ECONOMICS OF DRIP IRRIGATION Vis-a-vis CONVENTIONAL METHOD OF IRRIGATION FOR POMEGRANATE CULTIVATION IN SOLAPUR DISTRICT

By

ARCHANA PRABHAKAR KARANDE

(Reg. No.0194)

A thesis submitted to the

MAHATMA PHULE KRISHI VIDYPEETH,
RAHURI – 413722 DIST. AHMENHAGAR
MAHARASHTRA STATE (INDIA)

In partial fulfillment of the requirements for the degree

Of

MASTER OF SCIENCE (AGRICULRURE)

In

AGRICULTURAL ECONOMICS

DEPARTMENT OF AGRICULTURAL ECONOMICS,
POST GRADUATE INSTITUTE,
MAHATMA PHULE KRISHI VIDYAPEETH,
RAHURI, DIST. AHMEDNAGAR, M.S. (INDIA)

2004

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Approved by

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MAHARASHTRA, INDIA**

2004

CANDIDATE'S DECLARATION

I hereby declare that this thesis or part thereof has not been submitted by me or other person to any other University or Institute for a Degree or Diploma

Place MPKV, Rahuri

Dated 30/01/2004

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CERTIFICATE

This is to certify that the thesis entitled **"ECONOMICS OF DRIP IRRIGATION Vis-à-vis CONVENTIONAL METHOD OF IRRIGATION FOR POMEGRANATE CULTIVATION IN SOLAPUR DISTRICT"**, submitted to the Faculty of Agriculture, Mahatma Phule Krishi Vidyapeeth, Rahuri, Dist Ahmednagar, Maharashtra, in partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE (AGRICULTURE) in AGRICULTURAL ECONOMICS,** embodies the results of a piece of bonafide research work carried out by **Miss KARANDE ARCHANA PRABHAKAR**, under my guidance and supervision and that no part of the thesis has been submitted for any other degree, diploma or publication in any other form

The assistance and help received during the course of investigation have been duly acknowledged

Place MPKV, Rahuri

Dated / /2004

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Place MPKV, Rahuri
Date 31/07/2004

(D.M. Sawant)
Associate Dean (PGI)

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Place M P K V, Rahuri

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(Archana P. Karande)

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ABSTRACT

COMPARATIVE ECONOMICS OF DRIP Vis-à-vis CONVENTIONAL METHOD OF IRRIGATION FOR POMEGRANATE CULTIVATION IN SOLAPUR DISTRICT

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Water is scarce resource and its use in agriculture is of vital importance from sustainability and stability point of view. In DPAP areas water availability and its use is having prime importance. The farmers in DPAP area are also trying to change their traditional pattern and trying to diversify to cash crops to meet their growing demand of cash. As such, Solapur district is one of the DPAP districts where pomegranate cultivation was started in early ninties. The pomegranate Growers became expert in production of quality pomegranate. These farmers started adoption of improved irrigation technology for efficient use of scarce resource. There was no enough information on economies of drip irrigation system. Therefore, the present study was intended to depict the comparative economics of drip and conventional method of irrigation for pomegranate cultivation in Solapur district. The specific objectives of the study are to study the investment made for irrigation systems, cost and returns under drip vis-a-vis conventional irrigation method, benefits of drip system compared

to conventional method and lastly to study the constraints and problems faced by pomegranate growers in drip system of irrigation in Solapur district. For the study purpose, the Pandharpur and Sangola tahsils were selected purpos ely as the pomegranate is largely cultivated in this area. The data were collected for the year 2001-2002 by survey method. The data pertains to 120 sample pomegranate growers randomly selected and further processed by tabular method and functional analysis in view of objectives.

The literacy percentage of pomegranate growers adopting drip irrigation system was more compared to conventional system. The average size of holding was also more with high proportion of irrigated area. Thereby, cropping intensity was more on drip irrigated farms. The average per hectare investment on drip irrigation was to the extent of Rs.37589.73. The per hectare cost of establishment under drip irrigation method was higher (Rs.92226.67) and in the conventional irrigation method was (Rs.70109.65) at the overall level. The higher cost was due to more investment for installation, depreciation and interest on drip set. The total establishment cost was apportioned an 15 years life period of the pomegranate garden. The per hectare annualized establishment cost was Rs.4673.98 and Rs.6148.45, respectively, under surface and drip irrigation system at overall level. The establishment cost was 31.54 per cent higher on drip irrigated pomegranate farms compared to surface irrigated pomegranate farms. However, due to adoption of drip irrigation system there was little additional cost but the savings in regards to human labour, bullock

labour, machine labour, use of electric motor etc. were observed in same of the operations.

