socio-economic development of rural people might take development program to create self-employment opportunity for the target groups through production and distribution of improved seeds of off season crops. This study will also be helpful to the academicians and researchers for further conceptualization. The country might be benefited by reducing malnutrition through year around availability of vegetables which will have an effect on the economic wellbeing of the country. Moreover, a few field level studies had been conducted on offseason vegetables in Bangladesh so this will help the policy makers to come with appropriate policies. to increase the offseason cultivation of vegetables.

1.5 Organization of the Study

This thesis contains a total of eight chapters which have been organized in the following sequence. Chapter 1 includes introduction. Chapter 2 presents review of literature on profitability, resource use efficiency, comparative advantage analysis and constraints of off-season vegetable production. Subsequently, methodology of the study is presented in chapter 3, description of study area in Chapter 4, socio-demographic profile of household population of off-season vegetable growers presented in chapter 5, financial profitability of off season vegetables production presented in chapter 6, factors affecting the yield of off-season vegetables presented in chapter 7 and finally chapter 8 represents summary, conclusion and recommendations.

CHAPTER 2
REVIEW OF LITERATURE

This chapter presents the review of relevant literature with a view to understand the method and cause-effect relationship of past and present research work on off season vegetable farming. This would help in narrowing down the problem correctly and in selecting the most appropriate technique of analysis. Review of literature was not only limited to works done in Bangladesh but also was extended to other countries for having a broader view.

More than 60 types of vegetables of indigenous and exotic origin are grown in Bangladesh. Based on the growing season, vegetables are categorized as summer/rainy season vegetables, winter season vegetables, and all-season vegetables. Summer/rainy season vegetables are cultivated during the monsoon season from May to October. On the other hand, winter vegetables are grown in short winter span from November to April. About two-thirds of the total vegetables, other than roots and tubers, are produced during this short winter season (Hazra, 2008). Vegetable production in Bangladesh has increased at an average rate of 2.8% over thepast 23 years. In some areas of Bangladesh (namely Jessore, greater Dhaka region, and Rangpur and Dinajpur districts), this growth has been tremendous and has contributed to a change of existing farming practices, replacing traditional crops as jute, pulses and rice. However, horticultural exports from Bangladesh remain negligible, and the supply of horticultural products can barely address the country's domestic requirements. Similarly, agro-processing industries, particularly for fruits and vegetables, remain limited in number (Weinberger and Genova II, 2005).

About two-thirds of the total vegetables, other than roots and tubers, are produced during the short winter season. So, only 30 percent of total vegetables are generally produced in summer/rainy season posing serious scarcity of vegetables. Consorted research and developmental initiatives need to be undertaken to augment vegetable production during the hot and wet months between March to October through development of wet heat tolerant varieties particularly of tomato, cauliflower, cabbage, etc. and adoption of low cost polyhouse technology for rain shelter (Hazra, 2008).

Bangladesh receives improved technologies for vegetables from other countries and assistance in developing its own research facilities. Several improved and off-season varieties of tomato, cabbage, and cauliflower have already been developed by BARI (Ali, ed. 2000). Basically subsistence farming community grows vegetables in Bangladesh mainly around their homesteads where the land is generally more fertile than the land used for field crops. Although, in some areas of Bangladesh this growth has been tremendous and has contributed to a change of existing farming practices, replacing traditional crops as jute, pulses and rice.(Hazra, 2008).

Availability is not only stagnant and at a low level in most of the part of the country, yearly supply of vegetables is quite irregular-as-well. Seasonality in vegetable prices is usually high where consumers' preference for vegetables is high, which suggests that consumers are willing to pay high prices to maintain their vegetable consumption level during the lean supply period. This induces producers to grow more vegetables in the off season, reducing seasonality in availability. Because preference for vegetables is normally related to income level, the above analysis implies that income-induced demand is concentrated during the off season. Vegetable production during the peak summer months is more difficult than during the peak winter months. This, combined with the fact that most Asian cities are located in the lowland tropics, creates a high demand for summer production technologies. (Ali, ed. 2000).

Bala et al., 2011 reported that, Vegetables sub-sector plays an important role for development of Bangladesh. As a developing country, Bangladesh is adequately suffering from the problems of poverty, unemployment and malnutrition. Vegetable sub-sector can play important role to solve these problems in the shortest possible time. The importance of vegetable can be realized from two stand points such as, economic point of view and nutritional point of view. Vegetable production being a labor-intensive activity can provide gainful employment to the rural populace. BARI hybrid tomato-3 and 4 is a profitable crop on the basis of its return to investment. Farmers are highly pleased and encouraged with these technologies as they have the bright scope to increase their income by cultivating this crop.

Karim et al. (2009) estimated the benefit cost ratio for off-season tomato production from on-farm data in Jessore district and estimated it to be 4.2. These estimates are based on data from experimental plots or from adopting farmers only and thus are probably not representative for the average vegetable farmer. Furthermore, these studies did not estimate the profitability of a similar group of non-adopting farmers.

Rahman et al. (2020) showed that the average yield of summer tomato was 32.45 t/ha which was significantly higher than that of the winter tomato growers. In the winter season, farmers usually received Tk 10 as selling price of per kg tomato, while in the case of summer tomato farmers they received Tk. 38 per kg, which is substantially high. Due to higher productivity and price, the gross return for off-season tomato growers was also significantly higher. Higher gross return implies higher profit.

Zaman et al. (2006) reported that cultivation of summer tomato is suitable for Jamalpur region. By cultivating summer tomato in one hectare of land, gross margin was BDT 695464 and net return or profit was BDT 690464 and the benefit cost ratio (BCR) was
3.32. Extension workers can encourage farmers to cultivate off season tomato. Government can also get benefited from the hard-earned foreign currency that was spent to import summer tomato. The findings of the study that net profit per acre (TK. 24011). Analysis on-station data from experimental plots and showed that every dollar (USD) invested in off-season tomato production gave revenues of 3.3 dollars (benefit cost ratio). In comparison, growing tomatoes in the *rabi* season gave only a benefit cost ratio of 1.7.

Farmers in Sonbhadra District, a part of Uttar Pradesh have shifted towards tomato cultivation (off-season rainfed crop during kharif under upland condition) where more than 12% of the area under paddy cultivation is converted into tomato cultivation. In the beginning the local cultivar named Kajala was popular, then Sel-7, Sel-22, DVRT-1, DVRT-2, H-86 and JK desi were popularized and recently hybrid varieties like 3585 of Sungrow, 2535 of Namdhari, US-404 of Agriseeds, NP-5005 (Lakshmi) of Nunhems Pro Agro are dominating and yield between 350 and 550 q/ha. The net return is doubled than the investment in the single cropping season as a result Sonbhadra district are marching towards self-sustenance with cultivation of off-season tomato (MEHTA, 2012).

A research conducted by parvin (2017) shows that small farmers cultivate more land & earn highest net profit. Priority should be given to the development of such roads which link villages to the main roads and markets. Most of the farmers are illiterate. Dissemination of market information should be increased so that farmers can get fair price of the Tomato. The policy implication is that while off-season vegetable production can create dramatic income improvements, it is important to emphasize safe and sustainable pest management methods as part of policies promoting it. Tomato farmers get lower price of Tomato during harvesting period, lack of good quality seed, higher price of inputs and lack of government intervention etc. Appropriate measures should be necessitated by Government to figure out this problem. This study also points out that Productivity is highest for small farmer (1308 mound) followed by large farmer (1050.75 mound) and medium farmer (562.5 mound). Profitability is also highest for small farmers (TK. 418769) followed by large farmer (TK. 333608) and medium farmer (TK. 180090). Because most of the small farmer has more land as well as more output.

Islam et al, (2020) reported that cauliflower production is profitable for farmers in Bangladesh. Per acre average yields of cauliflower was estimated to be 11470.37 kg. Per acre gross returns of cauliflower was Tk.229407. Per acre gross margins were estimated at Tk.167816.35 for cauliflower. Per acre net returns of cauliflower was Tk. 135546.85. Benefit cost ratios of cauliflower production per acre was 2.4.

Thakur et al. (1994) conducted a study of off-season vegetable production to examine the cost of production, gross income and net profit in Kullu and Saproon valleys of Kullu and Solan districts of Himachal Pradesh. Five important off-season vegetables viz. Tomato, cauliflower, cabbage, capsicum and pea were included for the study. The study reveals that vegetable cultivation was highly labour-intensive and required high doses of manure, fertilizers and pesticides. Gross and net returns from tomato were found to be Rs.
1.66.002 and Rs. 1,45,962 per hectare respectively. The suggested improved and intensive cropping systems, use of new technology, and recommended package of practices that can bring more production and income to the off-season vegetable growers according to the study.

