AN ECONOMIC ANALYSIS OF MAJOR VEGETABLES IN TIRUPUR DISTRICT

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Thesis submitted in part fulfillment of the requirements for the degree of
MASTER OF SCIENCE (AGRICULTURE) IN AGRICULTURAL ECONOMICS
to the Tamil Nadu Agricultural University, Coimbatore.

DEPARTMENT OF AGRICULTURAL ECONOMICS
AGRICULTURAL COLLEGE AND RESEARCH INSTITUTE
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CERTIFICATE

This is to certify that the thesis entitled **"AN ECONOMIC ANALYSIS OF MAJOR VEGETABLES IN TIRUPUR DISTRICT "** submitted in part fulfillment of the requirements for the degree of **MASTER OF SCIENCE (AGRICULTURE) IN AGRICULTURAL ECONOMICS** to the Tamil Nadu Agricultural University, Coimbatore is a record of *bonafide* research work carried out by **Ms. C. SATHYA** under my supervision and guidance and that no part of this thesis has been submitted for the award of any other degree, diploma, fellowship or other similar titles or prizes and that the work has not been published in part or full in any scientific or popular journal or magazine.

Place: Madurai **Dr. T.ALAGUMANI**
Date: **(Chairman)**

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Date: **EXTERNAL EXAMINER**

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(C. SATHYA)

ABSTRACT

AN ECONOMIC ANALYSIS OF MAJOR VEGETABLES IN TIRUPUR DISTRICT

By
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Degree	:	**MASTER OF SCIENCE IN (AGRICULTURE) AGRICULTURAL ECONOMICS**
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Year	:	**2011**

Vegetables play an important role both in regional and national economy of India. India is the second largest producer of vegetables in the world (ranks next to China) and accounts for about 13.4 per cent of the world's production of vegetables. The present production is not sufficient to meet the average per capita requirement of 285g of vegetables per day. Therefore, it is necessary to increase the production of vegetable crops at a much faster rate mainly by increasing the productivity. Considering the importance of vegetable farming, the present study was taken up with the following specific objectives. To examine the costs and returns of major vegetables, to assess the effect of technology (Drip irrigation) on vegetable production, to find out the resource use efficiency and technical efficiency of major vegetables, to trace the marketing channel and estimate the price spread for major vegetables and to identify the constraints in vegetable production and marketing and suggest measures for improvement.

Tirupur district is the universe of the study. Among six taluks of Tirupur district, Udumalpet taluk was selected for this study, because it had more area under vegetable farming in 2008-09. Tomato, Bhendi and Beetroot are major vegetables grown in the study area. Udumalpet taluk comprises three firkas viz. udumalpet, kuruchikottai and periavalavadi. From each firka, two villages were selected purposively based on the criteria of larger area under vegetable cultivation. Chinnaveramppatty, Periyakottai from Udumalpet firka, Kurichikottai, Andiakondanur from Kurichikottai firka and

Periyavalavadi, Modakkupatty from Periavalavadi firka were selected. From each village, 15 vegetable farmers were selected at random. The intermediaries involved in marketing of vegetables are commission agent, wholesaler cum retailer and retailer. From each category ten intermediaries are selected at random. Thus the total sample size was 90 farmers and 30 intermediaries.

The primary data on general characteristics of sample farmers, inputs used, and cost of cultivation and marketing details of sample farmers were collected by personal interview using pre-tested interview schedule for the agricultural year 2009-10.

The average yield of Drip Irrigated Tomato (DIT) was 68.36 t/ha and Conventional Irrigated Tomato (CIT) was 54.77 t/ha. The yield of DIT was 24.81 per cent higher than CIT. The total cost of cultivation per hectare of CIT (Rs.80,753.26) was higher than DIT (Rs.75,651.36). But net income realized was higher in DIT (Rs.1,662.01) than in CIT (Rs.1,016.73). The net gain of DIT over CIT was Rs.61, 133.75 per hectare. The total cost of cultivation per hectare was Rs.66, 420.70 for bhendi and Rs.61, 607.18 for beet root. Net income from bhendi crop was Rs. 55,879.30 per hectare and beet root crop was Rs. 1,58,307.82 per hectare.

To study the influence of various production factors on the yield of vegetables Cobb-Douglas production function was employed. For all vegetable farms, the yield of vegetable was the dependent variable and the explanatory variables were quantity of nitrogenous, phosphorus, potassium fertilizer, number of irrigations (not included in DIT), plant protection chemicals and human labourers. The functional analysis has indicated significant influence of quantity of nitrogenous, phosphorus, potassium fertilizers and plant protection chemicals on the return of tomato under drip irrigation. MVP/MIC ratios of nitrogeneous, phosphorus and potassium fertilizer have been found much higher, indicating scope for increase the profitability in tomato production under drip irrigation whereas in case of conventional irrigation, only nitrogeneous and potassium fertilizer have shown sufficient scope to raise the tomato yield.

In bhendi and beet root functional analysis showed that the quantity of phosphorus fertilizer, potassium fertilizer, number of irrigations and plant protection chemicals were found to be positive and have significant influence on the yield of bhendi and quantity of seeds, phosphorus fertilizer, potassium fertilizer, number of irrigations and quantity plant protection chemicals were found to be positive and have significant influence on the yield of beet root. MVP/MIC ratios of phosphorus and potassium fertilizer have been found much higher in both bhendi and beet root crops, indicating scope for increase the profitability in bhendi and beet root by applying more quantity of these fertilizers.

Data Envelopment Analysis was attempted to measure the technical efficiency and scale efficiency in tomato production under drip and conventional irrigation. The average technical efficiency score was found to be 0.54 and 0.53 in tomato under drip and conventional irrigation, respectively. It indicates that the average drip irrigated farm and conventional irrigated farm was producing the potential output 72 t/ha, 56.80 t/ha respectively. It also indicates there is possibility to increase the output level by 46 per cent in drip irrigation and 47 per cent in conventional irrigation. The average scale efficiency score of drip irrigated tomato was 0.55 and conventional irrigated tomato was 0.53 which indicated that there was scope for increasing the yield of tomato farms to obtain the frontier output.

Three types of marketing channels were identified in the study area and price spread were estimated for each of the three marketing channels. The analysis price spread could reveal that the marketing channel I namely producer – consumer was the efficient marketing channel as it had highest farmer's share (97.70% for tomato, 98.20% for bhendi and 97.76% beet root) and lowest price spread (2.30% for tomato, 1.80% for bhendi and 2.24% beet root) compared to other marketing channels which might be due to absence of intermediaries. The next efficient marketing channel was Producer – Commission Agent – Retailer – Consumer. The major constraints faced by the vegetable growers were non-availability of hired labour. Price fluctuation and perishability of vegetables were the marketing constraints expressed by the sample farmers.

Some of the policy implications drawn from the study were providing loans at a lower interest and subsidies for water soluble fertilizers will increase the adoption drip irrigation. Tomato, Bhendi and Beet root crops were found to be profitable. Hence efforts should be taken by Agricultural Department to bring more area under tomato, bhendi and beet root cultivation. Increasing the number of farmers markets, establishing co-operative marketing society for the vegetables, providing storage facilities both in production and marketing centre, would prevent distress sale and wastage. These measures will reduce the price fluctuations over time and space.

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CHAPTER I

INTRODUCTION

"Farmers alone can win us prosperity, nobody else"

- Mahatma Gandhi

In India, agriculture is one of the strongholds of the economy, is the source of livelihood of almost two thirds of the workforce in the country. It accounted for 14.6 per cent of the country's gross domestic product (GDP) in 2009-10, and about 10.23 per cent of the total exports. Furthermore it provided employment to 58.2 per cent of the workforce.

According to the Annual Report 2009-10 of the Ministry of Agriculture, the total geographical area of India is 328.7 million hectares; of which 140.3 million hectares is net sown area, while 193.7 million hectares is the gross cropped area. During the Eleventh Five Year Plan an amount of US$ 19 billion has been allocated for the Ministry of Agriculture which was higher than the tenth year plan allocation.

India has become the world's largest producer of agricultural and horticultural commodities due to its favourable agro-climatic conditions and rich natural resource base. The horticulture sector has emerged as economically rewarding and most viable option in diversification of agriculture, thus enhancing the returns per unit of land and water, generating employment and providing food and nutritional security.

In today's era of diversification of agriculture, farmers are now shifting from traditional subsistence agriculture to commercial agriculture. Land holdings are in general small in our country. This makes a farmer to adopt vegetable production. Reasons for increasing importance and scope of vegetables are:

- Increasing awareness of people towards balanced diet and concept of nutritional security.

- Changing food habits of people and so their food baskets.

- Vegetables produce more biomass per unit area and fetch more prices per unit production so are more economical to grow.

Vegetables and Human Nutrition

Vegetables are one of the cheapest and richest sources of natural protective food. They play an important role in human nutrition and are indispensable for maintaining good health. An analysis of the nutritional studies has highlighted the importance of growing vegetables as a subsidiary food crop to cereals and pulses, because of its capacity to sustain human life, which are a rich source of carbohydrates, proteins, vitamins, iron, nicotinic acid and growth hormones. It was shown that vegetables are capable of making good our nutritional deficiencies in terms of vitamins and minerals, even in terms of calories or nutrients.

In present scenario, we talk about *'Nutritional security"*. The diversified and highly nutritive vegetables are of great importance in alleviating hunger and malnutrition. The significance of vegetables in human diet and nutrition is well recognized and the numbers of vegetarians are increasing in the world due to greater awareness of good health and nutritious healthy food.

Importance of Vegetables

Vegetables play an important role both in regional and national economy of India. They are quick growing and are plucked in large number of pickings, and gives immediate returns to the growers. The cultivation as such occupies an important place in the agricultural development and economy of the country. The yield of vegetable is three to four times higher as compared to the yield obtained from cereal crops per unit area because of short duration. The cultivation of the crops being labour intensive in nature, provide employment opportunities for the rural labour force. Further, small and marginal farmers, who form the majority of the cultivators, are able to obtain periodical income within short span of time.

Global Vegetable Production

The vegetables sector is characterised by variety, not only in terms of the diversity of crops but also in terms of where they are produced - in almost 200 countries all over the globe. Asia cultivates by far the most vegetables in the world and has also shown strongest growth over the last decade. Productivity improvements have been achieved in the vegetables sector for a variety of reasons, including the use of higher quality inputs (e.g. seeds), technological advances, better management skills and the increased use of covered vegetables production.

The global production of major vegetables was 966 million metric tonnes from an area of 55.85 million hectare (NHB, 2009). China is the largest producer of vegetables in the world followed by India and other producers are USA, Turkey, Iran, Russian Fed., Egypt, Italy, Spain, and Japan. Area, Production and Productivity of major vegetables in the world (2008-09) is presented in Appendix I.

Indian Scenario

India is the second largest producer of vegetables in the world (ranks next to China) and accounts for 13.37 per cent of the world's production of vegetables. The total area under horticultural crops in the country was 20.66 million hectares and the production was 214.7 million tonnes. The average productivity per hectare was around 10 tonnes in 2008-09. The production of vegetable was 129.07 million tonnes. The share of vegetable alone is 60 per cent from the total area of 7.98 million hectares and the average productivity per hectare was around 16 tonnes.

The present production is not sufficient to meet the average per capita requirement of 285g of vegetables per day. By the end of 2030, country will need 150 million tonnes of vegetables to meet its requirement of growing population. Therefore, it is necessary to increase the production of vegetable crops at a much faster rate mainly by increasing the productivity (Singh *et al.*, 2010).

Major states that contribute for vegetables production are West Bengal, Uttar Pradesh, Bihar, Orissa, Tamil Nadu, Gujarat, Karnataka, Maharastra, Andhra Pradesh, Assam and Jharkand. West Bengal ranks first both in area and production of vegetables. It was 13.13 lakh hectares and 224.56 lakh tonnes respectively during 2008-09 while the productivity was highest in Tamil Nadu with 30.4 tonnes/ha.

Area, production and productivity of vegetables in India are presented (1994-95 to 2008-09) in Appendix II. It is evident that production showed increasing trend due to more demand for vegetables in domestic and international market and the promotional schemes of Government of India (Fig.1.1.).

Area has shown a compound growth rate of 10.30 per cent and production with 10.40 per cent and productivity with 10.13 per cent. From these results, it could be concluded that performance of vegetables in terms of area, production and productivity was found to be promising. The horticulture sector has witnessed tremendous growth as a result of investment through National Horticultural Mission (NHM) and a number of other programmes. The deviation of production was 19.70 (1994-2009). Though coefficient of variation for production was 21.02 per cent, there was a high variation in production of vegetables.

Area, production and productivity of vegetables in Tamil Nadu are presented in Appendix III (2005-06 to 2008-09). In Tamil Nadu, total area under vegetables was 2.86 lakh hectares with production of 86.94 lakh tonnes and productivity was 30.39 tonnes/ha during 2008-09.

Current Status of Vegetable Production

Area, production and productivity of vegetables are presented in Table 1.1. It is evident that vegetable production had increased during the last 10 years (2000-2009), increased to 129.07 million tonnes from 90.82 million tonnes in 1999-2000. In terms of percentage it was 42.11. During the last ten years the productivity increase was only 6.57 per cent. The increase in vegetable production was contributed mainly by increase in area. The percentage was 33.22. The production had to be increased because of greater demand resulting from continuous growth in population, greater urbanization and increase in incomes, mainly disposable income. Besides, changes in prices of agricultural inputs and vegetables, development in roads, markets, storage and communication systems and social changes, like education and awareness of good health and vegetarian diet are the other factors contributing to greater demand for vegetables. Characteristically vegetables have instability in production caused by considerable variations in climate, mainly temperature and humidity, rainfall and availability of water for irrigation and incidence of diseases and insect pest. Unfortunately the supply and demand gaps are greatly varying due to fluctuations in production and prices.

Table 1.1 Change in Area, Production and Productivity of Vegetable crops in India between 1999-2000 and 2008-2009

Year	Area (million ha)	Production (million tonnes)	Productivity (tonnes/ha)
1999-2000	5.99	90.82	15.2
2008-2009	7.98	129.07	16.2
Increase in percentage	**33.22**	**42.11**	**6.57**

Problem focus

All the agricultural commodities face production and marketing problems due to fluctuating prices. The problem is all the more pronounced for vegetables, being highly perishable in nature and seasonal in production. Further, storage and processing facilities are at very low level in respect of vegetable crops. These problems provide a fertile ground for market imperfection and manipulative trade practices, with the result the producers often have to face an unfavourable terms of trade. An in-depth analysis of the production and marketing of vegetables, raised under irrigated conditions could throw light for identifying strategies for further development.

Western Tamil Nadu is one of the important vegetable cultivating regions of Tamil Nadu. Coimbatore, Erode, Tirupur and the Nilgiris districts lies on the Western part of Tamil Nadu. Among these Tirupur is recently formed district in October, 2008 and not much studies have been made on production and marketing of vegetables. In this context, the present study assumes importance. The general objective of this study to assess the profitability and efficiency of vegetables production and the specific objectives are,

Objectives of Study

i) To examine the costs and returns of major vegetables

ii) To assess the effect of technology (Drip irrigation) on vegetable production

iii) To find out the resource use efficiency and technical efficiency of major vegetables

iv) To trace the marketing channel and estimate the price spread for major vegetables and

v) To identify the constraints in vegetable production and marketing and suggest measures for improvement.

Hypotheses

The study is based on the premises of the following hypotheses

1. Vegetable cultivation is not profitable.

2. The new technologies does not increases returns in vegetable production.

3. Resource use efficiency and technical efficiency in vegetable cultivation is non significant.

4. There are no farm level constraints in production and marketing of vegetables.

Scope of the Study

The study on different aspects of production and marketing of selected vegetables would be useful to identify the costs, returns and resource use efficiencies in vegetable production and functioning of the market system. The results of the study would be of much help to make decisions on the allocation of the inputs and to overcome the limitations in the production of vegetables. The study would also help the farmers in taking decisions on the efficiency in valuing their produce to realise greater returns. The findings could be used to formulate suitable policy measures to improve production and marketing of the vegetable crops.

Limitations of the Study

The study is based on the primary data collected from sample farmers, commission agents, wholesalers and retailers by personal interview. As the farmers did not maintain proper records of farm business, they had to give information from their memory and hence there is possibility for recall bias. However efforts were taken to minimize such bias through cross checking the data when collected. The findings of the study may be considered appropriate for the situations prevailing in the study area and hence the results of this study are interpreted with the above limitation in view.

Organization of the Thesis

The study is organized in the following chapters.

Chapter I: Introduction

Describe the importance of the topic, problem focus, objectives, scope and limitations of the study.

Chapter II: Concepts and Review

Concepts used in the study along with a brief review of related past studies are presented.

Chapter III: Design of the study

Sampling, units of measurement, methodology and tools of analysis used in the study are described.

Chapter IV: Description of the study area

Agro-Climatic features, Socio-Economic factors, Schemes implemented for Horticulture development and infrastructure facilities available in the study area are presented.

Chapter V: Results and Discussion

Results of the study are presented and discussed and inferences are drawn.

Chapter VI: **Summary and Conclusion**

Summaries the study and includes conclusions and policy options.

CHAPTER II

CONCEPTS AND REVIEW

To develop clarity and comprehension in any study, it is necessary first to review the various concepts, research methodologies and analytical tools used by the researchers in earlier studies. Such attempt would help the researcher to have better and precise understanding of the perspectives of the research problem and would also facilitate the researcher to modify and improve the present analytical framework in the right direction to suit the problem situation. In this chapter review of the concepts, research methodology, tools analytical and findings of past studies relevant to the present study are presented under the following topics.

2.1. Costs and returns

  2.1.1. Fixed costs and Variable costs

  2.1.2. Returns

2.2. Drip irrigation

2.3. Production function

2.4. Resource use efficiency

2.5. Technical Efficiency

2.6. Data Envelopment Analysis

2.7. Marketing

2.8. Marketing Channel

2.9. Marketing Cost

2.10. Marketing Margin

2.11. Price spread

2.12. Constraints

2.1. Costs

Cost refers to the money value of effort expended or sacrifice made in producing an article or rendering a service or achieving a specific purpose.

Cost concepts are widely used because of their relevance in the decision – making process.

Commission on Agricultural Costs and Prices (1996) categorized the costs components as follows:

Cost A_1 = It included all actual expenses incurred in production in cash and kind by the farmer as detailed below

Value of hired labour

Value of bullock labour (both hired and owned)

Value of machine power (both hired and owned)

Value of seeds (both owned and purchased)

Value of insecticides and pesticides

Value of manure (both owned and purchased)

Value of fertilizers

Depreciation on implements and farm buildings

Irrigation charges

Land revenue

Cesses and other taxes

Interest on working capital

Miscellaneous expenses (electricity charges etc)

Cost A_2: Cost A_1 + rent paid for leased in land

Cost B_1: Cost A_2 + interest on value of owned capital assets (excluding land)

Cost B_2 : Cost B_1 + rental value of owned land

Cost C_1: Cost B_1 + imputed value of family labour

Cost C_2: Cost B_2 + imputed value of family labour

Cost C_3: (Cost $C_2 \times 0.10$) + Cost C_2 (10 percent of Cost C_2 added to cost C_2): This is a recently added concept to provide allowance fro managerial functions undertaken by the farmer**.**

2.1.1. Fixed costs and Variable costs

Bishop and Toussaint (1958) classified two major categories of costs, namely fixed costs and variable costs. Costs which would be incurred even if no output were produced are referred to as fixed costs. Variable costs were incurred only if production is carried on, and the amount of these costs will depend on the kinds and quantities of inputs used.

Koutsoyiannis (1979) stated that in the traditional theory of the firm total costs are split into two groups: total fixed costs and total variable costs. The fixed costs included salaries of administrative staff, depreciation (wear and tear) of machinery, expenses for building depreciation and repairs, expenses for land maintenance and depreciation (if any). Variable costs included the raw materials, the cost of direct labour, the running expenses of fixed capital, such as fuel, ordinary repairs and routine maintenance.

Kahlon and Singh (1982) referred fixed cost as those costs which are of the recurring type and have to be incurred in every production period e.g., seed, fertilizers, insecticides, etc. Fixed costs are of non-recurring nature, e.g., cost of tractor, other machinery, buildings, irrigation structures, livestock, etc.

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Edgar and Jacquelene (1986) defined that the total cost is the sum of total fixed and total variable cost. Total fixed costs are the costs incurred by the firm that do not depend on how much output it produces. Total variable costs are the costs incurred by the firm that depend on how much output it produces.

Samuelson defined “fixed cost” represents the total dollar expense that goes on even when a zero output is produced. It is often called “over head cost” and it induced contractual commitments for mental, maintenance, depreciation, overhead salaries and wages, etc. “variable cost” represents all items of total cost except for fixed cost. It included raw materials, wages, fuel, etc.

Dewett and Varma (2004) stated that the cost of production of a commodity is composed of two types of costs: variable costs and fixed costs, also called prime and supplementary costs respectively. Prime or variable costs included the money cost of the raw material used in making a commodity, the wages of the labour directly spent on it, and the extra wear and tear of the machine that makes it. The supplementary or fixed costs do not vary with the volume of production. Whatever the quantity of goods produced, big or small, charges on account of rent, taxes, interest, salaries, etc., must be paid.

Jehle and Reny (2006) defined the optimized cost of the variable inputs called total variable cost. The cost of the fixed inputs called total fixed cost.

Rohit *et al.* (2006) referred the variable costs incurred on seeds, fertilizers, FYM, plant protection chemicals, electricity / diesel charges for irrigation, human labour, animal labour, machinery hours and interest on working capital. The fixed costs constitute interest on fixed capital, depreciation, land rent and repair charges.

Johl and Kapur (2009) categorized that costs namely (i) fixed costs and (ii) variable cost. Fixed costs are those which do not change in magnitude as the amount of output of the production process changes and are incurred even when production is not undertaken. Variable costs are the costs of using the variable inputs. These costs vary with the level of production.

According to Ahuja (2010) fixed costs as those which are incurred in hiring the fixed factors of production whose amount would not be altered in the short run. Variable costs were those costs, which were incurred on the employment of variable factors of production whose amount could be altered in the short run.

Dewett and Navalur (2010) defined fixed costs must be paid even though production has been stopped temporarily. It consists of rent of the factory building interest on capital invested in machinery and salaries of the permanently employed staff. Variable costs vary with output. It consists of raw materials used in the making of the commodity as well as the costs of casual or daily labour employed.

Jeyanthi (2002) used fixed and variable cost approach for estimating the cost of cultivation of tissue culture banana (TCB) and sucker propagated banana (SPB). The variable costs incurred in TCB were Rs. 1, 25,180.42 and SPB were Rs. 92,224.53 per hectare. The fixed cost in TCB was Rs. 15,859.43 and in SPB Rs. 16,069.12 per hectare.

Nalini rajan kumar *et al.,* (2008) estimated the total variable cost of potato cultivation was Rs. 65,077 per hectare and cost of production was Rs. 256,50 per quintal.

Smitha *et al.,* (2008) analysed the establishment cost and cultivation cost for Anthurium cultivation in organised sector and unorganised sector. They divided the cost of cultivation into operational cost, fixed cost and marketing cost. The total cost of cultivation was Rs. 10.9 lakhs in organised sector and Rs. 3.27 lakhs in unorganised sector. From the total cost of cultivation, fixed cost accounted 83.8 per cent in organised sector and 89 per cent in unorganised sector, the operation cost was 10.4 per cent in organised sector and 10.9 per cent in unorganised sector and the marketing cost was 5 per cent in organized sector.

Pravin (2008) estimated fixed and variable costs in drip and conventional irrigated sugarcane. Fixed costs including the items such as rental value, land revenue, depreciation on fixed investment and interest on fixed capital and variable costs was the sum of cost of ploughing, setts, manures, plant protection chemicals, human labour and interest on working capital.

Singh and Anupama (2010) worked out cost of cultivation in tomato (kharif and rabi) which includes fixed and variable costs. Cost of cultivation for kharif and rabi tomato was Rs. 26,011 and Rs. 23,523 per hectare, respectively. They also stated proportion of fixed and variable costs were 15 and 85 per cent in kharif tomato and 17 and 83 per cent in rabi tomato.

In the present study, fixed cost is the sum of rental value of land, land revenue, depreciation on fixed investment, and interest on fixed capital. Variable costs includes cost on ploughing, seeds, manures and manuring, plant protection, human labourer and interest on working capital.

2.1.2. Returns

Kahlon and Karam Singh (1982) defined that gross income is a measure of the size as well as of the volume of business. It is derived by adding together gross sales, home consumption of farm products, changes in inventory and purchases.

According to Subba Reddy *et al.* (2004) gross income is derived by sale of main product as well as by products from the enterprises taken up by the farmer in a year. It included the value of home consumed products plus the value of products sold.

Sreenivasa murthy *et al.* (2004) stated the net price received by the farmer is estimated as the difference in gross price received by him and sum of his marketing costs and value loss during harvesting, grading, transit and marketing.

Rohit *et al.* (2006) worked out gross return by multiplying the total output with price received by farmers and the net returns were calculated by deducting the total costs from gross returns.

Johl and Kapoor (2009) defined that gross returns are equal to total production times the price. Returns to fixed farm resources are equal to gross returns minus variable costs. These are also known as returns over variable costs. Net returns are equal to gross returns minus all costs (fixed and variable; cash and kind).

Singh and Anupama (2010) studied production and marketing of tomato in Kanke block of Ranchi district. They estimated the gross income from kharif and rabi tomato and it was Rs. 42,974 and Rs. 43,826 per hectare, respectively. The net income was Rs. 16,963 in kharif tomato and Rs. 20,303 in rabi tomato.

Nalini rajan kumar *et al.,* (2008) found the net return of potato was about Rs. 48,874 per hectare over variable cost in potato cultivation.

In the present study, gross income was calculated by the quantity of vegetables harvested in each harvest multiplied by the respective weekly average prices and the gross income was obtained by adding the value of produce in all the harvest. Net income is the difference between the gross income and total cost.

2.2. Drip irrigation

Narayanamoorthy (2005), studied the economics of drip irrigation in sugarcane cultivation. He found that the drip method of irrigation (DMI) has many advantages over flood method of irrigation (FMI). While the productivity gains due to drip method of irrigation is about 54 per cent (30 tonnes / ac), water saving due to DMI comes to about 58 per cent over flood method of irrigation, that leads to reduction in cost of cultivation to the tune of Rs. 3,450 per acre particularly in operations like weeding, interculture and irrigation cost (both labour and other costs).

Vijay K. Choudhary *et al.*, (2010) studied the comparative economics of drip irrigation and conventional method of irrigation for vegetable crops in Chhattisgarh. They found that the cost of installation of drip irrigation system was Rs.80, 860 per hectare and the yield of all the vegetables was higher under drip irrigation than conventional method. The yield of tomato was 275 quintals per hectare in drip irrigation where as it was only 210 quintals in conventional method and also in brinjal the yield was 300 quintals per hectare in drip irrigation and only 240 quintals in conventional method.