The average per hectare cost of cultivation of pomegranate was Rs.115113.01 under drip irrigated pomegranate farms and it was Rs.112127.79 under surface irrigated pomegranate farms. The average cultivation cost was 2.66 per cent higher under drip system compared to surface irrigation system The average production of pomegranate was 171.71 qtls. under drip irrigation and it was 133.85 qtls. under surface irrigation. The B:C ratio was 2.17 and 1.69, respectively, under drip and surface irrigation system. The average addition returns over cost 'A', 'B' and 'C' were 46.65, 65.95, 75.15 per cent under drip irrigation compared to surface irrigation system. From the above it can be seen that drip irrigation system was quite profitable in pomegranate cultivation compared to conventional method.

The economic efficiency in resource use was attempted and it was noticed that there was saving in human labour, irrigation structure, irrigation and plant protection chemicals due to adoption of drip irrigation system. The inefficiency in resource use was noticed in cultivation of pomegranate under both systems of irrigation. There was greater scope to increase use level of resources under drip system compared to surface irrigation system. From the above it can be revealed that pomegranate cultivation under drip irrigation system was more profitable compared to surface irrigation system.

The pomegranate growers were facing technical, economical,

infrastructural constraints as well as general problems in adoption of drip irrigation system for pomegranate cultivation. Therefore, the necessary measures are required to be taken so as to overcome their constraints and problems in adoption of drip irrigation system for pomegranate cultivation. Besides this the trainings, result demonstration as well as infrastructure development for technical guidance and maintenance at village level need to be attained which can minimize the constraints of pomegranate growers in use of drip irrigation system.

The study concluded that the initial cost for establishment of drip irrigation system on farm was excessive but, the returns from this were much more than the investment. It is also concluded that with the help of drip irrigation method the productivity can be increased with less and optimum use of valuable scarce resources.

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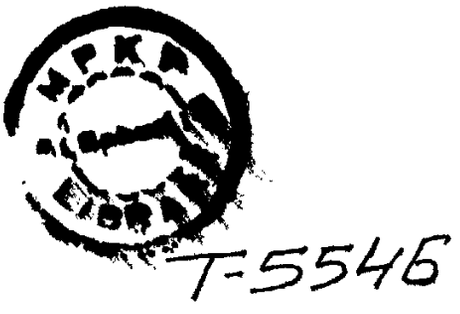


INTRODUCTION

1. INTRODUCTION

1.1 General

India is basically an agricultural country. About 63 per cent of the population directly or indirectly is still depending on the agriculture sector. Agriculture and allied activities contributes 24.9 per cent to the total GDP of India (2002). The technological breakthrough in agriculture viz; evaluation of high yielding varieties of crops, increased use of facilities and chemicals, use of modern machinery and adoption of improved agricultural practices have increased our agricultural production of food grains to 208.87 million tones and horticultural production of fruits and vegetables to 45.5 and 90.8 million tones, respectively, in the year 1999-2000. Presently, India ranks second in both fruits and vegetable production, next to China in the world.

Even though we have achieved substantial records in terms of production, the inequalities remained from point of view of various requirements of peoples in various parts of the country. The demand of growing population for food, water, sanitation, nutrition etc. found to be increasing. The various needs of growing population have to be met. The

resources need to be mobilized to meet the demands. However, equitable distribution of various resources including natural resources would be difficult Water is one of the natural resource which has become scarce in nature. The water resource of India, as a whole, is substantial. However, the regional, seasonal and spatial distribution over its geographical area is uneven. The uncertainty of assurance of rainfall location, time and in the optimum quantity, has necessitated building of storage reservoirs The need of water is ever increasing with the development in general and agriculture in particular. The water requirement for agriculture, industry, drinking etc.are increasing day by day As a result the disputes on water distribution arised in country. In the year 1999-00 area under irrigation was 38.37 and 16.4 per cent of the total area under cultivation in India and Maharashra, respectively

Water helps to increase the use of yield enhancing inputs, cropping intensity and the productivity of the crops. However, the availability of water for irrigation has declined drastically. The demand for irrigation water has been growing at faster rate. In India the flood method of irrigation is widely practiced which directly leads to inefficient use of irrigation water. Owing to enormous losses in evaporation and distribution, the efforts need to be undertaken to minimise the losses. Efficient use of water for irrigation is of paramount important for

sustainable agricultural development. Therefore, different measures were required to be adopted. Accordingly, the Government have adopted corrective measures so as to conserve water and to improve the water use efficiency.

