AN ECONOMIC ANALYSIS OF TUNNEL TOMATO FARMING IN CHANDRAGIRI MUNICIPALITY, KATHMANDU

A Thesis

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By

SHYAM KUMAR PAL

Campus Roll No.: 398/072

TU Registration Number: 6-3-22-1179-2015

Patan Multiple Campus, Patandhoka

Lalitpur, Nepal

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DECLARATION

I hereby declare that this Master's Degree thesis entitled AN ECONOMIC ANALYSIS OF TUNNEL TOMATO FARMING IN CHANDRAGIRI MUNICIPALITY, KATHMANDU submitted to the Department of Economics, Patan Multiple Campus, Tribhuvan University, is entirely my independent work prepared under the supervision of my supervisor. I have made due acknowledgment to all ideas and information borrowed from different sources while writing this thesis. The result of this thesis has not been presented or submitted anywhere else for the award of any degree or for any other purpose. No part of the contents of this thesis has ever been published in any form before. I shall be solely responsible if any evidence is found against my declaration.

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Shyam Kumar Pal

June 2022

LETTER OF RECOMMENDATION

This thesis entitled AN ECONOMIC ANALYSIS OF TUNNEL TOMATO FARMING IN CHANDRAGIRI MUNICIPALITY, KATHMANDU has been prepared by SHYAM KUMAR PAL under my supervision and guidance. I hereby recommend it in partial fulfillment of the requirements for the degree of MASTER OF ARTS in ECONOMICS for final examination.

……..

Chakra Bahadur Khadka, Ph.D.
Thesis Supervisor
Department of Economics
Patan Multiple Campus

LETTER OF APPROVAL

We certify that this thesis entitled AN ECONOMIC ANALYSIS OF TUNNEL TOMATO FARMING IN CHANDRAGIRI MUNICIPALITY, KATHMANDU submitted by Mr. SHYAM KUMAR PAL to the Department of Economics, Faculty of Humanities and Social Science, Patan Multiple Campus, Tribhuvan University in partial fulfillment of the requirement for the degree of MASTER of ARTS in Economics has been found satisfactory in scope and quality. Therefore, we accept this thesis as a part of the aforementioned degree.

Thesis Committee

…….
Lecturer Chakra Bahadur Khadka, Ph.D.
Thesis Supervisor

……..
Associate Professor Yogesh Ranjit, Ph.D.
External Examiner

……
Associate Professor Raghu Bir Bista, Ph.D.
Head of Department

Date: ……..

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Shyam Kumar Pal
Department of Economics
Patan Multiple Campus
Patan Dhoka, Lalitpur

ABSTRACT

Agriculture is a major sub-sector of the Nepalese economy where 60.4 percent of the population are engaged producing varied fruits, crops, and vegetables throughout the year. Tomato cultivation is one of the most profitable and feasible crops to improve farmers' socio-economic conditions and, about 21747 hectares of land is used to produce 413761 metric tons of tomatoes annually in Nepal.

This study was conducted on order to analyze the tomato production and its market trend; to examine the cost benefit involved in tunnel farming of tomato; and to estimate the production function of tomato farming. The data was collected from 170 farmers involved in tomato farming in the Chandragiri municipality of Kathmandu district. using structured questionnaire. Three major cost components were taken, namely, total capital cost, total labour cost and total productivity cost. Net benefit per Ropani of land per year was calculated to examine the profitability of the tomato farming. Linear regression model by using Cobb Douglas production function was used where the variables are expressed in logarithmic form. The dependent variable is production output of tomato farming and independent variables are the total capital cost, total labour cost and total productivity cost.

The results found that have not acquired the training for the farming as very few farmers are trained. Market price of tomato for farmers is determined by demand and supply of tomato in Kalimati vegetable market. Most of the farmers wanted assurance of stable selling price of tomato. There is very high fluctuation in selling price (Min Rs.5/kg and Max Rs.130/kg) of tomato. Average capital expense, productivity resource cost, labour cost, total cost of farmers during a year were found to be Rs. 128.5 thousand, Rs. 84.4 Rs. 138.8 and Rs.351.7 thousand per Ropani per year respectively. Average gross revenue per year is Rs.362.2 thousand per Ropani and average net benefit was Rs.10.5 thousand per Ropani per year. The coefficient of the total capital cost, total productivity resource cost and total labour cost in linear regression model in determining total production of tomato were 0.360, 0.311 and 0.256 respectively and statistically significant.

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ABBREVIATIONS

BCR	Benefit Cost Ratio
CBS	Central Bureau of Statistics
CV	Coefficient of Variation
GDP	Gross Domestic Product
ha	hectare
INGOs	International Government Organizations
K	Capital Cost
kg	Kilogram
L	Labor Cost
Max	Maximum
Min	Minimum
MOALD	Ministry of Agricultural Livestock and Development
MOF	Ministry of Finance
MOI	Ministry of industry
NGOs	National Government Organizations
P	Productivity resource Cost
Rs.	Rupee
SPSS	Statistical Package for Social Science
UVA	Ultraviolet radiation

CHAPTER I

INTRODUCTION

1.1 Background of the Study

Agriculture is a major sub-sector of the Nepalese economy for livelihood, employment, economic and social transformation. Agriculture, forest, and fisheries contributed 25.8 percent to GDP and was estimated to increase despite the spread of the Covid-19 pandemic (MoF, 2021) and 60.4 percent of the population was engaged in the agriculture sector (ibid). The total cultivated land was 309100 hectares which is 21 percent of the total area of Nepal (MoALD, 2021). Due to diverse Agro-ecological conditions, Nepal has the geographical advantage for producing varied vegetables throughout the year (ibid).

Vegetable crops are more profitable than grain crops as it requires less land and time to yield market sellable products (Katovich & Sharma, 2014). Both seasonal and off-seasonal vegetables have been considered high-value crops as there is always higher market demand and logically high demand results increase in the price of the product. This benefits both producers as well as the market. An increasing number of populations are attracted to the commercial production of fresh vegetables.

Off-seasonal vegetables have emerged as an important source of income and an effective means of poverty reduction in Nepal. The increasing consumption volume of vegetables in the country, and in adjoining cities of India are creating market opportunities to vegetable farmers which means employment, reliable source of livelihood and capital creation. It has been a reliable source of regular employment and income for many marginal farmers. The government has formulated many programs and policies for off-seasonal vegetable production and aims to improve food self-sufficiency and reduce poverty through the commercialization of agriculture (Pokharel, 2021).

In the fiscal year 2020/21, the production of vegetables is estimated to be increased by 5.9 percent to 4.2 million metric tons compared to the production of fiscal year 2019/20. The contribution of vegetables is 17.2 percent and cash crop is 14.7 percent to total agriculture crops production during the period (MoF, 2021).

Tomato is second most important vegetable after cauliflower in terms of area of land used for cultivation, and volume of production in Nepal. It is cultivated in about 21747 hectares (ha) in Nepal and 413761 metric tons of tomatoes are produced annually (MoALD, 2021). Tomato is one of the most important vegetables with very high market demand. Open field (traditional) cultivation during the Autumn-Winter season is a very common practice in Nepal (ibid). The cultivation of tomatoes during offseason has been gaining popularity as it fetches more price than the seasonal production of tomatoes. Tomatoes are grown mostly as winter crops in plain region and as spring crops in mid-hill. The gradual increase in year-round demand for tomatoes for fresh consumption and industrial processing resulting from urbanization, hotels, tourism, nutritional awareness of the people, etc. are making the avenue for off-seasonal production (Kafle & Kumar 2017). Tomato cultivation is one of the most profitable and feasible crops to improve farmers' socio-economic conditions (Pokharel, 2021; Bashyal, et al, 2019).

The increase in temperature during the summer season and fog with prolonged low temperature during the winter season affects the commercial cultivation of tomato growth and unsustainable situation for farmers (KC et al, 2021). Cultivation in an open-field has become a challenge to farmer than before. Tomato is a warm-season crop and cannot stand severe frost. Geographically, the crop (tomato) grows at a temperature ranging from 18-27 degrees (Bhandari et al, 2021). In Kathmandu, the open-field (traditional) tomato production runs during the Autumn-Winter season but the demand for tomato is consistently increasing creating a huge supply deficit (MoALD, 2021). This has required the country to import a substantial quantity of tomatoes to meet the country's demand, especially from India and China (ibid). These climatic conditions prompted exploring other farming systems for tomato production to keep up with the increasing demand and tunnel technology was introduced in 1996 by the regional agriculture research station –Lumle in Nepal and subsequently, the government of Nepal, in support of commercial vegetable farming, initiated tunnel technology for tomato production in Kathmandu by providing training to facilitate the rollout of the technology (KC et al, 2021).

The tunnel farming system is a simple and low-cost practice that controls the micro climate surrounding and reduces the impact of the fluctuation in temperature. The main benefit of the cultivation of tomatoes under plastic tunnels is that it is an easy technique

to produce quality products in large quantities during the off-season and farmers get premium price for their harvest.

1.2 Statement of the Problem

In vegetable farming, tomato cultivation has been very crucial for increasing the productivity and income of farmers (Pokharel, 2021; Basyal, Khanal & Dhakal, 2019). Although there are benefits associated with tunnel technology and the establishment of a protected farming incubator for tomato production started by the government twenty-six years ago, there is still very low adoption of the technology. Despite the promotion and adoption, there is no evidence that the technology has been beneficial for smallholder farmers or not (KC et al, 2021). This has resulted sluggishness in tomato value chain development and bloated the import of fresh tomatoes-associated products. This drains foreign exchange reserve and negates effort/investments of government to diversify the cash crops vegetable farming subsectors and its huge investment into the cash crop vegetable farming sub-sector.

Tomato farming is big part of farming system and major source of cash income and livelihood for households in Kathmandu and on other side, there is lack of optimum production of tomato in Kathmandu (Pokhrel, 2021). Tomato cultivation has helped to improve the socio-economic status of farmers (MoALD, 2021). During 2020-21, the production of tomato was in increasing trend, securing the status of major cash crops vegetable in Nepal (MoF, 21). Shrestha et al (2018) stressed that the commercial vegetable farming in Kathmandu as well as in Nepal has been increasing in trend. Due to the profitability of the vegetable farming in Nepal and in urban area like Kathmandu, farmers are attracted to the commercial vegetable production (Shrestha et al, 2014).

The twenty-year (2015-2035) Agriculture Development Strategy has envisioned value chain development framework as the driving wheel for sustainable growth in agriculture (Paudel & Adhikari, 2021). Different studies on tomato vegetable production have revealed the benefit exceeded over the cost but there is not enough evidence to describe whether the studies are enough to justify the statements. As there are scanty studies investigating the cost benefits, awareness, and adoption of the technologies at the farm level, this study specifically intended to focus on cost-benefits analysis of tunnel tomato farm.

The study, therefore, investigates about cost-benefits analysis of tunnel tomato farming. This study's finding will aid in refocusing of required policy and research which is consistent with the key development strategy; the smart agriculture program, to achieve sustainable agriculture development. In addition, the finding will assist in bridging the huge information gap associated with tunnel farming in the Kathmandu district which can reflect situation of all others places of Nepal.

In this light this study has tried to answer the following questions.

- What is the tomato production and its current market trend?
- What are the costs, benefits in tunnel tomato farming of tomato?
- What is the nature of the production function of tomato farming?

1.3 Objectives of the Study

The objective of this study is to examine the cost-benefit analysis of tunnel tomato farming in Chandragiri municipality, Kathmandu. Specific objectives are:

- To analyze the tomato production and its market trend
- To examine the cost-benefit analysis of tunnel farming of tomato
- To estimate the production function of tomato farming.

1.4 Significance of the Study

Agriculture is a major sub-sector of the Nepalese economy and tomato is one of the most important cash crops (MoF 2021). So, the study regarding the cost-benefit of tunnel tomato farming is very necessary. Thus, cost-benefit analysis of tunnel tomato farming in Chandragiri municipality, Kathmandu will be beneficial to different stakeholders like farmers for farming, investors for their investment decision, bankers as an investor, researchers (academicians), policymakers to form policy, consumers to know the real cost, government for subsidy, NGOs, INGOs, competitors, vegetable traders, economists for further analysis, and students for further study and other stakeholders who are involved directly or indirectly in farming.

1.5 Limitations of the Study

Every research may not be free from its limitations. The study is subjected to the following limitations:

- The study may not represent the tomato farming of rural areas and nation.

- This study is based on primary data derived and based on the responses given by the respondent. So, reliability depends on the responses of the of the participants.
- The study examined only the financial cost and benefits of tomato tunnel farming rather than economic cost or benefits.

1.6 Organizations of the Study

The entire study is organized as follows:

Chapter 1: Introduction

This chapter deals with the background of the study, statement of the problem, objectives of the study, significance of the study, limitations of the study and organization of the study.

Chapter 2: Review of literature

This chapter deals with the review of literatures related to tomato as well as the other vegetable production in national and international context. This chapter contains the review of empirical research analyzing the costs, benefits, and the profitability of various vegetable farming. The reviews of the literature are arranged in chronological order.

Chapter 3: Research methodology

This chapter gives the answer of the questions about how the research will be conducted. It includes the conceptual framework, research design, nature and source of data, population and sampling of data, data collection procedure/methods, data processing, data analysis tools and techniques and empirical model.

Chapter 4: Data presentation and analysis

This part is regarded as the main body of the research. This chapter includes the overall descriptions of the study area which provides the presentation of collected data, population, sample, sampling procedure, tools and method of data collection and analysis of them by using various statistical as well as financial tools. The research design has been formulated according to the objectives of the study.

Chapter 5: Summary, conclusion, and recommendations

This chapter contains summary of overall findings, conclusions, recommendations, and further suggestions which is made based on the whole study.

CHAPTER II

REVIEW OF LITERATURE

2.1 Introduction

The review of literature will highlight the existing literature and helps to find the research gap. This section consists of relevant and existing literature on cost-benefit analysis of tunnel tomato farming both in the context of national and international data. In this section review of articles, journals and dissertations that were published in different mediums like newspapers, online portals and journals are included.

2.2 Review of Related Literature

2.2.1 International Context

Badimo (2020) analyzed constraints and the factors influencing adoption of high tunnels for tomato production in Botswana. The study was conducted in North-East district of Botswana and the data was collected from 116 farmers involved in horticulture business and some key informants. Semi-structured questionnaire was used to collect the information from the respondents. Stratified random sampling technique was used to select the respondents. Among 16 farmers, 85 were non-adopter of tunnel while remaining 31 were tunnel adopter. Probit regression model was used in the study to analyze the factors that affect the adoption of tunnel technology in the study area. In the regression model adoption of high tunnel was taken as dependent variable while farm size, market distance, occupation of farmer, access to credit, access to extension, farmer's experience and age of farmer were taken as independent variables. The regression results showed that farm size, farm experience, extension services were statistically significant variables that influence the adoption of high tunnel technology. Farm size and extension service had positive effect on the adoption of high tunnel while experience of farmer had negative effect on adoption of high tunnel. The results of the study showed that high cost of tunnel, inadequate knowledge, inadequate capital, insufficient markets were the major constraints in adoption of high tunnel.