In Nowshera a district of Pakistan, the trend of growing offseason vegetable is very common. Beside the normal Rabi crops, more area is allocated to cucumber and tinda mainly grown in plastic tunnels (Ishaq et.al., 2003). Shaheen et al. (2011) divided off- season crops into two: Off-season crop-I (Jan/Feb-April) and off-season crop-II (May- August) and found that most of the farmers were technical efficient in off-season II. A study was conducted on cauliflower cultivation in Pakistan and concluded that, only few farmers faced some problems of technical inefficiency and farmers of off-season II are more efficient due to high value also they used more inputs to fetch more output and higher profit. This study also indicates that, that small farmers were more efficient due to better utilization of available resources as compared to medium and large farms in both seasons.

Adenuga et al. (2013) reported that tomato is one of the major fruit vegetables in Nigeria. In view of its seasonal availability and the need to make it available all-year round, effort must be made to increase efficiency of its production especially during the dry season. A study was therefore carried out to examine the economics of dry season tomato production in Kwara state, Nigeria. It estimated the costs and returns and assessed the technical efficiency of dry season tomato production. A two-stage random sampling technique was used to select 105 respondents for the study. A well-structured questionnaire was used to collect data from the respondents. Major tools of analysis used for the study were the gross margin analysis and the stochastic frontiers model. Results of the study showed that a gross margin of N 18,956.75/ha (US$ 120.74/ha) was realized from dry season tomato production. Furthermore, the result of the stochastic frontier model shows that age, education status of the farmers and access to credit had significant effect on the efficiency of dry season tomato production. This study therefore highlights the need for government to invest in public education and to make credit available to farmers as a way of reducing the burden of high cost of production.

CHAPTER 3
METHODOLOGY

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. A chronological description of the methodology used for this study is presented below.

3.1 Sources of Data

Both primary and secondary data had been collected. Primary data had been collected by survey method with the help of pre-designed and pretested interview schedule. Questions had been designed to raise basic issues on the assessment. Besides, other necessary information had been collected from various research documents and papers like-

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

3.2 Sampling Technique

Sampling is an important part of survey work. Brahmanbaria and Kishoregonj districts were purposively selected for summar tomato and cauliflower. Simple random sampling technique was used for collecting cross sectional data and information from a total of 100 farmers (summar tomato-50 and cauliflower-50) in the selected areas.

3.3 Processing, Editing and Tabulation of Data

The data was checked and verified for the sake of consistency and completeness. Editing and cleaning 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. Raw data were inserted in computer using the concerned software Microsoft Excel.

3.4 Analytical Technique

Data were analyzed with a view to achieving the objectives of the study. Descriptive statistics like average, percentage etc. were followed to analyze the data to achieve the objectives of the study.

3.5 Economic Profitability Analysis

The net economic returns of summer tomato and off-season cauliflower 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
- Seed
- Urea
- TSP
- Mop
- Manure
- Insecticide
- Irrigation
- Interest on operating capital
- Land use

The returns from the crops were estimated based on the value of main products and by-products.

3.6 Description and Method of Measuring Cost Items

In this study variable cost, fixed cost and total cost had been described. Total variable cost (TVC) included land preparation, human labour, seed, urea, TSP, MoP, manure, insecticides and irrigation. Fixed cost (FC) included interest on operating capital and rental value of land. Total cost (TC) included total variable cost and fixed cost.

3.6.1 Cost of Land Preparation

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

3.6.2 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, cleaning, 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.

3.6.3 Cost of Seed

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

3.6.4 Cost of Urea

Urea was one of the important fertilizers in summer tomato and cauliflower production. The cost of urea was computed on the basis of market price. The market price of urea was Tk. 16 per kg for the study areas. In order to calculate cost of urea the recorded unit of urea per hectare were multiplied by Tk. 16.

3.6.5 Cost of TSP

The cost of TSP was also computed on the basis of market price. The market price of TSP was Tk. 22 per kg for the study areas. In order to calculate cost of TSP the recorded unit of TSP per hectare were multiplied by Tk. 22.

3.6.6 Cost of MoP

Among the three main fertilizers used in summer tomato and cauliflower 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. The market price of MoP was Tk. 15 per kg.

3.6.7 Cost of Insecticides

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

3.6.8 Cost of Irrigation

Water management helps to increase summer tomato and cauliflower production. Cost of irrigation varies from farmers to farmers. It was calculated based on how many times irrigation needed per hectare and how this was done.

3.6.9 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 8 percent per annum interest on operating capital for four months was computed for summer tomato and cauliflowers. Interest on operating capital was calculated by using the following formula (Miah and Hardekar, 1988)

IOC= AIit

Where,

IOC= Interest on operating capital

i= Rate of interest

AI= Total operating capital / 3

t = Total time period of a cycle

3.6.10 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.

3.7 Calculation of Returns

3.7.1. 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.

3.7.2 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

3.7.3 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 summer tomato and cauliflower production at the farm level:

$$\Pi = P_r Q_r + P_b Q_b - \sum_{i=1}^{n} (P_{xi}.X_i) - TFC$$

Where,

Π = Profit per hectare for producing summer tomato and cauliflower

P_r = Per unit price of output (Tk/Kg)

Q_r = Quantity of output (Kg/ha)

P_b= Per unit price of by-products (Tk/kg)

Q_b= Quantity of by-product (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

3.7.4 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.

$$BCR = \frac{\text{Total Return}}{\text{Total Cost}}$$

3.8 Cobb-Douglas Production Function

A Cobb-Douglas regression model was used to estimate the production function of summer tomato and cauliflowers. It was used to find out the factor effect in summer tomato and cauliflower production. The advantage of using the Cobb-Douglas production function is its reasonable proximately with economic theory and its ability for easy computation of the partial elasticity of output with respect to input and returns to scale. To determine the contribution of the most important variables in the production process, the following type of Cobb-Douglas production function was used in the study.

$$Y= a X_1^{b1} X_2^{b2} X_3^{b3} X_4^{b4} X_5^{b5} X_6^{b6} X_7^{b7} X_8^{b8} + U_i$$

For the purpose of the present empirical exercise, the Cobb-Douglas production function was converted into the following logarithmic (Double log) form:

$$l_nY= \ln a + b_1\ln X_1 + b_2 \ln X_2 + b_3 \ln X_3 + b_4 \ln X_4 + b_5 \ln X_5 + b_6 \ln X_6 + b_7 \ln X_7 + b_8 \ln X_8 + U_i$$

Where,

ln= Natural logarithm

Y= Yield of summer tomato and cauliflower (Kg/ha)

X_1= Land preparation cost (Tk. /ha)

X_2= Human labour cost (Tk. /ha)

X_3= Amount of seed (Kg /ha)

X_4= Amount of urea (Kg/ha)

X_5= Amount of TSP (Kg/ha)

X_6= Amount of MoP (Kg/ha)

X_7= Cost of insecticide (Tk/ha)

X_8= Cost of irrigation (Tk/ha)

a= Constant or intercept term

$b_1, b_2, b_3, b_4, b_5, b_6, b_7, b_8$ = Coefficient of the respective variables to be estimated;