In the scarcity area, the efficient use of water irrigation is an important mean to increase the benefits of irrigation. One has to think of economic use of water. Several attempts have been adopted to economies use of water, which, include soil and water conservation, rain water management, water shade development, etc. Now a days, micro irrigation has become a better alternative to save water, avoid losses and increase water use efficiency.

The low pressure irrigation system i.e. micro irrigation is also, know as 'drip irrigation' is adopted in our country. Amongst the recent technologies attempted for judicious utilization of irrigation water, drip irrigation or trickle irrigation has been drawing foremost attention of the farmers since last decade. It has proved itself as a strong factor in augmenting crop yields under limited irrigation facilities. It is the latest innovation of irrigation technology introduced first time in the world by Israeli engineer Symcha Blass in 1940.

1.2 Importance of Drip irrigation in Maharashtra

Drip irrigation is an efficient method of providing irrigation water directly into the root zone of plant and it permits the irrigation to

limit the watering closely to the crop water requirement of plants. It also permits the utilization of fertilizers, pesticides and other water soluble chemicals along with the irrigation water. The system applies water at low rate and under pressure to keep the soil moisture within the desired range of plant growth. The application of irrigation efficiency under drip irrigation is around 90 per cent as compared to 25-30 per cent for surface irrigation.

The drip irrigation method substantially reduces the evaporation, conveyance and distribution losses, and cost of cultivation when compared to flood method of irrigation. Drip method of irrigation increases crop yield significantly. Besides water saving and productivity gains, drip irrigation is also well suited for undulating terrain, shallow soils, etc.

1.3 Present status of Drip irrigation in Maharashtra

Drip irrigation was introduced in India during early seventies. Significant development has taken place in the research on drip irrigation from eighties till date. The last decade registered the momentum in the growth of drip irrigation in India. From around 1500 hectare in 1985 the area under drip irrigation had increased to 6000 ha in 1988. The area under drip irrigation in India, by the end of the year 1996 was around 1.38 lack ha. and reached to 3,55,400 hectares during 2002-03. Out of

which, about 1,54,000 hectare alone is located in Maharashtra state, which accounts for nearly 44 per cent of the area under drip irrigation in India. The developments have taken place mainly in areas where there has been acute water scarcity and mainly for commercial, horticultural crops.

Banana shares the highest (22.20 per cent) area under drip irrigation, followed by grapes (18.70 per cent), sugarcane (12.58 per cent), citrus (11.37 per cent) and pomegranate (10.33 per cent) . The proportion of area under drip irrigation was between 3 to 5 per cent in case of mango, cotton , vegetables and flowers and other crops, while it was between 1 to 3 per cent in case of ber, sapota, papaya and guava. The area under drip irrigation was below one per cent in other fruit crops (Kumar and Alam, 2003).

1.4 Importance of Fruit Cultivation

Fruit culture has been practiced in India since ancient time. The cultivation of fruits plays important role in the prosperity of the nation. In agriculture due to liberalization, the process of the commercialization of agriculture has been started.

Indian topography and agro- climatic conditions are suited for fruit crops which will be an ideal method to achieve sustainability in agriculture and increase employment opportunities. This will facilitate to create export potential and above all achieve nutritional security. As a

result, due to above facts, an emphasis on diversification of agriculture towards fruit crop cultivation has been given in agricultural policy.

Cultivation of fruit crops is identified as most remunerative enterprise for replacing subsistence farming in the dry land farming. These crops are characterized by high productivity per unit area, much higher returns, higher potential for employment generation and export, comparatively low requirement of water and easily adaptable to adverse soil and waste land situation. Their role in improving environment is an added advantage. The bio-mass available particularly from the tree crops is phenomenal, which either gets recycled into the soil to add its fertility or is amenable to industrial use for value addition. Thus, further enhancing their economic viability, horticulture can surely make a major contribution towards economic and nutritional status in the country. India is second largest producer of fruits next to China and it's production has tripled over the last 50 years. (The Hindu Survey of Indian Agriculture- 2002). Pomegranate is one of the important fruit crops in our country especially in water scarcity areas.