2.3. Production function

Bishop and Toussaint (1958) defined production function is a mathematical relationship describing the way in which the quantity of a particular product depends upon the quantities of particular input used.

Bilas (1971) stated that production function is a physical relationship between firm's inputs of resources and its output of goods and services per unit of time.

Baumol and Blinder (1979) defined that production function indicates the maximum amount of product that can be obtained from any specified combination of inputs, given the current state of knowledge.

According to Koutsoviannis (1979) production function is purely a technical relationship between factor inputs and outputs. It would describe the transformation of factor inputs into products at any particular time period.

According to Ahuja (1979) the functional relationship between physical inputs and physical output of a firm is known as production function.

Browning and Browning (1986) stated production function identifies the maximum quantity of a commodity that can be produced per time period by each specific combination of inputs.

Venkata reddy (1990) defined production function is purely a technical concept, which expresses physical relationships of maximum quantities of well defined physical output obtainable from all the technologically feasible combinations of equally well defined factors under given state of technology.

Raju and Rao (1990) defined production function is a technical and mathematical relationship, describing the manner and extent to which a particular product depends upon the quantities of inputs or services of inputs, used at a given level of technology and in a given period of time.

Johl and Kapoor (1997), stated production function is a technical and mathematical relationship describing the manner and extent to which a particular product depends upon the quantities or services of input used.

According to Samuelson (1998), the production function is the technical relationship telling the maximum amount of output capable of being produced by each and every set of specified inputs (or factors of production). It is defined for a given state of technical knowledge.

Dewett and Navalur (2010) stated production function as the functional relationship between physical inputs (i.e., factors of production) and physical outputs (i.e., the quantity of goods, produced).

Pansion *et al.* stated production function characterizes the causal relationship between input and output.

In the present study, the production function was defined as the mathematical relationship between the inputs used in production of vegetables to the output produced.

2.4. Resource use Efficiency

Raju (1985), evaluated resource use efficiency in cauliflower production by using Cobb-Douglas production function. He reported that the co-efficient of multiple determination was 0.94 which indicated that 94 per cent variation in production was explained by the selected independent variables such as land area, human labour, expenditure of FYM and chemical fertilizer, expenditure on pesticides and expenditure of electric charge.

Ganapathi Krishnan (1986) studied the resource use efficiency in rainfed tomato by using production function analysis. He reported that the co-efficient of multiple determination was 0.89 which indicated that 89 per cent variation in the output of rainfed tomato was explained by the independent variables such as land area, human labour, expenditure on manures and fertilizers, expenditure on plant protection chemicals.

Shunmugiah (2000) estimated resource use efficiency in lime cultivation by using Cobb-Douglas production function. The dependent variable was yield of lime (kg) while the explanatory variables were area under lime (ha), age of the tree (years) and quantity of manure (kg). Two functions were fitted, one for 5-9 years gardens and another for 10-20 years. He found that the co-efficient of multiple determination was 0.88 and 0.87 for 1^{st} and 2^{nd} group respectively. For 5-9 years gardens, the area under lime and age of trees were found to be significant and has positive influence on yield. For 10-20 years gardens, the area under lime, age of trees and manures had significant and positive influence on lime yield.

Jeyanthi (2002) studied the performance of tissue culture banana (TCB) with sucker propagated banana (SPB). She estimated Resource use efficiency by using Cobb-Douglas production function. The gross return per farm as dependent variable and sucker cost, cost of manures, fertilizer cost, labour cost, land area and dummy were the independent variables. From this function she found that the co-efficient of multiple determination (AdR^2) was 0.82 for TCB and 0.69 for SPB which indicated 82 per cent of variation in the gross return of TCB and 69 per cent of variation in the gross return of SCB was explained by the variables included in the model.

Govindarajan *et al.* (2002) analyzed the resource use efficiency in productivity levels of the field crops in various zones of Tamil Nadu. For their study, they selected three major crops of the state namely Paddy, Sugarcane and Groundnut. Labour wages formed a major portion (73-80 per cent) of the expenses incurred on farm power for paddy. In groundnut the same was as high as 84 per cent in the western zone. Among the farm resources seeds, capital and human labour had positive significant influence on the yields of paddy, sugarcane and groundnut, respectively.

Srinivas and Ramanathan (2005) studied the resource use efficiency in Elephant foot yam production by using Cobb-Douglas production function. They reported that co-efficient of multiple determination were 0.82, 0.86 and 0.56 for low land farmers in Kerala, irrigated farmers in Tamil Nadu and Andhra Pradesh respectively, which indicates that 56 to 82 per cent variations in gross income was influenced by the selected independent variables such as farm size, cost on human labour, family labour, planting material, manures, fertilizers and irrigation.

Duraisamy (2007) in his study used Stochastic Frontier Production function (MLE method) to study the technical efficiency in the production of crops. The mean technical efficiency levels of kharif paddy, rabi paddy, sugarcane, banana, maize and sorghum were 66.61 per cent, 72.68 per cent, 74.76 per cent, 74.27 per cent, 66.97 per cent and 74.32 percent respectively.

Pagire and Dangare (2008) estimated resource productivity of potato by using Cobb-Douglas production function. They found that the co-efficient for manures (0.124), phosphorous (0.409), other working capital (1.533) were positive and highly significant which indicted the scope to increase the quantity of the inputs in the production of potato.

Smitha *et al.*, (2008) studied Resource use efficiency in Anthurium cultivation by fitting Cobb- Douglas Production function. The gross return of Anthurium in rupees per ha as dependent variable and expenditure on fertilizers, labour, PPC and irrigation as independent variables. From this function they found that expenditure on PPC had significant influence on the variation in gross return in the organized sector and expenditure on fertilizer was the significant variable in the unorganized sector.

Rupasena *et al.* (2008) have estimated resource use efficiency in rice cultivation in three districts of Srilanka using Cobb-Douglas (CD) production function. Land, labour, seeds, fertilizer, plant protection chemicals were the explanatory variables used in CD production function. The results showed that seed was positively related with production while increase in fertilizer and labour had no impact on production in all the three districts. They have estimated profitability ratio (MVP / MFC) for labour and fertilizer and found that these were less than unity, which highlight that the additional expenditure on these inputs would reduce the revenue.

Arti sharma and Jyotikachroo (2009) studied the resource use efficiency in maize by using Cobb-Douglas production function. They reported that the co-efficient of multiple determination was 0.51 which indicated that 51 per cent of variation in production was explained by the selected independent variables such as fertilizers (N, P, K), FYM, human labour, capital and seeds. They found that the regression co-efficient of fertilizer (N, P, K), capital and seeds were significant and FYM, human labour were non-significant.

Tarunvir singh and Jyoti kachroo (2009) studied resource use efficiency in dry land maize by applying Cobb-Douglas production function. Yield of dry land maize were regressed on various factors of production viz area, seed, machine labour, FYM + fertilizer, human labour taken as the explanatory variables. They found that the regression co-efficient of area and FYM + fertilizer were 0.971 and 0.211 respectively which indicated that one percent increase in the use of these inputs could increase the return by 0.971 per cent and 0.2111 per cent, respectively. The negative sign of the regression co-efficient of human labour (-0.386) showed that one per cent additional expenditure on human labour would reduce the return by o.386 per cent.

In the present study, Cobb-Douglas production function was used to evaluate the resource use efficiency. Yield was taken as dependent variable and independent variables included quantity seeds, nitrogen, phosphorus, potash, plant protection chemicals, number of irrigation and mandays.

2.5. Technical efficiency

Mythili and Shanmugam (2000) studied the technical efficiency of rice production in Tamil Nadu by using stochastic frontier production function (MLE method). They found that the mean technical efficiency was 82 per cent, which indicates that on an average, the realized output can be increased by 18 per cent without any additional resources.

Shanmugam (2003) employed the stochastic frontier production function (MLE method) to estimate the technical efficiency of Rice, Groundnut and Cotton in Tamil Nadu. He reported that the mean technical efficiency values of rice I, rice II, irrigated groundnut, rainfed groundnut and cotton were 82 per cent, 82 per cent, 68 per cent, 76 per cent, 68 per cent respectively. The above results indicated there is considerable room for improvement in the productivity of the sample farms.

Rama Rao *et al.*(2003), examined the levels of technical efficiency in the production of three major crops namely rice, groundnut and cotton in the state of Andhra Pradesh. They used stochastic frontier production function (MLE method) to measure the technical efficiency by taking human labour, seed, fertilizer, FYM and plant protection chemicals as independent variables and yield as the dependent variable. They found that the mean technical efficiency was 85 per cent in rice, 79 per cent in groundnut, 72 per cent in Cotton. From this result they concluded that there was considerable scope to improve the yield of these crops in the existing conditions of input use and technology.

Reddy and Sen (2004) studied technical inefficiency in rice production and influence of farm specific socio-economic characteristics on inefficiency in the canal command area of Bihar state. They found that technical inefficiency of sample farms ranged between 6.67 and 66.42 per cent with an average of 25.55 per cent. The analysis indicates the scope to increase physical production of rice by 25.55 per cent with the judicious use of existing resources and technology. To reduce technical inefficiency in the production of rice and wheat, measures like encouraging co-operative type of farming, land consolidation, improving literacy rate, strengthening extension services and providing alternative employment opportunities should be taken up in the study area.

Laila Arjuman Ara *et al.* (2004) referred the technical efficiency is the ability of a firm to produce the maximum possible output from a given set of inputs and given technology.

Anupama *et al.* (2005) used stochastic frontier production function to estimate technical efficiency in maize production in Madhya Pradesh. They found that the mean technical efficiency was 77 per cent it implied that the maize output of the "average farmer" could be increased by 23 per cent by adopting the technology followed by the "best practice" farmers.

Surender Singh (2007) attempted to examine the farm specific technical efficiency of wheat cultivation in Haryana using stochastic frontier approach. The estimates of technical efficiency indicated a high degree of inefficiency in the production of wheat. The technical inefficiency worked out to be 27 per cent at the aggregate level and 25 per cent, 27 per cent and 26 per cent for small, medium and large – size farms, respectively.

Abate Bakele *et al.* (2009) employed stochastic frontier production to study the effect of technical efficiency on farm size in wheat production. The results revealed that large farmers were technically more efficient than small farmers with the mean technical efficiency of 0.84 and 0.76 respectively.

Anuradha Narala and Zala (2010), estimated the technical efficiency of Rice farms in Central Gujarat. The study has assessed the effect of farm – specific socio – economic factors. They used stochastic frontier production function to measure the technical efficiency by taking area, experience, education, number of working members in the family, contact with extension agencies, distance of field from canal structure as independent variable and technical efficiency as the dependent variable. The mean technical efficiency was 73 per cent in sample farms. They concluded that on an average, the realized output can be raised by 27 per cent without any additional resources.

Sekhon *et al.* (2010), examined the technical efficiency in different regions as well as in Punjab state by fitting stochastic frontier production function. The mean technical efficiency was 76 per cent in the Punjab state. They found that costs of human labour (0.2016) fertilizers (0.1465) and machinery (0.1462) influence the value of output of crops positively and significantly, whereas the coefficient of irrigation (-0.2184) was negative and significant, indicating the over-use of water in crop production in the state. The results showed possibility to increase the value of crop output by about 24 per cent with the given level of input use and technologies.

Manjeet kaur *et al.,* (2010), studied the technical efficiency in wheat production in different regions of Punjab using stochastic frontier production function. The study was conducted in semi- hilly region, central region, south- western region and Punjab state as a whole. Area under crop, expenditure on plant protection chemicals, irrigation, human labour used, quantity of fertilizer, regional dummies are the explanatory variables used. They found that the mean technical efficiency of wheat production was 87 per cent in semi hilly region, 94 per cent in central region, 86 per cent in south-western and 87 per cent in Punjab state as a whole.

2.6. Data Envelopment Analysis

Nasurudeen (2009) used Data Envelopment Analysis to measure the technical, allocative and scale efficiencies of paddy farms in the union territory of Pondicherry.

The results showed that the mean technical efficiency was 64 per cent, it indicated that the average farm was producing only about two-thirds of the potential output (i.e. 4185 kg/ha) and also indicates that there is possibility to increase the output level by 36 per cent in the short run. The mean allocative efficiency was 76 per cent, which indicated that rice farmers could reduce the costs by about 24 per cent (Rs. 4736) by adopting appropriate technologies and management practices. The average scale efficiency was 94 per cent, it indicated that there was a scope for increasing the yield of the rice farms to obtain the frontier output. The frequency distribution of scale efficiency revealed that 38.65 per cent of the farms were operating under most efficiency category (90-100 per cent) and only 4.18 per cent under least efficiency category (<50 per cent).

Sreenivasa Murthy *et al.,* (2009), have estimated technical efficiency and scale efficiencies of tomato in Karnataka using Data Envelopment Analysis (DEA). The study was conducted under three production situations, viz., Small, Medium and Large farms. DEA model was used at different production scales under the assumption of Constant returns to scale (CRS) and Variable returns to scale (VRS). In this study they used 0.9 or more than 0.9 as the cut-off score for efficient farms. They reported that the efficiency of small farms about 20 per cent under CRS and 43.3 per cent under VRS. As regarding to scale efficiency, 60 per cent of small farms were performed at the optimum scale or close to optimum scale. In case of medium farms they found 50 per cent of farms were efficient under CRS and 66.7 per cent under VRS and the optimum scale was marginally higher at 63.3 per cent than the small farms. The large category of farms was found 16.7 per cent efficient under CRS and 43 per cent efficient under VRS and optimum scale was 56 per cent. The above results indicated that the medium farms have higher technical efficiency in both CRS and VRS models because of their higher scale efficiency.

In the present study, data envelopment analysis was used to study the technical efficiency in tomato production under drip and conventional irrigation. Yield was taken as dependent variable and the explanatory variables included were seeds (g), nitrogen (kg), phosphorus (kg), potassium (kg), number of irrigation (not included in drip irrigation), plant protection chemicals (lit/ha), mandays, age of the farmer, years of education and experience.

2.7. Marketing

Kohls and Uhl (1972) defined food marketing as the performance of all business activities involved in the flow of food products and services from the point of initial agricultural production until they are in the hands of consumers.

Cundiff *et al.* (1985) defined marketing as the managerial process by which products are matched with markets and through which the consumer is enabled to use or enjoy the product.

Herman defined "marketing is the process of discovering the translating consumer needs and wants into product and service specifications, creating demand for these product and services, and then, in turns, expanding this demand.

Stanton defined "marketing is a total system of interacting business activities designed to plan, price, promote and distribute want satisfying products and services to present and potential customers.

Clark and Clark wrote that, "marketing consists of those efforts which effect transfer in ownership of goods and care for their physical distribution".

Richard Kohls defined, "Marketing is the performance of all business activities involved in the flow of goods and services from the point of initial agricultural production until they are in the hands of the ultimate consumer.

Committee of the American Marketing Association defined," Marketing includes all activities having to do with effecting changes in the ownership and possession of goods and services. It is that part of economics which deals with the creation of time and place and possession – utilities and that phase of business activity through which human wants are satisfied by the exchange of goods and services for some valuable consideration".

In this study, marketing is conceptualized as a set of activities carried out by the producer and all the intermediaries until the product reaches the consumer.

2.8. Marketing channel

A marketing channel is simply the path by which the commodity passes from producer to ultimate consumer or the manner in which the product is moved from one agency to another.

Cundiff *et al.* (1985) defined marketing channel is a path traced in the direct or indirect transfer of ownership to a product, as it moves from a producer to ultimate consumers.

Ganapathi Krishnan (1986), studied marketing of rainfed tomato in Veppanapalli Block. In this study he identified following marketing channels, viz., (i) producer – Retailer – consumer (ii) producer, commission agent – Retailer – consumer (iii) producer – wholesaler – commission agent @ Madras – retailer – madras – consumer (iv) producer – commission agent – wholesaler – retailer – consumer (v) producer – wholesaler – retailer – consumer. He stated the most efficient channel was channel I which showed a lowest value of technical efficiency index (13.26) and economically index (0.44).

Thakur *et al.* (1994) identified four following marketing channels in marketing of off season vegetables in Hills. Channel I comprised of producer, primary whole salers or commission agents, secondary wholesalers, retailers and consumers, Channel II comprised of producers, forwarding agents or commission agents, wholesalers, retailers and consumers, Channel III comprised of producers, retailers and consumers and Channel IV comprised of producers, village traders, wholesalers, retailers and consumers.

Ladaniya *et al.* (2003) in their study traced marketing channels for pomegranate. The major channels were (i) producer-commission agent – wholesaler – retailer – consumer, (ii) producer – co-operative society – commission agent – retailer – consumer, (iii) producer – commission agent (local) – trader (distant) – wholesaler – retailer – consumer.

Acharya and Agarwal (2004) viewed marketing channels as routes through which agricultural products move from producers to consumers. The length of the channel varies from commodity to commodity, depending on the quantity to be moved, the form of consumer demand and degree of regional specialization in production.

Randev (2008) stated marketing channels are routes / chain of intermediaries through which product moves from producers to consumers. His study revealed that among the different marketing channels used by the fruits / vegetable growers, mostly followed channels were (i) producer – forwarding agent –commission agent – wholesaler – Retailer – consumer, (ii) producer – pre –harvest contract – commission agent – wholesaler – Retailer – consumer and (iii) Producer – Co-operative / Association – Wholesaler – Retailer – Consumer.

Nalini Rajan Kumar *et al.,* (2008), studied marketing practices in cabbage and cauliflower in Coochbehar district of West Bengal. Mainly three marketing channels are involved in this area, (i) Producer - Forwarding agent / Commission agent cum Wholesaler - Secondary wholesaler – Retailer - Consumer, (ii) Producer - Commission agent cum Wholesaler - Retailer - Consumer, (iii) Producer – Retailer - Consumer. They concluded that channel II was the most important for both the cabbage and cauliflower in terms of quantity of these vegetables marketed. The estimated post harvest losses at farm level on weight and number basis were 3.4 and 6.1 per cent in cabbage and 5 and 7.9 per cent in cauliflower respectively.

Study conducted by Ganga *et al.* (2008) on marketing of Henna identified the following marketing channels, Channel I: Producer – Retailer – Consumer, Channel II: Producer – Village trader – Wholesaler – Retailer – Consumer, Channel III: Producer – commission agent / Broker – wholesaler / Export firm – consumer. Among these channels they found channel II is most important and popular channel.

Ahire and Bhonde (2008) identified six marketing channels for grapes. Channel V, Producer – Wholesaler – Retailer – Consumer, was the most common channel, through which 46.59 per cent of quantity was disposed.

Singh and Anupama (2010) stated marketing channels play an important role in marketing process i.e., the return over cost of production is higher in direct sale and decline with the increase in number of intermediaries in the marketing process.

Sharma *et al.* (2010) identified three marketing channels of walnut in Budgram district of Jammu and Kashmir. The channels were: (1) Producer – Retailer – Consumer; (2) Producer – Wholesaler – Retailer – Consumer; (3) Producer – Kachha / Arhatia – Wholesaler – Retailer – Consumer. They found that the most important channel is III, through which major share (50.87 per cent) of the total produce was marketed, followed by channel II (39.16 per cent).

Baba *et al*., (2010) conducted a study in Kashmir valley on vegetables marketing. They have selected five major vegetables viz., cauliflower, cabbage, kale, tomato and brinjal. They adopted multistage stratified random sampling technique for selection of 120 farmers. In this study they identified four marketing channels viz.,

(i) Producer - Consumer, (ii) Producer - Vendors/Retailer - Consumer, (iii) Producer - Pre-Harvest Contractor - Wholesaler - Retailer - Consumer, (iv) Producer - Wholesaler/Forwarding agent - Retailer - Consumer. They found that as expected farmers are benefited by selling directly to the consumers (Channel – I). Comparing other three channels it was found that channel II was the efficient one for all selected vegetables.

In the present study, marketing channel is defined as a path traced in the movement of vegetables from the producer to the ultimate consumer.

2.9. Marketing Cost

Marketing cost includes the expenses incurred on all functions or services bringing the produce from farmer to ultimate consumers.

According to Nawadkar *et al.* (1991) the marketing cost for vegetables include grading charges, packing charges, packing material, transport, Hamali, weighing, commission and miscellaneous expenditure.

Khemnar *et al.* (1994), in their study on tomato cultivation the marketing cost constituted the expenses on items like grading, packing, transportation, hamali, weighing charges, commission, market rent, postage etc. They found that per quintal cost of marketing of tomato was Rs. 95.46.

Thakur *et al.* (1994) explained the marketing cost of vegetable producers in marketing of off season vegetables. It included cost of grading and packaging, transportation, loading and unloading, commission charges and other costs including postage.

Ladaniya *et al.* (2003) stated that marketing cost incurred by the producer were commission, other marketing charges (market fee, auction etc.) packaging cost, transportation charges, processing cost and miscellaneous expenses. They found that packaging, long distance transportation and commission charges accounted for 90 per cent of the marketing costs.

Acharya and Agarwal (2004) stated marketing cost as the cost involved in moving the commodities from the producers to consumers in performing the various marketing functions and of operating various agencies.

Navadkar *et al.* (2005) explained that the marketing cost of vegetables involved grading, packing, transportation, commission of commission agent, commission of hundekari, postage and weighing charges. Among these costs they observed commission, transportation and packaging charges were the major items of total marketing cost.

Randev (2008) defined marketing cost as the summation of costs incurred on each marketing function.

Ganga *et al*. (2008) found that the total marketing cost for Henna ranged from Rs. 350 to Rs. 453 per quintal, cost of processing and packaging, commission, mandi fee, charges for gunny bags and transportation were accounted large share in total market cost.

Balaji *et al.* (2010) referred marketing cost as the actual expenses incurred by marketing agencies engaged in the distribution process.

Singh and Anupama (2010) explained that the marketing cost of tomato involved packaging cost, transport cost, market charges, labour cost and miscellaneous cost. They found that packaging cost and market charges were the most important marketing cost.

In the present study, marketing cost is defined as cost of moving vegetables from producer to consumer. It includes cost on packing, loading and unloading, transportation, commission charges, labour cost, market charges, and other miscellaneous cost incurred by producers and intermediaries.

2.10. Market margin

Acharya and Agarwal (2004) stated that marketing margin includes the cost involved in moving the product from the point of production to the point of consumption, that is the cost of performing the various marketing functions and of operating various agencies and profits of the various market functionaries involved in moving the produce from the initial point of production till it reaches the ultimate consumer. The absolute value of the marketing margin varies from channel to channel, market to market and time to time.

Sreenivasa murthy *et al.* (2004) referred the margins of market intermediaries include profit and return, which accrue to them for storage, the interest on capital and establishment after adjusting for the marketing loss due to handling.

Singh and Anupama (2010) defined marketing margin is the difference between the total payments (cost + purchase price) and receipts (sale price) of the middleman (the agency).

Balaji *et al.* (2010) stated the gross market margin is the difference between values of physical quantity equivalent at different levels of marketing. They also stated the marketing margins include all costs of assembling, processing, storage, transportation and handling, wholesaling, retailing, remuneration of the intermediaries, etc.

In the present study, marketing margin is conceptualized as the profit margins of various intermediaries involved in the marketing channel of vegetables.

2.11. Price spread

It covers all the expenses and profits of the marketing functionaries. It is the difference between the price paid by consumer and price received by the producer. Price spread consists of marketing cost and margin of the intermediaries.

Raju (1985) indentified two marketing channels for cauliflower in Oddanchatram block. Channel I comprised of producer, commission agent, terminal market wholesaler trader, retailer and consumer. Channel II comprised of producer, commission agent, retailer and consumer. He worked price spread for both channels in three different markets namely Madurai, Salem, Trichy and also local market. He found that the farmers' share in consumer rupee was 43.4 per cent, 40.2 per cent, and 38.10 per cent for Madurai, Salem, Trichy markets in channel I and 64.1 per cent for local market in channel II.

Ganapathi Krishnan (1986), reported that the share of consumer price received by the producer was 75.84 per cent in producer – retailer – consumer (channel I), 65.4 per cent in producer – commission agent @ madras – Retailer @ madras – consumer (channel II), 43.38 per cent in producer – commission agent – wholesaler – retailer – consumer (channel-III) and 61.7 per cent in producers – wholesaler – retailer

– consumer (channe-IV). It could be observed that the producers' share declined in channels I, II, V, IV and III. The above results showed that, in rainfed tomato marketing the price spread increased with the increase in number of market intermediaries.

Ravichandran (1991), evaluated price spread of dry chillies in Kamarajar district. He found that the producer's share in consumer price was 62.74 per cent in Channel I: producer – commission agent – wholesaler – retailer – consumer, 60.66 per cent in Channel II: producer – village merchant – commission agent – wholesaler – retailer – consumer, and 66.14 per cent in Channel III: producer – regulated market – wholesaler – retailer – consumer. The results showed that the producer's share was highest in channel III when compared to channel I and II.

Chahal and Gill (1991) referred the price spread is the difference between the price received by the producer and the price paid by the consumer for a given commodity in a market at a point of time. The market is said to be efficient if the price spread is minimum.

Nawadkar *et al.* (1991) studied marketing of vegetables in Pune and Bombay markets. They referred price spread gives the information on the prices paid and received by all the concerned and marketing expenses incurred by each of them. They revealed that the producer's share in consumer's rupee were 41.10, 40.72, 53.94, 48.47, 58.79 and 72.69 per cent, respectively for tomatoes, cabbage, cauliflower, bhendi, brinjal and onion sold at Pune market while they were 23.07, 29.50, 29.61, 40.19, 42.78 and 53.12 per cent for the respective vegetables sold at Bombay.

Thakur *et al.*(1994) studied off season vegetable production and marketing in Hills. They stated that the producer's share in the consumers' rupee refers to how much price is actually obtained by the farmers for their produce out of the final price paid by the consumer or charged by the retailers.

Bhupal (2000), analysed the changing market structure, marketing practices and price spread with regard to selected vegetables in Azadpur vegetable market of Delhi over a period of time 1987-88 to 1997-98. In the 1989 study smallest price spread was observed in the direct sale from Producer to Consumer. About 89 per cent share of the consumers' price was observed going to the producer and the rest was incurred on the marketing cost of vegetables. In case of marketing channel involving the Mashakhore (small wholesaler) the producer of cauliflower got as much as 75 per cent net of cost of the price paid by the consumer. However with entry of Retailer along with Mashakhores net profit declined to 7.5 per cent from 12.5 per cent. In case of potato, Wholesaler / Commission agent, Mashakhore and Retailer were involved in potato trading. In 1989, the net of costs share of the producer in consumer's price was 45 per cent; commission agent got 6 per cent which is statutorily fixed. But the wholesaler cum commission agent managed to increase his net profit to 9.61 per cent (gross 16.57 per cent) mashakhore got net 12.37 per cent and the retailers' net share was 13.61 per cent. Through the same channel producer's share in 1999 has come down to 37 percent, mashakhore's to 3 per cent and the retailer's share has gone up to 43.69 per cent and 39.19 per cent net of costs. From the above results he concluded that retailer / vendor has increased its share tremendously in the consumer's price and mostly at the cost of producer as well as purchaser.