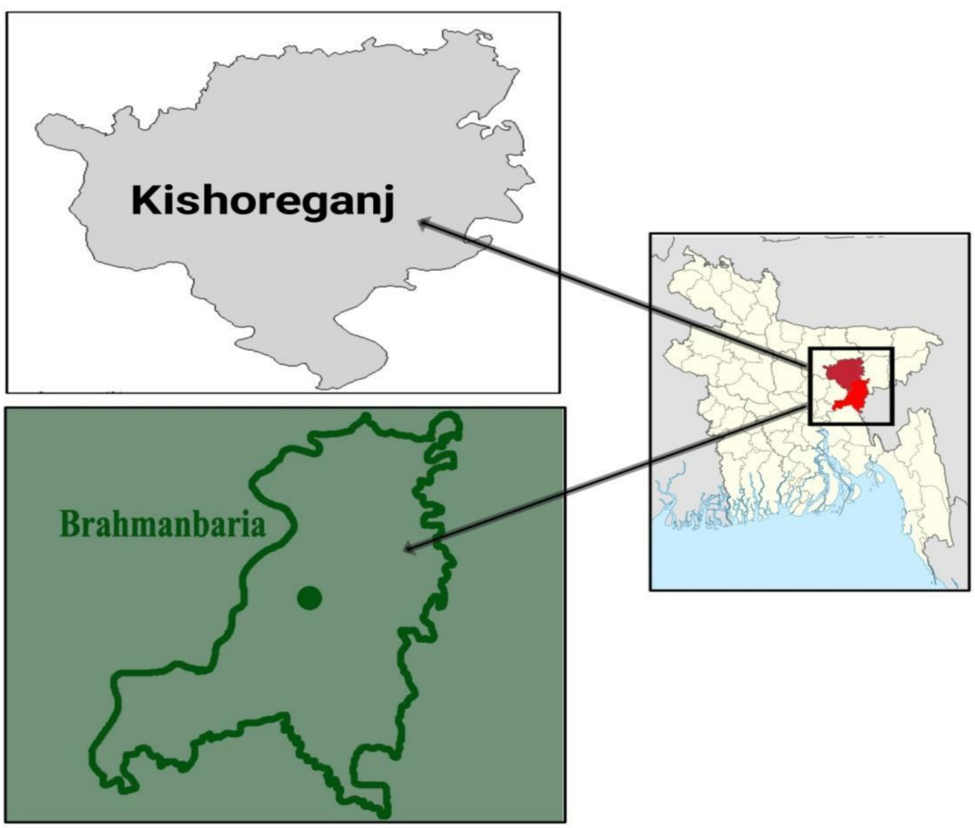
and $U_{i=}$ Error term

CHAPTER 4
DESCRIPTION OF THE STUDY AREA

This chapter presents a detailed view of the area where study was conducted. As 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.

4.1 Location

The study was conducted in four unions namely, Ramrail, Sultanpur, Shuhilpur and Bitghar Union of Brahmanbaria district and Bajitpur upazila and Bhairab Upazila of kishoreganj district of Bangladesh.



4.1 Figure: A map showing the study area

4.2 Physical Features, Topography and Soil Condition

Brahmanbaria is a district in east-central Bangladesh. Brahmanbaria district is a part of the Chittagong Division. It lies between 23°39’ and 24°16’ north latitudes and between 90°44’ and 91°51’ east longitudes. The total area of the district is 1,927.11 sq. km (726.00 sq. miles). The geography of the district is characterized by low-lying land with small hills and hillocks of red soil. The economy of Brahmanbaria is predominantly agricultural. Out of total 465.720 holdings of the district 55.28% holdings are farms that produce varieties of crops namely local and HYV rice, wheat, vegetables, jute, spices, cash crops, pulses, oilseeds and others.

Kishoreganj is a district in central Bangladesh. Kishoreganj district is a part of the Dhaka Division. Kishoreganj district is surrounded on the north by Netrokona district, on the east by Habiganj and Brahmanbaria districts, on the south by Narsingdi and Brahmanbaria districts and on the west by Mymensingh, Gazipur and Narsingdi districts. The district lies between 24º 02 ′ and 24º 39 ′ north latitudes and between 90º 15 ′ and 91º 15 ′ east longitudes. The total area of the district is 2688.59 sq. km (1038.00 sq. miles).

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**	Miscellaneous Land	Grand Total
Brahmanbaria	6640	31842	58844	28614	31470	157410	25301	183905
Kishoreganj	28811	39357	42725	76049	26628	213570	43688	257258

Source BBS 2011

4.3 Area and Population

The total area, population and density of population of the Brahmanbaria and kishoreganj districts are presented in Table 4.2.

Table 4.2: Population Size of the Study Areas

District	Area (sq. km)	Household	Population		Average size of households	Density Per sq. Km.
			Male	Female		
Brahmanbaria	1881.16	538937	1367	1474	5.25	1510
Kishoreganj	2688.54	627322	1432242	1479665	1083	1083

Source: BBS, 2011

4.4 Climate, Temperature and Rainfall

The geography of Brahmanbaria is characterized by low-lying land with small hills and hillocks of red soil. Annual average temperature of the district is maximum 34.3°C and minimum 12.7°C.Total annunal rainfall is 2551 mm. In kishoreganj the annual average temperature of the district varies from maximum 33.3°C to minimum 12°C to minimum and annual rainfall is 2174 mm. In kishoreganj The annual average temperature of the district varies from maximum 33.3°C to minimum 12°C to minimum and annual rainfall is 2174 mm.

Table 4.3 Temperature, rainfall, humidity of Brahmanbaria for the year 2008-2011

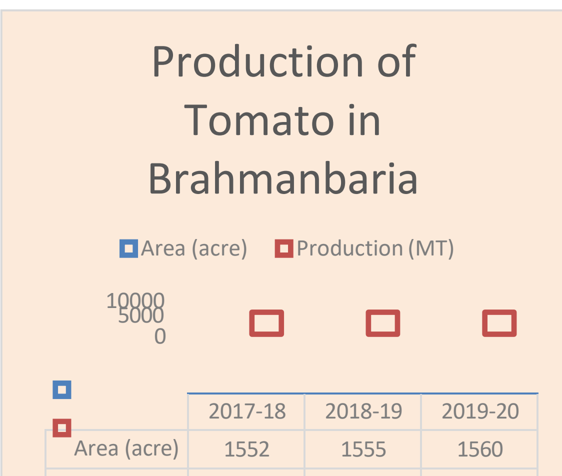
Years	Temperature (centigrade)		Rainfall (millimeter)	Humidity (%}
	Maximum	Minimum		
2008	33.2	11.1	2064	79.0
2009	33.9	13.4	1924	80.0
2010	33.5	11.0	1055	64.2
2011	24.3	11.3	1879	77.6

Table 4.4 Temperature, rainfall, humidity of Kishoregonj for the year 2008-2011

Years	Temperature (centigrade)		Rainfall (millimeter)	Humidity (%}
	Maximum	Minimum		
2008	34.12	10.8	2235	79.0
2009	33.00	13.2	1653	80.0
2010	32.40	11.71	1811	66.3
2011	22.20	10.80	2153	79.3

4.5 Land and Agriculture

Structured, grey sandy loams to clays, strongly acid, developed in piedmont out-wash in the piedmont aprons and valleys in areas adjoining or within the north-eastern hilly region. These soils are often affected by flash floods. Soils in some areas are very strongly acid, grey to dark grey heavy plastic clays they are mainly in Kishoreganj, usually seasonally deeply flooded some floodplain areas in Brahmanbaria and Kishoreganj are Brahmaputra and Teesta alluvia are rich in mica and biotite.



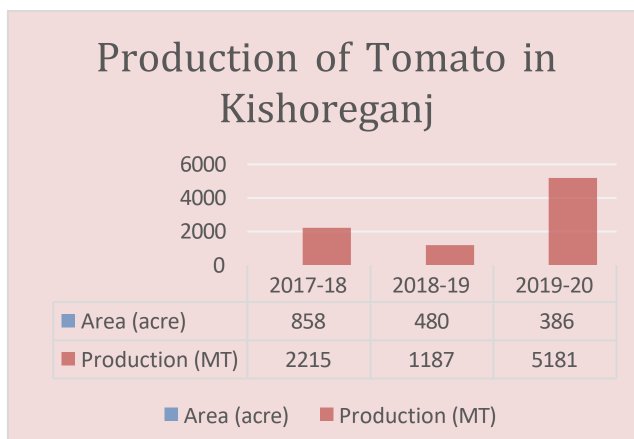
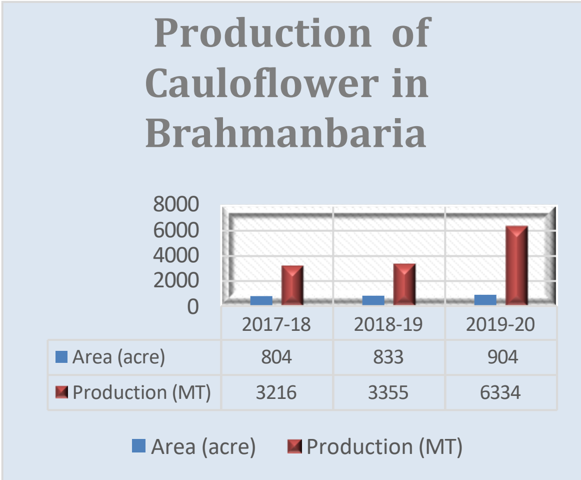


Figure 4.2 production of Tomato in Brahmanbaria & Kishoreganj



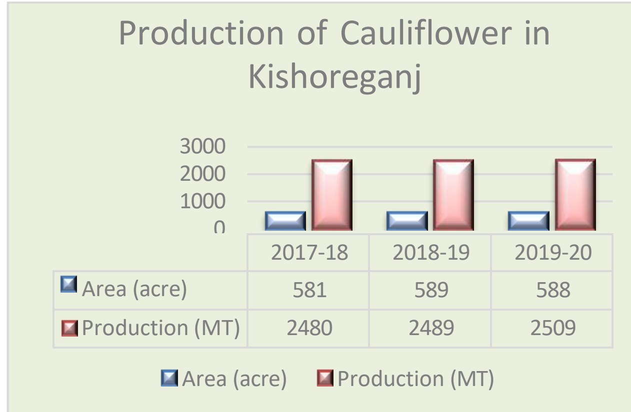


Figure 4.3 Production of Cauliflower in Brahmanbaria & Kishoreganj

4.6 Transportation, Communication and Marketing Facilities

For overall development of a region Transportation and communication facilities are the most important pre-condition. The selected areas for the study are well communicated with the different places of Bangladesh especially with the Dhaka division. 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. The modes of transportation of this area are rickshaw, van, truck and motor cars. Farmers directly sell their products to the consumer to road side side markets. Most of the roads in the study areas are concreted and easily accessible. Farmers sell their vegetables to the local market directly sue to well communication facilities.