1.5 Economic Importance of Pomegranate Crop

. Pomegranate (*Punica granatum* L.) belonging to the family Punicaceae is one of the most favorite fruits of the tropical and sub-tropical regions. Pomegranate cultivation was started since ancient time

Origin of the pomegranate is Iran, where it was cultivated since 2000 B.C. Pomegranate is cultivated in large scale in the countries like Spain, Egypt, Iran, Iraq, Pakistan, Afghanistan, Palestine, India, China, Japan and Russia.

Pomegranate has it's chief characteristics like drought resistant, hardy, low water requirement, less gestation period, It is deciduous in temperate region, while, it is evergreen or partially deciduous in tropical and sub topical regions. It gives good response for irrigation and modern package of practices. It furnishes in three 'bahars' viz; Mrug, Hast and Ambe in a year. Farmers can take any one of it, hence, it gives employment throughout the year. The expenses during resting period are low. It is less risky crop compared to the other fruit crops. It is less perishable than other fruits. Hence, it has become more popular in arid and semi arid regions of India, especially in Maharashtra and for the farmers of all categories. A well managed orchard gives better yield and net returns per hectare which is nearly 8 to 10 times more than the average per hectare income received from traditional cereal dominated cropping pattern of arid and semi arid regions of the country. In Maharashtra state, Ganesh and G-137 are the promising varieties which cover most of the area under pomegranate plantation.

Many types of processed products are prepared from pomegranate such as bottle juice, beverages, syrup, jelly, anar rub, concentrate wine etc. Wild form of pomegranate are highly acidic from which anardana is prepared commercially. Demand for export of pomegranate and its by-products is increasing due to introduction of GATT and WTO. The export potential of fruit crops has been increased to a greater extent.

1.6 Pomegranate in Maharashtra

In 1972-73, the area under pomegranate in India was only 1200 hectares, out of which 800 hectares was in Maharashtra state. Government of Maharashtra has promoted and encouraged planting of orchard by giving loans and subsidies to the farmers. The activity was covered under 'Employment Guarantee Scheme' from the year 1990-91. During the 1990-91 total area under pomegranate was 4576 ha. at the end of year acreage reached to 12669 ha., and further it was increased to 47171 ha. at the end of 1996-97. (Source : Director of Horticulture, Maharashtra State, Pune). Now, about 75,000 hectare area was covered under pomegranate in Maharashtra till end of the year 2001-2002 (Patil 2002).

In Maharashtra, this crop is being cultivated on large area particularly in Solapur, Ahmednager, Satara, Sangali, Nasik and Pune districts with small area in other parts (Maharashtra sinchan parishad 2002-2003) . Solapur district ranks first in area and production of pomegranate crop, with 23,147 hectares and 152600 quintal respectively. Nasik district occupied second position in area and third in production of pomegranate crop, whereas Ahmednager stands third in area and second in production of pomegranate crop.(Source : Commissioner of Agriculture 2002)

The area under pomegranate in the Solapur district to the extent of 21.189 ha. in the year 1999-2000, which was having 29.70 per cent share in total cropped area. In 2002-2003 the area is increased to 23,147 hectares ,which was ranked first in Maharashtra. The share of Sangola and Pandharpur tahsils together is around 60 per cent, with acreage of 7, 399 hectares (34.92 per cent of GCA) and 5,068 hectares (23.92 per cent of GCA) under this crop, respectively. (District statistical abstract 2001-2002).

1.7 The Problem

Age-old conventional method of irrigation is practiced throughout the India. Indian farmers are lacking in sufficient technical

knowledge of efficient method of water application. The discriminate use of irrigation water creates other serious problems like cracking of fruits, infestation of soil born diseases and overall wastage of water The available water is not being used judiciously, through the conventional method of irrigation even though, it is limited. Due to prolonged application of excessive water, productive land is being detoriated day by day and converted into saline, saline-sodic, or sodic soil. In some of the part of the state..

In view of scare availability of irrigation facility, expansion of irrigated cultivation largely depends on economic method of irrigation like drip and sprinkler. So far about 24 per cent of the total area under pomegranate is covered under drip irrigation. The drip irrigation involves large investment. The economic benefits need to be known by the uses. Therefore, the estimation of potential economic benefits of drip irrigation was tested. There is always query from the various parts of the society for economic analysis of the improved irrigation method. There are few studies carried out in some crops, however, no sufficient empirical information is available. In view of this a study on "Economics of drip irrigation vis-à-vis conventional method of irrigation for pomegranate cultivation in Solapur district" is undertaken with following objectives.