Ernst (2020) analyzed the economics of high tunnel. The author claimed that high productivity in high tunnel as compared to the traditional field leading to the high profitability. The author also claimed that the profitability of the high tunnel agriculture depends on price of the products. The author stressed that, as based on the history of

Kentucky, USA, those products had to be sold at steady and premium prices to meet all the costs of production. The author also performed sensitivity analysis to compare the all the scenarios that might impact on the overall profitability of a firm. The author had assumed that a farmer would spend 40 hours in panning and managing high tunnel production. By this assumption, the profitability per hour was negative at $1.5 retail price if the production was less than 2000 pounds while the profitability per hour was increased if the production was increased beyond 2000 pounds. Similarly, if the retail price was $ 1.75, the production should be more than 1800 pounds. The profitability was gradually increased if the price and production were gradually increased. The author also stressed on the difference on the cost of construction of high tunnel as tunnel may need extensive grading, drainage, and heaters. The labour cost might also vary according to the need of high tunnel, and different types of crops.

Khan and Khan (2020) studied the role of tunnel farming on the productivity of off-season vegetables and farmers' income and overall profitability. The major crops considered in the study were tomato, cucumber, and bottle gourd. The study was conducted in sex villages of Peshawar. Data was collected from the farmers who were involved in tunnel farming of off-season vegetables as well as those who were not involved in tunnel farming by using questionnaire. 64 farmers were selected for the data collection randomly. The research found that the farm productivity of tomato, cucumber, and bottle gourd per acre of land were significantly increased in tunnel farming as compared to the without tunnel. Similarly, the revenue of the tomato, cucumber and bottle gourd were significantly increased in tunnel farming as compared to without tunnel farming. The study found that the net revenue of the farmers in these crops were significantly increased in tunnel farming as compared to non-tunnel. The benefit cost ratio revealed that there are increased benefits in tunnel farming as compared to the non-tunnel. The study concluded that the tunnel has positively impacted in the livelihood of the local farmers who were involved in the tunnel farming.

Lopez-Marin et al (2019) analyzed the cost benefit of tomato crops under different greenhouse covers in Torre Blanca, Spain. Six different greenhouse covers were used for the purpose of the study. Kyoto model tunnel greenhouse were used for the study. The types of cover used were long duration experimental, thermal polyethylene commercial, ultraviolet A 100 percent experimental, anti-thermal, long duration commercial and ultraviolet A 90 percent experimental. Each cover had three blocks and

15 plants and tomatoes were harvested in the optimum collection time and classified as commercial and non-commercial with different calibers. The discount rate of 4.26 percent was used to calculate the net present value. The study showed that the different caliber tomato had different prices. The results showed that highest net value for ultraviolet A 100 percent experimental followed by ultraviolet A 90 percent experimental. The long duration experimental cover had the lowest net value.

Moranga (2016) analyzed the factors influencing tomato farmers' willingness to adopt innovative approaches for the management of climate change effects in Kenya. The study was conducted in Taita County which is the coastal region of Kenya. Multinomial Logit regression model was used to analyze the effect of different independent variables on the willingness to adopt the innovative timing approaches. The three timing approaches taken for the study were off-season production, transportation of products during cool periods of the day and processing of tomatoes to extend shelf life. The independent variables taken for the study were gender of the respondent, access to extension services, access to credit, group membership, age of the respondent and income of the respondent. Semi-structured questionnaire was used to collect the information from 196 respondents. The results of the study showed that the farmers were coping with the climate changes. The multinomial regression showed that gender, access to credit, group membership, age and income were the factors that affect the farmers' willingness to adopt the innovate timing approaches.

SMEDA (2016) examined the feasibility condition of off-season vegetable farming using high tunnel. The study consisted of vegetables as tomato, sweet pepper, and cucumber. The time of tomato production was about 7 months. For the experiment, 10,000 tomato pants, 15,000 sweet pepper and 15,000 cucumber plants were planted. The estimated produce of the experiment was 50 tons of tomato, 20 tins of sweet pepper and 45 tons of cucumber excluding wastage. The internal rate of return was found to 64 percent which was way more than the market rate of interest. The payback of high tunnel farming was only 1.67 years and net present value of the farming was found to be Prs. 13,671,302, though authors had discussed about the variability of profitability due to practical knowledge possess by farmer, selection of land, selection of high yield seed, cultivation, and selection of right time. The author had discussed about the requirement of the project such as project financing, project cost, land, machinery and

equipment, furniture and fixture, structure requirement, raw materials, human resources.

Duhan (2016) analyzed the cost and benefits incurred in tomato production in protected and open farm. The study used primary as well secondary data. 20 farmers for each poly house and open farm were interviewed using structured questionnaire. The research was conducted in Sonipat district, Haryana. In polyhouse farming as well open farm, labour cost was highest among other types of cost. But the cost of polyhouse was seemed to be higher than the open farm. The total revenue per acre of land in poly house was also higher for polyhouse than open farm leading to the higher net benefit in polyhouse technique than open farm. The researcher had also estimated the net benefit for 5 years including the installment cost for polyhouse which seemed to be higher for the polyhouse than the open farm. The reduction of water amount and chemical. Multiple cropping, production of high quality of vegetables, possibility of production in high altitudes were the major benefits of poly house. However, there were some limitations of this technology such as unsubsidized polyhouse might lead farmer to the loss, lack of huge demand, vulnerability of polyhouse to fire and animal attack.

2.2.2 National Context

Acharya and Dhungel (2021) examined the cost and benefit analysis of mushroom farming in Nepal. The study was conducted in Balambu, Matatirtha and Thankot areas of Chandragiri municipality. Out of 90 mushroom farming existing in Chandragiri municipality, 33 farmers, i.e., 11 from Balambu, Matatirtha and Thankot were interviewed using structured questionnaire and observation. The authors also compared the national and international data with their data for consistency. Secondary data were collected form Central Bureau of Statistics. The total cost included fixed cost and variable cost. The costs considered by the study were tunnel construction, irrigation management, land leased, depreciation of equipment, labor cost, ball preparation, use of pesticide, transportation cost, fire wood, plastic, lime, seeds, and boiling drum. Net benefit and benefit cost ratio were calculated to analyze the profitability in the mushroom farming. The study found that the net benefit in the study area was found to be NPR 67,962 and benefit cost ratio was 1.14 in the study period. This showed that total revenue exceeded over the cost of production. The study showed that the cost of production of mushroom was NPR 87 per kg and the market price of the mushroom

was NPR 100 per kg showing the profit of NPR 13 per kg. The study also found that the market price might sometime decrease and reached to NPR 80 per kg. The breakeven point of the mushroom farming was found to be 692 kg of mushroom.

KC et al (2021) examined the effects of tunnel technology on crop productivity and livelihood of smallholders farmers in Nepal. The study was conducted in 2019 in the areas of Tokha municipality, Mahalaxmi municipality and Suryabinayak municipality of Bagmati province of Nepal. 154 households were selected purposively where 62 were tunnel adopters while remaining 92 were non-adopters. Only the small farmers having farms less than 1 hectare and tunnel crops more than 80- 90 percent of the total farmland were selected for the study. This was done to assess the impact of tunnel technology in reality. For the non-adopters, the small farmers having less than 1 hectare farmland were selected. This was done purposively by the researchers to match the adopter and non-adopter groups. Semi-structured questionnaire was used in the study to collect the data. Focus group discussion was conducted with experts, key informants to prepare the questionnaire to include all the possible variables of costs and benefits. The study found that tunnel adopters grew tomatoes for one cropping cycle that lasts for 9 to 10 months while it was 4 to 5 months for non-adopters. Probit regression model was used to analyze the impact of different variables on the adoption of tunnel technology by the farmers. Also, the researchers used treatment model and ordinary least square (OLS) regression examine tunnel technology's effect. The study found that the cost of production of crops as well as crop productivity per hectare of land was higher for tunnel technology adopters than the non-adopters. This gave the increased net income per hectare for the tunnel technology adopters. The probit model showed that farmers from Dalit groups were less likely to adopt tunnel technology. Higher educated farmers were more likely to adopt the tunnel technology. Farm size and neighbor influence had positive effect on the adoption of tunnel technology. While aged farmers were less likely to adopt the tunnel technology. Treatment and linear regression model showed that tunnel technology had impact on the crop productivity as well as net income.

Parajuli et al. (2021) examined the viable option for food security and agricultural sustainability. The researchers reviewed organic agriculture in Nepal exploring past literatures. The researchers focused on the organic farming and agriculture to promote the integrated livestock culture of Nepalese society. The researchers argued that organic

farming reduces the cost of agricultural production and, also improves the soil health and fertility. Furthermore, the researchers reviewed that there was positive relationship between organic farming and food security. The authors claimed that various forms of organic agriculture could be implemented to control the pest and thus leading less impact to the environment. The researchers also emphasized that the Nepalese society were practicing the traditional agriculture focusing on the use of local resources as well as it was free of chemical fertilizers. Government of Nepal has also promoted the organic farming from the 10^{th} five years plan. The researchers elaborated that organic agriculture is better than traditional agriculture in terms of direct energy consumption and indirect energy consumption. The authors further explained that conventional agriculture method leads to loss of ecosystem resilience, biodiversity loss, pest resurgence and resistance, bioaccumulation and bio magnifications of the pesticides, and food contaminations.

Pokharel (2021) assessed the economics of offseason tomato production in Kathmandu, Nepal including costs and returns of tomato production using tunnel technology, marketing channel of offseason tomato production and identification of problems in the adoption of tunnel technology. Primary data was collected using telephone form 30 offseason tomato cultivators from 80 cultivators. The tomato cultivators were from Tokha, Tarkeshwor and Budhanilkantha municipalities of Kathmandu district. The data of tomato cultivators were taken from Agriculture Knowledge Centre of Kathmandu district and simple random sampling method was used to select the sample from the population. Benefit cost ratio was used to analyze the profitability of the business. The results showed that the positive net benefit with benefit cost ratio of 2.15 which meant that the benefit is 2.15 times of the cost. Most of the farmers used to sell the products in the local market followed by the purchase by traders or middle person. Most of the producer used to sell the product according to the market price while few used to sell according to the agreement between the buyer and seller. The results also showed that most of the farmers followed producer-wholesaler-retailer-consumer channel for selling followed by producer-middle man-wholesaler-retailer-consumer. The respondents in the study also revealed that comparative advantage from different marketing channel was easier way of selling the product in the market. The most problems faced by the farmers was transportation of output. Most of the farmers expected the technological knowledge from technician and local government.

CASA (2020) explored the vegetable sector strategy in Nepal. The study was conducted in Bagmati and Gandaki Provinces of Nepal. The study revealed that farmers in Nepal were diversifying the crops in search of better profits. Over 3.2 million of households were cultivating vegetables which contributed 9.7 percent of the Nepal's GDP in the study year. Vegetable cultivation was dominated by small scale production units. The researchers also found that major drivers in the vegetable cultivation commercialization were favorable climatic growing conditions, expanded road access, increasing involvement of the private sector and cooperatives, greater government interest, buoyant domestic demand and increasing competitiveness against imports. Though there was increasing trend in commercialization, Nepal remained importer. The study revealed that vegetable sector had problem in both demand and supply side. Low productivity, poor market access, high post-harvest loss were major problems in supply side. Acute lack of timely market information, limited avenues to sell the products beyond local middlepersons were causes for weak market orientation of small farmers. Lack of storage facilities in market, weak farmer organizations, limited access to finance were some problems in market side. The authors suggested the strategy for accelerating commercialization of vegetables sector by strengthening organization, improving small and medium enterprises to investment opportunities, promoting innovation and technology, and improving post-harvest management practices.

Acharya (2019) studied the status, scope, and obstacles of organic farming in Kathmandu, Nepal. The data were taken from Tarkeshshwor, Budhanilkantha, Tokha and Chandragiri municipalities of Kathmandu district. The study showed that organic farming was not old as it was started not so longer, most of farmers started after training provided by Ministry of Agriculture. Mostly female were found to be engaged in organic farming. Organic farming consisted of mostly vegetables such as tomato, cucumber, pumpkin, pea which were sold in five-star hotels and supermarkets. Small farmers tended to sell their product through middleperson. The consumers were willing to pay more for organic product due to awareness in health issues. The researcher found that there was misconception in organic farming and organic products. Many of the farms used intermediate method where chemical pesticides were also used. Only few farmers used organic way of pest control. Also, farmer used organic farming due to lack of finance to buy chemicals. Lack of understanding among farmers, land fragmentation,

political instability, low seed quality and poor irrigation facilities were limitations of the organic farming in Kathmandu valley.

Bashyal et al (2019) analyzed the socioeconomic status of farmers involved in tomato farming in Lamahi, Dang, Nepal. 60 households were selected for the collection of information using simple random technique while Lamahi municipality was selected on purpose as most of the people in this municipality were involved in the agriculture. 2 wards of this municipality were selected for the study. The study revealed that the major source of income was agriculture for them. The highest cost for tomato cultivation was found to be land preparation cost, followed by harvesting cost, plant protection cost, seed cost, irrigation cost and fertilizer cost. The average production of tomato was found to be 32.51 quintals and 14.67 quintals in 2 wards. The average income was found to be Rs 93296.67 and Rs 40715 per household in these 2 wards. The average cost of production was found to be Rs 23149.70 and Rs 12021.30 per household in these 2 wards. Benefits cost ratio was found to be 4.03 and 3.38 per household.

Dhakal et al (2019) analyzed the cost benefit of rice production system in different agriculture landscapes. The researcher also examined the resource use efficiency of rice production systems. 102 rice farmers were surveyed for the study out of 600 farmers of Chitwan district. Only those farmers having farm size less than 0.5 hectares were surveyed. The farmers were from hilly as well as plain areas. Semi structured questionnaire was used to collect the information from the farmers. Cobb Douglas production function was used for the estimation of rice production. The results of study showed that use of inputs like seeds, chemical fertilizers and tractor were significantly greater in plain areas while use of labor, farmyard manure and bullocks were significantly greater in hilly areas. The study also showed that costs of fertilizer, machinery, pesticide, and transportation were found higher in the plain area while costs of seed, labor and bullocks were significantly higher in the hilly area. The results showed that production of rice was 2.8 ton per household and productivity was 5.2 ton per hectare with benefit cost ratio of 1.6 in plain area. However, in the hilly areas, production of rice was 0.9 ton per household and productivity was 3.3 ton per hectare with benefit cost ratio of 1.2. The results of regression showed that machinery and bullocks, cost of pesticides, transportation were significant variables in determining the return in rice cropping system in Chitwan. Machinery and bullocks as well as

transportation had positive effect on gross return while cost of pesticides had negative effect on gross return.

Rai et al (2019) analyzed the constraints and opportunities of vegetable farmers in Kirtipur, Nepal by taking the sample of 80 farm households from 242 vegetable farmers purposively. Semi-structured questionnaire was used to collect the data. 20 key informants were interviewed to collect the information of opportunities and constraints faced by the farmers. The results showed that most of the households had leasehold farmland out of which just 64 percent had contracted legally. The average cultivated land was found to be 5.7 Ropani with tomatoes and mushrooms as major vegetable product. Cauliflower and green leafy vegetables were secondary vegetables grown in the area. For the irrigation, dug well were used. Only 42 percent of farmers had associations and only 37 percent had basic training on vegetable training. Most of the farmer used to save from the sale of the products. Price fluctuation, middleman margins, delay in payment by contractors, vegetable disease, inadequate supply of seeds, were the constraints faced by the farmers. Self-employment generation, growing market demand were the opportunities created by vegetable farming.