Sundar (2002) in his study of Gloriosa identified two major marketing channels viz., (i) producer – village merchant – exporter – importers and (ii) producer – commission agent cum traders – exporters – importers. He found that the price spread in both the Channels was around 37 per cent.

Randev (2008) stated that the difference between the price paid by the consumer and price received by the producer for an equivalent quantity of the product known as farm – retail spread or price spread.

Sanjeev Kumar *et al.*. (2008) estimated price spread in selected vegetables. Marketing channel, started with the vegetable farmers, passes through commission agent, wholesaler cum retailer, retailer and ended with the ultimate consumer. The price spread was higher for tomato (72.85%) compared to brinjal (49.76%), bhendi (44.73%) and cauliflower (42.99%). They stated higher price spread for tomato is due to its perishability and higher fluctuations in prices.

Gaganjot singh and Chahal, (2008) studied Green Chilli marketing in Amristar and Patiala districts of Punjab. They selected two marketing channels for their study, (i) Producer - Itinerant merchant / local trader – Wholesaler – Retailer - Consumer, (ii) Producer – Wholesaler – Retailer – Consumer. They reported that, in Channel I the producer received Rs.550 and Rs.625 per quintal for the produce at Patiala and Amristar markets respectively. In Channel II the producer received Rs.650 per quintal at Patiala market and Rs.735 per quintal at Amristar market. The above results clearly indicated that in Channel II the producer received higher share in the consumer's rupee in both the markets.

Singh and Anupama (2010) studied production and marketing of tomato in Kanke block of Ranchi district. They identified three main channels in the marketing of tomato. Channel I comprised of producer and consumer, Channel II comprised of producer, wholesaler and consumer, Channel III comprised of producer, wholesaler, retailer and consumer. They found that in channel I the producer's net share was 96 per cent of consumer price in marginal farms. In small farmers the producer's net share was 94 per cent, 55 per cent, 44.35 per cent of consumer's price in Channel, I, Channel II and Channel III respectively.

In the present study, price spread is defined as the difference between the price received by the producer and the price paid by the ultimate consumer and it is expressed in percentage to consumer's price.

2.12. Constraints

Raju (1985), used Garrett's ranking method to rank constraints faced by the farmers production and marketing of cauliflower. Non availability of good quality seeds, more pest problem, erratic maturity, non-availability of labour, fluctuation in price, high commission, absence of grading and transport facility were included in the study.

Ganapathi Krishnan (1986), identified the problems encountered by the farmers in production of rainfed tomato viz., (i) perishability, (ii) water scarcity, (iii) loss due to heavy rain (iv) incidence of pest and disease, (v) labour scarcity, (vi) fruit setting, (vii) high fertilizer consumption, (viii) high cost of seed and (ix) non-availability of good seed and also he identified the problems in marketing of rainfed tomato. They were (i) absence of assured market, (ii) price fluctuation, (iii) absence of grading, (iv) transport cost, (v) poor road and (vi) too many intermediaries.

Thakur *et al.* (1994) identified problems faced by the farmers in production and marketing of off-season vegetables in Hills. Production constraints are (i) Inadequate or no irrigation facilities, (2) shortage of labour, (3) fertilizers (Not available in time and lack of finance), (4) Lack of good quality seed in sufficient quantity, (5) Lack of mobile soil testing lab, (6) High cost and non availability of pesticides and weedicides and (7) Lack of latest technical know-how, extension and crop loans. The marketing problems are (1) unorganized marketing and low prices paid to farmers, (2) Malpractices, high and undue marketing margins and deductions in the market, (3) lack of mechanical grading, packing and proper storage facilities, (4) lack of village roads, sufficient and low cost transportation facilities, (5) lack of market information and market news, (6) lack of price regulation and control and (7) lack of processing units and cooperative societies.

Navadkar *et al.* (2005) studied marketing of vegetables in Pune city. They found that the important constraints faced by the sample growers in marketing of selected vegetable were high cost of packaging material, absence of timely payment and malpractices adopted in the market.

Singh and Kumar (2008) studied the constraints in marketing of betel leaf. They stated most serious constraints were price fluctuation (100%), lack of organized marketing (97.29%), lack of market information (94.59%), lack of procurement centre at village level (90.54%), lack of transport infrastructure (85.75%), lack of institutional finance (83.76%), Bumper harvest of the crop (82.43), distantly located market (79.73%), lack of proper packaging facilities (78.83%) and lack of storage facilities.

Pawar and Hange (2008) examined the problems in production and marketing of medicinal and aromatic plants. They reported that unawareness of the agro-techniques, high cost of seed material, unavailability of crop loan, lack of market intelligence and low demand for the produce in the local markets were the important problems.

In the present study, the constraints related to production and marketing of vegetables were studied by using the Garrett ranking technique.

CHAPTER III

DESIGN OF THE STUDY

Designing of proper methodology is important to carry out a systematic analysis of any economic problem. This chapter presents the methodology followed for the selection of study area, choice of sample respondents, collection of data, measurement of variables and the tools of analysis of data relevant to the objectives of the study.

3.1. Selection of the Study Area

Western Tamil Nadu is one of the important vegetable cultivating regions of Tamil Nadu state. Coimbatore, Erode, Tirupur and Nilgiris districts lies on the Western part of Tamil Nadu. Tirupur is the recently formed district in this region. It was carved from Coimbatore and Erode districts in 2008. The universe of the study is Tirupur district.

Among six taluks of Tirupur district, udumalpet taluk was selected for this study (Fig.3.1.), because this taluk had more area under vegetables in 2008-09. Tomato, bhendi and beetroot vegetables are major vegetables. The farmers of this area preferred these crops as it can be raised all round the year. In this area not much studies have been made on production and marketing of vegetables.

3.2. Sampling Procedure

Udumalpet taluk comprises three firkas viz. udumalpet, kuruchikottai and periavalavadi (Fig.3.2.). From each firka, two villages were selected purposively based on the criteria of larger area under vegetable cultivation. Chinnaveramppatty, Periyakottai from Udumalpet firka, Kurichikottai, Andiakondanur from Kurichikottai firka and Periyavalavadi, Modakkupatty from Periavalavadi firka were selected. From each village, 15 farmers were selected at random. Thus the total sample size was 90. The details of distribution of sample farmers in the selected villages are given in Table 3.1. The sample farmers of Udumalpet firka are cultivating tomato under drip irrigation system and conventional irrigation.

Table 3.1 Distribution of Sample Farmers in the selected villages of Udumalpet Taluk

Sl. No	Name of the firka	Village Code	Name of sample villages	Number of respondents

1.	Udumalpet	V1 V2	Chinnaveramppatty, Periya Kottai	15 15
2.	Kurichikottai	V3 V4	Kurichikottai, Andiakondanur	15 15
3.	Periavalavadi	V5 V6	Periyavalavadi, Modakkupatty	15 15
			Total	**90**

The intermediaries involved in marketing of vegetables namely commission agent, wholesaler cum retailer and retailer. From each category ten intermediaries are selected at random. Thus the total sample size was 30. The details of selection of intermediaries involved in vegetable marketing are given in Table 3.2.

Table 3.2 Selection of Intermediaries involved in marketing of vegetables in Udumalpet Taluk

Sl. No	Name of the intermediary	Number of respondents
1.	Commission Agent	10
2.	Wholesaler cum Retailer	10
3.	Retailer	10
	Total	**30**

3.3. Period of Study

The study was undertaken during the month of November - December 2010 and the data were collected for the agricultural year 2009-2010.

3.4. Data Collection

A pilot survey of the study area was undertaken to acquire first hand knowledge about the area and the scope for a study. Based on the survey, an interview schedule was designed and pre-tested. Then suitable modifications were made in the interview schedule and finalised.

3.4.1. Primary Data

A well structured and pre-tested interview schedule was used to collect primary data. Two separate sets of interview schedules were prepared, one for farmers and another one for the intermediaries. Purpose of the survey was explained to the respondents to seek their co-operation and cross checks were made to minimise the error.

The interview schedule for farmers covered aspects such as family size, educational status, asset position, land holding pattern, cropping pattern, resource use and costs and returns of vegetable cultivation, details on marketing of vegetables and problems in production and marketing. The schedule for intermediaries covered aspects such as general characteristics, quantity of vegetables handled, cost incurred and profit realized by different market functionaries and the problems faced.

3.4.2. Secondary Data

The secondary data relating to the study area such as demography, physiography, soil type, climate, rainfall, irrigation potential, land use pattern, cropping pattern, distribution of land holdings and infrastructure facilities were collected from the official records of Assistant Director of Agriculture, Udumalpet, Joint Director of Agriculture, Tirupur and from other related websites.

3.5. Units of Measurement

3.5.1. Materials/Input cost

The seeds, manures, fertilizers, pesticides were valued at the actual price paid by the farmers.

Seeds:

The total quantity of seeds per hectare was expressed in grams for Tomato and kilograms for Bhendi and Beetroot.

Fertilizers:

It was measured as the total quantity of Nitrogenous fertilizer, Phosphorus fertilizer, Potassium fertilizer and other organic and inorganic fertilizers used for selected vegetable cultivation.

Cost of Pesticides:

It was the total expenses on insecticides and pesticides used in selected vegetable cultivation.

Human Labour:

The total number of male and female labourers employed for various operations in selected vegetable cultivation was expressed in terms of man days. The wages were valued at rupees paid to labourers for various operations.

Land:

Land was measured in terms of net area under selected vegetables in hectares. All the sample farms were owner operated. To include the share of land in cost of production, the prevailing market rate paid by neighbouring farmers in the respective villages were considered to impute the rental value of owned land.

Interest on working capital:

Components included in the working capital were cost of human labour, machine labour, manures and fertilizers, irrigation and plant protection material. Interest on working capital was computed at the rate of seven per cent which was the interest rate for crop loans.

Depreciation on fixed capital (other than land):

Depreciation on fixed capital was calculated by straight line method that is at the rate of five per cent for farm buildings and ten per cent for farm equipments and implements.

3.5.2. Yield and Income

Yield:

The total output of Tomato, Bhendi and Beetroot are collected from farmers. It is expressed in terms of tonnes per hectare.

Gross income:

The selected vegetables namely tomato, bhendi and beetroot are harvested at certain intervals. The number of harvest was 10-20 in tomato, 10-15 in bhendi and two in beetroot. The market prices of these vegetables are fluctuating in nature. In this study average weekly prices are considered to derive gross income. Quantity of vegetables harvested in each harvest was multiplied by the respective weekly average prices and the gross income was obtained by adding the value of produce in all the harvests.

Net income:

It was estimated by deducting total cost from gross income.

3.5.3. Cropping intensity

It is the ratio of sum of area planted under different crops and harvested in a single year, to the net cultivated area. The cropping intensity was expressed in percentage. The formula of cropping intensity is given below.

$$\text{Cropping intensity} = \frac{\text{Gross cropped area}}{\text{Net cropped area}} \times 100$$

3.6. Tools of Analysis

3.6.1. Conventional Analysis

The average and percentage analysis were used to examine the characteristics of sample farm households such as age, educational status, size of operational holdings, different cost components, cost of production and returns from the tomato, bhendi and beetroot.

3.6.2. Descriptive Statistics

Descriptive statistics was used for yield analysis of tomato, bhendi and beetroot. Descriptive statistics include mean, standard deviation and coefficient of variation of selected vegetables.

Mean

Mean is the value arrived by dividing the sum of observation by the total number of observations.

$$\overline{X} = \frac{X_1 + X_2 + ... + X_n}{n}$$

Standard deviation

Standard deviation is defined as the square root of the mean of the mean of the squared deviations of individual values from their mean.

$$\text{Standard deviation} = \sqrt{\frac{\sum_{i-1}^{n}(x_i - \bar{x})^2}{n-1}}$$

Coefficient of Variation

The coefficient of variation (CV) is defined as the ratio of the standard deviation to the mean.

$$\text{Co-efficient of Variation} = \frac{\text{Standard deviation}}{\text{Mean}} \times 100$$

3.6.3. Test of significance – Z Test

Z-test is a statistical test for large sample distribution.

$$Z = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\frac{S_1^2}{n_1} + \frac{S_2^2}{n_2}}}$$

where

$\bar{X}_1$ = Mean yield of drip irrigated tomato

$\bar{X}_2$ = Mean yield of drip conventional irrigated tomato

S_1 = Variance of drip irrigated tomato

S_2 = Variance of conventional irrigated tomato

n_1 = Number of farmers followed drip irrigated method

n_2 = Number of farmers followed drip irrigated method

3.6.4. Costs and Returns

3.6.4.1. Costs

To estimate the cost of cultivation of vegetables, cost approach was used. The total cost was classified as fixed costs and variable costs. Fixed cost included rental value of land, land revenue, depreciation on fixed investment and interest on fixed capital. The variable costs included cost on ploughing, seeds, manures and fertilizers, plant protection chemicals, human labour and interest on working capital.

3.6.4.2. Returns

Gross return was obtained by adding the value of produce in all the harvests. Net income was estimated as the difference between the gross return and total cost of cultivation.

3.6.5. Functional analysis

Resource use efficiency

To evaluate the resource use efficiency and estimate the marginal productivity, production function analysis was used. Production function analysis was used as an analytical tool to exhibit the relationship between inputs and outputs of sample farms and to arrive some judgment about the efficiency of prevalent factor proportions in production and also to suggest changes in these proportions in order to increase the efficiency.

Cobb-Douglas type of exponential production function was used with yield per hectare as dependent variable and inputs as independent variables. The Cobb-Douglas function used in this study is given below.

a) Cobb-Douglas Production function for Drip irrigated Tomato

$$Y = a\ X_1^{\beta 1}\ X_2^{\beta 2}\ X_3^{\beta 3}\ X_4^{\beta 4}\ X_5^{\beta 5}\ X_6^{\beta 6}\ e^U$$

Where,

Y = Yield of Tomato from DIC (t/ha)

X_1 = Quantity of seeds (g /ha)

X_2 = Quantity of Nitrogen (Kg /ha)

X_3 = Quantity of Phosphorous (Kg /ha)

X_4 = Quantity of Potassium (Kg /ha)

X_5 = Plant protection chemicals (lit/ha)

X_6 = Human labour (man days/ha)

U = Error term

a = Intercept

$\beta_1 \ldots\ldots\ldots \beta_6$ - Régression coefficients

b) **Cobb-Douglas Production function for Tomato (CIC), Bhendi and Beetroot**

$$Y = a\ X_1^{\beta 1}\ X_2^{\beta 2}\ X_3^{\beta 3}\ X_4^{\beta 4}\ X_5^{\beta 5}\ X_6^{\beta 6}\ X_7^{\beta 7}\ e^U$$

Where,

Y = Yield of Tomato (CIC)/Bhendi/Beetroot (t/ha)

X_1 = Quantity of seeds - tomato (g /ha)/ bhendi, beetroot (Kg /ha)

X_2 = Quantity of Nitrogen (Kg /ha)

X_3 = Quantity of Phosphorous (Kg /ha)

X_4 = Quantity of Potassium (Kg /ha)

X_5 = Number of irrigation

X_6 = Plant protection chemicals (lit/ha)

X_7 = Human labour (man days/ha)

U = Error term

a = Intercept

$\beta_1 \ldots\ldots\ldots \beta_7$ - Regression coefficients

Estimation procedure

The Ordinary Least Square (OLS method) is used for estimating the parameters associated with different independent variables. The estimable form of the Cobb-Douglas production function is formally expressed as.

$$\ln Y = \ln a + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + \beta_4 \ln X_4 + \beta_5 \ln X_5 + \beta_6 \ln X_6 + \beta_7 \ln X_7 + U$$

Marginal productivities of factors

Estimate of the parameters $\beta_1 \ldots \beta_7$ were elasticities of Y with respect of j^{th} input. The marginal products of the resources were derived from these elasticity coefficients.

The marginal productivities of significant inputs were worked out at its geometric mean level by using the formula

$$MVP_j = \beta_j \frac{\bar{Y}}{\bar{X}_j} P_y$$

Where,

MVP_j - Marginal value product of j^{th} product

$\bar{Y}$ - Geometric mean level of output (in tonnes)

$\bar{X}_j$ - Geometric mean of input 'j'

β_j - Estimated co-efficient of elasticities for j^{th} input

P_y - Price of output (Rs /tonnes)

Marginal Value Product (MVP) of each input was compared with its Marginal Input Cost (MIC) in order to estimate the resource use efficiency.

Equality of MVP_j to the MIC of input 'j' indicates the optimum use of jth input.

3.6.6. Data Envelopment Analysis

The DEA method is frontier method that does not require specification of a functional or distributional form, and can accommodate scale issues. This approach was first used by Farrell (1957) as a piecewise linear convex hull approach to frontier estimation and later by Bolls (1966) and Afrait (1972). This approach did not received wide attention till the publication of the paper by Charnes *et al.* (1978), which coined the term ***data envelopment analysis.*** A large number of papers have extended and applied the DEA technology in the western world. Very few studies have used this approach in India, especially in agriculture or horticulture for measuring efficiency. DEA method has the disadvantage that it does not explicitly accommodate the effect of data noise. In the present case, the DEA method was preferred because data noise was less of an issue as most of the variable in tomato production were included and because of ability to readily produced rich information on technical efficiency, scale efficiency and peers.

The DEA was applied by using both classic model CRS (Constant Returns to Scale) and VRS (Variable Returns to Scale) with input orientation, in which one seeks input minimization to obtain a particular product level. Under the assumptions of constant return to scale, the linear programming model for measuring the efficiency of tomato farms are (Coelli *et al.*, 1998):

$$\text{Min}_{\theta,\lambda}\ \theta$$

$$\text{Subject to}\quad -y_i + Y\lambda \geq 0$$

$$\theta x_i - X\lambda \geq 0$$

$$\lambda \geq 0 \qquad \text{..... (1)}$$

Where,

y_i is a vector (m x 1) of tomato output of the i th Tomato Producing Farms,

x_i is vector (k x1) of inputs of the i th Tomato Producing Farms,

Y is a tomato output matrix (n x m) for n Tomato Producing Farms,

X is the tomato input matrix (n x k) Tomato Producing Farms,

θ is the efficiency score, a scalar whose value will be the efficiency measure for the i^{th} tomato producing farms. If $\theta = 1$, tomato producing farms will be efficient; otherwise, it will be inefficient, and

λ is a vector (n x 1) whose values are calculated to obtain the optimum solution. For an inefficient tomato producing farms y values will be weights used in the linear combination of other, efficient, tomato producing farms, which influenced the projection of the inefficient tomato producing farms on calculated the frontier.

The specification of constant returns is only suitable when the firms work at the optimum scale. Otherwise, the measures of technical efficiency can be mistaken for scale efficiency, which considers all the types of returns to production, ie., increasing, constant and decreasing. Therefore, CRS model was reformulated by imposing the convexity constraint. The measure of technical efficiency obtained in the model with variable return is also named as “pure technical efficiency”, as it is free of scale effects. The following linear programming model estimated it:

$$\text{Min}_{\theta,\lambda}\ \theta$$

Subject to $- y_i + Y \lambda \geq 0$

$\theta x_i - X \lambda \geq 0$

$N_1 \lambda = 1$

$\lambda \geq 0$ ..… (2)

Where, N_1 is a vector (n x 1) of ones.

When there are differences between the values of efficiency scores in the models CRS and VRS, scale inefficiency is confirmed, indicating that return to scale is variable, i.e. it can be increasing or decreasing (Fare and Grosskopf, 1994). The scale efficiency values for each analysed unit can be obtained by the ratio between the scores for technical efficiency with constant and variable returns as follows:

$$\theta_s = \theta_{CRS} (X_{K,} Y_K) / \theta_{VRS} (X_{K,} Y_K) \quad \text{..… (3)}$$

Where,

$\theta_{CRS} (X_{K,} Y_K)$ = Technical efficiency for the model with constant returns,

$\theta_{VRS} (X_{K,} Y_K)$ = Technical efficiency for the model with variable returns, and

θ_s = Scale efficiency.

It was pointed out that model (2) makes no distinction as to whether tomato producing forms is operating in the range of increasing or decreasing returns (Coelli *et al.*, 1998). The only information one has is that if the value obtained by calculating in the scale efficiency in Equation (3) is equal to one, the tomato producing forms will be operating with constant returns to scale. However, when θs is smaller than one, increasing or decreasing return can occur. Therefore, to understand the nature of scale inefficiency, it is necessary to consider another problem of linear programming, i.e. the convexity constraint of model (2), $N_1\lambda = 1$, is replaced by $N_1 \lambda \leq 1$ for the case of non-increasing returns, or by $N_1 \lambda \geq 1$, for the model with non-decreasing returns. Therefore, in this work, the following models were also used for measuring the nature of efficiency.

Non-increasing returns:

$\text{Min}_{\theta, \lambda}\ \theta$

Subject to $- y_i + Y \lambda \geq 0$

$\theta x_i - X \lambda \geq 0$

$$N_1 \lambda \leq 1$$

$$\lambda \geq 0 \quad \text{..... (4)}$$

Non-decreasing returns:

$\text{Min}_{\theta, \lambda}\ \theta$

Subject to $\quad -y_i + Y\lambda \geq 0$

$$\theta x_i - X\lambda \geq 0$$

$$N_1 \lambda \geq 1$$

$$\lambda \geq 0 \quad \text{..... (5)}$$

It is to be stated here that all the above model should be solved n times, i.e. the model is solved for each tomato producing farms in the sample.

Tomato production (t/ha) was used as an output (Y) in the present case and seeds (g), nitrogen (kg), phosphorus (kg), potassium (kg), number of irrigation (not included in drip irrigation), plant protection chemicals (lit/ha) and mandays as inputs (X).

The computer program DEAP version 2.1 developed by T.J.Coelli, Centre for efficiency and productivity Analysis, University of New England, Australia, was used for the estimation of efficiencies in production.

Determinants of Technical Efficiency

Ray (1991) and Worthington and Dollery (1999), used traditional DEA in the first stage to estimate the technical efficiency and in the second stage estimated the determinants of technical efficiency by using econometric procedure.

In the present study, the technical efficiency values obtained from the DEA model considering CRS input oriented model were used for examined the relationship between technical efficiency and factors influencing. The technical efficiency score from CRS model was chosen as the dependent variable for it high accuracy in discriminating efficiency as compared to VRS (Goncnkves *et al.*, 2008). The explanatory variables included were seeds (g), nitrogen (kg), phosphorus (kg), potassium (kg), number of irrigation (not included in drip irrigation), plant protection chemicals (lit/ha), mandays, age of the farmer, years of education and experience. The traditional method of regression was used for this purpose and ordinary least square was carried out to estimate the regression equation. The regression model specified for the present study is given in Equation (6):

$$Y = a X_1^{b1} X_2^{b2} X_3^{b3} X_4^{b4} X_5^{b5} X_6^{b6} X_7^{b7} X_8^{b8} X_9^{b9} X_{10}^{b10} U \qquad \ldots\ldots (6)$$

Where,

Y	=	Technical efficiency score
X_1	=	Quantity of seeds (g /ha.)
X_2	=	Quantity of nitrogen (Kg /ha.)
X_3	=	Quantity of phosphorous (Kg /ha.)
X_4	=	Quantity of potash (Kg /ha.)
X_5	=	Number of irrigation (not included in drip irrigation)
X_6	=	Plant protection chemicals (lit/ha.)
X_7	=	Human labour (man days/ha.)
X_8	=	Age of the farmer
X_9	=	Years of education
X_{10}	=	Years of experience
U	=	Error term

a, b_1, b_2, …….. b_{10} are Parameters to be estimated

3.6.7. Price Spread Analysis

The cost involved in marketing of tomato, bhendi and beetroot at different stages of marketing channel were collected from the farmers and traders. The cost of marketing includes transport, loading and unloading, storage and other incidental expenses incurred for marketing the produce.

“Price spread” was defined as the difference between price paid by the consumer and the price received by the producer for an equivalent quantity of selected vegetables. Data on profits of the various market functionaries involved in moving the produce from the initial point of production till it reached the ultimate consumer were collected. In this study, sum-of-average gross margin method was used in the estimation of price spread.

a. Sum-of-Average Gross Margin Method

The average gross margins of all the intermediaries were added to obtain the total marketing margin as well as the break up of the consumer's rupee.

$$MT = \sum_{i=1}^{n} \frac{S_i - P_i}{Q_i}$$

Where,

MT = Total Marketing Margin

S_i = Sale value of a product for i^{th} intermediary

P_i = Purchase value paid by the i^{th} intermediary

Q_i = Quantity of the product handled by the i^{th} intermediary

i = 1, 2, 3 … N (Number of intermediaries involved)

b. Farmer's Share in Consumer Rupee

Further, the Farmer's share in consumer rupee was calculated with the help of the following formula.

$$Fs = (Fp/Cp) \times 100$$

Where,

Fs = Farmer's share in consumer rupee (percentage)

Fp = Farmer's price

Cp = consumer's price

3.6.8. Garrett's ranking technique

Garrett (1965) suggested a scoring technique procedure for converting the ranks into scores when the number of items ranked differs from respondent to respondent. The respondents were asked to rank the problems in tomato, bhendi and beetroot production and marketing. In the Garrett's ranking technique these ranks were converted into percent position by using the formula,

$$\text{Percentage position} = \frac{100\,(R_{ij} - 0.5)}{N_j}$$

Where,

R_{ij} = Rank given for i^{th} factor by j^{th} individual

N_j = Number of factors ranked by j^{th} individual

By referring to Garrett’s table, the percentage positions estimate was converted into scores and then for each factor the scores of all respondents were added and mean value was arrived at. These means were arranged in descending order. The problem having the highest mean value was considered to be the most important and was given the highest rank and vice versa.

CHAPTER-IV

DESCRIPTION OF STUDY AREA

The usefulness of any research work can be fully appreciated only when the results are analysed with the background information such as physical and socio-economic conditions of the study area. Hence details on agro-climatic as well as socio-economic characteristics of the study area have been presented in this chapter.

4.1 Tirupur district

4.1.1. Location

Tirupur is a new district of Tamil Nadu, formed in October 2008. It has been carved out of the Coimbatore and Erode districts making it as the 32nd district of Tamil Nadu. It is a well developed and highly revenue yielding district in Tamil Nadu. This district is famous for Tirupur banian industry, Cotton market, and Uthukkuli butter etc.

Tirupur district lies on the western part of Tamil Nadu bordering the Western Ghats and hence the district enjoys a moderate climate. It lies between 11º11’ and 11º18’ north latitude and 77º15’ and 77º25’ east latitude. The district is surrounded by Coimbatore district in the west, Erode district to the north and north east, Karur district in the east, Dindigul district in the south east and Kerala in the south. The total area of the district is 5106.12 square kilometers.