1.8 The Specific Objectives of the Study

The present investigation has been undertaken with the following specific objectives

1) To study per hectare investment for drip and conventional methods ^ for pomegranate orchard.
2) To estimate comparative cost and return structure of drip and conventional method of irrigation.
3) To estimate and compare resource use productivity and efficiency
4) To estimate economic benefits of drip irrigation method.
5) To study constraints faced by pomegranate growers and obtain feed back points

1.9 Hypotheses

The following hypotheses were developed for the study.

1. The drip irrigation system generally adopted by economically and socially well to do farmers.
2. In drip irrigation method per unit investment is more as compared to conventional method.
3. Even though the drip irrigation method involves high cost structure, it is economically viable.

4 The resource use efficiency is better in drip irrigation method

1.10 Scope and Utility of the Study

The present study was undertaken in order to estimate and compare economics of drip irrigation over the conventional irrigation system for pomegranate in the Solapur district of Maharashtra state The study will provide in details the various items of comparison of costs and benefits of drip irrigation technology in pomegranate production with those of conventional irrigation practices. The said information and analysis will be useful for the farmers for knowing the application of drip irrigation system. By considering the cost of cultivation it will be helpful to the farmers for deciding the adoption of suitable irrigation method

Economical analysis of drip irrigation compared with conventional irrigation will be helpful for deciding the balanced and judicial use of crucial inputs such as human labour, manure, fertilizer etc. in drip irrigation. The study will be useful to the farmers for deciding proper irrigation water management practices to conserve irrigation water and increase production.

The study will not only be useful for the cultivators but also for the government, planners, traders and also researchers The financial institutions, which supply credit would get information regarding the

economic feasibility of the technology. Considering the remarkable losses due to the application of conventional method of irrigation water, study will help to indicate the potential profitability of drip irrigation system and thereby promote its adoption

1.11 Limitation of the study

The present study was local and exploratory type. It was conducted in Pandharpur and Sangola tahsils of Solapur district and as such its finding would be of limited use. Application of results in other areas, would however, depends on the similarity of soil, climatic complex, cropping pattern and social economic conditions of the farmers. This study was conducted only for selected pomegranate growers. Objectively this study was limited for respondent ability to recall and their honesty in providing requisite information for the study.

REVIEW OF LITERATURE

2. REVIEW OF LITERATURE

A comprehensive review of literature is an essential part of any scientific investigation. The main purpose of this chapter is to present critical review of past researcher to provide sound basis for scientific investigation. It helps a researcher to compare the finding of study with the studies undertaken by previous research workers. It helps to develop theoretical framework to delineate the research methodology. A brief account of the previous work done or the observations and opinions of concerned researchers having a direct or indirect bearing on different aspects of present study, are summarized under the following topics

1. Importance of irrigation
2. Cost and return under drip irrigation method
3. Resource use productivity and resource use efficiency under drip irrigation system.
4. Constraints in management and maintenance of drip irrigation unit.

2.1 Importance of irrigation

The development of water resources for irrigation and drinking purpose has been practiced since ancient times. The modern techniques of

development of water resource, however, became popular from the beginning of 20th century. The importance of irrigation has been recognized by all in the context of it's magnificent contribution to increase in cropping intensity, crop yields, resource use level, income and employment

Gadgil (1948) pointed out that in an agrarian economy, irrigation accelerates the process of capital formation in agriculture. Investment in an irrigation project, results in creation of additional employment, improvement of crop productivity and increase in crop production. Ramlingam (1963), Shah (1963), Bagi (1981), Bisalish (1984) and Gujar (1990) tried to study empirically the farm level impact of irrigation in different parts of the country. They observed that irrigation lifts up an agricultural economy from subsistence to more prosperous agriculture, which is manifested in higher production. The development of irrigation helps to raise the general level of output of the farmer producer through higher yields as a result of injection of larger inputs facilitated by irrigation. Irrigation raises yields per unit area by inducing use of high yielding varieties and other complementary yield raising inputs viz., chemicals/fertilizers and pesticides. It leads to expansion of gross cropped area by resorting to multiple cropping practices. With full irrigation, farmers can go for commercial crops and crops and new crop production technologies, which requires greater investments and get much income from

them. The technical and allocative efficiencies are also higher on the irrigated farms. Thus, irrigation is an important factor influencing the cropping pattern, crop yield levels and the income of the farmers.