Amatya et al (2018) analyzed the participatory market chain for full range of agroforestry products by taking sampling of 6 from 2 districts of Nepal namely, Kavrepalanchowk and Lamjung. 80 persons from different institutions were interviewed to collect the information. Information on agroforestry products were collected by participatory rural appraisal tools through field survey. 14 agroforestry products in Lamjung and 20 in Kavrepalanchowk were selected for the analysis. commodity selection process was conducted to identify the most promising options which included focus group discussion which had the criteria of market and market demand, economy of scale and outreach, high value, stakeholders' interest and commitment, coordination, short turnover, and leverage. Second step was determination of weightage percentage. Market and market demand was given more weightage than others. The third step was to assess the commodities according to each criterion. From the study, buffalo milk, goat meat, banana, tomato, cardamom, ginger, and round chilies had the highest score than other commodities. The research pointed out producers, collectors, retailers, and cooperatives were major actors in the market chain in the study area. The results showed that major constraints to the effective and

efficient market chain development and management were the small-scale production and insufficient service to farmers.

Paudel and Adhikari (2018) analyzed the tomato farming under different production system in Dhading district in Nepal. 77 respondents were selected from different level of actors of tomato value chain. The study was conducted in 6 villages of Dhading district. 52 producers, 10 collectors, 5 wholesalers and 10 retailers were interviewed. Total cost was classified as fixed cost and variable cost. Fixed cost included cost of irrigation equipment, pipes, crates, sprayers, depreciation of tunnel and interest on the loan. Benefit cost ratio was calculated to examine the profitability of tomato farming. Marketing efficiency was also calculated which was computed as the ratio of net price received by farmer to the sum of marking cost and margin of the intermediaries. The average cost of tomato production in tunnel in off-season was Rs. 21.73 per kg while it was Rs. 15.52 per kg open field in off-season. But it was only Rs. 9.76 per kg in open field in season. The productivity of tomato in tunnel was found to be higher than the open field in off-season. But the benefit cost ratio was found to be higher for open field in off-season rather than open field main season and tunnel off-season. The marketing efficiency was found to be higher for tunnel off-season. Lack of suitable transportation facility to the market, lack of market information about price and volume, lack of market facilities at the market center, distant market center for sale were the major constraints faced by the actors involved in tomato farming.

Shrestha et al (2018) analyzed the performance of tomato with organic manures produces in plastic tunnel. For the study, a field experiment in plastic tunnel was conducted in Khumaltar, Horticulture Research Division, Lalitpur for 2 consecutive years. A tomato hybrid named Srijana was selected for the study. Data was collected on yield and yield attributes of tomato. 8 treatments were used as randomized design and replicated 3 times. Soil samples were also taken before plantation and after harvest of tomato to analyze the available nutrients in the soil. The results of the study showed that there was positive relationship between plant height and yield of tomato. The results also showed that mixture of compost dose of 12.5 ton per hectare with half dose of chemical fertilizers was best among the 8 treatments followed by 15 tons per hectare of compost manure with cattle urine. Benefit cost ration shows that 12.5 ton per hectare of compost manure with half dose of chemical fertilizer had produced highest benefit cost ratio among 8 treatments but none of the ratios showed that benefit exceeded the

cost. Same treatment was found to be have least change in organic matter, nitrogen, phosphorus, and potassium level percent before and after the harvest.

Kafle and Shrestha (2017) analyzed the cost of the construction of plastic house and income from the off-season tomato cultivation and scope for production and marketing system and challenges in the tunnel farming of tomato. The study was conducted in Hemja VDC of Kaski district. Out of 75 farmers, 25 farmers were selected purposively. 5 tomato retailers selected for the tomato market price survey. Semi-structured questionnaire was used to collect the data. The results showed that the cost of installing plastic house of standard size was Rs. 28,515 and 3 such plastic house could be installed in 1 Ropani land. Such house could be used up to 4 years and cost of maintenance was Rs. 13,665 per Ropani from the second year. The cost of cultivation of tomato was found to be Rs. 28, 962 per Ropani excluding land rent. The average gross income of the tomato farming for 4 years was found to be Rs 1.08 lakh. The income from the tomato farming seemed to be decreasing for the succeeding year. Benefit cost ratio showed that the it was on loss in first year while it was profitable in the following years. Lack of quality of seeds, disease, pest infection, loan facility and lack of technical knowledge were the major production problem in plastic house tomato farming. Similarly, price variation, trader's monopoly in price fixation, lack of market price information, lack of quality packaging and lack of organized market were the major market problems.

Bhandari et al (2016) analyzed the demand and supply situation of tomato in Nepal. The authors also examined the scenario of market dynamics of tomato and tomato products; identified the actors, stakeholders and institutions involved in tomato value chain; identified the major constraints hindering development of tomato value chain. Both primary and secondary data were used for the study. For the primary data, purposive sampling technique was used to select the sites from Lalitpur, Dhading, Lamjung, Illam, Dhanusa. The results of the study showed that productivity of the tomato in Nepal was increasing yearly as from the fiscal year 1991/92 to 2013/14. The comparative analysis showed that the yield of tomato was increased in hilly area rather than mountains and terai, though the productivity was higher in Terai region. The results also showed that the purchase of tomato was far greater than the production in Nepal. The demand for tomato was increasing yearly. Only 27 ton was exported to India while 8,006 ton was imported from India in the fiscal year 2012/13. The trend of tomato

import was increasing for the study period. For the trade of tomato, most of the trade flow was grower to village level collector to district level wholesaler to traders. Initial investment in tunnel was the major cost of production of tomato. Average farm price for tomato was found to be Rs. 20.25 per kg and Rs. 2.75 per kg was the additional cost for collection, packaging, storage, and transportation. The average price to wholesalers was Rs. 28 per kg and average retail price was Rs 42 per kg. Intermediaries were found to earn more than growers. The benefit cost ratio was found to be 3 on an average of 5 sampled districts.

Magar et al (2016) studied hybrid tomato named Srijana and its development in Nepal. The study used both qualitative and quantitative research methods. The study was conducted in 2014/15 and 2015/16. In 2014/15, assessment of the seed value chain of Srijana hybrid tomato was conducted and in the second year, the study on adoption and economics of tomato farming was done. To examine the value chain of seed, study was conducted in Kathmandu, Kavrepalanchowk, Nuwakot, Dolakha and Kaski. A survey was conducted with 30 agro-vets involved in marketing of Srijana seed and 30 commercial tomato farmers. Based on the volume, one district from terai, two districts from Kathmandu valley, one district from mountain region of eastern, central, and western region were selected. Altogether, 390 farmers were included in the study. The research found that number of actors were involved in production of Srijana tomato seed some of which were privately owned, few are public, one was non-governmental and one was farmer group. The study showed the production of Srijana seed was increasing in trend. Gorkha seed company was the major producing institution. The price of the Srijana seed seemed to be increasing throughout the study year. Collection and packaging of the seed was done by private company while wholesaling was performed by wholesaling agrovets and retailing by retailing agrovets. The final product was exported to India and domestically consumed by the domestic farmers. The marketing margin of the seed seemed to be higher for some companies. Majority of farmers were not satisfied with the price of the seed. The benefit cost ratio of Srijana seed production showed the ratio of 1.96 which meant the benefit exceeded over the cost. The benefit cost ratio of tomato farming was found to be 1.48 in open farm in Terai, 1.50 in plastic house in mid hills, 1.50 in open field in mid hills and 1.22 in mountains in tunnel. Poor technical knowledge, limited availability of quality seed, limited availability of wage laborers and crop damage were some of production

constraints while lack of storage facilities, higher market competition of domestic tomatoes with Indian tomatoes, lower bargaining power of the producers and limited access to motorable roads and market were some marketing constraints.

Bhandari et al (2015) analyzed the cost and profit margin of some major commercial crops like pulse, oilseed, spice. The study was based on the primary data and survey was conducted in 72 districts of Nepal which was selected purposively. The data was collected through structured questionnaire. Cost of production included variable cost including human labor, bullock labor, manures and fertilizers, irrigation, seed, other material inputs, management cost, land lease and interest, while fixed cost included land tax, other tax, depreciation, repairs, and maintenance. The benefit cost ratio of improved main-season lentil in the sampled Terai district was found to be1.66. The benefit cost ratio of local main-season lentil in hill district was found to be 1.82. The benefit cost ratio of improved main-season pigeon pea was 1.59 and that of main season black gram was 1.64. Similarly, the benefit cost ratio of improved main season kidney bean, improved main season snow pea, improved main season cowpea showed that these were profitable to the farmers. Likewise, benefit cost ratio of improved main season mustard, improved main season yellow mustard, improved main season sesame, improved main season chilly, improved main season onion, improved main season garlic, improved main season ginger, turmeric, cardamom, commercial crops showed that these were profitable to the farmers.

Katovich and Sharma (2014) analyzed costs and returns of grains and vegetable crop production in Mid-Western Development Region of Nepal. Cost of production consisted of labor costs, capital costs, costs of credit, opportunity costs of land, and opportunity costs of investment. The results showed that most of the rice produced by the farmers were consumed by themselves while most of the chilies the farmer had produced were sold to the market. The results also showed that the most of the cost incurred in the production of grains and vegetables were covered by labour cost. The results showed that net profit per Ropani of land in tomato production was Rs. 11659 while producing Bitter Gourd generated a profit of Rs. 15189 and chili of Rs. 12852. Least profit was generated by rice.

A matrix of the review of literature is presented in Table 2.1.

Table 2. 1: Review of Related Literature

S. N.	Authors	Objectives	Data	Methodology	Main Finding
1	Acharya and Dhungel (2021)	To analyze cost and benefits of mushroom farming	Primary data by Questionnaire from 90 farmers	Net profit, benefit-cost ratio, and break-even point	Net profit per kg was Rs13, the break-even point was 692 kg of mushroom
2	KC, et al (2021)	To examine the effects of tunnel technology on crop productivity and livelihood of smallholders farmers	Primary data by Questionnaire from 154 farmers, Focus group discussion	Probit regression model,	Dalit groups were less likely to adopt tunnel technology, educated farmers were more likely to adopt the tunnel technology, farm size and neighbor influence had positive effect.
3	Parajuli, et al (2021)	To examine the viable option for food security and agricultural sustainability	Secondary data	Past literature review	An organic farming system is a viable option for food security and agricultural sustainability
4	Pokharel, (2021)	To assess the economics of offseason tomato production	Secondary data (1970/71 to 2015/16)	benefit-cost ratio,	benefit cost ratio of 2.15
5	Badimo (2020)	To analyze constraints and the factors influencing adoption of high tunnels for tomato production	Primary data collected from 116 farmers of Botswana	Probit regression model	farm size, farm experience, extension services influence the adoption of high tunnel technology

6	CASA (2020), UK AID	To explore the vegetable sector strategy	data collected from Bagmati & Gandaki Province of Nepal	descriptive analysis	vegetable sector had problem in both demand and supply side
7	Ernst (2020)	To analyze the economics of high tunnel	Primary data	Comparison of cost and return	Profitability would increase increasing the production beyond 2000 pounds
8	Khan and Khan (2020)	To study the role of tunnel farming on the productivity of off-season vegetables and farmers' income and overall profitability	Primary data using questionnaire from 64 farmers	Comparison of with and without tunnel technology, benefit cost ratio	Tunnel farming contributed to the productivity and revenue of off-season vegetables. Benefits increased for tunnel farming
9	Acharya (2019)	To study the status, scope and obstacles of organic farming in Kathmandu	Primary data using questionnaire	Descriptive statistics	Mostly female were found to be engaged in organic farming, organic farming consisted of mostly vegetables such as tomato, cucumber, consumers were willing to pay more for organic product
10	Bashyal et al (2019)	To analyze the socioeconomic status of farmers involved in tomato farming	Primary data using questionnaire from 60 farmers	Descriptive statistics, Benefits cost ratio	major source of income was agriculture, land preparation cost was highest, positive benefit cost ratios
11	Dhakal et al (2019)	To analyze the cost benefit of rice production system in	Primary data using questionnair	Cobb Douglas production function,	use of inputs like seeds, chemical fertilizers and tractor were significantly greater in plain areas while

		different agriculture landscapes	e from 102 farmers	regression, benefit cost ratio	use of labor, farmyard manure and bullocks were significantly greater in hilly areas, positive benefit cost ratios
12	Lopez-Marin et al (2019)	To analyze the cost benefit of tomato crops under different greenhouse covers	Primary data from experiment	Experiment of six different greenhouse covers	highest net value for ultraviolet A 100 percent experimental followed by ultraviolet A 90 percent experimental
13	Rai et al (2019)	To analyze the constraints and opportunities of vegetable farmers	Primary data using questionnaire from 80 farmers	Descriptive statistics	Price fluctuation, middleman margins, delay in payment by contractors, vegetable disease, inadequate supply of seeds were constraints faced by the farmers
14	Amatya et al (2018)	To analyze the participatory market chain for full range of agroforestry products	Primary data using interview of 80 persons	Descriptive statistics	producers, collectors, retailers, and cooperatives were major actors, small scale production and insufficient service to farmers were constraints
15	Paudel and Adhikari (2018)	To analyze the tomato farming under different production system	Primary data using questionnaire from 77 farmers	Comparison of tunnel and open field, benefit cost ratio	productivity of tomato in tunnel was higher, benefit cost ratio was found to be higher for open field in off-season than open field main season and tunnel off-season
16	Shrestha et al (2018)	To analyze the performance of tomato with organic manures produces in plastic tunnel	a field experiment for 2 consecutive years	Experiment of 8 treatments	positive relationship between plant height and yield of tomato, mixture of compost dose of 12.5 ton per hectare with half dose of chemical fertilizers was best among the 8 treatments

17	Kafle and Shrestha (2017)	To analyze the cost of the construction of plastic house and income from the off-season tomato cultivation	Primary data using questionnaire from 75 farmers	Benefit cost ratio	income from the tomato farming was decreasing for the succeeding year, positive benefit cost ratio
18	Bhandari et al (2016)	To analyze the demand and supply situation of tomato in Nepal	Both primary and secondary data	comparative analysis, benefit cost ratio	productivity of the tomato in Nepal was increasing, the yield of tomato was increased in hilly area than mountains and terai, intermediaries were found to earn more than growers, positive benefit cost ratio
19	Magar et al (2016)	To study hybrid tomato named Srijana and its development in Nepal	Primary data collected from 390 farmers	qualitative and quantitative research methods, benefit cost ratio	Srijana seed was increasing in trend, majority of farmers were not satisfied with the price of the seed, positive benefit cost ratio
20	Moranga (2016)	To analyze the factors influencing tomato farmers' willingness to adopt innovative approaches for the management of climate change effects	Primary data from the three timing approaches from 196 respondents	Multinomial Logit regression model	gender, access to credit, group membership, age and income affect the farmers' willingness to adopt the innovate timing approaches
21	SMEDA (2016)	To examine the feasibility condition of off-season vegetable	Primary data from experiment of different	internal rate of return, net present	Internal rate of return of 64 percent, payback of high tunnel farming was 1.67

		farming using high tunnel	vegetable farming	value, payback period	years, positive net present value
22	Duhan (2016)	To analyze the cost and benefits incurred in tomato production in protected and open farm	Primary from 20 farmers as well secondary data	Comparison between polyhouse and open farm	Cost, revenue and net benefit of polyhouse was higher
23	Bhandari et al (2015)	To analyze the cost and profit margin of some major commercial crops	primary data and survey were conducted in 72 districts	benefit cost ratio	Positive benefit ratios of commercial crops
24	Katovich and Sharma (2014)	To analyze costs and returns of grains and vegetable crop production	primary data	Descriptive statistics	most of the cost incurred in the production of grains and vegetables were covered by labour cost, positive net profit

2.3 Research Gap

Review of literatures related to farming which were carried out by different scholars were performed and very few literatures were found related to tunnel tomato farming. Very few research works have used statistical models and tools to analyze an economic analysis of tunnel tomato farming. Many research papers are used for secondary data so they may not have realistic findings of research work. So, a proper study is required in this very important sector of agro-economy which is being overlooked by the academy as well as the market to date. This study will compensate weakness and incompleteness of previous research works and benefit farmers, policymakers, and academicians. It will be a reliable literature for future researchers for understanding the cost-benefits analysis of tunnel tomato farming and its adoption in Kathmandu.