4.1.2. Demography

The demography features of the district are furnished in Table 4.1.

Table 4.1 Demography of Tirupur district (2011 census)

Sl. No	Particulars	Numbers	Percentage to total Population
1.	Total population	24,71,222	100.00
	(i) Males	1242974	50.30
	(ii) Female	1228248	49.70
2.	Population Density (per Sq.m)	484	
3.	Sex Ratio (Females per 1000 Males)	988	
4.	Literates	1779379	72.00
	(i) Males	972032	78.20
	(ii) Females	807347	65.73

Source: Director of Census Operations, Tamil Nadu.
www.censusindia.gov.in

It could be seen from above table that as per 2011 census, the total population of the district was 24.71 lakhs. The density of population was 484 people per square kilometre. The district had higher sex ratio of 988. About 72 per cent of the people were literates. The male literacy rate was higher (78.20 per cent) than females 65.73 per cent.

4.1.3. Soil

The soil types and their occurrence in the study area are presented in Table 4.2 Tirupur District has different types of soils such as red loamy soil, literatic soil, black soil, sandy coastal alluvium soil, red sandy soil and calcareous soil (Table 4.2). The study area udumalpet taluk has both red loam and black soil.

Table 4.2 Soil Types and their Places of Occurrence

S.No.	Type of Soil	Places in the District (Taluks)
1.	Red loamy soil	Avinashi , Palladam, Tirupur and Udumalpet
2.	Literatic soil	Dharapuram
3.	Black soil	Avinashi, Palladam, Dharapuram, Tirupur and Udumalpet
4.	Sandy coastal alluvium	Palladam, Dharapuram
5.	Red sandy soil	Avinashi
6.	Calcareous soil	Avinashi , Palladam, Tirupur

Source: Office of Joint Director, Soil Survey and Land Utilization and Organization

4.1.4. Climate

4.1.4.1. Temperature

Tirupur has a pleasant, salubrious climate. The mean maximum and minimum temperatures during summer and winter vary between 35°C to 18°C. The highest temperature ever recorded is 41 °C and lowest is 12 °C.

4.1.4.2. Rainfall

The southern and south western parts of the district enjoy maximum rainfall, due to the surrounding of Western Ghats. The rest of the district lies in the rain shadow region of the Western Ghats.

Tirupur district receives an average annual rainfall of 617 mm with the North East and the South West monsoons contributing to 50.58 per cent and 27.86 per cent respectively to the total rainfall. Season wise rainfall data are furnished in Table 4.3.

Table 4.3 Season wise Rainfall of Tirupur District (2008-09)

S.No	Season	Average annual rainfall (mm)	Percentage to total rainfall
1.	South-West Monsoon (June to Sep)	171.90	27.86
2.	North-East Monsoon (Oct to Dec)	312.10	50.58
3.	Winter (Jan to Feb)	7.50	1.22
4.	Summer (Mar to May)	125.50	20.34
	Total (June to May)	617.00	100.00

Source: Office of Joint Director of Agriculture, Tirupur.

4.1.5. Land Use Pattern

The land utilization pattern of the Tirupur district is furnished in Table 4.4.

The total geographical area of Tirupur district is 4,72,630 hectares. The net area sown accounted for 41.48 per cent of the total geographical area. The area under forest is very small accounting for 0.26 per cent of total geographical area. The area sown more than once was only 2.91 per cent which indicates the scope for intensive cultivation if irrigation facilities are provided. The cultivable waste occupies 0.84 per cent of the total area, while the current fallows and other fallow land occupied 20.76 per cent and 21.46 per cent, respectively indicating the scope for improving the land use for agriculture to some extent. The area under non-agricultural use is 67,406 hectares with a significantly large share of 14.26 per cent, indicating the rapidity with which agricultural lands have been diverted to non-agricultural uses.

Table 4.4 Land Utilisation Pattern in Tirupur District (2008-09)

Sl.No	Classification of land	Area (ha)	Percentage to total geographical area
I	Total Geographical area	4,72,630	100.0
1.	Net area sown	1,96,042	41.48
2.	Land put to Non-Agricultural use	67,406	14.26
3.	Current fallow	98,101	20.76
4.	Other fallow	1,01,409	21.46
5.	Barren and uncultivable area	2,542	0.53
6.	Area under forest	1,238	0.26
7.	Permanent pastures and grass land	126	0.03
8.	Area under Miscellaneous tree crops and groves	1,812	0.38
9.	Cultivable waste	3,954	0.84
II	Area sown more than once	5,890	2.91
III	Gross Cropped Area	2,01,932	100.00

Source: ‘G’ Return, JDA’s office, Tirupur.

4.1.6. Rivers and Irrigation

Two main rivers that flow across the district are Amaravathi and Noyyal. Major reservoirs of the district are Amaravathi reservoir, Thirumoorthi dam, Upper dam, Vatta malaikarai stream and Nallathangal stream.

Apart from these canals, tanks / ponds / kanmai, tube wells, bore wells and open wells contribute major role in irrigation system of Tirupur district. The source wise area irrigated is furnished in Table 4.5. It could be seen from the table that the major source of irrigation was open wells (54.90 per cent) followed by canals (35.40 per cent). The gross and net area irrigated by different irrigation sources were 123074.42 hectares and 119264.26 hectares respectively.

Table 4.5 Net and Gross Irrigated area in Tirupur District (2008-2009) - (ha)

Sl.No	Irrigation source	Number	Net area irrigated	Gross area irrigated
1.	Canals	18	42217.48 (35.40)	43261.25 (35.15)
2.	Tanks / Ponds / Kanmai	178	1444.27 (1.22)	1496.52 (1.21)
3.	Tube wells and Bore wells	8701	10117.27 (8.48)	10117.47 (8.22)
4.	Open wells	79244	65485.24 (54.90)	68199.18 (55.42)
	Total irrigated area	88141	119264.26 (100.00)	123074.42 (100.00)

Source: JDA's office, Tirupur.

4.1.7. Cropping pattern

The area under different crops in Tirupur district during 2008-09 is presented in Table 4.6.

It is evident from the table area under cereals and millets was highest with 32.80 per cent of Gross Cropped Area (GCA). Maize alone accounted for 14.11 per cent followed by jowar (13.10 per cent), paddy (5.47 per cent) and bajra (0.10 per cent).

Among pulses, horse gram, bengal gram, green gram and cowpea were the major pulses which accounted for 2.89 per cent, 1.85 per cent, 1.78 per cent and 1.67 per cent of the gross cropped area respectively. Edible and non edible oilseeds occupy about 29.00 per cent of the gross cropped area, in which coconut alone occupied 21.92 per cent of the gross cropped area. Groundnut and gingelly were the other oilseeds occupying 4.78 and 1.23 per cent, respectively. Spices and condiments occupied 3.15 per cent of the gross cropped area. Sugar crops and fibre crops accounted for 3.15 per cent and 0.21 per cent of the gross cropped area respectively. Fodder crops occupied about 14.35 per cent of the gross cropped area. Fruits and vegetables occupy an area of 7054.62 hectares (3.49 per cent) and 8103.84 hectares (4.01 per cent) respectively. Other misc non food crops accounted for 0.34 per cent of the gross cropped area in the district.

Table 4.6 Area under different crops in Tirupur district during 2008-09

Sl. No	Crops	Area (ha.)	Percentage to Total
I	**Cereals and Millets**	**66239.03**	**32.80**
1.	Paddy	11060.42	5.47
2.	Jowar (Cholam)	26466.73	13.10
3.	Bajra (Cumbu)	207.36	0.10
4.	Ragi	3.07	0.01
5.	Maize	28501.45	14.11
I I	**Pulses**	**20476.60**	**10.13**
6.	Bengal gram	3737.81	1.85
7.	Red gram	102.59	0.05
8.	Black gram	1779.10	0.90
9.	Green gram	3608.65	1.78
10.	Horse gram	5855.65	2.89
11.	Mochai	524.44	0.25
12.	Cow pea	3377.64	1.67
13.	Avarai	486.44	0.24
14.	Nari payiru	1004.28	0.49
	Total spices and condiments	**3539.06**	**1.80**
15.	Turmeric	1277.91	0.63
16.	Chillies	1021.03	0.60
17.	Tamarind	367.36	0.18
18.	Others	872.76	0.39
	Sugar crops	**6399.60**	**3.15**
22.	Sugar cane	6377.82	3.15
23.	Palmyrah	21.78	0.01
24.	**Cotton**	**429.27**	**0.21**
	Total Edible and Non Edible Oilseeds	**58538.48**	**29.00**
25.	Groundnut	9670.49	4.78
26.	Gingelly	2495.66	1.23
27.	Coconut	44281.96	21.92
28.	Sun flower	1710.35	0.84
29.	Others	380.02	0.19
30.	Total Fodder crops	28979.52	14.35
31.	Total Manure crops	4.05	0.01
32.	Fruits	7054.62	3.49
33.	**Vegetables**	**8103.80**	**4.01**
34.	Flowers	44.75	0.02
35.	Medicinal crops	1420.35	0.70
36.	Misc Non Food Crops	702.84	0.34
	Gross Cropped Area	**2,01,932**	**100.00**
	Area sown more than once	5,890	2.92
	Net sown area	1,96,042	97.08
	Cropping Intensity (%)	**103.00**	

Source: G-Return: Fasli 1418(2008-09), JDA’s office, Tirupur.

Area under vegetables in Tirupur district is presented in Table 4.7. It could be seen from table that among the vegetables onion occupies an area of 3044.13 ha (37.56 per cent) followed by tomato 1534.62 ha (18.93) and also the major vegetables in this district are drumstick (8.02), beetroot (4.94), brinjal (4.20) and bhendi (1.80).

Table 4.7 Area under Vegetables in Tirupur district during 2008-09

Sl. No	Crops	Area (ha.)	Percentage to Total
1.	Onion	3044.13	37.56
2.	Tomato	1534.62	18.93
3.	Brinjal	339.81	4.20
4.	Bhendi	145.14	1.80
5.	Beet Root	400.81	4.94
6.	Drum Stick	650.05	8.02
7.	Lab lab	53.08	0.65
8.	Pumpkin	103.28	1.27
9.	Snake gourd	39.07	0.50
10.	Ribbed gourd	47.35	0.60
11.	Bottle gourd	13.80	0.17
12.	Bitter gourd	93.22	1.15
13.	Ash gourd	4.73	0.05
14.	Cucumber	1.50	0.01
15.	Beans	0.44	0.01
16.	Cowpea	159.81	1.97
17.	Cauliflower	62.06	0.77
18.	Raddish	8.65	0.10
19.	Greens	49.12	0.60
20.	Cluster bean	2.59	0.03
21.	Chow chow	0.05	-
22.	Carrot	0.08	-
23.	Tapioca	1294.31	15.98
24.	Yam	56.10	0.69
	Total vegetables	**8103.80**	**100.00**

Source: G-Return: Fasli 1418(2008-09), JDA's office, Tirupur.

4.1.8. Agricultural schemes

The State Department of Agriculture and Horticulture have implemented state and central schemes to augment production and productivity of the agricultural and horticulture crops and thereby enhance the living standards of the farmers in Tirupur district.

The high quality seeds of leafy vegetables, tomato, bhendi, brinjal and chilles are being distributed at subsidised rates to farmers. The following schemes were implemented during 2008-09 and 2009-10.

State schemes

- Area coverage
- Seed multiplication
- TN-IAMWARM (Irrigated Agriculture Modernisation and Water-Bodies Restoration and Management).
- Quality control scheme and TANWABE

Central Government schemes

- Macro management (ICDP Rice)
- ICDP (Integrated Cooperative Development Project) – Cotton
- ISOPOM (Integrated Scheme of Oilseeds, Pulses, Oilpalm and Maize)
- Farmer’s Interest Group
- Coconut Development Board
- Seed Village Scheme
- NADP (National Agriculture Development Programme)
- NFSM (National Food Security Mission)
- ATMA (Agriculture Technology Management Agency)

4.1.9. Animal husbandry

Livestock plays a major role with rural economy of the District. More than 60 per cent of the rural people depend upon Animal husbandry activities such as Dairy, Poultry, Goat rearing, and Rabbit farm etc., for their daily income and livestock rearing is the way of life in rural areas. Hence, Animal husbandry forms the backbone of rural economy. In Tirupur district, there are 45 numbers of veterinary dispensaries to protect the animal health care. The particulars about the veterinary dispensaries are given in Table 4.8.

Table 4.8 Block wise Veterinary hospitals in Tirupur district (2008-09)

Sl.No	Block	Veterinary Hospital	Dispensary	Sub centre
1.	Tirupur	Tirupur	4	3
2.	Pongalur	Pongalur	3	4
3.	Palladam	---	4	3
4.	Avinashi	---	3	6
5.	Udumalpet	Udumalpet	4	9
6.	Gudimangalam	---	3	7
7.	Madathukulam	---	3	6
8.	Kangayam	Kangayam	4	2
9.	Kundadam	Pettaikalipalayam	4	6
10.	Vellakoil	Muthur	3	4
11.	Dharapuram	Dharapuram	3	4
12.	Moolanur	---	3	7
13.	Uthukuli	--	4	8
	Total		**45**	**69**

Source: www.tirupur.tn.nic.in

Knowledge about animal population is important because it acts as a source of income and manure to the farmers.

4.1.10. Infrastructural Facilities

4.1.10.1. Transport and Road Facilities

Roads and communications play crucial role in social economic development of any district. In Tirupur district the fast growing knitwear industries and assured irrigated agriculture activities required transport and communication network between various parts of the state.

There are four major types of road network in the district such as National Highway, State Highways, Panchayat Union road and Village Panchayat road. District has 625.516 km of state high ways and 128 km of national highways.

4.1.11.2. Railways

Tirupur falls on the Chennai-Calicut BG main line (laid in 1893) which is fully electrified and double track. It has the following railway stations.

- Tirupur (TUP)
- Vanjipalayam (VNJ)
- Koolipalayam (KUY)
- Uthukuli (UKL)
- Somanur (SNO)

4.1.12.3. Airport

The nearest international airport is the Coimbatore Airport. Proposals are being made to expand the Coimbatore International Airport as a green field's airport, which would eventually shift the airport to the east of the present airport and would be easier for Tirupur citizens to access the airport. The present airport is just 40 minutes drive from Tirupur.

4.1.12.4. Industrial Facilities

Tirupur city is the ***"knitwear capital"*** of India. It has spurred up the textile industry in India for the past three decades. Its economic boom boosts the morale of Indian industrialists and it contributes to a huge amount of foreign exchange in India.

Tirupur has the largest and fastest growing urban city in Tamil Nadu. It stands as the life for millions of people in Tamil Nadu. The knitwear industry which is the soul of Tirupur has created millions of jobs for all class of people. There are nearly about 2500 garment making units, 1500 knitting units, 700 dyeing and bleaching units and 500 fabric and other ancillary units. The details of knitwear making units in Tirupur district are presented in Table 4.9.

Table 4.9 Knitwear making units in Tirupur District (2008-09)

Sl. No	Operations	Number of units
1.	Knitting Units	1500
2.	Dyeing and Bleaching	700
3.	Fabric Printing	500
4.	Garment Making	2500
5.	Embroidery	250
6.	Other Ancillary Units	500
7.	Compacting and Calendaring	300
	Total	**6250**

Source: www.tirupur.tn.nic.in

The annual foreign exchange business for the year 2008 stands at Rs. 8,000 crore. Due to the climate and availability of raw materials and work force Tirupur had made a large contribution to the export of knitwear garments. Tirupur accounts for a fifth of the garment exports from India.

Tirupur Exporters Association

The association formed by the Exporters of Tirupur (TEA) is one of the most successful association in India trying hard and been successful in helping the trade in Tirupur.

Wind mills:

Wind mills were erected in this region with the help of Ministry of New and Non Conventional Energy and Tamil Nadu Energy Development Agency. One can enjoy the huge wind mill tower with fan shield revolving for generating electricity either travelling from Palladam to Udumalpet via Kethanur and Gudimangalam or from Pollachi to Dharapuram via Gudimangalam.

4.1.12.5. Financial Facilities

The number of commercial banks in this district is given in Table 4.10. The financial needs of farmers are being met by 60 public sector banks and 45 private sector banks.

Table 4.10 Number of Public Sector Banks and Private Sector Banks

Sl.No	Bank	Number
1.	Public Sector Banks	60
2.	Private Sector Banks	45

Source: www.tirupur.tn.nic.in

4.1.12.6. Education

Increase in literacy helps in transfer of latest technologies to enhance crop production. Hence, the details of number of educational institutions are furnished in Table 4.11.

From the table, it could be seen that the district has more number of primary schools followed by other schools. Sainik School, is an English medium residential school for boys providing Public School Education with a military bias, located at Amaravathinagar, Udumalpet.

Table 4.11 Educational Institutions in Tirupur district during 2008-09

Sl.No	Items	Numbers
1.	Primary School	890
2.	Middle School	293
3.	High School	65
4.	Higher Secondary School	70
5.	Matriculation School	105
6.	Arts and Science College	17

Source: www.tirupur.tn.nic.in

4.2. Udumalpet Taluk

Udumalpet taluk comprises of Udumalpet firka, Kuruchikottai firka and Periavalavadi firka.

4.2.1. Location

Udumalpet town lies on 559Km South-West of Chennai and 69Km South-East of Coimbatore on the Dindigul-Mysore National Highway (No.209). The important towns around Udumalpet are Palani at a distance of 34 km in the east and Pollachi at a distance of 29 Km in the west. It is located at 10.58 º North latitude and 77.24 º East latitude.

The town has a rich agriculture land fed by the Parambikulam – Aliyar irrigation project and is directly linked to Thirumoorthy dam project and hence it serves as an important trading/ commercial and industrial town for the neighbouring area. This town is an important trading centre for cotton, jaggery, rice and other food grains.

4.2.2. Demography

According to 2001 Census, Udumalpet town has a population of 59,668 (Male 29,330 and Female 30,338). Udumalpet town has recorded with a literacy rate of 81 per cent in the year 2001.

4.2.3. Soil

Black and red soil types are found in this taluk. The soil contains more of alumina and gypsum. While black soil area is utilized for agriculture, the area with red soil has more urbanized usages.

4.2.4. Agriculture

The average altitude of the town is 1208 feet above MSL. The topography is undulated and general slope is from west to north. Black clay soil is the predominant soil of the area. Agricultural activities are developed mainly in the hinterlands of the town, wherever water facility is available, wet crops like paddy, sugarcane, etc., are grown in those areas. Mainly coconut trees and vegetables are grown in this area. Onion, tomato, bhendi, beetroot and brinjal are major vegetables grown in this area. To increase the production, productivity of vegetables in this area the following schemes are provided by the horticultural department.

Major Horticultural Schemes

- NHM (National Horticultural Scheme)
- TN-IAMWARM (Irrigated Agriculture Modernisation and Water-Bodies Restoration and Management)
- Micro Irrigation Scheme
- Precision Farming
- ATMA (Agriculture Technology Management Agency)

4.2.5. Irrigation

Thirumoorthy and Amaravathi water reservoir provides irrigation to the agricultural lands around the town. The main source of irrigation for this taluk is the Parambikulam Aliyar River Project. About 83491.75 acres of land are benefited by the project in udumalpet taluk.

Apart from this canals, tanks / ponds and open wells contributes major role in irrigation system of udumalpet taluk. The source wise area irrigated is furnished in Table 4.12. It could be seen from the table that the major source of irrigation was open wells (63.14 per cent) followed by canals (31.91 per cent). The gross and net area irrigated were 23,777.75 and 22,347.28 hectares respectively.

Table 4.12 Net and Gross Irrigated area in Tirupur District (2008-2009) - (ha)

Sl.No	Irrigation source	Number	Net area irrigated	Gross area irrigated
1.	Canals	5	7133.10 (31.91)	7133.10 (30.00)
2.	Tanks / Ponds	10	1104.51 (4.95)	1156.76 (4.86)
3.	Open wells	7244	14109.67 (63.14)	15487.89 (65.14)
	Total irrigated area	7259	22347.28 (100.00)	23777.75 (100.00)

Source: G-Return: Fasli 1418(2008-09), JDA’s office, Tirupur.

4.2.6. Climate

4.2.6.1. Temperature

Udumalpet enjoys a pleasing atmosphere due to the Palghat gap on the Western Ghats during the south west monsoon. The maximum and minimum temperatures are 39.0ºC and 15.0ºC respectively and located in an altitude of about 120 mt above.

4.2.6.2. Rainfall

Udumalpet received 808.80 mm rainfall during 2010-11, of which maximum of 577.80 mm rainfall was received during northeast monsoon period (Table 4.13).

The time series data on season wise rainfall are furnished in Table 4.13. Over the period of 11 years, highest rainfall of 1032.30 mm was recorded in 2005-06 and lowest rainfall of 371.90 mm rainfall during 2006-07. North east monsoon have contributed more than in other seasons. The deviation of rainfall was 182.63 mm (2000-2011). Though coefficient of variation for annual rainfall was only 27.85 per cent, there was a high variation seasons.

Table 4.13 Season wise Rainfall Particulars of Udumalpet Taluk from 2000-01 to 2010-11

(in mm)

Year	South West Monsoon (June-Sep)	North East Monsoon (Oct-Dec)	Winter (Jan-Feb)	Hot weather (Mar-May)	Annual Rainfall
2000-2001	307.00	272.30	-	60.00	639.30
2001-2002	81.80	329.00	19.60	132.00	562.40
2002-2003	86.80	325.60	9.00	128.60	550.00
2003-2004	9.40	299.20	-	220.20	528.80
2004-2005	157.60	240.40	12.40	355.60	766.00
2005-2006	177.80	742.50	25.00	87.00	1032.30
2006-2007	76.60	300.30	7.60	64.00	371.90
2007-2008	117.60	432.20	35.20	207.00	792.00
2008-2009	107.20	364.90	6.00	171.20	649.30
2009-2010	73.40	378.70	-	59.80	511.90
2010-2011	142.80	577.80	4.00	84.20	808.80
Standard Deviation	76.96	149.13	10.88	91.12	182.63
Mean	121.64	387.54	14.85	142.69	655.70
Coefficient of Variation (%)	63.27	34.48	73.26	63.86	27.85

Source: Assistant Director of Statistics, Udumalpet.

4.2.7. Land Utilization Pattern

The land utilization pattern of Udumalpet Taluk is furnished in Table 4.14. It is evident from table that total geographical area is 96749.18 ha. Net area sown in the taluk accounted for 65.62 per cent of the total geographical area. The current fallow occupies 12.29 per cent of the total geographical area. The land under non-agricultural use and current fallow were occupying 15.86 per cent and 12.29 per cent respectively. The area under other fallow was only 2.11 percent and there is no forest area.

Table 4.14 Land Utilization Pattern of Udumalpet Taluk (2008-09)

Sl.No	Classification of land	Area (ha)	Percentage to total geographical area
I	Total Geographical area	96749.18	100.00
1.	Net area sown	63485.76	65.62
2.	Land put to Non-Agricultural use	15350.61	15.86
3.	Current fallow	11896.96	12.29
4.	Other fallow	2044.24	2.11
5.	Barren and uncultivable area	1783.70	1.85
6.	Area under forest	-	-
7.	Permanent pastures and grass land	5.98	0.01
8.	Area under Miscellaneous tree crops and groves	170.46	0.18
9.	Cultivable waste	2011.46	2.08
II	Area sown more than once	4724.17	6.92
III	Gross Cropped Area	68209.93	100.00

Source: ‘G’ Return, JDA’s office, Tirupur.

4.2.8. Cropping pattern

The area under different crops in Udumalpet taluk during year 2008-09 is presented in Table 4.15.

Table 4.15 Area under different crops in Udumalpet taluk during 2008-09

Sl. No	Crops	Area (ha.)	Percentage to Total
I	**Cereals and Millets**	**20527.64**	**30.09**
1.	Paddy	3945.81	5.78
2.	Jowar (Cholam)	2180.77	3.19
3.	Bajra (Cumbu)	154.58	0.22
4.	Ragi	0.05	-
5.	Maize	14246.43	20.88
	Pulses	**7892.66**	**11.57**
6.	Bengal gram	3321.50	4.86
7.	Red gram	1.59	0.01
8.	Black gram	745.42	1.09
9.	Green gram	744.61	1.09
10.	Horse gram	704.38	1.03
11.	Mochai	503.55	0.73
12.	Cow pea	1514.57	2.22
13.	Avarai	321.90	0.47
14.	Nari payiru	35.14	0.05
	Spices and condiments	**950.09**	**1.39**
15.	Arecanut	14.78	0.02
16.	Chillies	212.26	0.31
17.	Pepper	1.00	0.01
18.	Curry leaves	1.31	0.01
19.	Coriander	638.54	0.95
20.	Turmeric	1.20	0.01
21.	Tamarind	81.00	0.11
	Sugar crops	**4087.08**	**5.99**
22.	Sugar cane	4085.43	5.98
23.	Palmyrah	1.65	0.01
24.	**Cotton**	**43.90**	**0.06**
	Edible and Non Edible Oilseeds	**28419.25**	**41.66**
25.	Groundnut	1212.79	1.78
26.	Gingelly	367.22	0.53
27.	Coconut	26399.74	38.70
28.	Sun flower	231.43	0.33
29.	Palm oil	2.14	0.01
30.	Castor	37.27	0.05
31.	Jatropha	168.53	0.26
32.	Neem	0.13	0.01
33.	Total Fodder crops	1730.30	2.53
34.	Total Manure crops	-	-
35.	Fruits	1753.20	2.60
36.	**Vegetables**	**2483.23**	**3.64**
37.	Flowers	4.36	0.01
39.	Medicinal crops	11.30	0.01
40.	Misc Non Food Crops	306.92	0.45
	Gross Cropped Area	**68209.93**	**100.00**
	Area sown more than once	4724.17	6.93
	Net sown area	63485.76	93.07
	Cropping Intensity (%)	**107.44**	

Source: G-Return: Fasli 1418(2008-09), JDA's office, Tirupur.

It is evident from the table that area under cereals and millets was 30.09 per cent of Gross Cropped Area (GCA). Maize alone accounted for 20.88 per cent followed by paddy (5.78 per cent), jowar (3.19 per cent) and bajra (0.22 per cent). The percentage area under pulses was 11.57.

Among pulses, Bengal gram and cowpea were the major pulses which accounted for 4.86 per cent and 2.22 per cent of the gross cropped area respectively. Edible and non edible oilseeds occupied 41.66 per cent of the gross cropped area. Coconut was the major oilseed crop that alone occupied 38.70 per cent of the gross cropped area. Sugar crops and spices and condiments accounted for 5.99 per cent and 1.39 per cent of the gross cropped area respectively. Fodder crops occupied about 2.53 per cent of the gross cropped area. Fruits and vegetables occupy an area of 1753.20 hectares (2.60 per cent) and 2483.23 hectares (3.64 per cent) respectively. Fibre crops accounted only 0.06 per cent of the gross cropped area in the taluk.