Mellor *et al.* (1968) indicated that the irrigation benefits the farmers by lessening risk of growing crops and increasing average yields. Singh (1973) showed that with the availability of irrigation facilities, the farmers can adopt high yielding variety programme, make more intensive use of land and follow a cropping pattern which require more water but gives higher yields and return.

Singh (1973) showed that with the availability of irrigation facilities, the farmers can adopt high yielding variety programme, make a more intensive use of land and follow a cropping pattern which requires more water but gives higher return and yield per hectare.

Sinha (1978), Deo (1979) and Senkhayan and Singh (1985), studied the impact of lift irrigation on cropping pattern and crop yields in Haryana, Maharashtra and Punjab respectively. A positive relationship was observed between irrigation facilities and intensity of cultivation.There was also change in both irrigation and non irrigated conditions showed dissimilarity and often these were higher in old irrigated areas than in the newly irrigated areas.

Patil (1988) and Rangarajan (1992) stated that water is becoming scarce resource. The water table is going down in many part of the country. Efficient use of available water has, therefore, become important and it is in this context that drip irrigation has an important role to play Controlled supply of water can check the problem of salinity and soil degradation due to water logging which has become a common feature in the command area of many large irrigation projects. Drip irrigation is in favour of cash crop.

Deshpande and Narayanmoorthy (2001) reported that up to May, 1994, 3,596 large dams were completed and 695 were under construction in the country out of which 1,229 dams in the country and thus Maharashtra has the distinction of having the largest number of large dams in the country. Maharashtra has about 15.8 per cent of the total capacity of live storage of water created in the country (including proposed) which is the second highest in India. Thus Maharashtra is comfortably placed at the top rank as far as creation of the storage capacity is concerned.

Shendge et.al.(2003) studied on impact of irrigation on farm economy in Western Maharashtra. The result of the study revealed that the cropping pattern of both the irrigated and rainfed areas was domined by foodgrains crops. The irrigation facilities enabled the farmers to introduce cash crops such as sugarcane, cotton and onion, fruits and vegetables in the cropping pattern A family worker of farm families was employed for 183

days and 176 days in irrigated and rainfed areas, respectively. The annual gross income of Rs.1,84,976 was received by the farm families in irrigated areas, which was 48 per cent more than Rs.88,307 in the rainfed areas. The crop production was the main source of income which contributed newly 73 and 62 per cent for the farm families in irrigated and rainfed areas, respectively Therefore, the study suggests that the creation of additional irrigation facilities besides the efficient use of available water through improved irrigation technologies would strengthen the process of rural development in Western Maharashtra.

2.2 Cost and return under drip irrigation

Before carrying out analysis for cost of cultivation/production it is necessary to take review of previous work done by researchers, hence some of the studies are discussed below.

Punde (1973) investigated cost and returns from grape cultivation in Baramati and Haveli talukas of Poona districts. The study revealed that cost of establishment of an orchard was very high and major items of the cost were cost of support which contributed about 36 to 42 per cent of total establishment cost. He has compared the cost of cultivation and net profit amongst three varieties of grapes i.e Thompson seedless, Anab-E-Shahi and selection – 7. In his study, it was concluded that cost of cultivation of Thompson seedless was higher than other two varieties The items of cost

were number of man-days required for plant protection, manuring and fertilizer cost etc. Contribution of family labour cost to total cost was negligible Net Profit per quintal was significantly very high in Thompson seedless than Anab-E-Shahi and selection-7.

Inamke *et.al* (1988) – studied on economics of grape cultivation by drip irrigation method in Western Maharashtra and they concluded that in drip irrigation method per hectare and per quintal additional return received were Rs.21,014 and Rs. 87.84,respectively

Kulkarni (1988) studied on response of pomegranate and lime trickle irrigation. He reported that B.C. ratio was more in drip (1 189) as compared to that of check basin (1.066) irrigation method which indicated the economic feasibility of drip irrigation system.

Hinge et.al. (1991) studied on economics of drip irrigation vis-à-vis conventional system of irrigation for grape and pomegranate in Nasik district They concluded that per hectare profit on working cost before drip works out to Rs. 59,918 and same after drip was 69,150 i.e. an increase by Rs 9232 Net profit after use of drip worked out to Rs. 62207, which was more by Rs.7060 than profit realized before drip. The B.C. ratio was increased from 2.55 to 2.77. Thus analysis indicated that on the whole it was beneficial to adopt drip method of irrigation for pomegranate crop.