CHAPTER 5

SOCIO-DEMOGRAPHIC PROFILE OF HOUSEHOLD POPULATION

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.

5.1 Age and Sex

The sample of 100 household in the study areas comprised a total population of 563 (Table 5.1**)**. In the selected study areas, 49.37 percent of the sample populations were male and 50.63 percent were female. About 29 percent of household populations were below 15 years of age, about 69 percent of the populations were under 15-64 years age group and only 2.31 percent were of 65 years or above. The sex ration in the study areas were found to be about 102 female per 100 male, which were higher than the national figure (100.2) (BBS, 2018b), possibly because of the sample framework used for the survey.

5.2 Marital Status

The marital status of the household population aged 18 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 female population in comparison with that of male population.

5.3 Education

Figure 5.1 showed that, 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 39 percent were found to have secondary and/or higher secondary level education and only 3.77 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 the study areas, which might be due to gender discrimination against female (Table 5.3).

Table 5.1: Age Distribution of the Household Members by Sex

Age Group	Male		Female		Total	
	No.	%	No.	%	No.	%
0-14 years	79	28.42	84	29.47	163	28.95
15-64 years	191	68.71	196	68.77	387	68.74
65 years or above	8	2.88	5	1.75	13	2.31
Total	278	100.00	285	100.00	563	100.00
Sex Ratio	102.52 Female per 100 Male					

Source: Field survey, 2021.

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

Maritral Status (Age>18 years)	Brahmanbaria, Kishoreganj					
	Male		Female		Total	
	No.	%	No.	%	No.	%
Married	64	32.82	65	33.85	129	33.33
Unmarried	129	66.15	121	63.02	250	64.60
Others	2	1.03	6	3.13	8	2.07
Total	195	100.00	192	100.00	387	100.00

Source: Field survey, 2021.

5.4 Occupation

The occupation of the study population aged 16 years or more showed that, in the study area, about 35 percent (out of 422) were engaged in agriculture as a main occupation and about 37 percent (out of 127) were engaged in agriculture as subsidiary occupation (Table 5.4**)**. On the other hand, 36.26 percent were engaged in domestic work as household activities and 13.74 percent were engaged in study. Household activities and study are not directly included in Gross Domestic Product (GDP).

5.5 Type of Family

A family of the household has been defined as total number of persons of either sex living together and taking meal from same kitchen. Type of the family of off-season vegetable farmers was divided into three types nuclear, joint and extended. Percentage of nuclear family was slightly higher (77 percent) in Brahmanbaria Sadar than that of Kishoreganj Sadar (72 percent). But percentage of joint family was higher in Kishoreganj Sadar (24 percent) compared to Brahmanbaria Sadar (18 percent). Considering all farmers, on an average, 21 percent, 74.50 percent and 4.50 percent were joint family, nuclear family and extended family, respectively (Figure 5.1**)**.

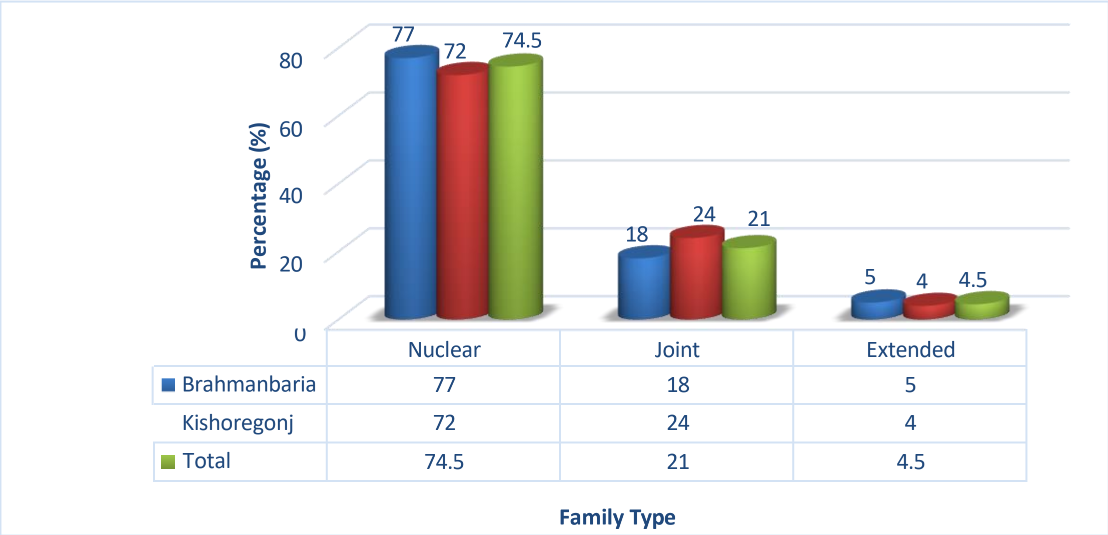


Figure 5.1: Family Type of the Respondent Household

5.6 Income

Figure 5.2 revealed that, in Brahmanbaria Sadar, 36 percent respondent households were found to earn more than Tk. 300000 in a year followed by Tk. 200001-250000 income group (23 percent). On the other hand, in Kishoreganj Sadar, 38 percent respondent households were found to earn more than Tk. 300000 in a year followed by Tk. 100001-150000 income groups (15 percent). Considering all farmers in the study areas, it was evident from the figure that, on an average, 37 percent respondent households was in 'More than Tk. 300000' income group followed by Tk. 200001- 250000 income group (18 percent).

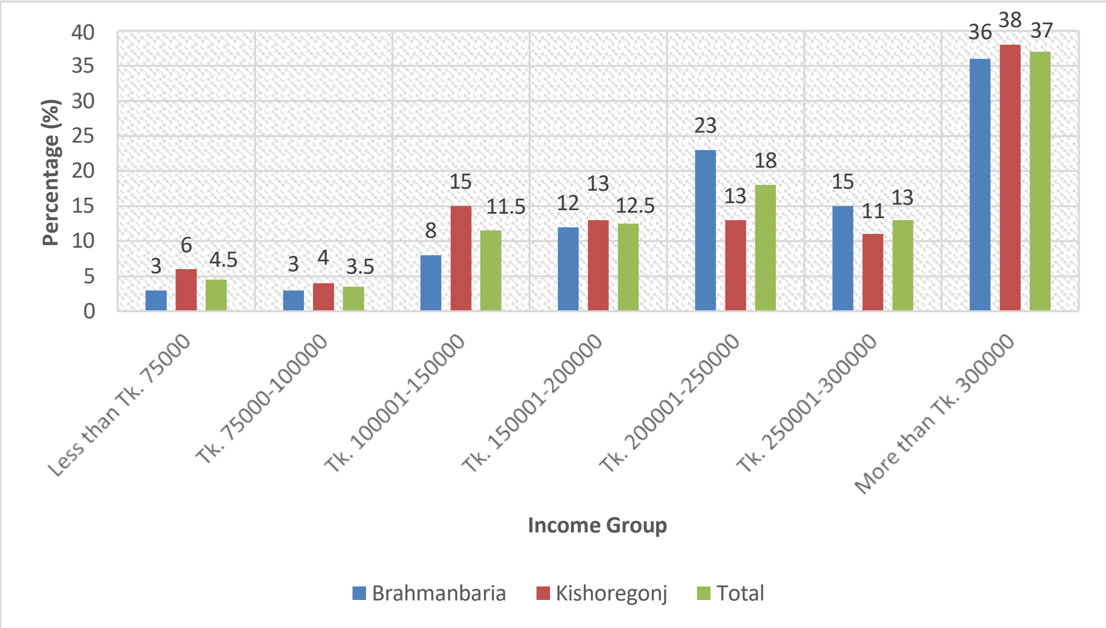


Figure 5.2: Income Distribution of the Respondent Household

5.7 Agricultural Training

Among the respondent producers, about 83.00 percent producers of Brahmanbaria Sadar got training on different agricultural technologies followed by producers from Kishoregonj (86.00 percent) (Table 5.5). 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 5.3: Agricultural Training of the Respondent Farmers

Training Received	Brahmanbaria Sadar		Kishoreganj Sadar	
	No.	%	No.	%
Yes	58	82.86	26	86.67
No	12	17.14	4	20.00
Total	70	100.00	30	100.00

Source: Field survey, 2021.