Area under vegetables in Udumalpet taluk is presented in Table 4.16. It could be seen from table that among the vegetables onion occupied an area of 1136.35 ha (45.77 per cent) followed by tomato 766.14 ha (30.90). Other major vegetables in this taluk were beetroot (12.50), brinjal (4.02) and bhendi(1.22).

Table 4.16 Area under Vegetables in Udumalpet Taluk during 2008-09

Sl. No	Crops	Area (ha.)	Percentage to Total
1.	Onion	1136.35	45.77
2.	Tomato	766.14	30.90
3.	Brinjal	99.96	4.02
4.	Bhendi	30.47	1.22
5.	Beet Root	310.17	12.50
6.	Drum Stick	24.44	0.98
8.	Pumpkin	84.26	3.39
9.	Snake gourd	1.93	0.07
10.	Ribbed gourd	1.41	0.05
11.	Bottle gourd	0.49	0.02
12.	Bitter gourd	10.91	0.44
13.	Cucumber	0.96	0.04
14.	Beans	0.28	0.01
15.	Cauliflower	0.28	0.01
16.	Raddish	8.65	0.35
17.	Greens (Except Agathi)	0.20	0.01
18.	Tapioca	5.55	0.22
	Total vegetables	**2482.45**	**100**

Source: G-Return: Fasli 1418(2008-09), JDA's office, Tirupur.

4.2.9. Agricultural Machinery and Implement

The usage of machineries and implements indicate the extent of mechanization and it also plays vital role in adoption of new technologies and income generation from farm activities. Hence, the details on number of machineries and implements in udumalpet taluk are furnished in Table 4.17.

It is evident from the table that of total number of machineries and implements, electric pumps accounted for the highest percentage (53.38 per cent), followed by wooden plough (26.97 per cent) and iron plough (10.58 per cent). Oil engine water pumps accounted for 3.66 per cent, followed by electric power sugarcane crusher (3.20 per cent) and tractors (2.21).

Table 4.17 Machineries and Implements in Udumalpet Taluk

S.No	Particulars	Number	Percentage to the total
1	Plough		
	i. Wooden	3268	26.97
	ii. Iron	1282	10.58
2	Water Pumps		
	i. Oil Engine	444	3.66
	ii. Electric	6469	53.38
3	Tractors		
	i. Government	-	-
	ii. Private	268	2.21
4	Sugarcane Crusher		
	i. Electric Power	387	3.20
	ii. Oil Engine	-	-
5	Total	12118	100.00

Source: Assistant Director of Statistics, Udumalpet.

4.2.10. Infrastructural Facilities

4.2.10.1. Marketing and Storage Facilities

There is one Regulated market and one Farmers market in udumalpet. There are 9 agricultural godowns and 20 Co-operatives.

Table 4.18 Marketing and Storage Facilities in Udumalpet Taluk

Sl.No	Particulars	Number
1.	Regulated market	1
2.	Farmers market	1
3.	Agricultural Godowns	9
4.	Co-operatives	20

4.2.10.2. Transport and Road Facilities

It is located abutting the National Highway connecting between Dindigul and Mysore. The town is well connected with Tirupur, Coimbatore and other near by urban settlements by an articulate system of railway and road ways.

4.2.10.3. Industrial Facilities

Udumalpet is an industrial town with number of textile, paper and farming related industries. There are many paper manufacturing plants located alongside the Amaravathi River. It has also 5 large scale, 12 medium scale and 105 small scale industries. This town is an important trading center for cotton, jaggery, rice and other food grains.

One of the biggest poultry companies in India, Suguna Poultry Ltd, was founded in this town. Recently, surrounding areas of the town has seen a huge rise in windmill installations. The location of the town across the Palghat gap aids tunneling of the wind flow through the region and aids in wind power generation.

CHAPTER-V

RESULTS AND DISCUSSION

The data collected from the sample farmers in the selected villages of Udumalpet taluk of Tirpur district were tabulated and analyzed by using appropriate tools. The results are presented and discussed in this chapter for the vegetable crops such as tomato (under drip irrigation and conventional irrigation), bhendi and beet root under the following major topics.

5.1 General characteristics of Sample Farmers

5.2 Yield analysis – Average and descriptive statistics for DIT and CIT

5.3 Economic advantage of Tomato cultivation under Drip Irrigation

5.4 Feasibility of DIT cultivation

5.5 Costs and Returns for Bhendi and Beet root

5.6 Per hectare Profitability of the Vegetables in Sample Farms

5.7 Resource use efficiency of Tomato (DIT, CIT), Bhendi and Beetroot

5.8 Technical Efficiency of tomato under Drip and Conventional irrigation condition

5.9 Marketing Channel

5.10 Production Constraints faced by Sample Farmers

5.11 Marketing Constraints faced by Sample Farmers

5.1. GENERAL CHARACTERISTICS OF SAMPLE FARMERS

5.1.1. Size and Family composition

The family size and composition to certain extent determine the availability of family labour for farming and consumption expenditure. The information on size and composition of family are presented in Table 5.1.

It could be observed from table that the total number of persons in the sample farm families was 344 members, of which 75.88 per cent were adults and

24.12 per cent were children. The percentage of adult male and female was 38.67 and 37.21, respectively. The adult female population in the sample farm households was lower than male population. Average family size was 3.82.

Table 5.1 Size and Family Composition of Sample Farmers (in Numbers)

Sl. No	Particulars	Family Size	Percentage to Total
1	No. of families	90	100.00
2	No. of family members		
	i) Adults		
	a. Male	133	38.67
	b. Female	128	37.21
	Sub Total (A)	261	75.88
	ii) Children		
	a. Male	28	8.14
	b. Female	55	15.98
	Sub Total (B)	83	24.12
3.	Total Family Members (A+B)	344	100.00
4.	Average family size	3.82	

5.1.2. Family Type

The family type of the sample farmers are presented in Table 5.2.

Table 5.2 Type of Family among Sample Farmers

Sl. No	Type of family	Number of family	Percentage to Total
1.	Nuclear Family	65	72.22
2.	Joint Family	25	27.78
	Total	90	100.00

Among the sample farmers, nuclear family type was found to be predominant with 72.22 per cent when compared to joint family type with 27.78 per cent.

5.1.3. Age of the Sample Farmers

The age of the sample farmers in general influence the level of adoption of innovation and risk taking behavior. The details of age of the sample farmers are presented in Table 5.3.

Table 5.3 Age-wise Distribution of the Sample Farmers

Sl. No	Age in years	Number of farmers	Percentage to Total
1.	Up to 35	4	4.44
2.	36 – 45	52	57.78
3.	46 – 55	26	28.89
4.	Above 55	8	8.89
	Total	90	100.00

It is evident from the table that 57.78 per cent of sample farmers were in the age group of 36 – 45 years followed by 28.89 per cent of the farmers coming under the age group of 46 - 55 years and only 4.44 per cent were young farmers i.e., in the group of up to 35 years. Aged farmers (above 55 years) constituted only 8.89 per cent to the total number of sample farmers. It could be concluded from the results that 36 – 45 years old farmers constituted higher percentage to the total number of sample farmers.

5.1.4. Literacy Level

The literacy level of the sample farmers are furnished in Table 5.4.

Table 5.4 Literacy Level of the Sample Farmers

S. No	Literacy level	Number of farmers	Percentage to Total
1	Primary (Upto 5th std.)	12	13.33
2	Secondary (Between 6-10th std.)	57	63.33
3	Higher secondary (12th std.)	12	13.34
4	Collegiate (Above 12th std.)	-	-
	Total Literates	81	90.00

5	Illiterate	9	10.00
	Total	90	100.00

It could be seen from the table that 90 per cent of the sample farmers were literates. Among the literates, sample farmers with education up to secondary level were the highest with 63.33 per cent. Primary education and higher secondary level of education was 13.34 per cent and 13.33 per cent, respectively. None of the sample farmers were graduates. Illiterates were only 10 per cent of total sample farmers. Hence it could be concluded that majority of the sample farmers were literates with secondary level.

5.1.5. Occupational Status

The occupational status of farmers would influence the pattern of investment in vegetable cultivation. Hence it was analysed and presented in Table 5.5.

Table 5.5 Occupational Status of Sample Farmers

Sl.No	Particulars	Number of farmers	Percentage to Total
1.	Primary Occupation (Agriculture)	82	91.11
2.	Secondary Occupation	8	8.89
	Total	90	100.00

It could be observed from the table that, 91.11 per cent of farmers' primary occupation was agriculture. It could be inferred that the major occupation of the sample farmers is agriculture.

5.1.6. Land particulars

It could be seen from the Table 5.6 that sample farmers owned higher proportion of garden land with 89.50 per cent to total area followed by rainfed land with 10.50 per cent to total. Hence it is concluded from the above results that vegetables are grown in garden lands in the study area due to suitable soil and water availability.

Table 5.6 Land particulars of Sample Farmers

S.No.	Particulars	Area owned (in ha)	Percentage to Total
1	Garden Land	294.73	89.50

2	Rainfed	34.61	10.50
	Total	329.34	100.00

5.1.7. Size Distribution of Sample Holdings

Size of land holdings would determine the income and employment generation. The land holding details are given in Table 5.7.

It could be seen from the table that, 51 per cent of the sample farmers had medium farm size and about 27 per cent had large farm size. These two accounted for 92 per cent of the total area. Hence it could be inferred that farmers having more than two hectares raised vegetables in the study area.

Table 5.7 Size Distribution of Sample Holdings

S.No	Size group	No. of holdings	Total area (ha)	Average area (ha)
1	Marginal (below 1.0 ha.)	4 (4.44)	3.24 (1.10)	0.81
2	Small (1.01-2.0 ha.)	16 (17.78)	20.45 (6.94)	1.28
3	Medium (2.01-4.0 ha.)	46 (51.11)	118.82 (40.32)	2.58
4	Large (4.01 ha. and above)	24 (26.67)	152.23 (51.64)	6.34
	Total	**90 (100)**	**294.74 (100)**	**3.27**

(Note: Figures in parentheses indicate percentages to respective total)

5.1.8. Cropping Pattern of the Sample Farmers

The details on area under major crops of the sample farms in the year 2008-2009 are presented in Table 5.8.

Table 5.8 Cropping Pattern of the Sample Farms

S. No	Crop	Number of farmers	Area(ha)	Percentage to total	Season
1	Maize	84	112.55	25.16	July – November
2	**Vegetables**				
	Onion	41	53.40 (24.26)	11.96	June - Sep/Oct

	Tomato – I	79	79.15 (35.95)	17.69	July – October
	Tomato – II	43	41.90 (19.02)	9.36	January – April
	Bhendi	30	15.80 (7.17)	3.53	Aug/Sep-Nov/Dec
	Beetroot	30	18.02 (8.18)	4.02	June - September, January – April
	Chiilies	7	3.04 (1.38)	0.70	January - April
	Brinjal	4	2.03 (0.92)	0.45	January - April
	Gourds	13	6.88 (3.12)	1.53	January - April
	Sub Total	**232**	**220.26 (100)**	**49.24**	
3	Coconut	47	104.85	23.44	January - April
4	Mango	6	9.72	2.17	Sep – December
	Gross cropped area		447.38	100.00	
	Net cropped area		152.65		
	Cropping intensity (%)		293.07		

(Note: Figures in parentheses indicate percentages to total area under vegetables)

It could be observed from the above table that vegetables were the principal crop in the sample farms. It accounted for 49.24 per cent of the total cropped area. Maize and Coconut occupied 25.16 per cent and 23.44 per cent of the total cropped area, respectively. The main seasons for vegetables are June - September and January - April. Maize is raised in two seasons viz July – November and September – January.

In vegetables, tomato I and II accounted for about 55 per cent of the total area under vegetables. Onion was the next major crop to tomato and occupied 24.26 per cent of total vegetable cropped area. Beet root and bhendi occupied around 8 per cent and 7 per cent respectively. The cropping intensity was 293.07 per cent.

5.1.9. Area under Tomato in Sample Farms

All the sample farmers had raised tomato. Hence the tomato farmers were categorized based on the area under tomato and the results are presented in Table 5.9.

Table 5.9 Area under Tomato in the Sample Farms

S.No	Size group	No. of holdings	Total area (ha)	Average area (ha)
1	Less than 1.0 ha.	62 (68.89)	45.75 (50.45)	0.74
2	1.01-2.0 ha.	21 (23.33)	27.13 (29.91)	1.29
3	2.01-4.0 ha.	6 (6.67)	13.77 (15.18)	2.30

4	4.01 ha and above	1 (1.11)	4.05 (4.46)	4.05
	Total	90 (100)	90.70 (100)	1.00

(Note: Figures in parentheses are percentages to respective total)

It could be seen from the table that around 69 per cent of the sample farmers raised tomato in less than one hectare accounting for 50.45 per cent of the total tomato area and another 30 per cent of area occupied by small farmers accounting for 27.13 hectares of the total tomato area. The average area under tomato was one hectare.

5.1.10. Area under Bhendi in Sample Farms

The bhendi farmers were categorized based on the area under bhendi and the results are presented in Table 5.10.

Table 5.10 Area under Bhendi in the Sample Farms

S.No	Size group	No. of holdings	Total area (ha)	Average area (ha)
1	Less than 1.0 ha.	27(90.00)	13.36 (77.72)	0.46
2	1.01-2.0 ha.	2 (6.66)	1.81 (10.53)	0.60
3	2.01-4.0 ha.	1 (3.34)	2.02 (11.75)	2.02
4	4.01 ha and above	-	-	-
	Total	30 (100)	15.78 (100)	0.57

(Note: Figures in parentheses indicate percentages to total)

It could be seen from the table that in bhendi farms, 90 per cent of the sample farmers raised bhendi in less than one hectare accounting for 77.72 per cent of the total area under bhendi and another 2.01 to 4 hectare farms accounted for 11.75 per cent of area. The average area under bhendi in the sample farms was only 0.57 hectare.

5.1.11. Area under Beet root in Sample Farms

The beet root farmers were categorized based on the area under beet root and the results are presented in Table 5.11.

Table 5.11 Area under beet root in the Sample Farms

S.No	Size group	No. of holdings	Total area (ha)	Average area (ha)
1	Less than 1.0 ha.	20 (66.65)	11.13 (47.82)	0.55
2	1.01-2.0 ha.	7 (23.34)	6.07 (26.10)	0.87
3	2.01-4.0 ha.	2 (6.67)	2.02 (8.68)	1.01
4	4.01 ha and above	1 (3.34)	4.05 (17.40)	4.05
	Total	30 (100)	23.27 (100)	0.77

(Note: Figures in parentheses indicate percentages to total)

It could be seen from the above table that 66.65 per cent of the sample farmers raised beet root in less than one hectare accounting for 47.82 per cent of the total area under beet root and another 1.01 to 2 hectare farms accounted for 26.10 per cent of area. The average area under beetroot was 0.77 hectare. Hence it could be inferred that farmers raised vegetables in less than one hectare.

5.1.12. Experience of Sample Farmers in Farming

The details about experience of the sample farmers are furnished in Table 5.12.

Table 5.12 Experience of Sample Farmers in Farming

Sl. No	Experience in years	Number of sample farmers	Percentage to Total
1	Up to 15	13	14.45
2	16 – 25	47	52.22
3	26 – 35	28	31.11
4	More than 35	2	2.22
	Total	90	100.00

It is evident from the table that about 52 per cent of sample farmers had experience of 16-25 years and 31.11 per cent of farmers had experience of 26-35 years in farming. Hence it could be concluded that 83 per cent of sample farmers had more than 15 years experience in farming.

5.1.13. Experience of Sample Farmers in Vegetable Cultivation

The experience of the sample farmers in the cultivation of vegetables are presented in Table 5.13.

Table 5.13 Experience of Sample Farmers in Vegetable Cultivation

Sl. No	Experience in years	Number of sample farmers	Percentage to Total
1	Up to 15	56	62.22
2	16 – 25	30	33.33
3	26 – 35	4	4.45
	Total	**90**	**100.00**

It could be seen from the table that 62 per cent of the sample vegetable farmers had less than 15 years of experience and 33 per cent of the farmers had experience of 16 - 25 years. Only 4.45 per cent of farmers had 26-35 of years experience in vegetable cultivation. These results indicated that two third of sample farmers started vegetable cultivation within 15 years.

5.1.14. Asset position of the Sample Farms

Farm assets play a major role in assessing the infrastructure available in the farms. It includes land, farm building, tools and implements and machineries especially tractors. The asset position of the sample farms are presented in Table 5.14.

Table 5.14 Asset Position of the Sample Farms

Sl. No	Particulars	Number of sample farmers possessed	Average value of asset (Rs.)
1	Land	90	74,00,000.00
2	Farm Building	24	1,65,000.00
3	Irrigation structure	82	42,000.00
4	Tools and Implements	22	2,500.00
5	Machinery (Tractor)	12	5,55,000.00
	Total		81,64,500.00

It could be observed from the above table that, all the sample farms had own land and 82 of them possessed irrigation structure and 24 had farm building only 12 sample farms owned tractor. Average value of land was highest (Rs.74, 00,000) followed by machineries (Rs.5,55,000) and farm building (Rs.1,65,000). The average value of irrigation structure, tools and implements Rs.42,000, Rs.2500 respectively.

5.1.15. Livestock particulars of Sample Farms

The livestock details of the sample farmers are given in Table 5.15.

Table 5.15 Livestock Particulars of Sample Farms

Sl. No	Livestock particulars	Number of farmers owned	Average Value (Rs)
1	Bullocks	24	30,000
2	Milch animals	62	45,000
3	Poultry	27	6,750

It could be observed from the above table that the sample farmers having milch animals were high when compared to bullocks and poultry, because milch animals giving additional income to sample farmers in the study area.

The average value of bullocks, milch animals and poultry were Rs.30,000, Rs.45,000 and Rs.6,750 respectively.

5.2. YIELD ANALYSIS

Tomato crop is being raised under drip irrigation and conventional irrigation method. Yield of tomato under Drip (DIT) and Conventional Irrigation (CIT) were analysed by using average and descriptive statistics. The results are presented in this section.

5.2.1. Average yield of DIT and CIT

The average yield of DIT and CIT were worked out and the yield performance of DIT was compared with CIT. The results are presented in the Table 5.16.

Table 5.16 Average yield of Tomato under Drip and Conventional Irrigation Method in the Sample Farms

Sl. No.	Particulars	Average yield (t / ha.)
1.	Drip irrigated Tomato	68.36
2.	Conventional irrigated Tomato	54.77
3.	Difference between DIT and CIT	13.59
4.	Percentage difference	24.81

It could be seen from the table that average yield of DIT and CIT were 68.36 t/ha and 54.77 t/ha respectively. The yield difference between DIT and CIT was 13.59 tonnes per ha. It could be inferred that the yield of tomato under drip irrigation was 24.81 per cent higher than in conventional irrigation method.

Test of significance – Z Test

Sl.No	Particulars	Mean yield (t/ha)	Variance	Size of sample	Test statistic - Z test
1	Drip irrigated tomato	68.36	8.9	30	8.08**
2	Conventional irrigated tomato	54.77	3.4	60	

Note: ** - Significant at one percent level

The significance of tomato yield under drip irrigation and conventional irrigation was tested by Z-statistics, which found to be significant at one per cent level. This result indicated superiority of drip irrigation over conventional irrigation.

5.2.2. Descriptive statistics for yield of Tomato under Drip Irrigation

The results of descriptive statistics for yield of tomato under drip irrigation were presented in Table 5.17.

Table 5.17 Descriptive statistics for yield of Tomato under Drip Irrigation

Sl. No	Yield (t / ha.)	Numbers	Mean	Standard deviation	Variance	Maximum	Minimum
1	<50	-	-	-	-	-	-
2	51 – 60	-	-	-	-	-	-
3	61 – 70	24 (80)	67.33	2.35	5.54	70	64
4	>70	6 (20)	72.50	0.85	0.70	74	72
	Total	30 (100)	68.36	2.99	8.93	74	64

It could be observed from the table that in Drip irrigation 80 per cent of farmers obtained 61 to 70 tonne per hectare. The mean yield recorded by Drip irrigated farmers under this category was 67.33 tonnes. The maximum and minimum yield was 70 tonnes and 64 tonnes respectively. Another 20 per cent of farmers recorded greater than 70 tonnes of yield with 72.5 tonnes of mean yield. Maximum and minimum yield was 74 tonnes and 72 tonnes respectively in this category. On the whole in Drip irrigated farms, the mean yield, maximum and minimum yield recorded was 68.36 tonnes, 74 tonnes and 64 tonnes respectively.

5.2.3. Descriptive statistics for yield of CIT

The results of descriptive statistics for yield of CIT were presented in Table 5.18.

Table 5.18 Descriptive statistics for yield of tomato under Conventional Irrigation

Sl. No	Yield (t / ha.)	Numbers	Mean	Standard deviation	Variance	Maximum	Minimum
1	<50	3 (5)	48.93	1	1.01	50	48
2	51 – 60	57 (95)	55.06	1.3	1.69	56.8	52.8

3	61-70	-	-	-	-	-	-
4	>70	-	-	-	-	-	-
	Total	60 (100)	54.77	1.85	3.44	56.8	48

It could be observed from the table, in conventional irrigation 95 per cent of farmers obtained 51 to 60 tonnes / ha. The mean yield recorded by conventional irrigated farmers under this category was 55.06 tonnes. The maximum and minimum yield was 56.8 tonnes and 52.8 tonnes, respectively. The remaining five per cent of farmers recorded less than 50 tonnes of yield with 48.93 tonnes of mean yield. Maximum and minimum yield was 50 tonnes and 48 tonnes, respectively in this category. For the whole conventional irrigated farmers, the mean yield, maximum and minimum yield recorded was 54.77 tonnes, 56.8 tonnes and 48 tonnes, respectively.

Conventional irrigated farmers could not able to realize the yield as that of Drip irrigation as evident from the fact that maximum yield in Conventional irrigation was only 56.8 tonnes (Fig. 5.1). The reason for high yield in Drip irrigation might be due to the potential of drip irrigated plants to produce more yields by efficient utilization of resources applied. The variance was found to be less in both the category of farms which indicated that the yield risk was very less during the study period.

5.3 ECONOMIC ADVANTAGE OF TOMATO CULTIVATION UNDER DRIP IRRIGATION

The comparative advantage of drip irrigation versus conventional irrigation would give a clear picture about the economic feasibility of drip irrigated cultivation in the area studied. Therefore, cost involved in purchase of fertilizer, operation – wise labour utilization and charges, costs and returns were discussed and presented in this section.

5.3.1. Expenditure incurred on fertilizers

The fertilizers used by sample farmers for tomato crop were listed and the expenditure incurred on various fertilizers is given in Table 5.19.

Table 5.19 Expenditure incurred on fertilizers in Sample Farms under Drip and CI method

(Rs / ha)

Sl. No.	Fertilizers	DIT		CIT	
		Cost	Percentage to total	Cost	Percentage to total
1.	Urea	1383.20	24.35	968.24	19.07
2.	DAP	2289.69	40.31	2544.00	50.09
3.	Potash	899.08	15.83	642.20	12.65
4.	Factomphos	1108.54	19.51	923.78	18.19
	Total	5680.51	100.00	5078.22	100.00

It could be seen from table that among the fertilizers, expenditure on DAP was highest in both the category. Urea and Factomphos constituted 24.35 per cent and 19.51 per cent in Drip irrigation and 19.07 per cent and 18.19 per cent in Conventional irrigation respectively. Among these three fertilizers, farmers applied large amount of DAP and urea to induce the vegetative plant growth of tomato during initial growth in both irrigation condition.

Altogether the expenditure incurred on fertilizers was Rs. 5,680.51 in Drip irrigation and Rs. 5,078.22 in Conventional irrigation. The total fertilizer cost was higher for Drip irrigation, which accounted for 11.86 per cent increase in fertilizer cost than that for Conventional irrigation, which was due to high fertilizer requirement by drip irrigated tomato.

5.3.2. Operation – wise labour utilization and labour charges incurred by sample farmers

The labour utilization and charges paid to labour for each operation in tomato cultivation were worked out and the comparative analysis of DIT and CIT was made. The results are discussed in the Table 5.20.

It could be seen from the table, that the total labour utilized in DIT and CIT was 141.9 mandays and 164.9 mandays, respectively. The total labour utilization was higher in CIT than that of DIT by 16.20 per cent.

The total labour cost worked out was Rs. 19,038 and Rs. 24,724.4 in DIT and CIT, respectively. Regarding women labour, the utilization was high in DIT and less in CIT i.e., 125.62 mandays and 115.5 mandays, whereas in, men labour utilization, CIT was high with 49.4 mandays and in DIT, it was 16.28 mandays.

In tomato cultivation, many operations were done by women labours. Men labours were engaged for field preparation, nursery preparation and spraying. The percentage share of these operations in total men labour use in DIT was 53.26 per cent, 25.18 per cent and 21.56 per cent, respectively.

In DIT, harvesting operation required 102.46 mandays per hectare. Women labourers were used for harvesting. About 82 per cent of the total women labour was used for harvesting alone. Labour cost for harvesting was Rs. 12,295.20/ ha. Next to this, weeding and transplanting constituted 11.16 per cent and 7.28 per cent of total women labour and it accounted for 10.96 per cent and 8.94 per cent of labour cost respectively.

In CIT also, 73.15 mandays of women labour were required for harvesting, which constituted 63.34 per cent followed by weeding and transplanting with 22.90 per cent and 9.04 per cent of total women labourers, respectively. It is also worth mentioning that 43.60 per cent of men labourers were utilized for irrigation alone in the CIT.

It could be inferred from the table that the total labour utilization and labour cost was higher in conventional irrigation than that of drip irrigation. Women labour utilization was higher in drip irrigation than conventional irrigation. Harvesting was the major labour intensive operation both in drip irrigation and conventional irrigation. The total labour cost was high in CIT by about 29.86 per cent when compared to DIT.

5.3.3. Input wise expenditure incurred by DIT and CIT farmers

Expenditure incurred on each input was worked out for DIT and CIT separately and the results are presented in Table 5.21 and Fig. 5.2.

Table 5.21 Input wise expenditure incurred by DIT and CIT (Rs/ha)

Sl. No.	Inputs	DIT		CIT	
		Cost	Percentage to total	Cost	Percentage to total
1	Seeds	4075.00	10.90	5580.00	12.14
2	Farmyard manure	4940.00	13.22	3990.00	8.67
3	Fertilizers	5680.51	15.21	5078.22	11.05
4	PP chemicals	3630.00	9.72	6600.00	14.36

5	Labour charges	19038.00	50.95	24724.40	53.78
	Total	**37363.51**	**100.00**	**45972.62**	**100.00**

The total input cost incurred on DIT and CIT was Rs. 37363.51 and Rs. 45972.62 respectively. The input cost was high for CIT, which accounted for 23.04 per cent increase in cost than that for DIT.