Pujari (1993) studied the progress and prospect for development of pomegranate and ber in Solapur district and reported that there was an inverse relationship between the establishment cost and size of orchard. Working cost as per cent of aggregated establishment cost increased directly with the size of holding, while capital cost as per cent of aggregated establishment cost remained more or less same with all the farm sizes. Managerial cost as per cent of aggregated establishment cost was inversely related to the size of holding. The establishment cost for small, medium and large size orchard were Rs.20718, Rs.17243 and Rs.16673 per acre, respectively. The cost of cultivation at the overall level, for aggregate cost was worked out to Rs.17174 per acre in which share of working cost, capital cost and managerial cost was 76, 9 and 15 per cent respectively. While the per acre cost of cultivation at aggregated cost was maximum in small group (Rs.18570) followed by large group (Rs.17076) and was minimum in medium group (Rs.16004). The net returns per acre were Rs.46858, Rs.44975, Rs.43361 for small, large and medium size orchards respectively. It was concluded that though small size orchard has more per acre cost of cultivation, net returns were also more.

Singh and Khatkar (1994) has analysed the table grape cultivation in Hissar district of Haryana state and concluded that the average establishment cost was Rs.88,164 per hectare. Operational cost increases

with the age of vineyard up to 7'th year and there after remains relatively constant. Positive returns were obtained in the 4'th year of establishment Grape cultivation provided a net discounted return of Rs.61,734, an internal rate of return of 23 per cent, a pay back period of 8 years and a benefit cost ratio of 1.8

Bhujbal (1995) has worked out the establishment cost and cultivation cost for producing vineyard. The per hectare total establishment cost was Rs.1,05400 and the item wise costs were viz, preparation of land Rs.8,500, fertilizer Rs.10500, plantation and planting material Rs.3,600, support Rs.4,200, drip irrigation set Rs.4,200, training system Rs.55,000 and management including other operations i.e. weeding , disease and pest control, irrigation etc Rs.7,600. He has also worked out per hectare cost of cultivation of producing vineyard, which was Rs.1,02,000. The items of cost included cultivation and canopy management, fertilizer and irrigation, disease and pest control and harvesting and marketing were 10, 25, 15, 25 per cent respectively, of the total cost.

Anonymous (1996) studied the economics of pomegranate cultivation through conventional and drip irrigation method. The study revealed that per hectare investment cost and cost of installment of drip set were Rs.54626.25 and Rs.34226, respectively The per hectare cost of cultivation worked out to Rs.1,02,381.63 and which was additional by

Rs.1597 than conventional method. But, there was cost saving for the items such as plant protection (Rs.4755), manures and fertilizers (Rs.2835), human labour charges (Rs 2865) and irrigation (Rs 100) as compared to conventional irrigation method. Additional profit at cost 'C' for per hectare , per plant and per quintal was Rs.12804, Rs.24 and Rs.129, respectively. The internal rate of return in drip method was 29.90 per cent

Anonymous (1997) worked out the economics of cultivation of pomegranate in Western Maharashtra. The per hectare total establishment cost worked out to Rs.61815.94 of which the important items of cost were expenses on total human labour (26.21per cent), crop protection (11.35 per cent) ,fertilizers (7.23 per cent) and manures (5.37per cent). The indirect cost has a share of 27.87 per cent to total cost. The cost of cultivation at the overall level worked out to Rs.55046.63. The major items of direct cost were total human labour (15.66 per cent) followed by establishment cost (7.53 per cent), fertilizers (6.13 per cent), crop protection (5.86 per cent) interest on working capital (5.14 per cent) and manure (4.40 per cent). Indirect cost like rental value, depreciation and interest on fixed capital has a share of 43.46, 2.14 and 2.57 per cent respectively to cost 'C'. The overall productivity per hectare was 93.60 quintal and per quintal cost of production was Rs.587.67.

Anonymous (2002) evaluated the economics of production and marketing of pomegranate in Solapur district. The study revealed that at the

overall level per hectare production was 169.73 qtls However, per quintal returns, cost C, cost of marketing and net profit worked out to be Rs.1329 59, Rs.684.37, Rs.434 70 and Rs.210.47, respectively, with 1.19 B C. ratio.