Table 5.4: Education of the Household Members by Sex and Study Area

Educational status (Age>5 years)	Male		Female		Total	
	No.	%	No.	%	No.	%
Illiterate	13	5.53	22	9.09	35	7.34
Read and/or write	27	11.49	17	7.02	44	9.22
1-5 years of schooling	97	41.28	98	40.50	195	40.88
6-10 years of schooling	74	31.49	89	36.78	163	34.17
11-12 years of schooling	13	5.53	9	3.72	22	4.61
12 years of schooling	11	4.68	7	2.89	18	3.77
Total	235	100.00	242	100.00	477	100.00

Source: Field survey, 2021.

Table 5.5: Occupation of the Household Members by Occupational Category

Occupation (Age>15 years)	Main		Subsidiary	
	No.	%	No.	%
Agriculture	149	35.31	47	37.01
Service	17	4.03	3	2.36
Business	33	7.82	34	26.77
Agricultural labor	0	0.00	4	3.15
Non-Agricultural labor	4	0.95	0	0.00
Rural transportation	6	1.42	0	0.00
Domestic work	153	36.26	29	22.83
Student	58	13.74	9	7.09
Others	2	0.47	1	0.79
Total	422	100.00	127	100.00

Source: Field survey, 2021

CHAPTER 6
ECONOMIC PROFITABILITY OF SELECTED OFF-SEASON VEGETABLE PRODUCTION

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

6.1 Economic Profitability of Summer Tomato Production

6.1.1 Variable Costs

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 summer tomato cultivation. In summer tomato production, the land preparation cost was found Tk. 2246.93 per hectare, which was 8.20% of total cost (Table 6.1).

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 summer tomato. It is generally required for different operations such as land preparation, sowing, weeding, fertilizer and insecticides application, irrigation, harvesting and carrying, storing etc. The quantity of human labour used in summer tomato production was found to be about 53.42 man-days per hectare and average price of human labour was Tk. 382.88 per man-day. Therefore, the total cost of human labour was found to be Tk. 20453.45 representing 19.47 percent of total cost (Table 6.1).

Cost of Seed

Cost of seed varied widely depending on its quality and availability. Per hectare total cost of seed for summer tomato production were estimated to be Tk. 6027.00, which constituted 5.74 percent of the total cost (Table 6.1).

Cost of Urea

In the study area, farmers used different types of fertilizers. On an average, farmers used urea 298.45 kg per hectare. Per hectare cost of urea was Tk. 4775.20, which represents 4.55 percent of the total cost (Table 6.1).

Cost of TSP

Among the different kinds of fertilizers used, the rate of application of TSP was found to be 193.48 kg per hectare. The average cost of TSP was calculated at Tk. 1697.50 per hectare which representing 4.05 percent of the total cost (Table 6.1).

Cost of MoP

The application of MoP per hectare was found to be 152.61 Kg. Per hectare cost of MoP was Tk. 984.00, which represents 2.18 percent of the total cost (Table 6.1).

Table 6.1: Per Hectare Cost of Summer tomato Production

Items of Cost	Quantity (Unit/ha)	Rate (Tk./Kg)	Cost (Tk./ha)	% of Total Cost
Land preparation			8612.06	8.20
Human labour (Man-days)	53.42	382.88	20453.45	19.47
Seed (Kg)	0.6	10045	6027.00	5.74
Urea (Kg)	298.45	16	4775.20	4.55
TSP (Kg)	193.48	22	4256.56	4.05
MoP (Kg)	152.61	15	2289.15	2.18
Manure			20507.00	19.52
Cost of insecticides			8741.83	8.32
Cost of irrigation			2300.35	2.19
A. Total Variable Cost (TVC)			**77962.60**	**74.22**
Interest on operating capital @ of 8% for 4 months			2079.00	1.98
Rental value of land			25000.00	23.80
B. Total Fixed Cost (TFC)			**27079.00**	**25.78**
C. Total Cost (A+B)			**105041.60**	**100.00**

Source: Field survey, 2021.

Cost of Manure

Farmers used manure to increase the soil fertility. The average cost of manure for summer tomato production was found to be Tk. 20507.00 which was 19.52 percent of the total cost (Table 6.1).

Cost of Insecticides

Farmers used different kinds of insecticides to keep their crop free from pests and diseases. The average cost of insecticides for summer tomato production was found to be Tk. 8741.83 which was 8.32 percent of the total cost (Table 6.1).

Cost of Irrigation

Production of summer tomato requires irrigation. The average cost of irrigation was found to be Tk. 2300.35 per hectare, which represents 2.19 percent of the total cost (Table 6.1).

Total Variable Cost

Therefore, from the above different cost items it was clear that the total variable cost of summer tomato production was Tk. 77962.60 per hectare, which was 74.22 percent of the total cost (Table 6.1).

6.1.2 Fixed Cost

Interest on Operating Capital

Interest on operating capital for summer tomato production was estimated at Tk. 2079.00 per hectare, which represents 1.98 percent of the total cost (Table 6.1).

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 summer tomato farmers the land use cost was found to be Tk. 25000.00 per hectare, and it was 23.80 percent of the total cost (Table 6.1).

Total Cost (TC) of Summer Tomato 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 summer tomato was found to be Tk. 105041.60 (Table 6.1).

6.1.3 Return of Summer tomato Production

Gross Return

Return per hectare in summer tomato cultivation is shown in table 6.2. Per hectare gross return was calculated by multiplying the total amount of product with respective per unit price and then adding the value of by-product. It is evident from table that the average yield of summer tomato per hectare was 22210.00 kg and the price of summer tomato was Tk. 49.50 per Kg. As there is no by-product in tomato cultivation, the gross return was found to be Tk. 1099395.00 per hectare.

Gross Margin

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. 1021432.40 per hectare (Table 6.2).

Net Return

Net return or profit was calculated by deducting the total production cost from the gross return. On the basis of the data the net return was estimated as Tk. 994353.40 per hectare (Table 6.2).

Table 6.2: Per Hectare Cost and Return of Summer Tomato Production

Measuring Criteria	Quantity (kg/ha)	Rate (Tk./kg)	Cost (Tk./ha)
Main Product Value	22210	49.50	1099395.00
By-product Value			0.00
Gross Return (GR)			1099395.00
Total Variable Cost (TVC)			77962.60
Total Cost (TC)			105041.60
Gross Margin (GR-TVC)			1021432.40
Net Return (GR-TC)			994353.40
BCR (undiscounted)(GR/TC)			**10.47**

Source: Field survey, 2021.

6.1.4 Benefit Cost Ratio (undiscounted)

Benefit cost ratio (BCR) was found to be 10.47 which implies that one taka investment in summer tomato production generated Tk. 10.47 (Table 6.2). From the above calculation it was found that summer tomato cultivation is profitable in Bangladesh.

6.2 Profitability of Off-season Cauliflower Production

6.2.1 Variable Costs

Cost of Land Preparation

Land preparation, same as summer tomato cultivation, included ploughing, laddering and other activities needed to make the soil suitable for cauliflower cultivation. The average land preparation cost of cauliflower production was found Tk. 9137.44 per hectare indicating 5.71 percent of total cost (Table 6.3).

Cost of Human Labour

Human labour is one of the most important and largely used inputs for producing cauliflower. It is generally required for different operations such as land preparation, sowing, weeding, fertilizer and insecticides application, irrigation, harvesting and carrying, cleaning, storing etc. The quantity of human labour used in cauliflower production was found to be about 72.78 man-days per hectare. The total cost of human labour was found to be Tk. 27482.46 representing about 17.17 percent of total cost (Table 6.3).

Cost of Seed

In case of cauliflower production, farmers used 0.525 kg seed per hectare. Per hectare total cost of seed for cauliflower production were estimated Tk. 12051.67 per hectare and it constituted 7.53 percent of the total cost (Table 6.3).