CHAPTER III

RESEARCH METHODOLOGY

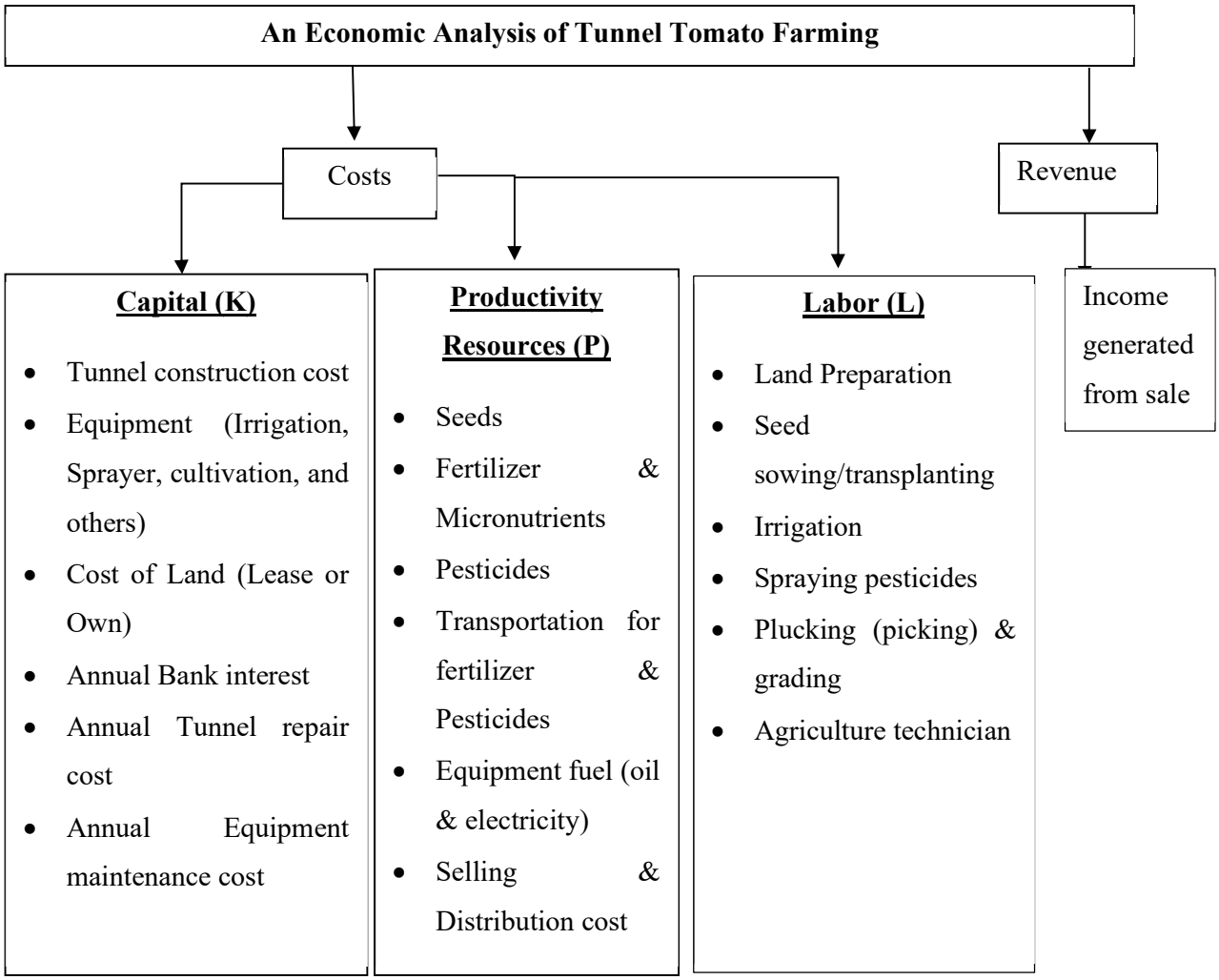
3.1 Conceptual Framework

This section presents theoretical aspect of the study, which includes the concept of an economic analysis tunnel tomato farming. Production can be defined as a process through which a firm transforms input into output. It is a process of creating goods and services with the help of factors of production or inputs for satisfaction of human wants. Transformation of input into output whereby value is added is broadly called production. Whatever is used in the production of a commodity is called input. For example, in the production of tomato, the use of land, seed, fertilizer water, pesticides, tractors, labor etc. are inputs and fruits bore by tomato plant is an output.

Production function also can be written as $Q= f (X_1, X_2, X_3.....X_n)$, where Q is the quantity of output and $X_1, X_2, X_3.....X_n$ are the quantities of inputs (such as capital, labor, land, or raw materials etc.).

On tunnel tomato farming, benefits depend upon cost of farming, selling and distribution. By selling output, farmer will get benefits and can calculate net benefits from tunnel tomato farming. Conceptual framework can be illustrated by below presentation:

Figure 3. 1: Conceptual Framework



Based on the conceptual framework production function can be written as:

$$Q = AK^{\alpha}L^{\beta}P^{\gamma}$$

Were,

Q = Output

A = Efficiency parameter

K = Capital

L = Labor

P = Other productive resource

α, β and ϒ = elasticities of output with respective variables

3.2 Research Design

To perform the study and achieve the desired results, it is important to first coordinate the study procedure with a suitable plan that helps for the study decision and aid in answering the thesis research objectives. On this study, descriptive statistics as well as an economic Analysis are used to examine the research objectives.

3.3 Nature and Source of Data

On this study primary data are used for research. Data was collected through field survey with the help of questionnaire. Other sources such as journals, past research work, related websites, publications made by other related agencies and books written by the various authors were used for conceptual understanding.

3.4 Population and Sampling of Data

As per agriculture department of Chandragiri municipality there are 300 tunnel farmers and most of them are farming tomatoes (Field survey, 2022). For this study, sample size is calculated by following formula:

$$\text{Sample size , } n = N * \frac{\frac{z^2 * p * (1-p)}{e^2}}{[N - 1 + \frac{z^2 * p * (1-p)}{e^2}]}$$

Where:

n = sample size

N = population size

Z = Critical value of the normal distribution at the required confidence level (1.96 at 95 percent)

P = sample proportion

e = margin of error

Based on above sample size calculation formula, 170 farmers have selected as sample for this study. Stratified Judgmental Sampling is used for field survey. 26 respondents were selected from Dahachowk area, 7 selected from Thankot area, 74 were selected from Satungal area, 56 from Balambu area, 5 selected from Naikap area and 1 selected

from Badbhanjyang and 1 from Machhegaun area to fulfill this research objective. The respondents were selected in such a way they were proportional to the population according to the ward.

Table 3. 1: Respondent Residing Ward Number

Ward Number	Frequency	Percent
1	26	15.3
2	1	0.6
3	4	2.4
4	3	1.8
9	1	0.6
10	32	18.8
11	42	24.7
12	56	32.9
13	2	1.2
14	3	1.8
Total	170	100.0

Source: Field survey, 2022

Table 3.1 show the residence of farmers in specific ward number in Chandragiri municipality. Maximum farmers reside in ward number 12 i.e., 32.9 percent and minimum in ward number 2 and ward number 9 i.e., 0.6 percent of respondents. Land nature of ward number 10, 11 & 12 is flat and very suitable for farming so most of farmers are residing in the area i.e., 76.5 percent.

3.5 Tools and Method of Data Collection

The study is mainly based on primary data. Field survey was conducted to collect data from tunnel tomato farmers of Chandragiri municipality, Kathmandu. During data collection some short interviews were conducted.

3.6 Data Processing and Organization

Descriptive research approach has been adopted for the study. The data collected from filed survey are recorded systematically. The accumulated information/data are grouped as per the need of research work in order to meet the study objectives. The collected data are present in appropriate form in table and chart. For the analysis

purpose different kinds of appropriate tools has applied. Further, to present the data in simple form diagrams and graphs are used. After tabulation, data are analyzed by applying both financial and statistical tools.

3.7 Data Analysis Tools and Techniques

The data collected from field survey are systematically recorded as necessary. SPSS and Microsoft Excel are used for data presentation. Data is present in appropriate forms of tables, graphs and charts which explain a lot about the data and information collected for the analysis of the study to get meaningful conclusion. In order to get research objectives different tools are used, some are:

1. Mean ($\bar{x}$)

Mean is the arithmetic average of range of values or quantities computed by dividing by total items. It represents the entire data which lies almost between the two extremes. For this reason, an average is frequently referred as a measure of central tendency. It is also known as the arithmetic average. It can be determined by following model.

$$Ungrouped\ data\ Mean(\bar{x}) = \frac{Xi + Xii + \cdots . Xn}{n}$$

Were,

($\bar{x}$) = simple arithmetic mean

Xi= value of variable i

n = Total number of observations

2. Standard Deviation (σ)

Standard deviation is defined as the positive square root of the mean as square of the deviation takes from the arithmetic mean. The standard deviation measures the absolute dispersion. The small value of standard deviation means the high degree of homogeneity of the observations. In simple term high standard deviation means very less similarity in the values and low standard deviation means high similarity among the values. It can be determined by following model.

$$Standard\ Deviation\ (\sigma) = \sqrt{\frac{(x-\bar{x})^2}{N}}$$

3. Coefficient of Variation (CV)

The coefficient of variation is the relative measure of dispersion, comparable across distribution, which is defined as the ratio of the standard deviation to the mean. Standard deviation is not appropriate to compare two pairs of variables so CV is used compare two variables independently in terms of their variability. Less CV means more uniformity and consistency and vice versa. It can be determined by following model.

$$CV = \frac{Standard\ deviation\ (\sigma)}{Mean(\bar{x})} \times 100$$

3.8 Empirical Model

The Cobb-Douglas production function can be defined as technical relationship between physical quantity of inputs and physical quantity of output of any sector like agricultural sector or industrial sector. To assess the total production of the tomato based on the factors of production, Cobb-Douglas production function has been used in the study as shown below.

$$Q = AK^{\alpha}L^{\beta}P^{\gamma} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ (1)$$

Were,

Q = Quantity of output per unit of time
A = technology or efficiency parameter
K = Capital input
L = Labor input
P = Other productive resource
α = elasticity of production of capital
β = elasticity of production of labor
ϒ = elasticities of production of other productive resources

Using a standard multiple linear regression model the parameters of the functions were obtained by taking the natural logarithm of each term in the above function equation (1). The above equation can be converted into log linear form as follows:

$$lnQ = lnA + \alpha lnK + \beta lnL + \gamma lnP \quad \ldots\ldots\ldots\ldots\ldots\ (2)$$

This equation (2) can be regressed so that value of lnA, α, β and ϒ can be found which later can be used to find the optimal value of output.

CHAPTER IV

DATA PRESENTATION AND ANALYSIS

In this chapter of the study, the analysis of the collected data in systematic order have been done according to the objectives of the study. First section consists of description of study area, second section consists of the demographic features of the respondents, third section consists of the analysis of tomato production and its trend and fourth section consists of an economic analysis of the tunnel farming of tomato.

4.1 Description of Study Area

Chandragiri Municipality is situated in south-west part of Kathmandu valley in Bagmati Province. The total area of the municipality is 43.92 sq.km. Chandragiri municipality is divided into 15 wards for efficient administration. Chandragiri Municipality is surrounded by Kirtipur Municipality in the east, Dhunibeshi Municipality in the West, Nagarjuna Municipality in the North, and Dakshinkali Municipality in the south.

Figure 4. 1: Wards of Nagarjuna Municipality

Source: http://kathmandu-valley-temples.com/

Chandragiri municipality was formed by merging the former eleven village development committees Purano Naikap Bhanjyang, Naya Naikap, Badbhanjyang, Thankot, Mahadevsthan, Matatirtha, Machhegaun, Balambu, Dahachowk, Tinthana, Satungal of Kathmandu (MoUD, 2018).

Chandragiri municipality is a historic town of Kathmandu District. It was from this hill that King Prithivi Narayan Shah caught the first glimpse of a much scenic and prosperous Kathmandu Valley. The major rivers flowing through the municipality are Balkhu Khola, Daudali Khola and Ghatte Khola. These rivers are perennial rivers. 23 community forest lies in Chandragiri municipality which covers 1170.78 ha (MoUD, 2018).

Chandragiri municipality has a total population of 85,195 according to Nepal census 2011 with area of 43.92 sq km, with male population 42,881 and female population 42,317 and the highest population is in Ward no. 15, the lowest population is in Ward no. 2, (MoUD, 2018).

The water supply in this Municipality has been managed by different committees and sources of water supplies are Chisapani water supply, Gairigaun Amarsingh tole water supply, Haddhunga Gaira water supply, Thosne Chaur Gairigaun water supply, Sangam Basti water supply, Balambu water supply and Tinthana water supply (MoUD, 2018). There is no proper sewerage network in Chandragiri Municipality.

The total literacy rate of population is 80.38 percent. There are 2 higher secondary school and 1 college. There are four private hospitals, one Ayurved Hospital, one Cancer hospital, 11 health post, one T.B. Treatment Center and 20 Pharmacy (ibid).

There are altogether 35 Hindu temples, 2 Church, 3 Bihar and 1 stupa. 79 percent of people followed Hindu and 10.5 percent followed Buddhist. Dashain, Tihar, Ram Navami, Shiva Ratri, Chaite Dashain, Kushe Aunsi, Krishna Janmasthami etc. are the main festivals (ibid).

Population is increasing at fast rate primarily due to immigration from other districts. Chandragiri Cable Car has caused opening of many hotels, lodges, restaurants, and other related shops. According to agriculture officer/expert there is great potentialities for tomatoes and mushroom production in this municipality (MoUD, 2018). There are about 3000 shops and 80 are related to vegetables and fruits (ibid). Chandragiri has lots

of historical, archaeological, and religious sites which can attract many local and international tourists.

Paddy production is the most produced crop in this municipality and most of the farmers are also involved in livestock. Mushroom block farming program is in operation in Balambu, Dahachowk and Thankot with 50 farmers in each program area. farmers in group are cultivating tunnel tomato in commercial scale (MoUD, 2018).