It could be seen from the table that in DIT, the major expenditure was incurred on labour charges and fertilizers, which accounted for 50.95 per cent and 15.21 per cent respectively. In CIT also, the major expenditure was labour charges, which accounted for 53.78 per cent. Another major item was plant protection cost (14.36 per cent).

In CIT, the labour charges were 29.86 per cent higher than DIT because of conventional irrigation requires more laborers. Hence, traditionally raised tomato has been one of the labour intensive crops.

5.3.4. Costs and Returns incurred by DIT and CIT

The cost of cultivation and net returns realized per hectare of DIT and CIT were worked out and presented in Tables as follows. The cost components are discussed first.

i. Variable costs

The variable costs incurred by the sample farmers in cultivating DIT and CIT are presented in Table 5.22

Table 5.22 Variable costs incurred in the DIT and CIT (Rs/ha)

Sl. No.	Particulars	DIT		CIT	
		Value	Percentage to total	Value	Percentage to total
1	Cost of Ploughing	10890.00	20.52	10588.00	17.02
2	Cost of seeds	4075.00	7.68	5580.00	8.97
3	Cost of manures & fertilizers	10620.51	20.00	9068.20	14.57
4	Cost of plant protection chemicals	3630.00	6.84	6600.00	10.60
5	Cost of human	19038.00	35.86	24724.40	39.74

	labour				
6	Interest on working capital @ 10 %	4825.35	9.10	5656.06	9.10
	Total	**53078.86**	**100. 00**	**62216.66**	**100.00**

A scan over the table implies, the variable costs were higher in CIT with Rs. 62,216.66 per hectare as compared to DIT with Rs. 53,078.86 per hectare. In DIT and CIT, cost of human labour accounted for largest share in total variable costs with 35.86 per cent and 39.74 per cent respectively. Cost of ploughing ranked second in DIT with 20.52 per cent of total cost whereas in CIT, the same cost accounted for 17.02 per cent of the total cost in that category. The share of manures and fertilizers cost was higher in DIT with 20 per cent than that of CIT.

The other items contributed lesser amount of total variable cost. When compared to DIT, the variable cost of CIT was found to be on the higher side because of more utilization of human labour and plant protection chemicals. The variable cost of CIT was 17.21 per cent higher than DIT.

ii. Fixed costs

Fixed costs are those costs which do not vary with the level of output. The fixed costs incurred by the sample farmers in DIT and CIT were worked out and the results are given in Table 5.23.

Table 5.23 Fixed costs incurred in the DIT and CIT cultivation

(Rs/ha)

Sl. No.	**Particulars**	**DIT**		**CIT**	
		Value	**Percentage to total**	**Value**	**Percentage to total**
1	Rental value of land	15410.00	68.26	12394.30	66.86
2	Land revenue	494.00	2.18	496.31	2.67
3	Depreciation on fixed investment	4250.00	18.82	3660.00	19.75
4	Interest on fixed capital @ 12%	2418.48	10.74	1986.00	10.72
	Total	**22572.50**	**100.00**	**18536.60**	**100.00**

From the table, it could be observed that fixed cost was Rs. 22572.50 per hectare in DIT and Rs.18536.60 per hectare, for CIT. In DIT, the fixed cost was

21.77 per cent higher than CIT. The high fixed cost in DIT was mainly due to high rental value. In both the category rental value of land was the major cost.

iii. Total costs

Table 5.24 Total costs incurred by DIT and CIT

(Rs / ha)

Sl. No.	Particulars	DIT		CIT	
		Amount in Rs.	Percentage to total	Amount in Rs.	Percentage to total
1	Variable cost	53078.86	70.16	62216.66	77.05
2	Fixed cost	22572.50	29.84	18536.60	22.95
	Total cost	**75651.36**	**100.00**	**80753.26**	**100.00**

It could be seen from the Table 5.24., that the total cost of cultivation of CIT and DIT was Rs. 80753.26 per hectare and Rs. 75651.36 per hectare respectively and it was higher for CIT by 6.74 per cent. In DIT and CIT, the share of fixed cost was 29.84 per cent and 22.95 per cent respectively. Variable cost accounted for 70.16 per cent and 77.05 per cent, respectively in Drip irrigation and Conventional irrigation. Total cost of CIT was higher because of high variable cost.

iv. Returns

The gross income and net income realized per hectare of DIT and CIT were presented in Table 5.25

Table 5.25 Income from Drip irrigated and Conventional irrigated tomato

Sl. No.	Particulars	DIT	CIT
1	Mean yield (t / ha.)	68.36	54.77
2	Range of Mean price received at the time of harvest (Rs/t)	2000-5000	2000-5000
(i)	I,II week	2000	2000
(ii)	III,IV week	2500	2500
(iii)	V week	2000	2000
(iv)	VI week	3000	3000
(v)	VII week	2000	2000
(vi)	VIII week	5000	5000
(vii)	IX,X week	8000	
3	Gross income (Rs. / ha.)	189266.66	136440.00

4	Total expenses (Rs. / ha.)	75651.36	80753.26
5	Net income (Rs. / ha.)	113615.30	55686.74
6	Cost of production per tonne (Rs.)	1106.66	1474.40
7	Net income per tonne (Rs.)	1662.01	1016.73
8	B - C ratio	2.50	1.69

An insight into the table reveals that the gross income was higher in DIT by 38.71 per cent than CIT, which worked out to Rs. 189266.66 and Rs.136440 per hectare respectively. The net income was higher in DIT i.e., 104.03 per cent than CIT. The high net income indicated the economic advantage of DIT over CIT. The cost of production per tonne was low in DIT with Rs. 1106.66 than in CIT (Rs.1474.40). The net income realized per tonne of tomato was estimated at Rs 1662 and Rs. 1016.73 in DIT and CIT respectively. The output / input ratio (Benefit cost) ratio was also higher in DIT with 2.50 than in CIT (1.67).

5.4. FEASIBILITY OF DIT CULTIVATION

In the study area, tomato was a major vegetable crop cultivated by farmers. Tomato was also grown using drip irrigation in the study area. Therefore, the economic performance of DIT was compared with that of CIT to assess the feasibility of DIT cultivation. The partial budgeting technique was employed to arrive the net gain from DIT cultivation over CIT and the results are presented in Table 5.26.

Table 5.26 Partial budget for Introduction of DIT against CIT

(Rs/ha)

Sl. No.	Debit	Amount	Credit	Amount
1	**Added cost**		**1. Added returns**	52826.66
(i)	Ploughing	302.00		
(ii)	Manures & fertilizers	1552.31		
	Total	1854.31	Total	52826.66
2	**Reduced returns**	Nil	**2. Reduced cost**	
			(i) Seeds	1505.00
			(ii) Plant protection	2970.00
			(iii) Human labour	5686.40
	Total	-	Total	10161.40
	Total (1+2)	**1854.31**	**Total (1+2)**	**62988.06**

Net gain from Drip Irrigated Tomato = Credit – Debit = Rs.61, 133.75

It could be seen from the table 5.26 that with introduction of DIT, the added returns and reduced cost accounted for Rs. 52826.66 and Rs. 10161.40. The added return was due to high yield of DIT. Reduced cost was due to fewer requirements of seeds, plant protection chemicals and human labour. The added cost was only Rs.1,854.31 due to higher application of fertilizer. The net gain realized by introduction of DIT was Rs.61, 133.75 per hectare. This result clearly indicated the advantage of drip irrigation over conventional irrigation for tomato crop in the study area.

5.5. COSTS AND RETURNS FOR BHENDI AND BEET ROOT

The cost of cultivation and net returns realized per hectare of bhendi was worked out and are discussed in what follows. The cost components are discussed first.

5.5.1. Costs and returns for Bhendi

i. Variable costs

The variable costs incurred by the sample farmers in cultivating bhendi are presented in Table 5.27.

Table 5.27 Variable costs incurred in Bhendi cultivation (Rs/ha)

Sl. No.	Particulars	Amount	Percentage to total
1	Cost of Ploughing	7056.00	13.91
2	Cost of seeds	6718.00	13.25
3	Cost of manures & fertilizers	4238.00	8.36
4	Cost of plant protection chemicals	3096.00	6.10
5	Cost of human labour	25000.00	49.29
6	Interest on working capital @ 10 %	4610.80	9.09
	Total	**50718.80**	**100. 00**

It could be observed from the table that, the variable costs was Rs. 50,718 per hectare. Cost of human labour alone accounted for 49.29 per cent of total variable cost. The cost of ploughing and seeds were 13.91 per cent and 13.25 per cent, respectively. The other items contributed lesser amount of total variable cost.

ii. Fixed cost

Fixed cost includes rental value of land, land revenue, depreciation on fixed investment and interest on fixed capital. The fixed cost incurred by the sample farmers in bhendi crop cultivation was worked out and the results are given in Table 5.28.

Table 5.28 Fixed cost incurred in Bhendi Cultivation by the Sample Farmers

(Rs/ha)

Sl. No.	Particulars	Value	Percentage to total
1	Rental value	10500.00	66.87
2	Land revenue	269.56	1.73
3	Depreciation on fixed investment	3250.00	20.69
4	Interest on fixed capital @ 12%	1682.34	10.71
	Total	**15701.90**	**100.00**

From the table, it could be observed that total fixed cost incurred by the bhendi farmer was Rs.15, 701.90 per hectare. Rental value for land had major share in fixed cost accounting for 66.87 per cent while depreciation on fixed investment, interest on fixed capital and land revenue constituted 20.69 per cent, 10.71 per cent and 1.73 per cent, respectively.

iii. Total cost

Table 5.29 Total cost incurred in Production of Bhendi (Rs/ha)

Sl. No.	Particulars	Amount	Percentage to total
1	Variable cost	50718.80	76.35
2	Fixed cost	15701.90	23.64
	Total cost	**66420.70**	**100.00**

It could be seen from the Table 5.29., the total cost of cultivation of bhendi was Rs. 66,420.70 per hectare. Of which the share of variable cost and fixed cost was 76.35 per cent and 23.64 per cent, respectively.

iv. Returns

The gross income and net income realized per hectare of bhendi was presented in Table 5.30.

Table 5.30 Income from Bhendi cultivation in the Sample Farms

Sl. No.	Particulars	Value
1	Mean yield (t / ha.)	11.40
2	Range of Mean price received at the time of harvest (Rs/t)	10,000-15,000
(i)	I week	15,000.00
(ii)	II , III week	10,000.00
(iii)	IV week	14,000.00
(iv)	V week	12,000.00
3	Gross income (Rs. / ha.)	1,22,300.00
4	Total expenses (Rs. / ha.)	66,420.70
5	Net income (Rs. / ha.)	55,879.30
6	Cost of production per tonne (Rs.)	5,826.37
7	Net income per tonne (Rs.)	4,902.00
8	B – C ratio	1.84

The above table reveals that the gross income of bhendi was Rs.1, 22,300 per hectare and net income was Rs. 55,879.30. Cost of production per tonne was Rs. 5826.37 and the net income per tonne was Rs. 4902.

5.5.2. Costs and Returns for Beet root

The cost of cultivation and net returns realized per hectare of beet root was worked out and presented in Tables 5.31 to 5.34. The cost components are discussed first.

i. Variable costs

The variable costs incurred by the sample farmers in cultivating beet root are presented in Table 5.31.

Table 5.31 Variable costs incurred in Beet root cultivation (Rs/ha)

Sl. No.	Particulars	Amount	Percentage to total
1	Ploughing	7220.00	15.58
2	Cost of seeds	8062.00	17.39
3	Cost of manures & fertilizers	3615.00	7.79
4	Cost of plant protection chemicals	4478.00	9.66
5	Cost of human labour	18,770.00	40.49
6	Interest on working capital @ 10 %	4214.50	9.09

	Total	46359.50	100.00

It could be seen from the table that, the variable costs was Rs. 46,359.50 per hectare. Cost of human labour accounted for largest share in total variable costs with 40.49 per cent. The cost of seeds and ploughing was 17.39 per cent and 15.58 per cent respectively.

ii. Fixed cost

The fixed cost incurred by the sample farmers in beet root cultivation was worked out and the results are given in Table 5.32.

Table 5.32 Fixed costs for beet root cultivation in the Sample Farms (Rs/ha)

Sl. No.	Particulars	Value	Percentage to total
1	Rental value	9880.00	64.79
2	Land revenue	394.00	2.58
3	Depreciation on fixed investment	3340.00	21.92
4	Interest on fixed capital @ 12 %	1633.68	10.71
	Total	**15247.68**	**100.00**

From the table, it could be observed that total fixed cost was Rs.15247.68 per hectare. Rental value for land had major share in fixed cost accounting for 64.79 per cent while depreciation on fixed investment, interest on fixed capital and land revenue contributed about 21.92 per cent, 10.71 per cent and 2.58 per cent respectively.

iii. Total costs

Table 5.33 Total cost of Beet root production in the Sample Farms (Rs/ha)

Sl. No.	Particulars	Value	Percentage to total
1	Variable cost	46359.50	75.25
2	Fixed cost	15247.68	24.25
	Total cost	**61607.18**	**100.00**

The Table 5.33 shows that the total cost of cultivation of beet root was Rs. 61607.18 per hectare. The percentage share of variable cost and fixed cost was 75.25 and 24.25 respectively.

iv. Returns

The gross income and net income realized per hectare of beet root was presented in Table 5.34

Table 5.34 Income from Beet root cultivation in Sample Farms

Sl. No.	Particulars	Value
1	Mean yield (t / ha.)	36.2
2	Range of mean price received @ harvest (Rs. / t)	3,300-7,000
(i)	I week	7,000.00
(ii)	II week	3,300.00
3	Gross income (Rs. / ha.)	2,19,915.00
4	Total expenses (Rs. / ha.)	61607.18
5	Net income (Rs. / ha.)	1,58,307.82
6	Cost of production per tonne (Rs.)	1702
7	Net income per tonne (Rs.)	4373.14
8	B – C ratio	3.57

The above table reveals that the gross income from beet root crop was Rs.2,19,915 per hectare and net income was Rs. 1, 58,307.82. Cost of production per tonne was Rs. 1702 and the net income per tonne was Rs. 4373.14. The benefit cost ratio was found to be 3.57 which indicate the high profitability of Beet root crop.

5.6 Per Hectare Profitability of the Vegetables in Sample Farms

The profitability of any crop enterprise is judged by the economic parameters such as net returns and BC ratio. These parameters are depicted in Table 5.35.

Table 5.35 Per Hectare Profitability of the Vegetables in Sample Farms

Sl. No	Particulars	Tomato		Bhendi	Beet root
		Drip irrigation	Conventional irrigation		
1.	Yield (t/ha)	68.36	54.77	11.40	36.20
2.	Range of mean price (Rs. /tonne)	2000-5000	2000-5000	10,000-15,000	3,300-7,000
3.	Gross income (Rs.ha)	1,89,266.66	1,36,440.00	1,22,300.00	2,19,915.00
4.	Total expenses (Rs. / ha)	75,651.36	80,753.26	66,420.70	61,607.18
5.	Net income (Rs. / ha.)	1,13,615.30	55,686.74	55,879.30	1,58,307.82
6.	Cost of production per tonne (Rs.)	1,106.66	1,474.40	5,826.37	1,702.00
7.	Net income per tonne (Rs.)	1,662.01	1,016.73	4,902.00	4,373.14
8.	B – C ratio	2.50	1.69	1.84	3.57

The cultivation of major vegetables is observed to be profitable with the per hectare net return being Rs.1,13,615.30, Rs.55,686.74, Rs.55,879.30 and Rs.1,58,307.82, obtained from tomato under drip and conventional irrigation, bhendi and beet root crops, respectively. The Benefit - Cost ratio for the selected vegetables ranged between 1.69 and 3.57 indicating that all vegetable crops were profitable.

Among these crops beet root and tomato under drip irrigation were more profitable than conventional irrigated tomato and bhendi. The farmers raised tomato under conventional irrigation and bhendi have to minimize the cost on labour input and use the balanced composition of the fertilizer nutrients and bridge the yield gap by adopting improved agro-techniques.

5.7. RESOURCE USE EFFICIENCY OF TOMATO (DIT, CIT), BHENDI AND BEETROOT

The specific contribution of each resource to output was estimated through production function analysis. Cobb – Douglas type of production function was found to be the best fit to measure the efficiency of each resource.

The zero order correlation matrixes was formed and estimated before running the Cobb-Douglas production function to test the multicollinearity amongst the input variables. The variables such as quantity of seeds (tomato-g/ha., bhendi and beetroot-kg/ha.) nitrogeneous fertilizer (Kg/ha.), phosphorus fertilizer (Kg/ha.), potassium fertilizer (Kg/ha.), irrigation (numbers/ha.), plant protection (lit/ha.) and human labour (man days) were included in CIT, bhendi and beet root. The irrigation (numbers/ha.) variable was excluded in DIT.

5.7.1. Results of Cobb-Douglas Production Function of Drip irrigated tomato

The regression coefficient and their test of significance of DIT are presented in Table 5.36.

Table 5.36 Regression Co-efficient and their Test of Significance in Drip Irrigated Tomato

Sl.No	Variables	Nn.	Regression Co-efficient		Standard Error	t-value
			Nn.	Value		
1.	Intercept		β_0	0.0476	0.654	0.072
2.	Seeds (g/ha.)	X_1	β_1	0.193^{NS}	0.136	1.416
3.	Quantity of	X_2	β_2	0.281^{***}	0.097	2.878

	Nitrogenous fertilizer (kg./ha.)					
4.	Quantity of Phosphorus fertilizer (kg./ha.)	X_3	β_3	0.130^{***}	0.043	3.013
5.	Quantity of Potassium fertilizer (kg./ha)	X_4	β_4	0.167^{***}	0.054	3.061
6.	Plant Protection chemicals (lit/ha.)	X_5	β_5	0.043^{***}	0.012	3.376
7.	Human labour(mandays)	X_6	β_6	0.049^{NS}	0.074	0.659

Nn.- Notation ; Number of observations = 30
R^2 = 0.98; F - Value = 195.23
*** - Significant at one percent level; NS- Non-significant

It could be seen from the above table that the co-efficient of multiple determination (R Square) was 0.98 indicated that 98 per cent of the total variation in the yield was explained by the selected six variables in the functional analysis. The significance of R^2 was tested by F-statistics, which found to be significant at one per cent probability level.

5.7.1.1. Production Elasticities of Resources of DIT

The coefficients of quantity of nitrogenous fertilizer (X_2), phosphorus fertilizer(X_3), potassium(X_4) and plant protection chemicals (X_5) were found to be positive and have significant influence on yield. Other variables, quantity of seeds and human labour have positive influence but are not significant influence on yield. The regression coefficients of nitrogenous fertilizer was 0.28, which indicates that one per cent increase in quantity of nitrogenous fertilizer (X_2) will increase the yield by 0.28 per cent and the regression coefficients of phosphorus fertilizer was 0.13 which implies that one per cent increase in quantity of phosphorus fertilizer(X_3) would increase the yield by 0.13 per cent in *ceterius paribus* condition. Similarly, the regression coefficient of potassium fertilizer and quantity of plant protection chemicals were 0.16 and 0.04 respectively which implies that one percent increase in quantity of potassium fertilizer and plant protection chemicals would increase the yield by 0.16 per cent and 0.04 per cent respectively in *ceterius paribus* condition.

5.7.1.2. Marginal Value Productivities of DIT

The marginal value productivity (MVP) and marginal input cost (MIC) of significant inputs were estimated and the ratio between MVP and MIC was worked out and are presented in the Table 5.37.

The ratio of MVP to MIC for all the variables was found to be greater than one which indicates that use of these variables can be increased. The ratio was high for nitrogenous fertilizer, potassium fertilizer and phosphorus fertilizer under DIT farms which indicates scope for increasing the yield of tomato by increased use of these inputs at the existing technology.

Table 5.37 Marginal productivity of resources in Drip Irrigated Tomato

Sl. No	Variables	Geometric mean	Regression co-efficient	MVP (Rs.)	Factor cost (MIC) (Rs.)	MVP / MIC
1.	Yield (t./ha)	68.36				
2.	Quantity of Nitrogenous fertilizer (Kg./ha.)	220.76	0.281	304.54	5.60	54.38
3.	Quantity of Phosphorus fertilizer(kg./ha)	134.86	0.130	230.63	7.48	30.83
4.	Quantity of Potassium fertilizer(kg./ha)	49.73	0.167	803.46	5.20	154.51
5.	Plant Protection chemicals (lit/ha.)	3.46	0.043	2973.46	2000	1.48

5.7.2. Results of Cobb-Douglas Production Function of Conventional irrigated tomato

The regression coefficient and their test of significance of CIT are presented in Table 5.38.

Table 5.38 Regression Co-efficient and their Test of Significance in CIT

Sl.No	Variables	Nn.	Regression Co-efficient		Standard Error	t-value
			Nn.	Value		
1.	Intercept		β_0	0.038	0.66	0.057
2.	Seeds (g/ha.)	X_1	β_1	0.152^{*}	0.081	1.878
3.	Quantity of Nitrogeneous fertilizer (kg /ha.)	X_2	β_2	0.292^{***}	0.087	3.319
4.	Quantity of Phosphorus fertilizer (kg/ha.)	X_3	β_3	0.019^{NS}	0.073	0.265
5.	Quantity of Potassium fertilizer (kg/ha.)	X_4	β_4	0.157^{***}	0.055	2.843
6.	Irrigation (numbers/ha.)	X_5	β_5	0.183^{**}	0.060	3.013
7.	Plant Protection	X_6	β_6	0.038^{*}	0.020	1.855

	chemicals (lit/ha.)					
8.	Human labour(man days)	X_7	β_7	0.037^{NS}	0.094	0.396

Nn.- Notation
Number of observations = 60
R^2 = 0.82; F - Value = 35.67
*** - Significant at one percent level
* - Significant at ten percent level; NS- Non-significant

It could be seen from the above table that the co-efficient of multiple determination (R Square) was 0.82 indicated that 82 per cent of the total variation in the yield was explained by the selected seven variables in the functional analysis. The significance of R^2 was tested by F-statistics, which found to be significant at one per cent probability level.

5.7.2.1. Production Elasticities of Resources of CIT

The coefficients of quantity of seeds (X_1), nitrogenous fertilizer (X_2), potassium (X_4), number of irrigation (X_5) and plant protection (X_6) were found to be positive and have significant influence on yield. Other variable such as quantity of phosphorus and human laborers had positive influence but were not significant.

The regression coefficient of seeds was 0.15, which indicates that one per cent increase in quantity of seeds (X_1) will increase the yield by 0.15 per cent and the regression coefficient of nitrogenous fertilizer was 0.29 which implies that one per cent increase in quantity of phosphorus fertilizer(X_2) would increase the yield by 0.29 per cent in *ceterius paribus* condition. Similarly, the regression coefficient of potassium fertilizer, irrigation and quantity of plant protection chemicals were 0.15, 0.18 and 0.03 respectively which implies that one percent increase in quantity of potassium fertilizer, irrigation and plant protection chemicals would increase the yield by 0.15, 0.18 per cent and 0.03 per cent respectively in *ceterius paribus* condition.

5.7.2.2. Marginal Value Productivities of CIT

The marginal value productivity (MVP) and marginal input cost (MIC) of significant inputs (variables) were estimated and the ratio between MVP and MIC was worked out and are presented in the Table 5.39.

It is observed from the table that the ratio between MVP and MIC of the quantity of potassium fertilizer and nitrogeneous fertilizer were highest which indicates scope for increasing the yield of the farm by increased use of these inputs at the existing level resource use pattern. The ratio for seeds and plant protection chemicals was less than one which indicated that use of these inputs had to be reduced.

Table 5.39 Marginal productivity of resources in CIT

Sl. No	Variables	Geometric mean	Regression co-efficient	MVP (Rs.)	Factor cost (MIC) (Rs.)	MVP / MIC
1.	Yield (t./ha)	54.77	0.038			
2.	Seeds (g/ha.)	223.25	0.152	102.54	240	0.42
3.	Quantity of Nitrogeneous fertilizer (Kg./ha.)	234.63	0.292	187.44	5.60	33.47
4.	Quantity of Potassium fertilizer(kg./ha)	44.65	0.157	529.60	5.20	101.84
5.	Irrigation (no's/ha.)	20	0.183	1378.15	250	5.51
6.	Plant Protection chemicals (lit/ha.)	4.55	0.038	1257.90	2000	0.62

5.7.3. Results of Cobb-Douglas Production Function of Bhendi

The regression coefficient and their test of significance of bhendi are presented in Table 5.40.

Table 5.40 Regression Co-efficient and their Test of Significance in Bhendi

Sl.No	Variables	Nn.	Regression Co-efficient		Standard Error	t-value
			Nn.	Value		
1.	Intercept		β_0	0.192	0.346	0.556
2.	Seeds (kg/ha.)	X_1	β_1	0.002^{NS}	0.047	0.063
3.	Quantity of Nitrogeneous fertilizer (kg/ha.)	X_2	β_2	0.056^{NS}	0.050	1.108
4.	Quantity of Phosphorus fertilizer (kg/ha.)	X_3	β_3	0.169^{***}	0.054	3.106
5.	Quantity of Potassium fertilizer (kg/ha)	X_4	β_4	0.143^{**}	0.059	2.413
6.	Irrigation (numbers/ha.)	X_5	β_5	0.256^{*}	0.148	1.731
7.	Plant Protection chemicals (lit/ha.)	X_6	β_6	0.255^{**}	0.091	2.791
8.	Human labour(mandays)	X_7	β_7	0.001^{NS}	0.023	0.074

Nn.- Notation
Number of observations = 30
R^2 = 0.95
F - Value = 66.60
*** - Significant at one percent level

**- Significant at five percent level
*- Significant at one percent level
NS- Non-significant

The co-efficient of multiple determination (R Square) was 0.95 indicated that 95 per cent of the total variation in the yield was explained by the selected seven variables in the functional analysis. The significance of R^2 was tested by F-statistics, which found to be significant at one per cent probability level.

5.7.3.1. Production Elasticities of Resources for Bhendi

The quantity of phosphorus fertilizer (X_3), potassium fertilizer (X_4), number of irrigations (X_5) and plant protection chemicals (X_6) were found to have positive significant influence on yield of Bhendi. Nitrogenous fertilizer (X_2) and human labour (X_7) did not have any significant influence on yield.

The regression coefficient of phosphorus fertilizer and potassium fertilizer was 0.16 and 0.14, which indicate that one per cent increase in phosphorus and potassium fertilizer will increase the yield by 0.16 per cent and 0.14 per cent respectively in *ceterius paribus* condition. One per cent increase in number irrigation increases the yield by 0.25 per cent when all other inputs kept constant at their geometric mean level. One per cent increase in quantity of plant protection chemical would increase the yield by 0.25 per cent in *ceteris paribus* condition.