Cost of Urea

Farmers used different types of fertilizers for cauliflower production. On an average, farmers used 179.25 kg urea per hectare. Per hectare cost of urea was Tk. 2868.00, which represents 1.79 percent of the total cost (Table 6.3).

Cost of TSP

Among the different kinds of fertilizer used, the rate of application of TSP (155.00 kg per hectare) was higher than MoP fertilizer for cauliflower production. The average cost of TSP was Tk. 3410.00 per hactare which constituted 2.13 percent of the total cost (Table 6.3).

Cost of MoP

The application of MoP per hectare was calculated at 47.10 Kg. Per hectare cost of MoP was about Tk. 1425, which represents 0.89 percent of the total cost (Table 6.3).

Cost of Manure

As like summer tomato production, in cauliflower production farmers uses manure to increase the soil fertility. The average cost of manure for summer tomin off-season cauliflower production was found to be Tk. 59702.72 per hectare which was 37.30 percent of the total cost (Table 6.3).

Cost of Insecticides

Farmers used different kinds of insecticides to keep their crop free from pests and diseases. The average cost of insecticides for cauliflower production was found to be Tk. 12854.73 which was 8.03 percent of the total cost (Table 6.3).

Cost of Irrigation

Irrigation is also needed to increase the yield of cauliflower and it is one of the most major cost items for cauliflower production. The average cost of irrigation was found to be Tk. 2711.67 per hectare which represented 1.69 percent of the total cost (Table 6.3).

Total Variable Cost

The total variable cost of cauliflower production was Tk. 131643.68 per hectare which was about 82.24 percent of the total cost (Table 6.3).

Table 6.3: Per Hectare Cost of Off-season Cauliflower Production

Items of Cost	Quantity (Unit/ha)	Rate (Tk./Kg)	Cost (Tk/ha)	% of Total Cost
Land preparation			9137.44	5.71
Human labour (Man-days)	72.78	377.61	27482.46	17.17
Seed (Kg)	0.525	22955.56	12051.67	7.53
Urea (Kg)	179.25	16	2868.00	1.79
TSP (Kg)	155.00	22	3410.00	2.13
MoP (Kg)	95.00	15	1425.00	0.89
Manure			59702.72	37.30
Cost of insecticides			12854.73	8.03
Cost of irrigation			2711.67	1.69
A. Total Variable Cost (TVC)			**131643.68**	**82.24**
Interest on operating capital @ of 10% for 4 months			3438.19	2.15
Rental value of land			25000.00	15.62
B. Total Fixed Cost (TFC)			**28438.19**	**17.76**
C. Total Cost (A+B)			**160081.87**	**100.00**

Source: Field survey, 2021.

6.2.2 Fixed Cost

Interest on Operating Capital

Interest on operating capital for cauliflower production was estimated at Tk. 3438.19 which represented 2.15 percent of the total cost (Table 6.3).

Rental Value of Land

Rental value of land was similarly calculated as summer tomato 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 cauliflower farmers the land use cost was found Tk. 25000 per hectare, and it was 15.62 percent of the total cost (Table 6.3).

Total Costs of Cauliflower Production

Total cost was calculated by adding all the variable and fixed costs items. By doing so, per hectare total cost of producing cauliflower was found to be Tk. 160081.87 per hectare (Table 6.3).

6.2.3 Return of Cauliflower Production

Gross Return

Return per hectare of cauliflower cultivation is shown in Table 6.4. Per hectare gross return was calculated by multiplying the total amount of product with respective per unit price and then adding the value of by-product. It is evident from Table 6.4 that the average yield of cauliflower per hectare was 12820 kg and the price of cauliflower was TK. 48.00. Thus, the gross return was found to be Tk. 615360.00 per hectare.

Gross Margin

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. 483716.32 per hectare (Table 6.4).

Table 6.4: Per Hectare Cost and Return of Cauliflower Production

Measuring Criteria	Quantity (kg/ha)	Rate (Tk./kg)	Cost (Tk./ha)
Main Product Value	12820	48	615360.00
By-product Value			0.00
Gross Return (GR)			615360.00
Total Variable Cost (TVC)			131643.68
Total Cost (TC)			160081.87
Gross Margin (GR-TVC)			483716.32
Net Return (GR-TC)			455278.13
BCR (undiscounted)(GR/TC)			**3.84**

Source: Field survey, 2021.

Net Return

Net return 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. 455278 per hectare (Table 6.4).

6.2.4 Benefit Cost Ratio (undiscounted)

Benefit cost ratio (BCR) was found to be 3.84 which implied that one taka investment in cauliflower production generated Tk. 3.84 (Table 6.4). From the above calculation it was found that cauliflower cultivation is profitable in Bangladesh.

CHAPTER 7

FACTORS AFFECTING THE YIELD OF SELECTED OFF-SEASON VEGETABLES

In this chapter an attempt has been made to identify and measure the effects of different factors on yield of selected off-season vegetables in the framework of production function analysis. Eight explanatory variables were taken into consideration for production function analysis. The effects of each of the variables on the yield of selected off-season vegetables are interpreted below:

7.1 Factors Affecting the Yield of Summer Tomato and Cauliflower

7.1.1 Land Preparation Cost (X_1)

The regression coefficients of land preparation cost were found to be positive and significant at 1 percent and 10 percent level for summer tomato and cauliflower respectively (Table 7.1). Co-efficient of land preparation cost (X_1) was 0.189633 for summer tomato and 0.138957 for cauliflower production. The result of the analysis indicated that, keeping other factors constant, a 1 percent increase in additional expenditure on land preparation would increase the yield of summer tomato and cauliflower by 0.189633 and 0.138957 percent, respectively.

7.1.2 Human Labour (X_2)

The regression coefficients of Human labour (X_2) were positive and significant at 5 percent level for both summer tomato and cauliflower production. The regression coefficients of human labour (X_2) were 0.137523 and 0.224212 for summer tomato and cauliflower production, respectively, which implied that, other factors remaining the same, if expenditure on human labour was increased by 1 percent, then the yield of summer tomato and cauliflower would be increased by 0.137523 and 0.224212 percent, respectively (Table 7.1).

7.1.3 Seed (X_3)

The regression coefficients of seed were 0.319748 (significant at 5 percent level) and 0.448421 (significant at 5 percent level) for summer tomato and cauliflower repectively, which implied that, holding other factors constant, 1 percent increase in the amount of seed would increase the yield of summer tomato and cauliflower by 0.319748 percent and 0.448421 percent, respectively (Table 7.1).

7.1.4 Urea (X_4)

The regression coefficients of urea (X_4) were positive and significant at 5 percent level for both summer tomato and cauliflower production (Table 7.1). The regression coefficients of urea (X_4) were 0.029387 and 0.022261 for summer tomato and cauliflower production, respectively, which implied that, other factors remaining the same, if amount of urea was increased by 1 percent, then the yield of summer tomato and cauliflower would be increased by 0.029387 and 0.022261 percent, respectively.

7.1.5 TSP (X_5)

The regression coefficients of TSP (X_5) were 0.014362 (significant at 10 percent level) and 0.014459 (significant at 10 percent level) for summer tomato and cauliflower, respectively, which implied that, holding other factors constant, 1 percent increase in the amount of seed would increase the yield of summer tomato and cauliflower by 0.014362 and 0.014459 percent, respectively (Table 7.1).

7.1.6 MoP (X_6)

The regression coefficients for MoP (X_6) were found positive but insignificant for both summer tomato and cauliflower production (Table 7.1).

7.1.7 Cost of Insecticide (X_7)

The regression coefficient of insecticides cost (X_7) of summer tomato production was negative and significant at 10 percent level but positive and significant at 10 percent level for cauliflower, which implied that if the expenditure on insecticides was increased by 1 percent, then the yield of summer tomato would be decreased by 0.00694 percent and the yield of cauliflower would be increased by 0.008553 percent, other factors remaining constant (Table 7.1).

7.1.8 Irrigation (X_8)

The magnitudes of the coefficients of irrigation cost were negative and insignificant for summer tomato production but negative and significant at 5 percent level for cauliflower production (Table 7.1). The result of the analysis indicated that, keeping other factors constant, a 1 percent increase in additional expenditure on irrigation would decrease the yield of cauliflower by 0.01608 percent.

7.2 Performance of the Summer Tomato and Cauliflower Production Model

The Adjusted R^2's were found to be 0.772752 and 0.853164 for summer tomato and cauliflower, which implied that about 77.28 percent of the total variation in yield of summer tomato and about 85.32 percent of the total variation in yield of cauliflower could be explained by the independent variables included in the model (Table 7.1). Other 22.72 percent and 14.68 percent variables depend on the factors which were not included in the regression model of summer tomato and cauliflower. The F-values of summer tomato and cauliflower production were about 21.83 and 36.59, and both were significant at one percent level which implied good fit of the models. Highly significant F-value implied that the included variables collectively were important for explaining the variations in yield of summer tomato and cauliflower.