4.2 Demographic Features of the Respondents

In this section of the study, the demographic features of the respondents have been described. This section consists of the information of the residing status of the respondent, age structure of the respondent, gender of the respondent, educational level of the respondent, family size of the respondent, years of working experience of the respondent and acquisition of the training by the respondent

4.2.1 Distribution of Respondents by Ward

In this section of the study, residing status of the respondents taken for the study has been shown. The residing status of respondents has been classified as the temporary and permanent residence of the Nagarjuna Municipality

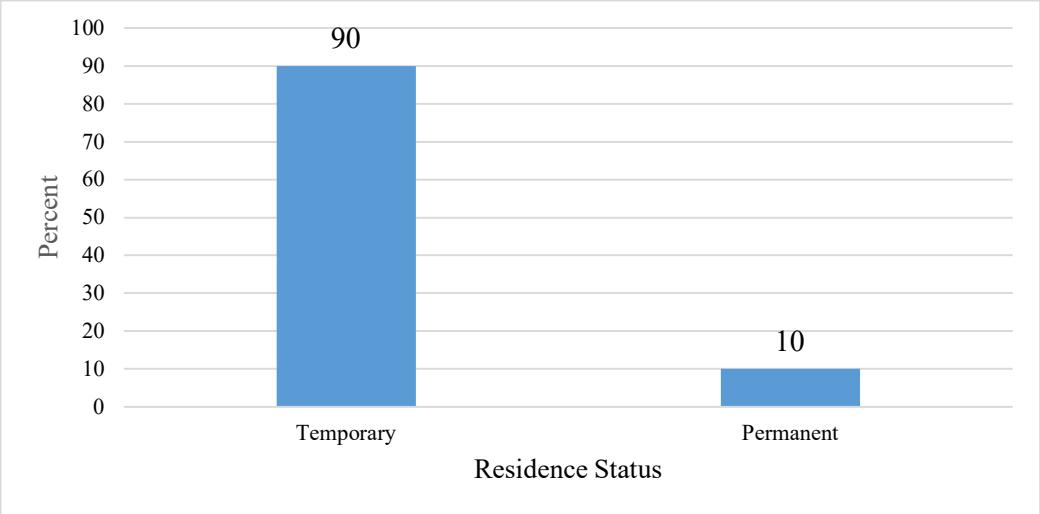
Table 4. 1: Residing Status of Respondent

Residing Status	Frequency	Percent
Temporary	153	90.0
Permanent	17	10.0
Total	170	100.0

Source: Field survey, 2022

Most of the farmers are temporary residents i.e., 90 percent and only 10 percent are permanent resident. Temporary residence farmers come from different places of Nepal and they are trying to produce cash crops and, their main targeted market is Kathmandu valley.

Figure 4. 2: Residing Status of Respondent



Source: Field survey, 2022

4.2.2 Distribution of Respondents by Age

In this section of the study, the age of the respondent farmers has been analyzed. The age of the respondent has been classified as below 25 years, 26 to 40 years, 41 to 55 years and 56 to 70 years.

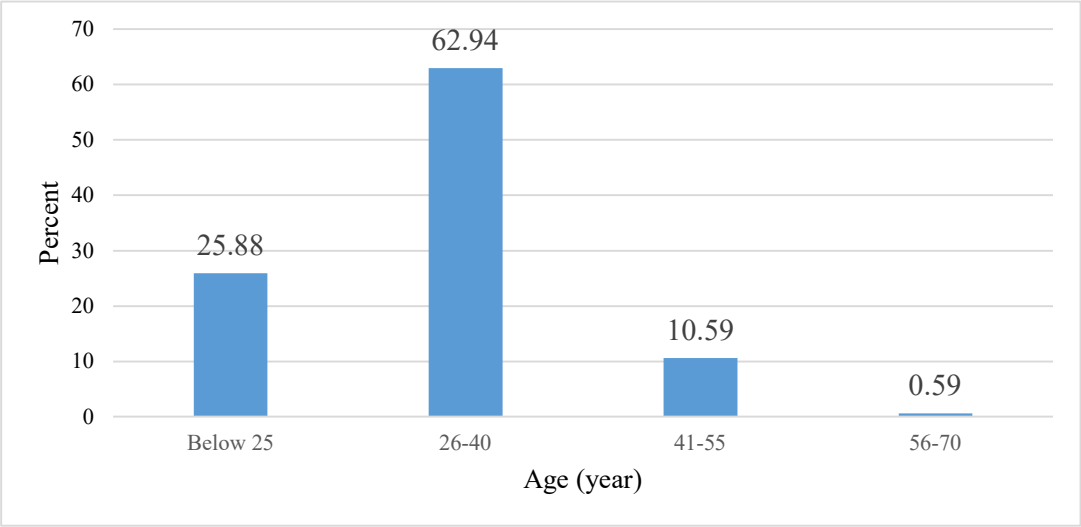
Table 4. 2: Age (year) of the Respondent

Age of the Respondents	Frequency	Percent
Below 25	44	25.9
26-40	107	62.9
41-55	18	10.6
56-70	1	0.6
Total	170	100.0

Source: Field survey, 2022

Table 4.2 shows the age group of farmers. Most of the farmers are young i.e., 26-40 years group and they represent 62.94 percent of study sample. Very low involvement of old aged group farmers (56-70 years groups) was found and they represent only 0.59 percent study sample.

Figure 4. 3: Age (year) of the Respondent



Source: Field survey, 2022

4.2.3 Distribution of Respondents by Gender

In this section of the study, the gender of the respondent has been shown.

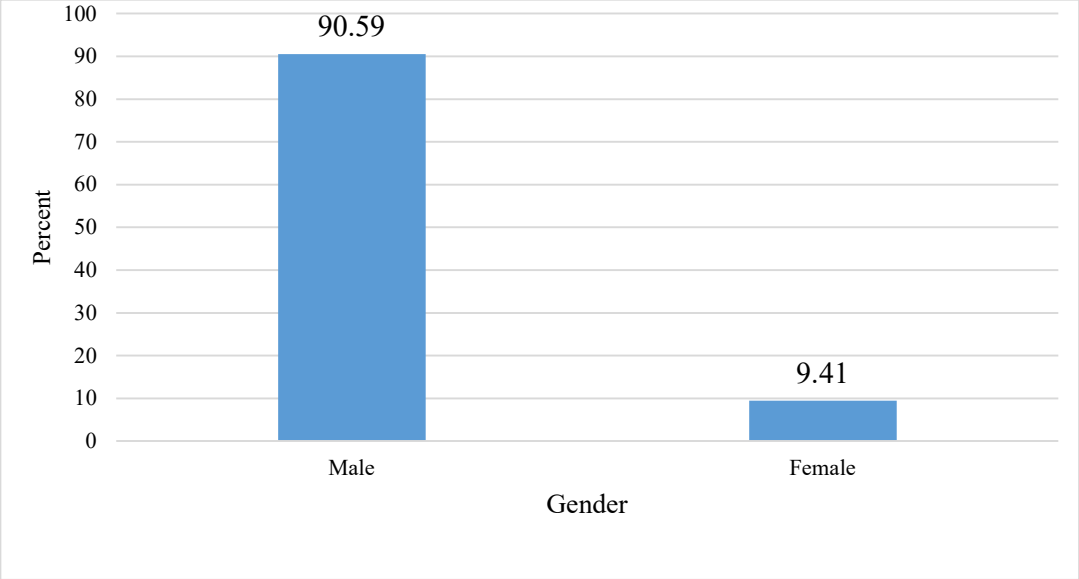
Table 4. 3: Gender of the Respondent

Gender	Frequency	Percent
Male	154	90.6
Female	16	9.4
Total	170	100.0

Source: Field survey, 2022

Table 4.4 shows the gender of farmers. Most of the farmers are male i.e., 90.6 percent and only 9.4 percent farmers are female. Most of female farmers do not have knowledge regarding costing and revenue incurred during the production of tomato under tunnel due to which they couldn't answer all the questions and referred their family to answer the survey's questions.

Figure 4. 4: Gender by Sex



Source: Field survey, 2022

4.2.4 Distribution of Respondents by Level of Education

In this section of the study, distribution of the respondents by the educational level has been shown.

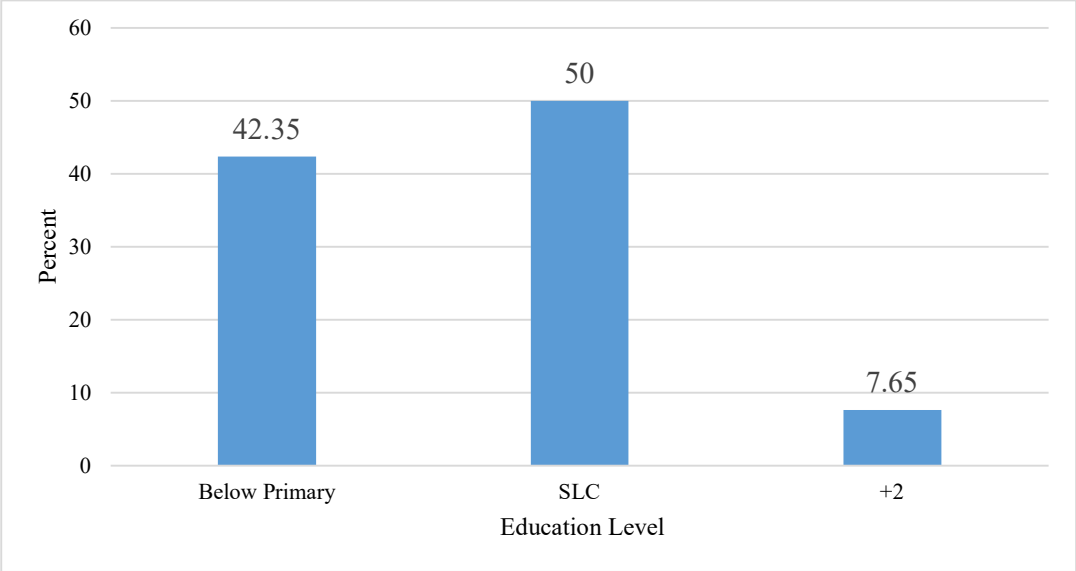
Table 4. 4: Education Level of Respondent

Level of Education	Frequency	Percent
Below Primary	72	42.4
SLC	85	50.0
+2	13	7.6
Total	170	100.0

Source: Field survey, 2022

Survey result shows that most of the farmers have low level of education i.e., below SLC that occupied the 92.4 percent and only 7.6 percent farmers have higher education (+2). It shows that the lack of educated farmers follows the inefficient production process and inefficient use of material which results into low output and high production cost. As per the farmers, they fell that they have no any other options to make money to finance regular household expenses because of low level of education.

Figure 4. 5: Education Level of Respondent



Source: Field survey, 2022

4.2.5 Distribution of Respondents by Size of Family

This section of the study shows the family size of the respondents.

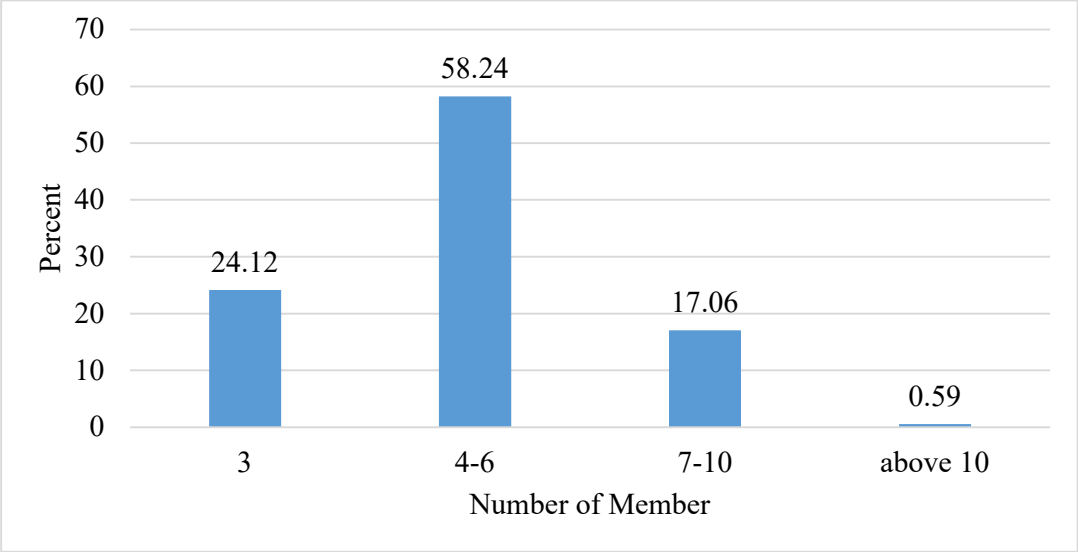
Table 4. 5: Family Size of Respondent

Number of Members	Frequency	Percent
<3	41	24.1
4-6	99	58.2
7-10	29	17.1
above 10	1	0.6
Total	170	100.0

Source: Field survey, 2022

In the sample respondents, 24.1 percent of the respondent farmers had the family size less than 3 members, 58.2 percent of farmers have medium size family i.e., 4-6 members in a family, 17.1 percent of the respondents have the family size of 7 to 10 and only 0.6 percent of farmer had family size above 10 members in their family.

Figure 4. 6: Family Size of Respondent



Source: Field survey, 2022

4.2.6 Distribution of Respondents by Years of Working Experience

In this section of the study, of experience of the farmers, involving in the tomato farming, has been shown.

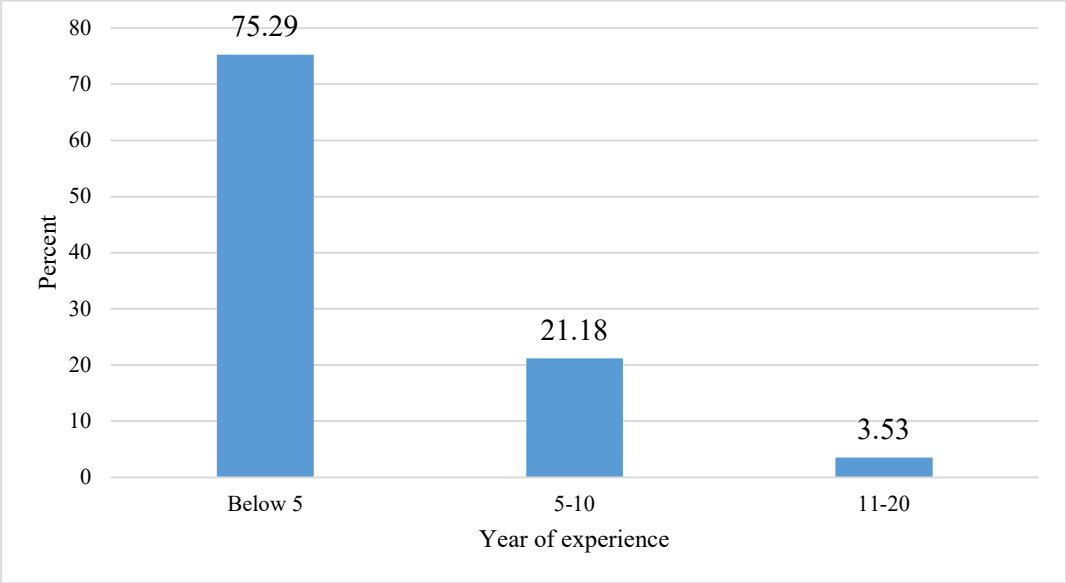
Table 4. 6: Year of Working Experience

Years of Experience	Frequency	Percent
Below 5	128	75.3
5-10	36	21.2
11-20	6	3.5
Total	170	100.0

Source: Field survey, 2022

The study shows that 75.3 percent of the farmers had below 5-years of experience, 21.2 percent of the farmers had the experience more than 5 years but less than 11 years and only 3.5 percent farmers had experience of more than 1 decade in farming. Experience is more necessary in any field. There is lack of experience among the farmers which may be due to high number of young aged farmers or new people involving in farming business.

Figure 4. 7: Year of Working Experience



Source: Field survey, 2022

4.2.7 Distribution of Respondents by Types of Training Acquired

In this section of the study, the acquisition of training by the farmer for the production of tomato has been examined.