5.7.3.2. Marginal Value Productivities for Bhendi

The marginal value productivity (MVP) and marginal input cost (MIC) of significant variables were estimated and the ratio of MVP and MIC was worked out and are presented in the Table 5.41.

It is evident from the table that the ratio between MVP and MIC of the quantity of phosphorus and potassium fertilizer were highest. This indicated that increase in use of phosphorus and potassium fertilizer would increase the yield. The ratio between MVP and MIC for plant protection chemical was less than one (0.78) which indicated the excessive use of plant protection chemical. The above results indicated the scope for increasing yield of bhendi by increasing the phosphorus and potassium fertilizer and by reducing the plant protection chemical.

Table 5.41 Marginal productivity of resources in Bhendi

Sl. No	Variables	Geometric mean	Regression co-efficient	MVP (Rs.)	Factor cost (MIC) (Rs.)	MVP / MIC
1.	Yield (t./ha)	11.4	0.192			
2.	Phosphorus fertilizer (kg./ha.)	11.01	0.169	481.21	7.48	64.33
3.	Potassium fertilizer (kg./ha)	11.80	0.143	379.91	5.20	73.05
4.	Irrigation (numbers/ha.)	15	0.256	535.04	250	2.14
5.	Plant Protection chemicals (lit/ha.)	4.4	0.255	1816.87	2300	0.78

5.7.4. Results of Cobb-Douglas Production Function of Beet Root

The regression coefficient and their test of significance of beet root are presented in Table 5.42.

Table 5.42 Regression Co-efficient and their Test of Significance in Beet root

Sl.No	Variables	Nn.	Regression Co-efficient		Standard Error	t-value
			Nn.	Value		
1.	Intercept		β_0	2.993	0.704	4.247
2.	Seeds (kg/ha.)	X_1	β_1	0.246***	0.080	3.070
3.	Quantity of Nitrogeneous fertilizer (kg/ha.)	X_2	β_2	0.141NS	0.133	1.057
4.	Quantity of Phosphorus fertilizer (kg/ha.)	X_3	β_3	0.209**	0.095	2.201
5.	Quantity of Potassium fertilizer (kg/ha)	X_4	β_4	0.172*	0.099	1.737
6.	Irrigation (numbers/ha.)	X_5	β_5	0.206***	0.067	3.069
7.	Plant Protection chemicals (lit/ha.)	X_6	β_6	0.107**	0.041	2.583
8.	Human labour(mandays)	X_7	β_7	- 0.615***	0.186	-3.306

Nn.- Notation
Number of observations = 30
R^2 = 0.96
F - Value = 98.39
*** - Significant at one percent level
** - Significant at five percent level
NS- Non-significant

The co-efficient of multiple determination (R Square) was 0.96 indicated that 96 per cent of the total variation in the beet root yield was explained by the selected seven variables in the functional analysis. The significance of R^2 was tested by F-statistics, which found to be significant at one per cent of probability level.

5.7.4.1. Production Elasticities of Resources for Beet root

The coefficients for seeds, phosphorus fertilizer, potassium fertilizer, irrigation and plant protection chemicals were found to have positive and significant influence on yield of beet root. Nitrogenous fertilizer (X_2) has positive influence but not significant. The variable human labour (X_7) was found to have negative significant influence on yield of Beet root.

The regression coefficients of seeds, phosphorus fertilizer and potassium fertilizer were 0.24, 0.20 and 0.17 respectively, which indicates that one per cent increase in quantity of seeds (X_1), phosphorus (X_3) and potassium fertilizer (X_4) will increase the yield by 0.24 per cent, 0.20 per cent and 0.17 per cent respectively in *ceterius paribus* condition. One per cent increase in number irrigation would increase the yield by 0.20 per cent and one per cent increase in quantity of plant protection chemical would increase the yield by 0.17 per cent in *ceteris paribus* condition.

5.7.4.2. Marginal Value Productivities for Beet root

The marginal value productivity (MVP) and marginal input cost (MIC) of significant variables were estimated and the ratio between MVP and MIC was worked out and are presented in the Table 5.43.

It is observed from the table that the ratio between MVP and MIC of all the inputs were greater than one. The ratio for phosphorus and potassium fertilizer was highest. This indicated that scope to increase the use of these fertilizers to increase the yield. It is inferred from the above results that in beet root, yield could be increased by increasing the application of phosphorus and potassium fertilizers.

Table 5.43 Marginal productivity of resources in Beet root

Sl. No	Variables	Geometric mean	Regression co-efficient	MVP (Rs.)	Factor cost (MIC) (Rs.)	Ratio of MVP and MIC
1.	Yield	36.20	2.993			

	(t./ha)					
2.	Seeds (kg/ha.)	6.50	0.246	7055.65	1440	4.89
3.	Phosphorus fertilizer (kg./ha.)	35.96	0.209	1083.53	7.48	144.85
4.	Potassium fertilizer (kg./ha)	44.33	0.172	723.34	5.20	139.10
5.	Irrigation (numbers/ha.)	10.00	0.206	3840.45	250	15.36
6.	Plant Protection chemicals (lit/ha.)	4.20	0.107	4749.52	2000	2.37

5.8. TECHNICAL EFFICIENCY OF TOMATO UNDER DRIP AND CONVENTIONAL IRRIGATION CONDITION

Data Envelopment Analysis was attempted to measure the technical efficiency in tomato production under drip and conventional irrigation. The Data Envelopment Analysis (DEA) is a non-parametric mathematical programming methodology based on the works of Farrell (1957) and Fraser and Cordina (1999).

The results of DEA, technical and scale efficiencies of tomato production under drip and conventional irrigation have been furnished in Table 5.44.

Table 5.44 Technical and Scale Efficiency Measures for Tomato under Drip and Conventional irrigation

Sl. No.	Parameters	Technical efficiency		Scale efficiency	
		Drip irrigation	Conventional irrigation	Drip irrigation	Conventional irrigation
1.	Mean	0.54	0.53	0.55	0.53
2.	Standard deviation	0.31	0.30	0.31	0.30
3.	Minimum	0.03	0.08	0.03	0.08
4.	Maximum	1.00	1.00	1.00	1.00

The average technical efficiency score was found to be 0.54 and 0.53 in tomato under drip and conventional irrigation respectively. Nasurudeen (2009) showed that the mean technical efficiency score of paddy farm was 0.64 in union territory of Pondicherry. The average technical efficiency of tomato farms indicated that the average drip irrigated farm and conventional irrigated farm was producing the potential output 72 t/ha, 56.80 t/ha respectively. It also indicates there is possibility to increase the output level by 46 per cent in drip irrigation and 47 per cent in conventional irrigation. The average scale efficiency score of drip irrigated tomato was only 0.55 and conventional irrigated tomato was only 0.53 which indicated that there is scope for increasing the yield of tomato farms to obtain the frontier output. Whereas paddy farms in union territory of Pondicherry it was 0.94.

The frequency distribution of technical and scale efficiency measures for tomato (drip and conventional) farms has been furnished in Table 5.45 (Fig. 5.3 & 5.4).

Table 5.45 Frequency Distribution of Technical and Scale efficiency measures for Drip and Conventional irrigated Tomato

Frequency levels	Technical efficiency		Scale efficiency	
	Drip irrigation	**Conventional irrigation**	**Drip irrigation**	**Conventional irrigation**
< 20	6 (20.00)	11 (18.33)	5 (16.66)	11 (18.33)
20 - 40	6 (20.00)	12 (20.00)	6 (20.00)	12 (20.00)
40 – 60	3 (10.00)	10 (16.67)	4 (13.34)	10 (16.67)
60 - 80	6 (20.00)	12 (20.00)	6 (20.00)	12 (20.00)
80 – 100	9 (30.00)	15 (25.00)	9 (30.00)	15 (25.00)
Total number of farms	**30** **(100.00)**	**60** **(100.00)**	**30** **(100.00)**	**60** **(100.00)**

A perusal of table reveals that about, 30 per cent of the drip irrigated farmers and 25 per cent of the conventional irrigated farmers belonged to meet the most efficiency category (80-100 per cent). It also indicates 20 per cent of drip irrigated farmers and 18.33 per cent of conventional irrigated farmers come under the least efficient group (less than 20 per cent) with mean technical efficiency of 54 per cent and 53 per cent in drip and conventional irrigated farmers, respectively.

The scale efficiency measures indicated that 30 per cent of drip irrigated farmers and 25 per cent of conventional irrigated farmers belonged to the most efficient scale group (80-100 per cent) and about 16.66 per cent of drip irrigated farms and 18.33 per cent of conventional irrigated farms operated in the least scale efficiency group.

5.9. MARKETING CHANNEL

Marketing of vegetables is more complex in nature because of perishability and need to be marketed immediately after harvest. The intermediaries including commission agents, wholesalers and retailers take more advantage and received greater part of the consumers' rupee. To regulate the marketing of vegetables, the government started the farmers market, which resulted in significant benefits to farmers to enhance the farmer's income by preventing intermediaries and distress selling. In order to understand the marketing practices and problems in marketing of vegetables, it was decided to find out the channels through which they have marketed and price spread in each channel was worked out.

The vegetable producers can sell their produce either through commission agents or farmers' market. The wholesalers, retailers and consumers buy the vegetables from the above intermediaries.

The following marketing channels were identified for Tomato, Bhendi and Beet root crops in the study area.

Channel I

Producer → Consumer

Channel II

Producer → Commission Agent → Wholesaler cum Retailer → Consumer

Channel III

Producer → Commission Agent → Retailer → Consumer

5.9. PRICE SPREAD ANALYSIS

The information on price spread provided in the Tables 5.44 through 5.46 are for all the three marketing channels.

Marketing channel I

It could be observed from the Table 5.46 that in Channel I, the total marketing cost incurred by the farmer per quintal was Rs.46.93 for tomato, Rs. 26 for bhendi and Rs. 28 for beet root. The net price received by the farmer was Rs. 2,003.07, Rs.1, 424 and Rs. 1,222 per quintal of tomato, bhendi and beet root, respectively.

In Channel I the producer’s share in consumer’s rupee was higher and the price spread was lower than other marketing channels because of direct selling of produce to consumers. The producer’s share in consumer’s rupee was the lowest for tomato (97.70%), compared to bhendi (98.82%) and beet root (97.76%) while the price spread for these vegetables was 2.30, 1.80 and 2.24 per cent respectively. The higher price spread of tomato is due to its perishability and higher fluctuations in prices.

Table 5.46 Price Spread of Tomato, Bhendi and Beet root in Market Channel I

Sl. No.	Particulars	Tomato		Bhendi		Beet root	
		Rs/Qtl	Per cent	Rs/Qtl	Per cent	Rs/Qtl	Per cent
1.	Net price received by producers	2003.07	97.70	1424	98.20	1222	97.76
2.	**Marketing cost incurred by the producer**						
	a. Cleaning and grading	34.33	1.67	16	1.10	16	1.28
	b. Packaging	12.60	0.62	10	0.70	12	0.96
	c. Loading and unloading						
	d. Transport						
	e. Commission charges						
	Sub total	**46.93**	**2.30**	**26**	**1.80**	**28**	**2.24**
3.	Price paid by the consumer	2050	100.00	1450	100.00	1250	100.00
4.	**Price spread**	**46.93**	**2.30**	**26**	**1.80**	**28**	**2.24**

Marketing channel II

The price spread analysis for marketing channel II is furnished in Table 5.47. It could be seen from the table that the net price received by the farmer was Rs. 1468.66, Rs. 909.67 and Rs. 677.5 per quintal of tomato, bhendi and beet root respectively. The commission agent’s, marketing cost per quintal was Rs.50.48 for tomato, Rs. 76.70 for bhendi and Rs. 50.48 for beet root.

The farmer’s share in consumer’s rupee was the lowest for beet root (56.45%) as compared to tomato (74.92%) and bhendi (65.95%) because of high cost involved in grading beet root (Rs.37.50/qtl). The price spread for tomato, bhendi and beet root was 25.07, 34.02 and 43.54 per cent, respectively.

Marketing channel III

It could be seen from Table 5.48 that in channel-III, the net price received by the farmers was Rs. 1689.56, Rs. 1179.70 and Rs. 773.02 per quintal of tomato, bhendi and beet root, respectively.

The cost incurred by the retailer was Rs. 262.64 for tomato (11.93%), Rs. 162.3 for bhendi (10.14%) and Rs. 304 for beet root (22.51%). The price paid by the consumer was Rs. 2200, Rs. 1600 and Rs. 1350 per quintal of tomato, bhendi and beet root respectively.

The farmer's share in consumer's rupee was the lowest for beet root (57.26%) as compared to tomato (76.8%) and bhendi (73.73%). The price spread for tomato, bhendi and beet root was 23.20, 26.27 and 42.74 per cent respectively.

Thus it could be inferred from the above analysis that the marketing channel I namely Farmer - Consumer as expected was the efficient one since the farmer's share was highest for all vegetables (97.70% for tomato, 98.20% for bhendi and 97.76% beet root) and lowest price spread (2.30% for tomato, 1.80% for bhendi and 2.24% beet root). Obviously it is due to direct marketing i.e., absence of intermediaries.

5.10. PRODUCTION CONSTRAINTS FACED BY SAMPLE FARMERS

The constraints faced by farmers in production of vegetables were ranked by Garrett's ranking technique and are presented in Table 5.49.

The producers expressed that the non-availability of hired labour was the most important constraint (72.80) as most of the labour in the area were willing to work under Mahatma Gandhi National Rural Employment Guarantee Scheme. The Second major constraint in the vegetable production was pest and diseases like fruit borer, white fly, leaf spot, leaf curl (70.00) etc. Hence the farmers had to spend more amounts to control pests and diseases. The next important problem was high wage rate (54.21) and it was Rs. 250 for men and Rs. 150 for women. Water scarcity was the (52.24) fourth major problem.

Lack of finance and credit facility (40.87) ranks fifth constraint. Regarding the adoption of drip irrigation sample farmers expressed the difficulty in getting Credit and inadequate knowledge about drip irrigation method. The sixth constraint was high cost of seeds (34.1). The cost of 100g tomato seed varied from Rs.250 to Rs.300, cost of bhendi seed was Rs.1200 per kg and the cost of beet root seed ranged between Rs.1400 and 1500 per kg. Seventh constraint ranked was poor quality of inputs such as seeds, fertilizers and plant protection chemicals.

Table 5.49 Constraints in Vegetable Production

S.No	Problems	Mean Score	Rank
1	Non-availability of labour	72.80	I
2	Pests and diseases attack	70.00	II
3	High wage rate	54.21	III
4	Water scarcity	52.24	IV
5	Lack of finance and credit facility	40.87	V
6	High cost of seeds	34.10	VI
7	Poor quality of seeds, fertilizers and plant protection chemicals	25.04	VII

5.11. MARKETING CONSTRAINTS FACED BY SAMPLE FARMERS

Four major marketing constraints were identified in vegetable marketing and they were ranked using Garrett's' ranking technique and the results are presented in Table 5.50.

The most important constraint identified by the vegetable growers was higher price fluctuation in vegetable market (73.00) as the price varied between Rs. 200 to Rs.2,000 per quintal. The second major constraint ranked by the sample farmers were perishability of vegetables (53.87). This indicated the farmers need storage facilities which would stabilize the prices. Low price (43.60) and lack of market information (31.20) were the other constraints faced by the vegetable growers in marketing of vegetables.

Table 5.50 Constraints in Vegetable Marketing

S.No.	Problems	Score	Rank
1	Price fluctuation	73.00	I
2	Perishability of vegetables	53.87	II
3	Low price	43.60	III
4	Lack of market information	31.20	IV

Table 5.47 Price Spread of Tomato, Bhendi and Beet root in Market channel II

Sl. No	Particulars	Tomato		Bhendi		Beet root	
		Rs/qtl	Per cent	Rs/qtl	Per cent	Rs/qtl	Per cent
1	**Net Price Received By Producers**	**1468.66**	**74.92**	**909.67**	**65.95**	**677.5**	**56.45**
2	**Marketing cost incurred by the producer**						
	a. Grading and Packaging cost	8.34	0.42	-	-	37.5	3.12
	b. Loading and unloading	26.33	1.34	25	1.81	20	1.67
	c. Transport	33.33	1.70	33.33	2.41	25	2.08
	d. Commission charges	130	6.63	132	9.57	140	11.67
	Sub total	**198**	**10.10**	**190.33**	**13.79**	**222.5**	**18.54**
3	Purchase price of commission agent	1666.66	85.02	1100	79.75	900	75.00
4	**Marketing cost incurred by the commission agent**						
	a. Labour cost	14.28	0.73	25.5	1.85	14.28	1.19
	b. Market charges	28.7	1.46	38.7	2.80	28.7	2.40
	c. Miscellaneous cost	7.5	0.38	12.5	0.90	7.5	0.63
	Sub total	50.48	2.57	76.7	5.56	50.48	4.20
5	Purchase price of wholesaler cum retailer	1717.14	87.60	1176.7	85.31	950.48	79.20
6	**Marketing cost incurred by the wholesaler cum retailer**						
	a. Loading and unloading charges	36	1.84	24	1.74	36	3.00
	b. Labour cost	53.5	2.73	45.5	3.3	53.5	4.45
	c. Market charges	34	1.73	34	2.46	34	2.83
	d. Losses @ 5 per cent	66.52	3.34	69.83	5.06	72.52	6.04
	e. Miscellaneous cost	16.5	0.84	-	-	-	-
	f. Margins of wholesaler cum retailer	36.52	1.86	29.97	2.17	53.5	4.46
	Sub total	**243.04**	**12.40**	**203.3**	**14.74**	**249.52**	**20.8**
7	Price paid by the consumer	1960.18	100.00	1379.3	100.00	1200	100.00
	Price spread	**491.52**	**25.07**	**469.33**	**34.02**	**522.5**	**43.54**

Table 5.48 Price Spread of Tomato, Bhendi and Beet root in Market channel III

Sl. No.	Particulars	Tomato		Bhendi		Beet rrot	
		Rs/Qtl	Per cent	Rs/ Qtl	Per cent	Rs/Qtl	Per cent
1	**Net price received by producers**	**1689.56**	**76.80**	**1179.7**	**73.73**	**773.02**	**57.26**
2	**Marketing cost incurred by the producer**						
	a. Packaging cost	7.66	0.35	-	-	37.5	2.78
	b. Loading and unloading	26.33	1.20	25	1.56	20	1.48
	c. Transport	33.33	1.51	33.33	2.08	25	1.85
	d. Commission charges	130	5.90	132	8.25	140	10.37
	Sub total	**197.32**	**8.97**	**190.33**	**11.89**	**222.5**	**16.48**
3	Purchase price of commission agent	1886.88	85.77	1370	85.62	995.52	73.74
4	**Marketing cost incurred by the commission agent**						
	a. Labour cost	14.28	0.65	23.5	1.46	14.28	1.05
	b. Market charges	28.7	1.30	35.6	2.22	28.7	2.13
	d. Miscellaneous cost	7.5	0.34	8.6	0.54	7.5	0.56
	Sub total	50.48	2.30	67.7	4.23	50.48	3.74
5 6	Purchase price of retailer **Marketing cost incurred by the retailer**	1937.36	88.06	1437.7	89.86	1046	77.48
	a. Transport	35.6	1.62	30.4	1.90	25.5	1.89
	c. Market charges	15	0.68	15	0.93	15	1.11
	d. Losses @ 3per cent	40.13	1.82	41.63	2.60	43.5	3.22
	d. Miscellaneous cost	18.5	0.84	-	-		-
	f. Margins of retailer	153.41	6.97	75.27	4.70	220	16.3
	Sub total	**262.64**	**11.93**	**162.3**	**10.14**	**304**	**22.51**
6	Price paid by the consumer	2200	100.00	1600	100.00	1350	100.00
7	**Price spread**	**510.44**	**23.20**	**420.3**	**26.27**	**576.99**	**42.74**

CHAPTER-VI

SUMMARY AND CONCLUSION

Vegetables play an important role both in regional and national economy of India. They are quick growing and give immediate returns to the growers. India is the second largest producer of vegetables in the world (ranks next to China) and accounts for about 13.4 per cent of the world's production of vegetables. The present production is not sufficient to meet the average per capita requirement of 285g of vegetables per day. By the end of 2030, country will need 150 million tonnes of vegetables to meet its requirement of growing population. Therefore, it is necessary to increase the production of vegetable crops at a much faster rate mainly by increasing the productivity (Singh *et al.,* 2010). Considering the importance of vegetable farming, the present study was taken up with the following specific objectives.

vi) To examine the costs and returns of major vegetables

vii) To assess the effect of technology (Drip irrigation) on vegetable production

viii) To find out the resource use efficiency and technical efficiency of major vegetables

ix) To trace the marketing channel and estimate the price spread for major vegetables and

x) To identify the constraints in vegetable production and marketing and suggest measures for improvement.

6.1. Methodology

Tirupur district is the universe of the study. Among six taluks of Tirupur district, Udumalpet taluk was selected for this study, because it had more area under vegetable farming in 2008-09. Tomato, Bhendi and Beetroot are major vegetables grown in the study area. Udumalpet taluk comprises of three firkas viz. Udumalpet, Kuruchikottai and Periavalavadi. From each firka, two villages were selected purposively based on the criteria of larger area under vegetable cultivation. Chinnaveramppatty, Periyakottai from Udumalpet firka, Kurichikottai, Andiakondanur from Kurichikottai firka and Periyavalavadi, Modakkupatty from Periavalavadi firka were selected. From each village, 15 vegetable farmers were selected at random. The intermediaries involved in marketing of vegetables namely commission agent, wholesaler cum retailer and retailer. From each category ten intermediaries are selected at random. Thus the total sample size was 90 farmers, 30 intermediaries.

The primary data on general characteristics of sample farmers, inputs used, and cost of cultivation and marketing details of sample farmers were collected by personal interview using interview schedule. The data is collected for the agriculture year 2009-10.

The tools of analysis used are simple percentage and average analysis wherever necessary in the study. Descriptive statistics was used to find the variation in yield and income of sample farmers. Cost of cultivation per hectare was worked out for tomato (drip irrigation and conventional irrigation), bhendi and beet root for the sample farms. To find the efficiency of inputs, Cobb-Douglas production function was employed for tomato (drip and conventional), bhendi and beet root and Data Envelopment Analysis was used to find the technical efficiency of tomato under drip and conventional irrigation. Garette's ranking technique was used to rank the constraints in production and marketing of vegetables.

6.2. General characteristics of sample farms

The study revealed that the sample farm families had totally 344 members. The average family size was about 4. The family type of sample farms showed that nuclear family type was found to be predominant with 72.22 per cent to total households as compared to joint family type with 27.78 per cent.

Head of the households with age of 36-45 years was highest with 57.78 per cent and 46-55 years was the next highest with 28.89 per cent to total sample farmers. This clearly indicated that relatively young farmers were involved in vegetable farming.

The proportion of sample farmers with education upto secondary level was highest with 63.33 per cent followed by primary and higher secondary level education with 13.33 per cent and 13.34 per cent, respectively. These results showed that educated farmers had opted for vegetable farming.

The primary occupation of 91 per cent of sample farmers was agriculture and only 9 per cent had secondary occupation. It could be inferred that the major occupation of sample farmers is agriculture.

The sample farmers owned higher proportion of garden land area 89 per cent followed by rainfed land with about 11 per cent to total area. Regarding size of land holding, medium farmers accounted for about 51 per cent and 26.67 and 17.78 per cent of sample farmers were large and small farmers. Vegetables were the major crop in sample farms accounting for about 50 per cent of the total cropped area and the main seasons for vegetables are June - September and January to April.

About 69 per cent of the sample farmers raised tomato in less than one hectare i.e., 0.74 ha. In bhendi and beet root farms, 90 per cent of the sample farmers raised bhendi in 0.46 hectare and about 66 per cent of sample farmers raised beet root in 0.55 hectare. Average area under tomato, bhendi and beet root was one ha, 0.57 ha and 0.77 ha respectively. This indicated that sample farmers had raised vegetables in less than one hectare.

The farmers with 16-25 years of farming experience were highest with 52 per cent followed by farmers with 26-35 years of experience with 31 per cent to total sample farmers. The study revealed that farmers with less than 15 years of experience in vegetable cultivation were highest about 62 per cent followed by 16-25 years of experience with 33 per cent.

In sample farms the value of land was higher than all other assets. The average value of land, farm building, irrigation structure, tools and implements and machineries were Rs.74, 00,000, Rs.1, 65,000, Rs.42, 000, Rs.2500 and Rs.5, 55,000 respectively. The average value of bullocks, milch animals and poultry were Rs.30, 000, Rs.45, 000 and Rs.6750, respectively.

6.3. YIELD ANALYSIS

6.3.1. Average yield

The average yield was found to be high in Drip Irrigated Tomato (68.36 t/ha) when compared to Conventional Irrigated Tomato (54.77 t/ha). The yield of drip irrigated tomato was 24.81 per cent higher than CIT.

6.3.2. Descriptive statistics for yield of Tomato under Drip Irrigation and Conventional Irrigation

In Drip Irrigated Tomato, the yield of 80 per cent of farmers was 61 to 70 tonnes per hectare with maximum and minimum yield of 70 tonnes and 64 tonnes per hectare respectively. Whereas in Conventional irrigation, 95 per cent of farmers obtained 51 to 60 tonnes of yield with 56.80 tonnes of maximum yield and 52.80 tonnes of minimum yield. The possible reason for high yield in Drip Irrigated Tomato might be due to the potential of drip irrigated tomatoes to produce more yields by utilizing the resources applied.

6.4. ECONOMIC ADVANTAGE OF TOMATO CULTIVATION UNDER DRIP IRRIGATION

Economic advantage of tomato cultivation under drip irrigation was assessed by comparing the costs and returns from drip irrigated tomato with conventional irrigated tomato. The expenditure incurred on fertilizers was high in Drip irrigation (Rs. 5680.51) than Conventional irrigation (Rs. 5078.22). In DIT, fertilizer cost was 11.86 per cent higher than CIT, because of high fertilizer requirement of DIT.

The labour utilization was high in CIT with 164.9 mandays and in DIT, it was 141.9 mandays. Women labourers were mostly engaged for harvesting, transplanting and weeding operations. The harvesting cost alone was Rs. 12,295 per hectare in drip irrigation and Rs. 8,778 per hectare in conventional irrigation.

The total input cost incurred on Drip irrigated tomato and Conventional irrigated tomato was Rs. 37363.51 and Rs. 45972.62 respectively. It could be incurred that input cost was high for conventional irrigation, which accounted for 23.04 per cent increase in cost than drip irrigation. In both the category of farms labour cost alone constituted more than 50 per cent of total input cost.

6.4.1. Costs and returns

The variable cost incurred in conventional irrigated tomato was found to be more by 17.21 per cent (Rs. 62,216.66) than on drip irrigation (Rs. 53,078.86). Among the variable costs, cost of human labour, ploughing and manures and fertilizers contributed more in both DIT and CIT.