Table 7.1: Estimated Values of Coefficients from Cobb-douglas Production Function Analysis for Summer Tomato and Cauliflower

Variables	**Summer tomato**			**Cauliflower**		
	Co-efficient	**Standard error**	**T-value**	**Co-efficient**	**Standard error**	**T-value**
Intercept	2.822434***	0.454263	6.213222	2.159303***	0.431093	5.008905
Land preparation cost	0.198633***	0.051161	3.882483	0.138957*	0.082236	1.689724
Human labour cost	0.137523**	0.06612	2.079884	0.224212**	0.094117	2.382278
Seed	0.319748**	0.143711	2.224944	0.448421**	0.211186	2.123346
Urea	0.029387**	0.013922	2.110761	0.022261**	0.011112	2.003269
TSP	0.014362*	0.007883	1.821941	0.014459*	0.007941	1.820824
MoP	0.004139	0.018958	0.218324	-0.01703	0.012405	-1.37264
Cost of Insecticides	-0.00694*	0.003911	-1.77466	0.008553*	0.005126	1.668497
Cost of Irrigation	-0.00247	0.003159	-0.78206	-0.01608**	0.007531	-2.13475
Adjusted R^2	0.772752			0.853164		
F value	21.82793***			36.58829***		
Return to scale	0.694382			0.823753		
Observations (n)	50			50		

Source: Field survey, 2014.
Note: ***, ** and * indicates significant at 1, 5 and 10 percent level respectively.

7.3 Returns to Scale in Summer tomato and Cauliflower Production

The summation of all the regression coefficients of the estimated production function of summer tomato and cauliflower were 0.694382 and 0.82375, respectively (Table 7.1). It indicated that the production functions exhibited a decreasing return to scale. If all the inputs specified in the function were increased by 1 percent, then the yield of summer tomato and cauliflower would be increased by 0.694382 and 0.82375 percent respectively.

CHAPTER 8
SUMMARY, CONCLUSION AND RECOMMENDATION

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.

8.1 Summary

Vegetables are important due to their nutritional value and versatile uses. Demand of vegetables in Bangladesh is augmenting day by day due to increasing population and consciousness. In Bangladesh, the problem of food insecurity can be met by increased food diversification. Off-season vegetable grows within a short time period and intercropping is possible with other crops. The present study was conducted to determine the profitability and identify factors contributing to the yield of summer tomato and cauliflower.

Brahmanbaria and Kishoregonj districts have been selected purposively as study area. The study was confined to only summer tomato and cauliflower. Simple random sampling technique has been used for collecting cross sectional data and information from a total of 100 farmers (summer tomato-50 and off-season cauliflower-50). All the collected data were summarized and scrutinized carefully to eliminate all possible errors. Data were presented mostly in the tabular form. Descriptive statistics like average, percentage etc. were followed to analyze the data to achieve the objectives of the study. Functional analysis was also adopted in a small scale to arrive at expected findings. A Cobb-Douglas production function was used to estimate the factors affecting the yield of pulses.

It was revealed from the study that 49.37 percent of the sample populations were male and 50.63 percent were female. About 29 percent of household populations were below 15 years of age, about 69 percent of the populations were under 15-64 years age group and only 2.31 percent were of 65 years or above. The sex ration in the study areas were found to be about 102 female per 100 male. The marital status of the household population aged 18 years or more (at the time of survey) were found that about 33 percent were married and about 65 percent were unmarried. About 22.00 percent of the study population, aged 5 years or more, were found to have no formal education. The occupation of the study population, aged 16 years or more, showed that about 38 percent and 35 percent were engaged in agriculture as a main occupation in Brahmanbaria and kishoregonj, respectively. It was also revealed from the study that about 35 percent of the study population aged 16 years or more were (out of 422) were engaged in agriculture as a main occupation and about 37 percent (out of 127) were engaged in agriculture as subsidiary occupation. Most farmers lived in a nuclear family. The study indicated that, in Brahmanbaria Sadar, 36 percent respondent households were found to earn more than Tk. 300000 in a year where as in Kishoreganj Sadar, 38 percent respondent households were found to earn more than Tk. 300000 in a year.

Costs and returns were calculated to identify the financial profitability of summer tomato and cauliflower producers. Cost items were identified as land preparation, human labour, seed, urea, TSP, MoP, manure, irrigation, insecticide, interest on operating capital and land use cost. All these cost were accounted for one production period of selected vegetables. Per hectare gross return of summer tomato and cauliflower were calculated at Tk. 1099395.00 and Tk. 615360.00, respectively. Net returns of summer tomato and cauliflower were calculated at Tk. 99435340.00 and Tk. 455278.13 per hectare, respectively. Benefit Cost Ratios (BCRs) were found to be
10.47 and 3.84 for summer tomato and cauliflower, respectively. The net returns of summer tomato and cauliflower were found to be positive and the BCRs were greater than one, which showed that the cultivation of summer tomato and cauliflower were profitable. Production function analysis suggested that land preparation cost, human labour cost, seed, urea and TSP had a positive and significant effect on the yield of summer tomato and cauliflower. MoP and irrigation cost had insignificant effect on the yield of both crops and irrigation cost had a positive and significant effect on the yield of cauliflower. Cost of insecticides had negative but significant effect on the yield of summer tomato, and had a positive and significant effect on the yield of cauliflower. The Adjusted R^2s were found to be 0.772752, and 0.853164 for summer tomato and cauliflower, respectively. The F-values of the estimated production functions of summer tomato and cauliflower were found to be significant at one percent level which implies good fit of the models.

8.2 Conclusion

Based on the findings, it can be concluded that summer tomato and cauliflower production are profitable. Although farmers were not aware about the right doses of inputs which could increase the cost of production to some extent, so it is necessary to make the farmers aware about efficient use of resources. Production of summer tomato and off-season cauliflower can also help in improving the nutritional status of the rural people as well as the urban people. Concern authorities need to take necessary steps to motivate producers to increase the area under off-season vegetable cultivation, particularly summer tomato and cauliflower. The present and future demand of off-season vegetables throughout the year should be determined initiating comprehensive study in order to initiate well planned off-season vegetable production programme at national level.

8.3 Recommendations

On the basis of the findings of the study, the following specific recommendation may be made for the development of pulse sector.

a) As summer tomato and cauliflower are profitable enterprise, government and concern institutions should provide adequate extension programme to expand their area and production.
b) Summer tomato and cauliflower-based cropping pattern should be introduced to those areas of Bangladesh where their production is suitable.
c) Farmers could be encouraged to employ more inputs in summer tomato and cauliflower production which have positive significant impact on yield through extension programme.
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 summer tomato and cauliflower.
e) Adequate training on recommended fertilizer dose, insecticides, water management practices, use of good seed, intercultural operations, etc., should be provided to the summer tomato and cauliflower farmers which will enhance production by improving the technical knowledge of the farmers.
f) Further in-depth studies need to be conducted to identify the factors influencing the yield of summer tomato and cauliflower and their resource use efficiency.

g) Comparative studies among other off-season vegetables as well as with their competing crops should be conducted to understand the obstacles in adopting off-season vegetable-based cropping pattern.

8.4 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 during COVID-19 pandemic. So, access to respondent farmers were difficult. 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) Off-season vegetables are grown without much care practices, so the record of the expenses or profit were not remembered by the farmers.
d) In the resource and time constraints, broad and in-depth study got hampered to some extent.

References

Abay, A, 2007. Vegetable marketing chain analysis in the case of Fogera Wereda, in Amehara National regional state of Ethiopia. An MSc Thesis Presented to School of Graduate Studies of Haramaya University

Adenuga, A. H., Muhammad-Lawal, A., & Rotimi, O. A. (2013). Economics and technical efficiency of dry season tomato production in selected areas in Kwara State, Nigeria. Agris on-line Papers in Economics and Informatics, 5(665-2016-44983), 11-19.

Akter, S., Islam, M., & Rahman, M. (2011). An economic analysis of winter vegetables production in some selected areas of Narsingdi district. Journal of the Bangladesh Agricultural University, 9(2). doi:10.3329/jbau.v9i2.11036

Ali, M. ed. 2000. Dynamics of Vegetable Production and Consumption in Bangladesh. Shanhua, Taiwan: Asian Vegetable Research and Development Center.

Arya, P. S. (2000). Off-season Vegetable Growing in Hills. APH Publishing.