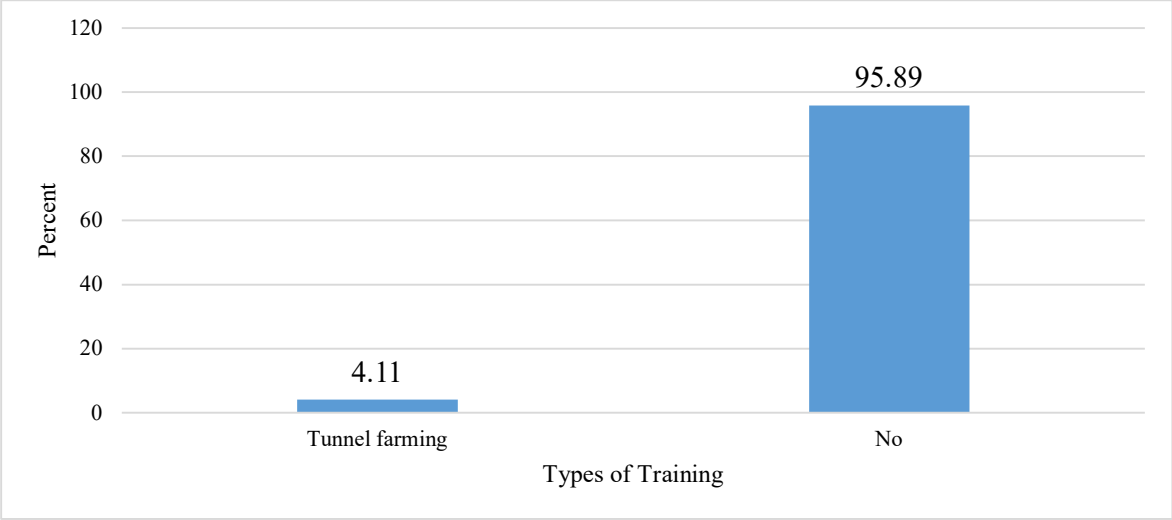
Table 4. 7: Types of Respondent Training

Types of Training	Frequency	Percent
Tunnel farming	7	4.1
No	163	95.9
Total	170	100.0

Source: Field survey, 2022

Tunnel farming of tomato production require the training. But in the context of Nepal, most of the farmers have not acquired the training for the farming as very few farmers are trained i.e., 4.1 percent and most of farmers are producing tomato without any training and proper knowledge of tunnel farming i.e., 95.9 percent. Training affects the output of production of tomatoes, low level of training means low level of output with high cost of production.

Figure 4. 8: Types of Respondent Training



Source: Field survey, 2022

4.3 Tomato Production and its Market Trend

The first objective of the study is to examine the tomato production and its market trend. Hence, section contains determination of tomato market price, status of tomato production, perception of best technology for the improvement of production and profitability, expectations of respondents from the government and public awareness regarding tunnel adoption,

4.3.1 Determination of Tomato Market Price

The respondents were asked how the market price of tomato had been determined. Options were given to the respondents such as agreement between buyer and seller, market demand and supply and cost of production.

Table 4. 8: Determination of Tomato Market Price (Kalimati)

Determinant	Frequency	Percent
Market demand and supply (Kalimati)	170	100.0

Source: Field survey, 2022

Table 4.8 shows that the determination of tomato market price. Market price of tomato is fully controlled by Kalimati vegetable wholesale and retail markets. Farmers have no any option to determine the selling price of tomato and are unknown about the selling price while handing to the mediator. So, market price of tomato for farmers is determined by demand and supply of tomato in Kalimati vegetable market.

4.3.2 Status of Tomato Production in the Study Area

Respondents in the study area were also asked about the status of tomato production in their farm. The responses given by the farmers were based on the past experience.

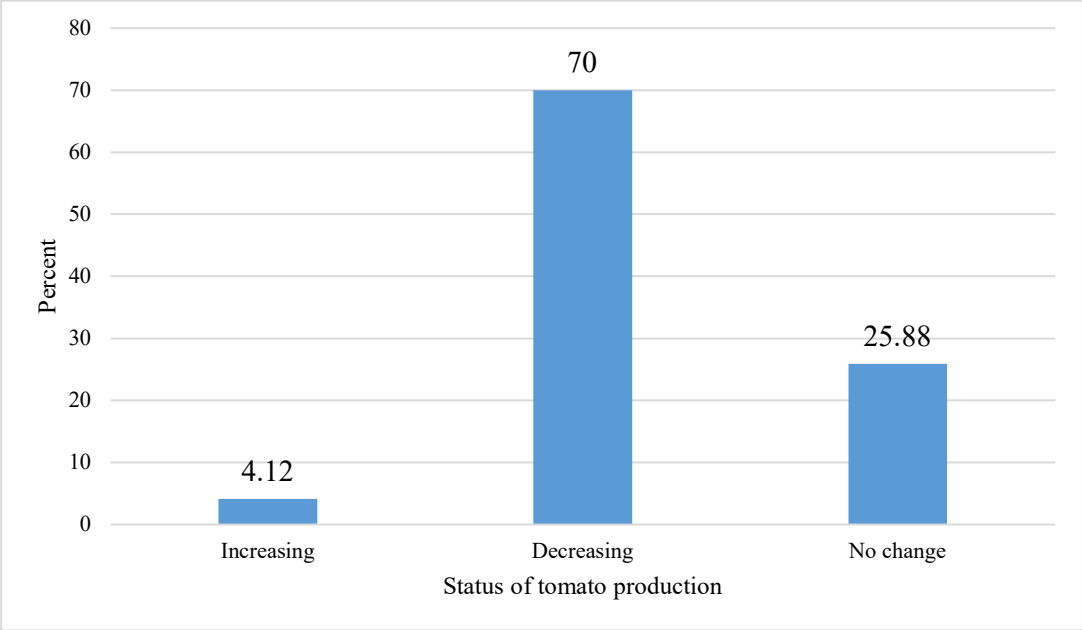
Table 4. 9: Status of Tomato Production

Status	Frequency	Percent
Increasing	7	4.1
Decreasing	119	70.0
No change	44	25.9
Total	170	100.0

Source: Field survey, 2022

Table shows that the status of tomato production. 70 percent of the respondents said that the tomato production has been decreasing. Only few farmers reported that production of tomato is increasing i.e., 4.1 percent and 25.9 percent of the respondent said that there was no change in output of tomato. Climate change, use of different micronutrients and spraying too much pesticides could be main reasons of decreasing the output of tomato as per some farmers opinion.

Figure 4. 9: Status of Tomato Production



Source: Field survey, 2022

4.3.3 Perception of Best Technology for Improvement of Production and Profitability

The farmers were asked about the best technology or method for improving the productivity and profitability of tomato farming on their perception. Options like the tunnel and open farming and others were given to the farmers.

Table 4. 10: Best Technology for Improving the Productivity & Profitability of Tomato Farming

Technology	Frequency	Percent
Tunnel	170	100.0

Source: Field survey, 2022

On the perception of the farmers, the best technology for improving the productivity and profitability of tomato farming was tunnel technology. For unseasonal production of tomato, traditional or open farming technology cannot be applied. Field survey result shows that tunnel is best for unseasonal tomato farming and improve productivity & profitability of tomato farming i.e., 100 percent.

4.3.4 Expectations of Respondents from the Government

The respondents were asked about the expectations from the government of Nepal such as local, provincial, and federal. The question was structured and contained the options like subsidy on loan, subsidy on inputs, assurance of selling price and training.

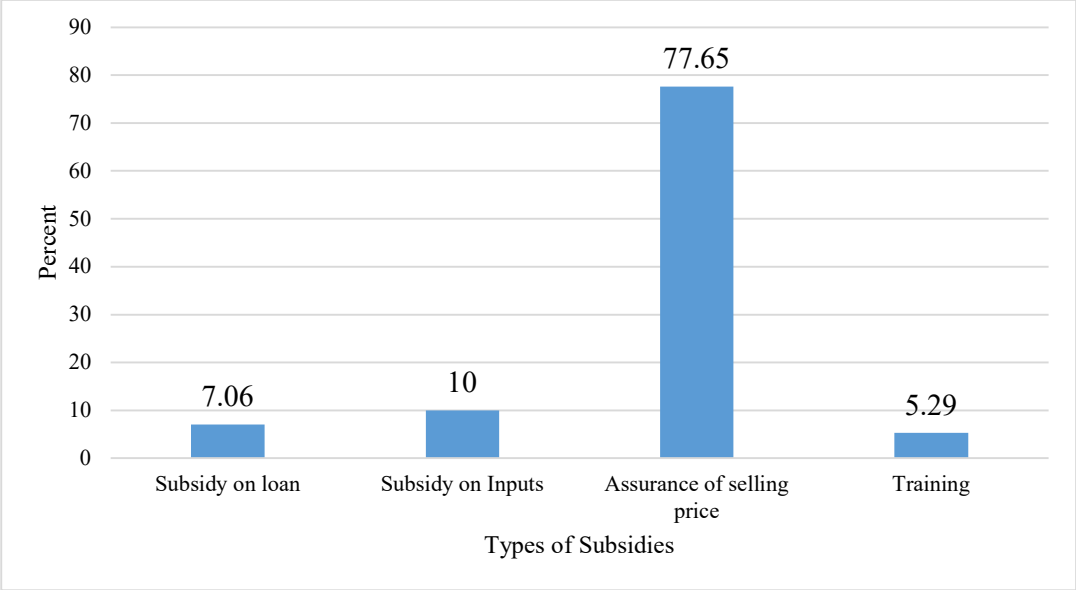
Table 4. 11: Expectations from the Government

Types of Subsidies	Frequency	Percent
Subsidy on loan	12	7.1
Subsidy on Inputs	17	10.0
Assurance of selling price	132	77.6
Training	9	5.3
Total	170	100.0

Source: Field survey, 2022

Most of the farmers wanted assurance of stable selling price of tomato i.e., 77.6 percent because there is huge gap in maximum and minimum selling price of tomato in the market. Only 10 percent of farmers wanted subsidy on inputs, 7.1 percent of the farmer wanted subsidy on loan and 5.3 percent of the farmer wanted training.

Figure 4. 10: Expectations from the Government



Source: Field survey, 2022

4.3.5 Public Awareness Regarding Tunnel Adoption

In this subsection of the study, public awareness of the respondents regarding the tunnel adoption has been examined.

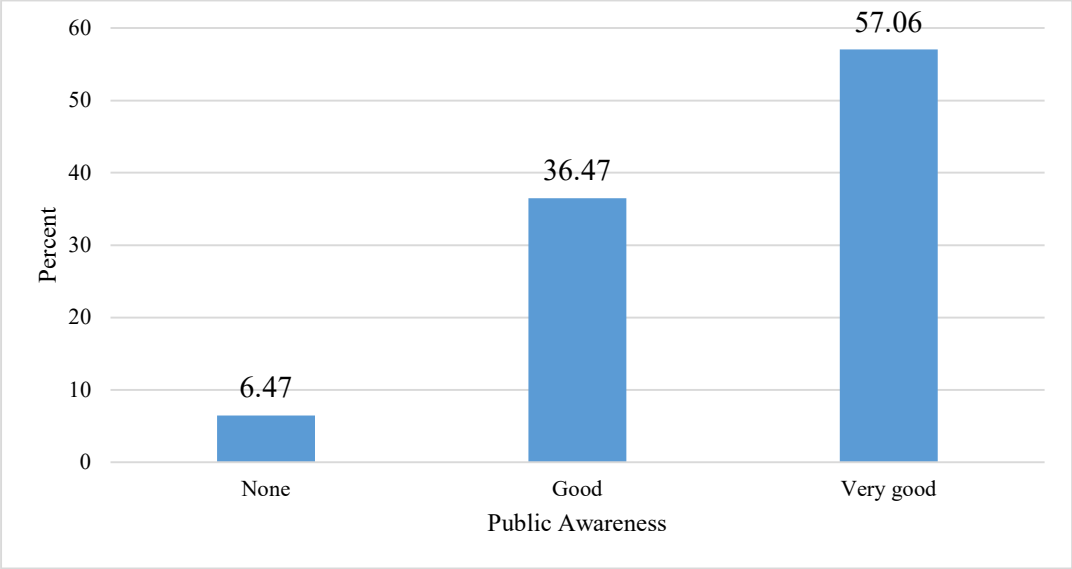
Table 4. 12: Public Awareness Regarding Tunnel Adoption

Public Awareness	Frequency	Percent
None	11	6.5
Good	62	36.5
Very good	97	57.1
Total	170	100.0

Source: Field survey, 2022

Table 4.12 shows that the level of public awareness regarding tunnel adoption for tomato farming. Survey results shows that 57.1 percent of the respondents were very aware. 36.5 percent of the respondents were adequately awareness regarding tunnel technology adoption and 6.5 percent of the farmers were not aware regarding the tunnel adoption for tomato farming.

Figure 4. 11: Public Awareness Regarding Tunnel Adoption



Source: Field survey, 2022

4.4 An Economic analysis

Table: 4.13 shows that the descriptive statistics of different components of cost and benefits of tomato farming. Table 4.13 contains the description of minimum, maximum, mean, standard deviation and coefficient of variation of different variable like highest price of tomato during the study period, lowest price of tomato in a year, total capital employed per Ropani per year, total productivity resources per Ropani per year, total labour employed per Ropani per year, total cost incurred per Ropani per year, total revenue from selling the tomato per Ropani per year and net benefits per Ropani per year.

Table 4.13 shows that highest selling price of tomato during the year (per kg) during the study year was Rs.130 whereas minimum highest selling price of tomato during the year was Rs.60.9 per kg and average highest selling price of tomato during the year was 102.3 per kg. Similarly, maximum lowest price of tomato during the year was Rs. 40 per kg while minimum lowest selling price of the tomato was Rs. 5 per kg. The average lowest selling price of tomato was found to be Rs. 11.8 per kg. There is very high fluctuation in selling price of tomato which demotivates the farmers or tomato farming. Due to high fluctuation, it is very difficult to take decision to invest in tomato farming or other vegetables. Coefficient of variation of highest selling price is 13.2 percent

while it was found to be 35.9 percent for lowest selling price which means that the variability in lowest price is higher than the highest price for the farmers.

Table 4. 13: Descriptive Statistics

Variables	Minimum	Maximum	Mean	Std. Deviation	Coefficient of Variance
Highest price of tomato during the year (per Kg)	60.9	130.00	102.3	13.5	13.2
Lowest price of tomato during the year (per Kg)	5.0	40.0	11.8	4.2	35.9
Total capital (K) per Ropani per year (‘000)	102.1	149.8	128.5	9.2	7.2
Total productivity resources (A) per Ropani per year	57.8	106.9	84.4	10.1	12.0
Total labor (L) Per Ropani per year (‘000)	45.0	180.0	138.8	24.4	17.6
Total costs per Ropani per year (‘000)	226.8	404.7	351.7	31.1	8.9
Total revenue from the selling tomato and other vegetables Ropani per year (‘000)	210.0	442.5	362.2	41.7	11.5
Net benefits per Ropani per year (‘000)	-60.3	76.4	10.5	30.0	286.1

Source: Field survey, 2022

Total capital cost comprises the tunnel construction, equipment, cost of land, annual bank interest, annual tunnel repair and annual equipment maintenance costs. Tunnel construction cost includes the tunnel structure including bamboo and steel, tunnel cover consisting of polyethylene, polycarbonate, fiberglass and glass, rope, nails, binding wire, labor cost including skilled and unskilled, transportation cost and other cost.

Respondents were asked about the life of the tunnel. Equipment cost consists of irrigation equipment, spryer equipment, cultivation equipment, other cultivation equipment. Respondents were also asked about the life of these equipment. Cost of land consists of lease or rent. From the study, it was found that maximum capital expenses of farmers during a year were Rs. 149.8 thousand per Ropani whereas minimum capital expenses of farmers during a year was Rs. 102.1 thousand per Ropani per year and average capital expenses of farmers during a year was Rs. 128.5 thousand per Ropani. The coefficient of variation of total capital expense was found to be 7.2 percent showing that there is less variability in the total capital expenses per Ropani among the sampled farmers.