Fixed cost was high in drip irrigated tomato (Rs. 22572.50), because of large share of rent in the sample farms. The total cost of cultivation was higher in conventional irrigation by 6.74 per cent than drip irrigation, which accounted for Rs. 80,753.26 and Rs. 75,651.36 in CIT and DIT respectively. The net income was higher in drip irrigated tomato (Rs. 1,662.01) than in conventional irrigated tomato (Rs. 1,016.73). The return over cost indicated the economic advantage of drip irrigated tomato cultivation.

6.5. FEASIBILITY OF DIT CULTIVATION

Partial budgeting was employed to arrive the net gain from drip irrigated tomato against conventional irrigated tomato. The net gain of DIT over CIT was Rs.61, 133.75 per hectare.

6.6. COSTS AND RETURNS FOR BHENDI AND BEET ROOT CULTIVATION

The total variable cost of bhendi and beet root was Rs. 50,718 and Rs. 46,359.50 per hectare. Among the variable costs, cost of human labour was more in both bhendi and beet root crops. Total fixed cost incurred by the bhendi and beet root farmers was Rs.15, 701.90 and Rs.15, 247.68 per hectare. Rental value for land had major share in fixed cost accounting for 67 per cent in bhendi and 65 per cent in beet root. The total cost of cultivation one hectare was Rs.66, 420.70 for bhendi and Rs.61, 607.18 for beet root. Net income from bhendi crop was Rs.55,879.30 per hectare and beet root crop Rs. 1,58,307.82 per hectare. This indicated the net income received by the beet root farmers was higher than the bhendi farmers.

6.7. PER HECTARE PROFITABILITY OF THE VEGETABLES IN SAMPLE FARMS

The cultivation of major vegetables is observed to be profitable with the per hectare net return being Rs.1,13,615.30, Rs.55,686.74, Rs.55,879.30 and Rs.1,58,307.82, obtained from tomato under drip and conventional irrigation, bhendi and beet root crops, respectively. Tomato under drip irrigation and beet root were more profitable than conventional irrigated tomato and bhendi.

6.8. RESOURCE USE EFFICIENCY OF TOMATO (DIT, CIT), BHENDI AND BEET ROOT

6.8.1. Resource use efficiency of Tomato under drip irrigation and conventional irrigation

The Cobb-Douglas production function was fitted to study the efficiency of resources to increase the gross return in tomato under drip irrigation and conventional irrigation. The co-efficient of multiple determination was 0.98 and 0.82 respectively for DIT and CIT.

The functional analysis showed that the quantity of nitrogenous and phosphorus, potassium fertilizers and plant protection chemicals contributed significant influence on gross return of drip irrigated tomato. The MVP analysis of DIT revealed that there was a scope to increase the gross return by increasing the quantity of nitrogenous, phosphorus and potassium fertilizers.

In conventional irrigated tomato, the quantity of seeds, nitrogenous and potassium fertilizers, number of irrigation and plant protection chemicals showed positive significant influence on gross income. But the MVP analysis showed that increasing the quantity of potassium and nitrogenous fertilizer and number of irrigations would increase the gross return.

6.8.2. Resource use efficiency of Bhendi

Cobb-Douglas Production function was used to find out the resource use efficiency in bhendi crop. It was found that, the coefficients of quantity of phosphorus fertilizer, potassium fertilizer, number of irrigation and quantity of plant protection chemicals were found to be positive and have significant influence the yield. The ratio between MVP and MIC was considerably high for phosphorus and potassium fertilizer and less than one (0.78) for plant protection chemical. It indicated the scope for increasing yield of bhendi by increasing the phosphorus and potassium fertilizer and by reducing the plant protection chemical.

6.8.3. Resource use efficiency of Beet root

In beet root farms, the coefficients of quantity of seeds, phosphorus fertilizer, potassium fertilizer, number of irrigation and quantity plant protection chemicals were found to be positive and have significant influence on the yield. The ratio of MVP to MIC of the quantity of phosphorus and potassium fertilizer was highest which indicates scope for increasing the yield of the beet root farm by increased use of these inputs from the existing level.

6.9. TECHNICAL EFFICIENCY OF TOMATO UNDER DRIP AND CONVENTIONAL IRRIGATION CONDITION

Data Envelopment Analysis was attempted to measure the technical efficiency and scale efficiency in tomato production under drip and conventional irrigation.

The average technical efficiency score was found to be 0.54 and 0.53 in tomato under drip and conventional irrigation, respectively. It indicates that the average drip irrigated farm and conventional irrigated farm was producing the potential output 72 t/ha, 56.80 t/ha respectively. It also indicates there is possibility to increase the output level by 46 per cent in drip irrigation and 47 per cent in conventional irrigation. The average scale efficiency score of drip irrigated tomato was 0.55 and conventional irrigated tomato was 0.53 which indicated that there was scope for increasing the yield of tomato farms to obtain the frontier output. The results revealed that about, 30 per cent of the drip irrigated farmers and 25 per cent of the conventional irrigated farmers belonged to meet the most efficiency category (80-100 per cent) and the scale efficiency measures also indicated same percentage of farmers belonged to the most efficient scale group (80-100 per cent).

6.10. MARKETING CHANNEL

The following marketing channels were identified for Tomato, Bhendi and Beet root crops in the study area.

Channel I

Producer → Consumer

Channel II

Producer → Commission Agent → Wholesaler cum Retailer → Consumer

Channel III

Producer → Commission Agent → Retailer → Consumer

6.11. PRICE SPREAD ANALYSIS

From the analysis of price spread it was found that marketing channel I namely Farmer - Consumer was the efficient marketing channel as it had highest farmer's share (97.70% for tomato, bhendi 98.20% and beet root 97.76%) and consequently lowest price spread (2.30% for tomato, 1.80% for bhendi and 2.24% beet root) for all the three vegetables compared to other marketing channels which might be due to obvious reasons.

6.12. PRODUCTION CONSTRAINTS FACED BY SAMPLE FARMERS

The producers expressed that the non-availability of hired human labour was the most important constraint in vegetable production. The second major constraint faced by the sample farmers was pests and diseases. High wage rate, water scarcity, lack of finance and credit facility, high cost of seeds, poor quality of seeds, fertilizers and plant protection chemicals were the other constraints expressed by the sample farmers in vegetable cultivation.

6.13. MARKETING CONSTRAINTS FACED BY SAMPLE FARMERS

The most important constraint identified by the vegetable growers was higher price fluctuation in vegetable market. The second major constraint ranked by the sample farmers were perishability of vegetables. Low price and lack of market information were the other constraints faced by the vegetable growers in marketing of vegetables.

CONCLUSIONS

From the findings of study, inferences are drawn with respect to each of the objectives by testing the hypotheses and to draw specific conclusion.

6.13.1. The first hypothesis is that vegetable cultivation is not profitable. The results indicated that the total cost of cultivation was Rs.75, 651.36 and Rs.80,753.26 per hectare of tomato under drip and conventional and Rs.66,420.70, Rs. 61,607.18 per hectare of bhendi and beet root, respectively. The net income realized from drip and conventional irrigated tomato cultivation was Rs.1, 13,615.30, Rs.55, 686.74 and for bhendi and beet root, Rs.55, 879.30 and Rs.1, 58,307.82 per hectare, respectively. The results showed that all the selected vegetables are profitable. Hence the first hypothesis that vegetable cultivation is not profitable was disproved.

6.13.2. The second hypothesis is that adoption of new technologies does not increase returns in vegetable production. The study has revealed that adoption of drip irrigation resulted in 24.81 per cent increase in yield of tomato. The gross return from drip irrigated tomato (DIT) was found to be higher by 38.71 per cent than conventional irrigated tomato (CIT). Consequently the net income was higher in DIT i.e., 104.03 per cent than CIT. The high net income indicated the economic advantage of drip irrigation technology over conventional irrigation. The above findings disproved the second hypothesis.

6.13.3. With respect to third hypotheses that resource use efficiency and technical efficiency in vegetable cultivation is non significant. The results indicated that the quantity of nitrogen, phosphorus and potassium fertilizers and plant protection chemicals had positive and significant influence on yield of drip irrigated tomato and quantity of seeds, nitrogen, potassium fertilizer, number of irrigation and plant protection chemicals had positive and significant influence on yield of conventional irrigated tomato. This result indicated that there was scope for increasing these variables could increase the yield of tomato under drip and conventional irrigation.

The results of bhendi and beet root revealed that the quantity of phosphorus, potassium fertilizers and number of irrigations had positive significant influence on yield of bhendi and beet root. Hence the results indicated there was scope for increasing these variables could increase the yield of bhendi and beet root.

The average technical efficiency score was found to be 0.54 and 0.53 in tomato under drip and conventional irrigation respectively. It indicates that the average drip irrigated farm and conventional irrigated farm was producing the potential output 72 t/ha, 56.80 t/ha respectively. It also indicated the possibility to increase the output level by 46 per cent in drip irrigation and 47 per cent in conventional irrigation. In the light of above findings, the third hypothesis was disproved.

6.13.4. The fourth and last hypothesis was that the there are no constraints in production and marketing of vegetables. Non availability of labour and pests and disease attack were the major constraints in production and price fluctuation, perishability of vegetables were important constraints in marketing of vegetables. This result disproved the fourth hypothesis.

POLICY IMPLICATIONS

- Tomato, bhendi and beet root crops were found to be profitable and hence efforts should be taken by Agriculture Department to bring more area under tomato, bhendi and beet root cultivation in Udumalpet taluk.
- Results indicated the feasibility of tomato under drip irrigation on a large scale in the study area. Therefore, a special programme may be implemented exclusively for DIT by drip irrigation companies and also by the government agencies to increase the area under tomato cultivation.
- Even the farmers, who knew about drip irrigation, have not come forward to cultivate tomato under drip irrigation, because of lack of finance and credit facilities. Hence, the study suggested that providing loans at a lower interest and subsidies for water soluble fertilizers will increase the adoption drip irrigation.
- The results of resource use efficiency showed that in the selected vegetables, farmers can increase the use of nitrogen, phosphorus and potassium fertilizer and reduce the use of plant protection chemicals in the context of increasing the yield. Hence, appropriate extension efforts may be undertaken by Department of Agriculture to provide knowledge about efficient use of resources at farm level.
- The results of technical efficiency analysis (DEA) had showed that the mean technical efficiency of tomato was only 54 per cent in drip irrigation and only 53 per cent in conventional irrigation. This indicated that there is potential to increase the output level by 46 per cent in drip irrigation and 47 per cent in conventional irrigation. Hence exposure visits may be arranged to discuss with the progressive vegetable growers to attain the frontier yield.
- The farmers felt that price fluctuations and perishability of vegetables were the major constraint in marketing of vegetables. The results showed that the profit of intermediaries' accounts for quite a large proportion of the price paid by the consumers in the marketing channels II and III. In order to increase production, consumption and upliftment of the economy of the vegetable growers assured remunerative prices are necessary. This could be done by increasing the number of farmers' markets, establishing co-operative marketing society for the vegetables. Providing storage facilities both in production and marketing centre would prevent distress sale and wastage. These measures will reduce the price fluctuations over time and space.

REFERENCES

A. Textbooks

Acharya.S.S and N.L.Agarwal., **Agricultural Marketing in India**, New Delhi: Oxford & IBH Publishing Co.Pvt.Ltd, 2004.

Ahuja, H.L., **A Modern Micro Economics**, New Delhi: S.Chand and Company, 1997.

Bilas, A,Richard **Micro Economic Theory,** Tokyo: International Students Edition, McGraw Hill, Kogakusha Ltd., 1971.

Bishop, C.B. and N.D. Toussant, **Agricultural Economic Analysis**, New York: John Willey Sons Inc., 1988.

Bansal, S.P., **Principles of Marketing,** New Delhi: Kalyani Publishers, Ludiana, 2004.

Clark, E. Fred **Principles of Marketing,** New York: John Willey and Sons, 1954.

Dewett, K. K. and M. H. Navalur, **Modern Economic Theory,** New Delhi: Shyam Lal Charitable Trust, 1982.

Dewett, K. K. and J. D. Varma., **Elementary Economic Theory,** New Delhi: S. Chand and Company Ltd., 2003.

Damodar, N. Gujarathi, **Basic Econometrics**, New Delhi: Tata Mc Graw Hill Publishing Company Limited, 2005.

Edgar, K. Browning and Jacquelene, **Microeconomic Theory and Applications,** New Delhi: Kalyani Publishers, 1986.

Edward, N. Cundiff and R.R. Still, **Fundamentals of Modern Marketing,** New Delhi: Prentice Hall of India Private Ltd., 1985.

Johl, S.S and T.K. Kapur, **Fundamentals of Farm Business Management**, Ludhiana: Kalyani Publishers, 1977.

John, B. Penson, Rulon D. Pope, and Michael L. Cook, **Introduction to Agricultural Economics**, New Jersey: Prentice-Hall.

Kahlon, A. S. and Karan Singh, **Economics of farm management in India**, Allied publishers limited, 1982.

Kohls, R.L and J.N. Uhl, **Marketing of Agricultural products**, Mac Million publishing co, Inc. New York, 1980.

Kohl, R. L, **Marketing of Agricultural Products**, Toronto: Mac Millan Co., 1967.

Koutsoyiannis, A., **Modern Micro Economics,** HongKong: Mac Millan Press, 1994.

Raju V.T. and D.V.S. Rao, **Economics of Farm Production and Management,** New Delhi: Oxford and IBH Publishing Co. Private Ltd., 1990.

Samuelson, A. Paul and Nordhans, **Economics,** New Delhi: Mc Graw Hill Publishing Company Ltd., 1998.

Suba reddy, S., P. Raghu ram, T. V. Neelakanta sastry and I. Bhavani devi, Agriculture Economics, Oxford and IBH publishing Co. Private Ltd., 2004.

William, J. Baumal and Alan S. Blinder, **Economics Principles and Policy,** New York, Harcourt Brace Jovanovich, Inc., 1979.

B. Periodicals /Journals

Abate Bekele Machiel F. Viljoen, Gezahegn Ayele and Syed Ali, “Effect of farm size on efficiency of wheat production in Moretna – Jirru District in Central Ethiopia”, **Indian Journal of Agricultural Economics,** 64(1): 133-143, 2009.

Alagumani, T., 2005, Economic Analysis of Tissue Cultured Banana and Sucker Propagated Banana, **Agricultural Economics Research Review**, 18 (1): 81-89.

Anil M. Ahire and Bhonde, S. R., “Marketing channels and Price Spread of Grapes – A study of District Nashik, Maharashtra”, **Financing Agriculture,** 27-30, 2008.

Anupama, J., Singh, R. P., and Ranjit Kumar, “Technical Efficiency in Maize production in Madhya Pradesh; Estimation and implications”, **Agricultural Economics Research Review**, 18: 305-315, 2005.

Anuradha Narala and Zala, Y. C., “Technical Efficiency of Rice farms under Irrigated Conditions in Central Gujarat”, **Agricultural Economics Research Review**, 23(2): 375-381, 2010.

Arti Sharma and Jyoti Kachroo, “Resource use efficiency and sustainability of maize cultivation in Jammu Region of J & K State”, **Agricultural Situation in India**, LXVI (3): 125-129, 2009.

Baba, S. H., Wani, M. H., Wani, S. A., and Shahid Yousuf “Marketed Surplus and Price Spread of Vegetables in Kashmir Valley”, **Agricultural Economics Research Review**, 23(1): 115-127, 2010.

Balaj, M. N., Chahal, S. S., and Kataria, P., “Market Intermediaries and their margins in marketing of potato in Punjab”, **Indian Journal of Agricultural Marketing**, 24(2): 165-177, 2010.

Bhupal, D. S., “Changing pattern of Agricultural Marketing”, **Indian Journal of Agricultural Marketing,** 14(3): 8-17, 2000.

Chahal, S. S., and Gill, K. S., “Measurement of Marketing Efficiency in Farm Sector: A Review”, **Indian Journal of Agricultural Marketing,** 5(2): 138-142, 1991.

Ganga, Lal, G., Saran, P. L., and Suhag, K. S., “Marketing of Henna (Lawsonia Inermis L.) in Pali District of Rajastan”, **Indian Journal of Agricultural Marketing,** 22(2): 70-78, 2008.

Gaganjot Singh and Chahal, S. S., “An Economic Analysis of Green Chilli Marketing in Punjab”, **Indian Journal of Agricultural Marketing,** 22(3): 1-10, 2008.

Jabir Ali and Sanjeev kapoor, “Farmers’ perception of Risks in Fruits and Vegetables Production: An Empirical Study of Uttar Pradesh”, **Agricultural Economics Research Review,** 21: 317-326, 2008.

Khemnar, S. H., Nawadkar, D. S., and Dangat, S.B., “Profitability of tomato cultivation in Ahmdnagar District of Maharastra State”, **Indian Journal of Agricultural Marketing,** 8(1): 96-100, 1994.

Ladaniya, M. S., Vinod Wanjari and Bipin Chandra Mahalle, “Price spread of pomegranate”, **Indian Journal of Agricultural Economics,** 58(4): 800-810, 2003.

Maheswari, R., Ashok, K. R., and Prahadeeswaran, M., "Precision farming Technology, Adoption Decisions and Productivity of vegetables in Resource – Poor Environments", **Agricultural Economics Research Review. 21 Conference Number**: 415-424, 2008.

Manjeet Kaur, Amrit Kaur Mahal, Seklon, M. K., and Kingra H. S., "Technical Efficiency of Wheat Production in Punjab: A Regional Analysis", **Agricultural Economics Research Review,** 23(1): 173-179, 2010.

Mythili, G., and Shanmugam, K. R., "Technical Efficiency of Rice Growers in Tamil Nadu : A study Based on Panal Data", **Indian Journal of Agricultural Economics,** 55(1): 15-25, 2000

Nalini Rajan Kumar, Pandey, N. K., and Rana, R. K., "Marketing and Post harvest Losses in Cabbage and Cauliflower in West Bengal", **Indian Journal of Agricultural Marketing,** 22(3): 25-37, 2008.

Narayanamoorthy, A., "Economics of Drip Irrigation in Sugarcane Cultivation: Case study of a farmer from Tamil Nadu", **Indian Journal of Agricultural Economics,** 60(2): 235-248, 2005.

Nasurudeen, P., "Efficiency of Rice Production in Union Territory of Pondicherry", **Agricultural Economics Research Review,** 22 Conference number: 361-364, 2009.

Navadkar, D. S., Sale, D. L., and Patil, U. D., "Marketing of Vegetables Grown Around Pune City" **Agricultural Situation in India:** 259-265, 2005.

Pawar, B. N., and Hange, D. S., "Economics of Production and Marketing of Selected Medicinal and Aromatic Plants in Western Maharashtra", **Indian Journal of Agricultural Marketing,** 22(3): 128-140, 2008.

Rama Rao, C. A., Chowdry, K. R., Reddy, Y. V. R., and Krishna Rao, G. V., "Measuring and Explaining Technical efficiency in Crop Production in Andhra Pradesh", **Indian Journal of Agricultural Economics,** 58(4): 768-779, 2003.

Randev, A. K., "Researchable issues for Improving Marketing Efficiency in Case of Fruits and Vegetables in Himachal Pradesh", **Agricultural Situation in India**: 215-216, 2008.

Reddy, A. R., and Sen, C., "Technical Inefficiency in Rice Production and its Relationship with farm - specific Socio-Economic Characteristics", **Indian Journal of Agricultural Economics,** 59(2): 259-267, 2004.

Rohit single., Chahal, S. S., and Kataria, P., "Economics of Production of Green Peas (*Pisum sativum* L.) in Punjab", **Agricultural Economics Research Review,** 19: 237-250, 2006.

Rupasena, L. P., Vijayakumar, H. S. and Kerur, N. H., "Resource use efficiency in Rice Cultivation in Srilanka", **Indian Journal of Agricultural Marketing,** 22(2): 1-10, 2008.

Sanjeev Kumar, Vinodkumar and Jha, A. K., "Marketing of vegetables in Vaishali District of Bihar", **Indian Journal of Agricultural Marketing,** 22(3): 80-88, 2008.

Sekhon, M. K., Amrit kaur Mahal, Manjeet kaur and Sidhu, M. S., "Technical Efficiency in Crop Production: A Region-wise Analysis", **Agricultural Economics Research Review,** 23(2): 367-374, 2010.

Shanmugam, K. R., "Technical Efficiency of Rice, Groundnut and cotton farms in Tamil Nadu", **Indian Journal of Agricultural Economics,** 58(1): 101-112, 2003.

Sharma, A., Singh, J., Ahmad, B., Tyagi, D. B., and Singh, N. P., "Produciton and Marketing of Walnut in Budgam District of Jammu and Kashmir", **Indian Journal of Agricultural Marketing,** 24(1): 74-85, 2010.

Singh, R. P., and Anupama Toppo., "Economics of Production and Marketing of Tomato in Kanke Block of Ranchi District", **Indian Journal of Agricultural Marketing,** 24(2): 1-16, 2010.

Smitha, P. R., Jayashree, A., Handigol and Guledgudda, S. S., "Cost, Returns and Resource use efficiency in Anthurium Cultivation in Coorg District", **Agricultural Situation in India,** VLX (9): 593-596, 2008.

Sreenivasa Murthy, D., Sudha, M., Hegde, M. R., and Dakhinamoorthy, V., "Technical Efficiency and its Determinants in Tomato Production in Karnataka, India: Data Envelopment Analysis (DEA) Approach". **Agricultural Economics Research Review,** 22: 215-224, 2009.

Srinivas, T., and Ramanathan, S., "A study on economic analysis of Elephant Foot Yam Production in India", **Agricultural Economics Research Review,** (18): 241-251, 2005.

Surender Singh, "A study on Technical Efficiency of Wheat cultivation in Haryana", **Agricultural Economics Research Review,** 20 : 127-135,2007.

Tarunvir singh and Jyotikachroo., "Resource use efficiency of Dryland maize in Jammu District of J & K state, **Agricultural Situation in India**. L x VI (7): 425-430, 2009.

Thakur sanjay, D. S., Thakur, D. R., and Sharma, K. D., "Economics of off-season vegetable production and marketing in Hills", Indian Journal of Agricultural Marketing, 8(1): 72-81, 1994.

C. Unpublished Thesis

Duraisamy. M.R., "Planning for Optimum Agricultural production in Theni District of TamilNadu - A Fuzzy goal programming Approach", **Unpublished Ph.D., (Ag)** Thesis Department of Agricultural Economics, TNAU, Madurai, 2007.

Ganapathikrishnan, B., "Production and Marketing of Rainfed Tomato in Veppanapalli Block – An Economic Analysis", **Unpublished M.Sc., (Ag)** Thesis, Department of Agricultural Economics, TNAU, Coimbatore, 1986.

Jeyanthi, P., "An Economic Analysis of Tissue culture banana vis-à-vis sucker propagated banana", **Unpublished M.Sc., (Ag)** Thesis, Department of Agricultural Economics, TNAU, Madurai, 2002.

Pravin, C. "A study on the Economic Analysis of Drip irrigated sugarcane vis-à-vis conventional irrigated sugarcane" **Unpublished M.Sc., (Ag)** Thesis, Department of Agricultural Economics, TNAU, Madurai, 2008.

Raju, B., "An Economic Analysis of Marketing of Cauliflower in Oddanchatram Block, Madurai", **Unpublished M.Sc., (Ag)** Thesis, Department of Agricultural Economics, TNAU, Madurai, 1985.

Ravichandran, S., “An Economic Analysis of Marketing of Dry Chillies in Kamarajar District”, **Unpublished M.Sc., (Ag)** Thesis, Department of Agricultural Economics, TNAU, Madurai, 2002.

Shunmugiah, S., “An Economic Analysis of Production and Marketing of Lime in Tirunelveli District. **Unpublished M.Sc., (Ag)** Thesis, Department of Agricultural Economics, TNAU, Madurai, 2000.

D. WEBSITES

1. www.indiastat.com

2. www.nhb.gov.in

3. www.tirupur.tn.nic.in

4. www.censusindia.gov.in

APPENDIX- I

Area, Production and Productivity of major Vegetables in the World (2008-09)

Country	Area (Million Ha)	Production (Million Tonnes)	Productivity (Tonnes /Ha)
China	24.08 (43.11)	457.73 (47.38)	19.00 (7.70)
India	7.98 (14.29)	129.07 (13.37)	16.20 (6.56)
USA	1.16 (2.08)	36.43 (3.78)	31.30 (12.70)
Turkey	1.10 (1.97)	27.13 (2.80)	24.60 (10.00)
Iran	0.64 (1.15)	16.17 (1.67)	25.00 (10.12)
Russian Fed.	0.86 (1.54)	14.05 (1.46)	16.30 (6.60)
Egypt	1.21 (2.16)	13.75 (1.42)	11.30 (4.57)
Italy	0.52 (0.93)	13.68 (1.41)	26.10 (10.57)
Spain	0.36 (0.65)	12.78 (1.32)	34.80 (14.10)
Japan	0.44 (0.79)	12.69 (1.31)	28.90 (11.70)
OTHERS	17.5 (31.33)	232.76 (24.08)	13.30 (5.38)
WORLD	**55.85 (100.00)**	**966.24 (100.00)**	**246.80 (100.00)**

(Note: Figures in parentheses indicate percentages to respective total)

Source: Indian Horticultural Database, 2009

APPENDIX- II

Area, Production and Productivity of Vegetables in India (1994-95 to 2008-09)

Year	**Area (Million Ha)**	**Production (Million Tonnes)**	**Productivity (Tonnes /Ha)**
1994-95	5.01	67.28	13.40
1995-96	5.33	71.59	13.40
1996-97	5.51	75.07	13.60
1997-98	5.60	72.68	13.00
1998-99	5.87	87.53	14.90
1999-00	5.99	90.82	15.20
2000-01	6.25	93.84	15.00
2001-02	6.15	88.62	14.40
2002-03	6.09	84.81	13.90
2003-04	6.08	88.33	14.50
2004-05	6.74	101.24	15.00
2005-06	7.21	111.39	15.40
2006-07	7.58	114.99	15.20
2007-08	7.84	128.44	16.40
2008-09	7.98	129.07	16.20
Standard Deviation	0.92	19.70	1.02
Mean	6.35	93.71	14.63
Coefficient of Variation (%)	14.48	21.02	6.97
CGR (%)	10.30	10.40	10.13

Source: National Horticulture Board

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APPENDIX- III

Area, Production and Productivity of Vegetables in Tamil Nadu (2005-06 to 2008-09)

Year	Area (Lakh Ha)	Production (Lakh Tonnes)	Productivity (Tonnes /Ha)
2005-06	2.34	65.46	27.97
2006-07	2.52	70.70	28.05
2007-08	2.62	79.75	30.43
2008-09	2.86	86.94	30.39

Source: National Horticulture Board.