Bala, B., Sharma, N., & Sharma, R. K. (2011). Cost and return structure for the promising enterprise of off-season vegetables in Himachal Pradesh. *Agricultural Economics Research Review*, *24*(347-2016-16885), 141

Bangladesh Bureau of Statistics (BBS). 2017. Ministry of Planning, Government of the People's Republic of Bangladesh.

BBS (2014). Statistical Year Book of Bangladesh, Bangladesh Bureau of Statistics, Statistical Division, Ministry of Planning, Government of the People's Republic of Bangladesh, Dhaka, Bangladesh.

BBS (2018). Statistical Yearbook of Bangladesh, Bangladesh Bureau of Statistics, Statistics Division, Ministry of Planning, Government of the People's Republic of Bangladesh, Dhaka

BBS (2018b). Gender Statistics of Bangladesh, Bangladesh Bureau of Statistics, Statistics Division, Ministry of Planning, Government of the People's Republic of Bangladesh, Dhaka

BBS (2019). Statistical Yearbook of Bangladesh, Bangladesh Bureau of Statistics, Statistics Division, Ministry of Planning, Government of the People's Republic of Bangladesh, Dhaka

Begum, M. E. A., Islam, M. N., Alam, Q. M., & Hossain, S. B. (2011). Profitability of some BARI released crop varieties in some locations of Bangladesh. Bangladesh Journal of Agricultural Research, 36(1), 111-122.

Chowdhury, M. A. H., & Hassan, M. S. (2013). Handbook of agricultural technology. Bangladesh Agricultural Research Council (BARC), Farmgate, Dhaka, Bangladesh.

D.V. Singh (1990). Production and Marketing of Off-season Vegetables. Mittal Publication. New Delhi.

Everaarts, A. P., & de Putter, H. (2009). *OPPORTUNITIES AND CONSTRAINTS FOR IMPROVED VEGETABLE PRODUCTION TECHNOLOGY IN TROPICAL ASIA. Acta Horticulturae, (809), 55–68.* doi:10.17660/actahortic.2009.809.3

FAO, 2011. Plant breeding and seed systems for rice, vegetables, maize and pulses in Bangladesh. FAO Plant Production and Protection Paper 207. Food and Agriculture Organization of the United Nations, Rome.

FAO., 2008, Food and Agriculture Organization of the united Nations, Soil Survey Project of Bangladesh. Soil Research Technology Report,vol. 57. pp. 140-141.

GOB (2017-18). Bangladesh Economic Review, Economic Adviser's Wing Finance Division, Ministry of Finance, Government of People's Republic Bangladesh.

Haque, M.S., Islam M.T. and Rhaman. M., 1999, Studied on the preservation of semi-concentrated tomato juice. Bangladesh Journal of Agricultural Science 26 (1): 37-43.

Hazra, P. (2008). Upgradation of the vegetable production scenario of Bangladesh: suggested strategy. J. Agrofor. Environ, 2(2), 201-204.

Hoque, F., Afrin, S., Akter, A., Khatun, M., Beg, T. H., Afrin, T., & Yoezer, K. (2021). Measuring technical efficiency of the cauliflower cultivation in Bangladesh: A case study on Dhaka district. Journal of Applied Horticulture, 23(1).

Hoque, M.E. (2000). Crop diversification in Bangladesh. In: M.K. Papdemetriou and F.J. Dent (eds.). Crop diversification in the Asia-Pacific region. Bangkok, Thailand: Food and Agriculture Organization of the United Nations

Ishaq, M., Sadiq, G., & Saddozai, S. H. (2003). An estimation of cost and profit functions for offseason cucumber produce in district Nowshera. Sarhad Journal of Agriculture, 19(1), 155-162.

Islam, M. S., Salehin, F., & Nayeem, A. R. (2020). Cauliflower cultivation productivity and resource utilization of agroeconomics: A study on selected areas of jamalpur district in Bangladesh. Globus An International Journal of Management & IT, 7(2), 10-16

Kamurzzaman, M., & Takeya, H. (2008). Importance, Structural Change and Factors Affecting Production of Vegetables in Bangladesh. *International Journal of Agricultural Research, 3*(6), 397-406. doi:10.3923/ijar.2008.397.406

Karim, M., Rahman, M., & Alam, M. (1970). Profitability of Summer BARI Hybrid Tomato Cultivation in Jessore District of Bangladesh. Journal of Agriculture & Rural Development, 73-79. doi:10.3329/jard.v7i1.4424

Kohli, U. K. (2000). off-season Vegetable Production: Perspective and Strategies, LR Verma. Natural Resources and Development in Himalya, Malhotra Publishing House, New Delhi, 184-208.

Maruf, S. A., Ahmed, J. U., & Khan, J. A. (2021). Journal of Bangladesh Agricultural University. J Bangladesh Agril Univ, 19(1), 99-108.

MEHTA, M. (2012). Conservation of chironji and cultivation of off-season rainfed tomato. Current Science, 102(2), 158.

Midmore, D. J., & Poudel, D. D. (1996). *Asian vegetable production systems for the future. Agricultural Systems, 50(1), 51–64.* doi:10.1016/0308-521x(95)00003-n

Mitra, S., & Yunus, M. (2018). Determinants of tomato farmers efficiency in Mymensingh district of Bangladesh: Data Envelopment Analysis approach. Journal of the Bangladesh Agricultural University, 16(1), 93-97. doi:10.3329/jbau.v16i1.36487

MoF (2018). Bangladesh Economic Review, Economic Advisory Section, Department of Finance, Ministry of Finance, Bangladesh.

MoF (2019). Bangladesh Economic Review, Economic Adviser's Wing Finance Division, Ministry of Finance, Government of People's Republic Bangladesh

Parvin, M. M. (2017). Farmer's profitability of tomato cultivation in the socio-economic context of Bangladesh: A study at Rangpur district, International Journal of Applied Research, ISSN Online: 2394-5869, 3(6): (09-15).

Rahman, M. S., & Acharjee, D. C. (2020). Impact of Off-Season Summer Tomato Cultivation on Income and Food Security of the Growers. In *Agricultural Economics*.

Rahman, S. (2009). Whether crop diversification is a desired strategy for agricultural growth in Bangladesh? Food Policy 34, 340–349.

Schreinemachers, P., Wu, M., Uddin, M. N., Ahmad, S., & Hanson, P. (2016). Farmer training in off-season vegetables: Effects on income and pesticide use in Bangladesh. *Food Policy*, *61*, 132-140. doi:10.1016/j.foodpol.2016.03.002

Shaheb, M. R., Nazrul, M. I., & Sarker, A. (2014). Improvement of livelihood, food and nutrition security through homestead vegetables production and fruit tree management in Bangladesh. Journal of the Bangladesh Agricultural University, 12(2), 377-387.

Shaheen, S., Anwar, S., & Hussain, Z. (2011). Technical efficiency of off-season cauliflower production in Punjab. J. Agric. Res, 49(3).

Sharmin, S. (2015). Relative profitability and resource use efficiency of participatory and non-participatory farmers of integrated FSRD project in Tangail district (Doctoral dissertation, MS Thesis. Department of Agricultural Economics, Bangladesh Agricultural University, Mymensingh).

Shrestha, B. (2008). Off-season vegetables marketing channels of small growers: a case of Yampaphant, Tanahun, Nepal. Retrived March, 10, 2010.

Singh, D. V. (1993). Regional Specialization in the Cultivation of Off-Season Vegetables on Commercial Scale: A case of Himachal Pradesh. Agricultural Situation in India, 12(13).

Thakur, D. S. (1994). High stakes for banks in off-season vegetable production and marketing. The Bihar Journal of Agricultural Marketing, 2(1), 89-95.

Von Braun, J. (1995). Agricultural commercialization: impacts on income and nutrition and implications for policy. Food policy, 20(3), 187-202.

Weinberger, K. and Genova II, C. A., 2005. “Vegetable Production in Bangladesh: Commercialization and Rural Livelihoods,” Technical Bulletin no. 33. Taiwan:AVRDC – The World Vegetable Center.

World Bank (2019). "Population, total". World Bank. Retrieved 19 August 2019.

Zaman, M. M., Anawarul Huq, A. S. M. and Chowdhury, M. J. A. (2006). *Production Potentiality of Summer Tomato in Jamalpur Region*. Int. J. Sustain. Crop Prod. 1(2): 12-15.

Zaman, M., Hemel, R. A., & Ferdous, T. (2010). Comparative Profitability of Winter Vegetables in a Selected Area of Dhaka District, ASA University Review, Vol. 4 No. 1 January-June, 2010.