Total productivity resources include the seeds, fertilizer and micronutrients, pesticides, transportation for fertilizer & pesticides, equipment fuel consisting of rent for cultivation tractor and electricity, tea and breakfast expenses and cost for other vegetables. Pesticides has the major portion of productivity resources. Maximum productivity resource costs per year is Rs. 106.9 thousand per year per Ropani whereas minimum productivity resource cost is Rs. 57.8 thousand per Ropani and average productivity resource costs is Rs. 84.4 thousand per Ropani per year. Pesticides and costs for the other vegetable is high comparable with other costs in this category. The coefficient of variation of total productivity resources cost was found to be 12 percent showing less variability of productivity costs of sampled tomato farmers.

Labor cost includes both tomato and other vegetable production labor cost and technician land preparation cost. From the study, it was found that maximum labor expenses per year is Rs. 180 thousand per Ropani per year where minimum labor expense is Rs. 45 thousand per Ropani per year and average labor expenses is Rs. 138.8 per Ropani per year. The coefficient of variation of the total labor cost per year per Ropani was found to be 17.6 percent showing a high variability of cost among the sampled farmers.

Total cost includes the capital, productivity resource and labor costs. From the study, it was found that maximum total tomato production cost per year is Rs. 404.7 thousand per Ropani per year whereas minimum total tomato production cost per year is Rs. 226.9 thousand per Ropani per year and average total tomato production cost per year is Rs.351.7 thousand per Ropani per year. The coefficient of variation of total cost of

tomato farming was found to be 8.9 percent per Ropani per year showing less variability of total cost among tomato farmers.

Gross revenue was calculated by adding the selling revenue of the tomato and other vegetables. From the study, it was found that maximum gross revenue that received by farmers from selling tomatoes and other vegetable during the year is Rs.442.5 thousand per Ropani where minimum gross revenue is Rs.210.0 thousand per Ropani per year and average gross revenue per year is Rs.362.2 thousand per Ropani. The coefficient of variation of total revenue from the selling tomato and other vegetable was found to be 11.5 percent per Ropani per year showing moderate variability of revenue generated among the farmers.

Net benefit was calculated by subtracting the total cost from the total revenue generated by selling the tomato and other vegetables. From the study, it was found that highest net benefit from the tomato farming per year is Rs. 76.4 thousand per Ropani per year where maximum net loss from the tomato farming per year is Rs.60.3 thousand per Ropani per year but in average of 170 farmers net benefit from the tomato farmer per year was found to be Rs.10.5 per Ropani per year. As per farmers, main reason of loss is very high fluctuation in selling price as the highest selling price of tomato per kg was Rs.130 where lowest selling price of tomato per kg was Rs.5. Also, seasonal and environment effects were the causes that affect the loss in the tomato farming. The coefficient of variation of the net benefit was found to be 286.1 percent which shows that there is huge variability of net benefits received by tomato farmers

4.5 Estimation of Production Function of Tomato Farming

Table 4.14 shows that the model summary of linear regression model where the output of the tomato (lnY) is dependent variable and labor (lnL), productivity resources (lnP) and capital (lnK) are the independent variables.

The value of R-Square is 0.302 which indicates the 30.2 percent variation of tomato output is explained by labor, productivity resources and capital costs. P-value of the f-statistics is 0.000 which is less than 0.05 showing that model is statistically significant. Durbin Watson is 1.576 which is less than the lower limit of DW statistics of 1.64 meaning that null hypothesis of having autocorrelation should be rejected. In other words, it shows that there is no autocorrelation among the variables.

Table 4. 14: Estimation of Production Function

Independent variable	B	Std. Error	t-stat	Sig.	Tolerance	VIF
(Constant)	-1.574	1.735	-.907	.365		
LnK	0.360	0.142	2.538	0.012	0.889	1.125
LnP	0.311	.080	3.909	0.000	0.976	1.024
LnL	0.256	.049	5.193	0.000	0.881	1.135

Source: Researcher's estimation in SPSS

Table 4.14 shows that the results of linear regression model where lnY is output of tomato farming per Ropani per year and labor (lnL) is the labour cost per Ropani per year, productivity resource (lnP) is the productivity resource cost per Ropani per year and capital (lnK) is the total capital cost per Ropani per year. The coefficients of the independent variables are positive and statistically significant at 5 percent level of significance. It means that the independent variables are positively related to the dependent variable.

The coefficient of total capital cost is 0.360 which means that one percentage increase in total capital cost leads to 0.360 percentage increase in total output of tomato. Similarly, the coefficient of total productivity resource cost is 0.311 which means that one percentage increase in total productivity resource cost leads to 0.311 percentage increase in total output of tomato.

Likewise, the coefficient of total labour cost is 0.256 which means that one percentage increase in total labour cost leads to 0.256 percentage increase in total output of tomato.

The value of variance inflation factor (VIF) of all independent variable is less than 10 which indicates there is no multicollinearity among the independent variables. Tolerance values of each independent variable is more than 0.1 which also shows the absence of multicollinearity among the independent variables. Hence the regression is free from multicollinearity as well as the autocorrelation.

Based on table 4.14 standard regression model is present as follow:

$$lnY = -1.574 + 0.360 \times lnk + 0.311 \times lnP + 0.256 \times lnL$$

4.6 Other Information by Respondent

During the field survey while interviewing the farmers, 45 farmers opted for no suggestion and comment to governing body or stakeholder of tunnel tomato farming whereas remaining farmer expressed idea for determination of stable tomato selling price through transparent and scientific method considering various factors like cost of production, market demand, quality, size, other vegetable product, agriculture product like dairy and others. Some farmers even expressed importance of subsidies and necessary helps to produce tomato, also to make import restriction policy to protect domestic production.

Availability of inputs for tomato production can play indicative role for farmers and market. Farmers also expressed not to politicize agriculture sectors for political gains and suggested that loan should be granted to real farmers without collateral and allocate sufficient budget for agriculture specially cash crops. They suggested for specialized training for farmers based on their production specialization so they must use less pesticides without compromising productivity of soil and protected from negative impact on environment.

Some farmers who were young having business idea suggested to open vegetable collection center and build the cold house to remove middle person commission so that farmers will get good price where consumer also consume tomato at lower cost. Their suggestions were as per their knowledge, experience and understanding.

CHAPTER V

SUMMARY, CONCLUSION AND RECOMMENDATIONS

In this chapter, the summary of the study, major findings of the study, conclusions and recommendations based on the findings of the study are described.

5.1 Summary

This study was conducted on order to analyze the tomato production and its market trend; to examine the cost benefit involved in tunnel farming of tomato; and to estimate the production function of tomato farming. To fulfill these objectives, the data was collected from the Chandragiri municipality of Kathmandu district. For the study, 170 farmers were interviewed to collect data using structured questionnaire. 26 respondents were selected from Dahachowk area, 7 selected from Thankot area, 74 were selected from Satungal area, 56 from Balambu area, 5 selected from Naikap area and 1 selected from Badbhanjyang and 1 from Machhegaun area to fulfill this research objective. The questionnaire the demographic information, total capital cost, total labour cost, total productivity cost, and total revenue generated from selling of tomato and other vegetables.

Total capital cost comprises the tunnel construction, equipment, cost of land, annual bank interest, annual tunnel repair and annual equipment maintenance costs. Tunnel construction cost includes the tunnel structure including bamboo and steel, tunnel cover consisting of polyethylene, polycarbonate, fiberglass and glass, rope, nails, binding wire, labor cost including skilled and unskilled, transportation cost and other cost. Equipment cost consists of irrigation equipment, spryer equipment, cultivation equipment, other cultivation equipment. Cost of land consists of lease or rent.

Total productivity resources include the seeds, fertilizer and micronutrients, pesticides, transportation for fertilizer & pesticides, equipment fuel consisting of rent for cultivation tractor and electricity, tea and breakfast expenses and cost for other vegetables. Labor cost includes both tomato and other vegetable production labor cost and technician land preparation cost.

Descriptive analysis was conducted to fulfill the first objective, while for fulfilling the second objective, net benefit per Ropani of land per year was calculated to examine the profitability of the tomato farming. Likewise, to analyze the third objective, linear

regression model by using Cobb Douglas production function was used where the variables are expressed in logarithmic form. The dependent variable is production output of tomato farming and independent variables are the total capital cost, total labour cost and total productivity cost.

Major findings of the study are

Demographic features of the respondents

- Most of the farmers are temporary residents i.e., 90 percent and only 10 percent are permanent resident.
- Most of the farmers are young i.e., 26-40 years group and they represent 62.94 percent of study sample.
- Most of the respondents are male i.e., 90.6 percent and only 9.4 percent farmers are female.
- Most of the farmers have low level of education i.e., below SLC that occupied the 92.4 percent and only 7.6 percent farmers have higher education (+2).
- In the sample respondents, 58.2 percent of farmers have medium size family i.e., 4-6 members in a family.
- The results also revealed that 75.3 percent of the farmers had below 5-years of experience, 21.2 percent of the farmers had the experience more than 5 years but less than 11 years and only 3.5 percent farmers had experience of more than 1 decade in farming.
- Most of the farmers have not acquired the training for the farming as very few farmers are trained i.e., 4.1 percent

Tomato production and its market trend

- Market price of tomato is fully controlled by Kalimati vegetable wholesale and retail markets.
- Market price of tomato for farmers is determined by demand and supply of tomato in Kalimati vegetable market.
- Only few farmers reported that production of tomato is increasing i.e., 4.1 percent and 25.9 percent of the respondent said that there was no change in output of tomato. 70 percent of the respondents said that the tomato production has been decreasing.

- On the perception of the farmers, the best technology for improving the productivity and profitability of tomato farming was tunnel technology.
- Most of the farmers wanted assurance of stable selling price of tomato. Only 10 percent of farmers wanted subsidy on inputs, 7.1 percent of the farmer wanted subsidy on loan and 5.3 percent of the farmer wanted training.
- Survey results shows that 57.1 percent of the respondents were very aware. 36.5 percent of the respondents were adequately awareness regarding tunnel technology adoption and 6.5 percent of the farmers were not aware regarding the tunnel adoption for tomato farming.

Economic analysis

- The highest selling price of tomato during the year (per kg) during the study year was Rs.130 whereas minimum highest selling price of tomato during the year was Rs.60.9 per kg and average highest selling price of tomato during the year was 102.3 per kg.
- Maximum lowest price of tomato during the year was Rs. 40 per kg while minimum lowest selling price of the tomato was Rs. 5 per kg. The average lowest selling price of tomato was found to be Rs. 11.8 per kg.
- From the study, it was found that maximum capital expenses of farmers during a year were Rs. 149.8 thousand per Ropani whereas minimum capital expenses of farmers during a year was Rs. 102.1 thousand per Ropani per year and average capital expenses of farmers during a year was Rs. 128.5 thousand per Ropani.
- Maximum productivity resource costs per year is Rs. 106.9 thousand per year per Ropani whereas minimum productivity resource cost is Rs. 57.8 thousand per Ropani and average productivity resource costs is Rs. 84.4 thousand per Ropani per year.
- From the study, it was found that maximum labor expenses per year is Rs. 180 thousand per Ropani per year where minimum labor expense is Rs. 45 thousand per Ropani per year and average labor expenses is Rs. 138.8 per Ropani per year.
- From the study, it was found that maximum total tomato production cost per year is Rs. 404.7 thousand per Ropani per year whereas minimum total tomato

production cost per year is Rs. 226.9 thousand per Ropani per year and average total tomato production cost per year is Rs.351.7 thousand per Ropani per year.

- From the study, it was found that maximum gross revenue that received by farmers from selling tomatoes and other vegetable during the year is Rs.442.5 thousand per Ropani where minimum gross revenue is Rs.210.0 thousand per Ropani per year and average gross revenue per year is Rs.362.2 thousand per Ropani.
- From the study, it was found that highest net benefit from the tomato farming per year is Rs. 76.4 thousand per Ropani per year where maximum net loss from the tomato farming per year is Rs.60.3 thousand per Ropani per year but in average of 170 farmers net benefit from the tomato farmer per year was found to be Rs.10.5 thousand per Ropani per year.

Estimation of Production Function of Tomato Farming

- The coefficients of the independent variables are positive and statistically significant at 5 percent level of significance.
- The coefficient of total capital cost is 0.360 which means that one percentage increase in total capital cost leads to 0.360 percentage increase in total output of tomato.
- Similarly, the coefficient of total productivity resource cost is 0.311 which means that one percentage increase in total productivity resource cost leads to 0.311 percentage increase in total output of tomato.
- Likewise, the coefficient of total labour cost is 0.256 which means that one percentage increase in total labour cost leads to 0.256 percentage increase in total output of tomato.

5.2 Conclusion

Commercial tunnel tomato farming is one of the major economic activities of Chandragiri municipality farmers. Most of the farms are owned by migrant farmers from different places as a leaseholder and they have below SLC education. Farmers have great attraction due to the increasing urban demand, its profitability, and accessibility of roads and growing market demand. Most of the farmers had no training regarding tunnel farming of tomato production. But the farmers felt that tunnel technology is the best technology to produce tomatoes around the year. Few farmers

had the long prior experience on tunnel farming of tomato production. The farmers were unknown about the market price of tomato as the market price of the tomato was determined by demand and supply of tomato in Kalimati vegetable market. Most of the farmers needed assurance of stable selling price of tomato.

The results showed the selling price of tomato fluctuates a lot in year resulting into uncertainty in the farmers decision of production. Pesticides cost most in productive resources. Labour cost was the highest among the three major components of

Farmers bear the high cost of production because of increasing price of inputs day by day. The net benefit of the tomato farming is fluctuating and the main reason is high fluctuation of selling price and increasing the cost of production. Some of the farmers in the sample were found to be earning negative. The stable selling price of tomatoes like dairy product helps farmers to make an investment decision to get expected profits.

The study found that increase in total capital cost leads to the total production of tomatoes. Also, the increase in total labour cost contributes towards the production of the tomato. Likewise increase in total productivity cost leads to the increase in the total production of the tomato.

5.3 Recommendations

Based on the major findings of the study and the above conclusion, the following recommendation is drawn:

- Determination of more stable selling price should be based scientifically considering different factors like cost of production, quality, size, and others.
- Additionally, the government should provide both financial and non-financial support to farmers and lunch public awareness programs to enhance the productivity of the land.
- Due to involvement of middle person at the time of trading, public consumes pay very high price for tomato and on the other part of market farmers are exploited with low price. Middle persons are making abnormal profit than farmers, who are the prime people in the business but are getting exploited. So, the tomato collection centers and cold store should be opened to remove middle person who take huge price margin for their own profit, it helps to store tomato

fresh (in cold store) when market has low demand but the production is very high so that tomato can be sold in other months.

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APPENDIX I

Survey Questionnaire

This questionnaire aims to gather information and data for academic use, in partial fulfillment of the requirement for the Degree of Master of Arts (M.A.) in economics. The thesis is entitled COST-BENEFIT ANALYSIS OF TUNNEL TOMATO FARMING IN CHANDRAGIRI MUNICIPALITY, KATHMANDU. Your kind participation will be very important for providing useful information required to complete this research. The respondent's name and the data will be handled confidentially. Your cooperation is very important and will be highly acknowledged.

A. Demographic information

1. Name of respondent: ……
2. Resident ward number: ……
3. Residence status:
    a. Temporary
    b. Permanent
4. Age (year):
    a. Below 25
    b. 26-40
    c. 41-55
    d. 56-70
    e. above 70
5. Gender:
    a. Male
    b. Female
6. Education:
    a. Below Primary
    b. SLC
    c. +2
    d. Bachelor
    e. Master
    f. above Master
7. The number of members in the family:
    a. Single
    b. 2
    c. 3

d. 4-6
e. 7-10
f. above 10

8. Year of experience:
    a. Below 5
    b. 5-10
    c. 11-20
    d. 21-40
    e. above 40
9. Training:
    a. Tunnel farming
    b. Organic farming
    c. Others
10. Price of tomato during the year (Per Kg):
    a. Highest
    b. Lowest
11. Determination of tomato market price:
    a. Agreement between buyer and seller
    b. Market demand and supply
    c. Cost of production
12. Status of tomato production:
    a. Increasing
    b. Decreasing
    c. No change
13. The best technology or methods for improving the productivity & profitability of tomato farming:
    a. Tunnel
    b. Open farming (Traditional)
    c. Other (If)
14. Expectations from the government:
    a. Subsidy on loanSubsidy on Inputs
    b. Assurance of selling price
    c. Training
15. Public awareness regarding tunnel adoption:
    a. None
    b. Good
    c. Very good

B. Total Capital (K) Per Ropani

S.N.	Material	Unit	Quantity	Per unit price (Rs)	Total (Rs)
			Q	P	T=Q*P
1	Tunnel construction cost				
1.1	Tunnel structure				
1.1.1	Bamboo	Piece			
1.1.2	Steel	Per Ropani			
1.2	Tunnel cover				
1.2.1	Polyethylene (Expt life 2-5 years)	Roll			
1.2.2	Poly carbonate (Expt life 10 years)	Roll			
1.2.3	Fiberglass (FRP) (Expt life 15 years)	m^2			
1.2.4	Glass (Expd life 25 years)	m^2			
1.3	Rope, Nails & binding Wire	Per Ropani			
1.4	Labor cost	Per Ropani			
1.4.1	Skilled	Person			
1.4.2	Unskilled	Person			
1.5	Transportation cost	Rs			
1.6	Other costs				
2	Life of tunnel (In Year)	Year			
3	Equipment (For farming)				
3.1	Irrigation Equipment	Per Ropani			
3.1.1	Life of irrigation equipment				
3.2	Spryer Equipment	Piece			
3.2.1	Life of spryer equipment	Year			
3.3	Cultivation Equipment	Piece			
3.3.1	Life of cultivation equipment	Year			
3.4	Others cultivation equipment				
3.4.1	Life of other cultivation equipment				
4	Cost of Land				
4.1	Lease or Rent	Per Ropani			
4.2	Own	Per Ropani			
4.3	Lease period	Year			
5	Annual Bank interest	Rs.			
6	Annual Tunnel repair cost (from 2^{nd} year)	Rs.			
7	Annual Equipment maintenance cost	Rs.			

Where: m^2 = square meter

C. Total productivity resources (A) Per Ropani / Year

S.N.	Material	Unit	Quantity	Per unit price (Rs)	Total (Rs)
			Q	P	T = Q*P
1	Seeds	Gram			
2	Fertilizer and Micronutrients				
2.1	Compost (Homemade) or organic	Gadi			
2.2	Poultry manure	kg			
2.3	Oil cakes	kg			
2.4	Urea	kg			
2.5	Di-ammonium Phosphate (DAP)	kg			
2.6	Potash	kg			
2.7	Cost of all fertilizer				
2.8	Others				
3	Pesticides (Insecticides, fungicides, herbicides, acaricides, rodenticides, molluscicides)	Gram			
4	Transportation for fertilizer & Pesticides	Rs.			
5	Equipment fuel				
5.1	Rent for cultivation tractor	Hour			
5.2	Electricity	Per Ropani			
6	Tea and breakfast				
7	cost for other vegetables	Rs.			

Where: kg = kilogram

D. Labor (L) Per Ropani/year

S.N.	Material	Unit	Quantity	Per unit price (Rs)	Total (Rs)
			Q	P	T = Q*P
1	labor cost for Tomato farming	Person			
2	labor cost for other vegetables	Person			
3	Technician (agriculture)Land preparation	Person			

E. Total revenue from the selling Tomato and other vegetables Ropani / year

S.N.	Details	Units	1st year		
			Q	P	Q*P
1	Tomato	Crate or kg			
2	Other vegetables	Per Ropani			
3	Tax	Per Year			

Where: Q = quantity, P = price, Per Crate 23 kg

F. Any suggestions / comments

APPENDIX II

Total revenue, total cost, and its components in per Ropani per Year (‘000)

S.N.	Total revenue	Total Costs	Net benefits	Total Capital	Total productivity resources	Labor cost
1	410.0	354.8	55.2	117.2	82.6	155.0
2	406.0	355.7	50.3	137.0	82.7	136.0
3	350.0	350.1	-0.1	126.4	87.7	136.0
4	367.5	376.0	-8.5	134.8	79.2	162.0
5	355.0	393.9	-38.9	144.2	79.7	170.0
6	367.5	341.5	26.0	123.2	82.3	136.0
7	387.5	345.1	42.4	120.6	92.5	132.0
8	377.5	357.6	19.9	137.2	80.4	140.0
9	380.0	379.5	0.5	129.9	89.6	160.0
10	405.0	367.5	37.5	134.5	73.1	160.0
11	405.0	361.4	43.7	125.5	70.9	165.0
12	344.4	376.7	-32.3	126.5	100.2	150.0
13	366.0	363.4	2.6	125.5	93.9	144.0
14	405.0	348.3	56.8	129.2	87.1	132.0
15	405.0	365.7	39.3	140.8	88.9	136.0
16	410.0	368.3	41.7	130.8	89.0	148.5
17	390.0	344.6	45.4	125.9	82.7	136.0
18	372.5	343.2	29.3	125.5	89.6	128.0
19	362.5	347.5	15.0	123.7	97.9	126.0
20	383.5	363.3	20.2	135.3	96.0	132.0
21	297.3	320.5	-23.2	137.4	98.1	85.0
22	410.0	386.5	23.5	131.6	79.9	175.0
23	394.0	351.0	43.0	122.4	92.7	136.0
24	332.0	356.3	-24.3	125.0	91.3	140.0
25	370.0	357.9	12.1	131.1	87.3	139.5
26	381.3	342.5	38.7	121.3	93.8	127.5
27	380.0	380.9	-0.9	121.8	79.1	180.0
28	442.5	377.1	65.4	127.3	92.4	157.5
29	340.0	277.9	62.1	110.9	77.0	90.0
30	408.0	349.3	58.7	125.3	88.0	136.0
31	362.5	366.1	-3.6	136.0	90.1	140.0
32	375.0	347.3	27.7	138.3	82.7	126.4
33	420.0	364.9	55.1	127.9	81.9	155.0
34	320.0	334.4	-14.4	127.9	71.5	135.0
35	423.8	366.4	57.3	123.6	87.8	155.0
36	335.0	318.7	16.3	135.8	82.9	100.0
37	362.5	347.6	14.9	121.1	90.5	136.0
38	319.0	320.3	-1.3	114.9	85.4	120.0
39	272.5	332.8	-60.3	133.6	75.2	124.0
40	330.0	329.6	0.4	123.8	89.8	116.0

41	428.0	356.5	71.5	114.5	98.0	144.0
42	366.0	351.0	15.0	127.4	75.6	148.0
43	345.0	362.0	-17.0	124.0	68.0	170.0
44	284.0	299.7	-15.7	104.2	71.5	124.0
45	353.0	345.2	7.8	123.2	75.7	146.4
46	389.0	357.4	31.6	131.9	97.5	128.0
47	357.5	368.0	-10.5	131.6	96.5	140.0
48	322.5	362.8	-40.3	143.1	95.7	124.0
49	393.0	360.5	32.5	125.1	75.5	160.0
50	312.5	369.8	-57.3	131.0	90.9	148.0
51	296.0	326.5	-30.5	119.8	71.7	135.0
52	358.0	360.1	-2.1	119.9	96.2	144.0
53	410.0	356.3	53.7	140.2	61.2	155.0
54	436.0	373.9	62.1	119.8	74.1	180.0
55	353.0	340.0	13.0	120.4	64.6	155.0
56	358.0	369.7	-11.7	125.9	73.8	170.0
57	375.0	386.0	-11.0	143.3	72.7	170.0
58	371.0	364.5	6.5	128.0	76.6	160.0
59	358.5	355.6	2.9	108.6	82.0	165.0
60	335.0	354.6	-19.6	139.5	83.2	132.0
61	350.0	305.7	44.3	114.3	66.4	125.0
62	367.5	356.3	11.2	128.8	83.5	144.0
63	345.0	312.6	32.4	125.1	75.0	112.5
64	385.0	355.0	30.0	141.0	69.0	145.0
65	320.0	356.0	-36.0	133.7	90.3	132.0
66	365.0	366.0	-1.0	129.8	92.3	144.0
67	343.0	353.0	-10.0	114.3	94.7	144.0
68	360.0	359.3	0.7	127.2	74.6	157.5
69	395.0	355.1	39.9	125.7	94.4	135.0
70	355.0	334.7	20.3	128.8	93.9	112.0
71	270.0	287.8	-17.8	121.1	66.7	100.0
72	410.0	394.9	15.1	144.0	106.9	144.0
73	300.0	265.3	34.7	102.1	89.7	73.5
74	384.8	403.9	-19.2	146.4	87.5	170.0
75	325.0	251.6	73.4	119.9	86.7	45.0
76	430.0	353.6	76.4	131.2	90.4	132.0
77	410.0	367.6	42.4	131.2	81.4	155.0
78	409.0	382.6	26.4	137.0	101.6	144.0
79	396.0	350.7	45.3	124.4	90.3	136.0
80	340.0	359.5	-19.5	125.1	94.4	140.0
81	368.0	355.5	12.5	120.2	91.3	144.0
82	400.0	363.9	36.1	137.5	90.4	136.0
83	352.5	333.4	19.1	128.5	80.8	124.0
84	334.5	383.7	-49.2	128.5	85.2	170.0
85	412.5	387.1	25.4	131.7	90.3	165.0
86	425.0	350.4	74.6	116.6	97.8	136.0

87	360.0	381.6	-21.6	122.4	79.2	180.0
88	405.0	349.0	56.1	128.3	88.6	132.0
89	390.0	379.0	11.0	135.4	78.5	165.0
90	351.8	371.1	-19.3	131.3	95.9	144.0
91	310.0	337.5	-27.5	131.2	70.3	136.0
92	370.0	365.6	4.4	138.4	83.2	144.0
93	410.0	365.9	44.2	131.7	79.2	155.0
94	380.0	355.0	25.0	137.3	73.7	144.0
95	407.0	391.2	15.8	142.6	86.6	162.0
96	330.0	330.0	0.0	130.1	87.9	112.0
97	368.3	362.8	5.5	126.7	61.1	175.0
98	375.0	331.0	44.0	139.9	86.1	105.0
99	334.0	322.0	12.0	117.6	92.4	112.0
100	405.0	394.5	10.5	137.6	87.0	170.0
101	405.0	356.9	48.1	127.7	101.2	128.0
102	310.0	322.4	-12.4	128.4	90.4	103.6
103	310.6	343.3	-32.7	121.4	86.9	135.0
104	336.0	371.3	-35.3	134.2	85.2	152.0
105	340.0	345.4	-5.4	113.1	96.3	136.0
106	300.0	304.9	-4.9	125.6	77.8	101.5
107	386.3	382.6	3.6	135.3	92.3	155.0
108	430.0	361.5	68.5	119.3	98.1	144.0
109	375.0	323.2	51.8	134.0	87.8	101.5
110	404.0	346.3	57.7	125.3	81.1	140.0
111	435.0	403.3	31.7	137.6	95.7	170.0
112	330.0	327.9	2.1	129.7	86.3	112.0
113	405.0	384.6	20.4	136.0	93.6	155.0
114	380.0	362.4	17.6	126.5	91.9	144.0
115	282.5	268.2	14.4	103.0	77.2	88.0
116	346.0	355.1	-9.1	127.6	87.5	140.0
117	430.0	385.1	44.9	133.0	97.1	155.0
118	295.0	283.7	11.3	122.6	73.6	87.5
119	380.0	385.6	-5.6	138.5	82.1	165.0
120	367.5	361.8	5.7	135.1	94.7	132.0
121	240.0	248.3	-8.3	107.8	63.5	77.0
122	316.0	337.4	-21.4	119.6	77.8	140.0
123	210.0	226.9	-16.9	106.1	64.7	56.0
124	405.0	391.5	13.5	127.2	104.4	160.0
125	389.0	362.5	26.5	128.8	78.7	155.0
126	287.5	279.0	8.5	106.9	72.1	100.0
127	368.0	394.2	-26.2	137.2	92.0	165.0
128	335.0	340.1	-5.1	140.6	83.6	116.0
129	350.0	365.3	-15.3	129.2	92.1	144.0
130	350.0	349.4	0.6	137.3	90.6	121.5
131	406.0	380.5	25.5	126.7	83.8	170.0
132	375.0	361.7	13.3	146.9	78.9	136.0

133	395.0	359.9	35.1	114.0	90.9	155.0
134	334.0	347.0	-13.0	124.0	73.0	150.0
135	350.0	371.0	-21.0	148.3	90.7	132.0
136	387.0	368.9	18.1	131.6	77.3	160.0
137	356.0	402.1	-46.1	136.1	91.0	175.0
138	389.0	353.5	35.5	127.8	89.7	136.0
139	433.0	400.0	33.0	131.9	93.1	175.0
140	375.0	350.8	24.2	124.0	82.8	144.0
141	420.0	365.5	54.5	132.4	68.0	165.0
142	305.0	322.2	-17.2	115.9	78.3	128.0
143	425.0	396.4	28.6	138.4	88.0	170.0
144	303.0	335.4	-32.4	117.2	74.1	144.0
145	358.0	352.2	5.8	127.7	88.6	136.0
146	350.0	343.2	6.8	127.5	79.7	136.0
147	351.5	371.1	-19.6	129.2	94.0	148.0
148	375.0	338.5	36.5	123.2	79.3	136.0
149	376.3	377.0	-0.8	133.2	99.8	144.0
150	319.0	323.4	-4.4	124.6	70.8	128.0
151	357.5	369.8	-12.3	117.4	90.5	162.0
152	345.0	345.1	-0.1	130.2	79.9	135.0
153	340.0	358.9	-18.9	129.8	93.1	136.0
154	325.0	281.9	43.1	140.3	63.1	78.5
155	376.3	363.0	13.3	130.5	96.5	136.0
156	315.0	350.5	-35.5	142.7	57.8	150.0
157	340.0	348.0	-8.0	127.0	77.0	144.0
158	288.5	336.7	-48.2	136.6	72.1	128.0
159	354.0	354.2	-0.2	124.1	80.1	150.0
160	346.0	363.1	-17.1	128.4	101.8	133.0
161	412.5	404.7	7.8	140.6	89.1	175.0
162	243.8	228.9	14.9	115.1	58.8	55.0
163	330.0	352.9	-22.9	120.7	100.2	132.0
164	345.0	347.6	-2.6	148.3	67.3	132.0
165	389.0	354.0	35.0	132.7	85.3	136.0
166	340.0	376.9	-36.9	132.3	69.6	175.0
167	310.0	360.1	-50.1	129.8	87.8	142.5
168	345.0	341.0	4.0	139.2	76.8	125.0
169	353.0	364.4	-11.4	149.8	84.6	130.0
170	360.0	365.8	-5.8	141.0	91.8	133.0
Average	362.2	351.7	10.5	128.5	84.4	138.8