Waykar et.al. (2002) studied on the economicsof drip irrigation system for sugarcane crop in Ahmednagar district, and revealed that sugarcane productivity was higher by 27 per cent on drip adopter farms than that of non drip adopter farms. The net returns from sugarcane crop on drip adopter farmswere Rs.38095, which was higher by Rs.20234 than sugarcane under non adopters farms. Per tonne production cost of sugarcane crop was Rs.521.74 on drip adopters farm and it was Rs.579.42 for non drip adopters farm. The investment on drip irrigation system was found to be economically viable since BCR was more than unity 1.51 and 1.25, under with and without subsidy conditions, respectively.

2.3 Resource use productivity and resource use efficiency under drip system

The drip irrigation system is one of the most latest efficient methodsof scheduling of irrigation having more than 90 per cent of irrigation efficiency Following are some research studies carried out on this technology.

Mane and Magar (1883) studied sugarcane response and water economy by adoption of drip irrigation technology on the basis of experiment at M.P.K.V. Rahuri. There was saving of water by 30 per cent and increase in yield by 20 per cent with drip method as compared to furrow method. The water use efficiency was double by drip method (902 kg/ ha-cm) than traditional method (529kg/ha-cm).

Anonymous (1986) studied with adsali sugarcane at Rahuri

(Maharashtra) and indicated that drip method resulted, in yield increase of 19.9 per cent with water saving of 29.5 per cent over furrow with earthing up, while in suru sugarcane the yield increased with drip was marginal (5.3 per cent with daily drip and 5.7 per cent with a water alternate day drip) with a water saving of 59.7 per cent.

Sivannappan (1987) stated that by introducing drip irrigation, it is possible to save about 50 to 70 per cent of water and yields can also be increased by about 10 to 15 per cent. Apart from saving water, several other features which indicate the superiority of this method for maximum crop production, viz; high quality produce, reduced diseases, higher fertilizer use efficiency, less weed growth, satisfactory use of pure quality water and less labour and operational cost.

Mane et.al. (1987) have conducted an experiment for comparative study of drip and furrow methods of irrigation for bhendi crop

and revealed that drip irrigation method recorded maximum yield of bhendi (17.72 t/ha).Drip method increased the yield by 16.14 per cent with water saving of 39.6 per cent when compared with conventional furrow method. The WUE in case of drip method was nearly twice that of furrow method.

Patil (1989) reported that drip irrigation method proved to be quite useful, for sugarcane cultivation on salty soils as it allows 58 per cent water saving and 15 per cent increase in yield as compared to the traditional furrow method.

Kulkarni (1989) studied on drip irrigation system in Maharashtra and revealed that there was saving of water to the extent of 30 per cent in case of sprinkler irrigation and about 60 per cent in case of drip irrigation. Increase in the yield is to the extent of 15 per cent in case of both the systems.

Nagare (1989) in his study of an evaluation of drip irrigation system under farmers conditions conducted in Haweli tahsil of Pune district. It was concluded that nearly three-fourth (73.45 per cent) of the drip owners could save 50 to 80 per cent of water due to drip irrigation, while 84.69 per cent of the drip owners reported saving of labour for interculturing and weeding,64.28 per cent owners reported saving in cost of electricity and there was increase in yield due to drip irrigation system.

Padmakumari and Shivanappan (1989) in their study on clogging of emitters in drip system in India, revealed that the improvement in cropping scheme with drip irrigation resulted in an average net gain of Rs.4711/ha. as against Rs.3290/ha. in conventional method.

Sivanappan (1989) studied on technical feasibility and economic viability of drip irrigation in India. He revealed that by introducing drip irrigation it is possible to save about 50 to 70 per cent of water and the yield can also be increased by about 10 to 15 per cent. Income of farmers would increase by about Rs.3000 to 5000 per hectare due to improvement in productivity as well as efficient use of water. Apart from these irrigation drip irrigation system helped to reduce disease, increase fertilizer use efficiency, less labour and operation cost.

Yadav (1989) conducted an experiment on water optimization studies under drip, furrow and pitcher method of irrigation for watermelon in vertisol at M.P.K.V, Rahuri. He reported the B.C. ratio as 2.87 and 1.92 in drip and furrow methods of irrigation respectively.

Jadhav *et.al.* (1990) studied economic feasibility of the drip irrigation system for tomato. The B:C ratio of the drip system for tomato crop was found to be 5.15, where as it was 2.96 for flood method

Gutal *et.al.* (1990) conducted an experiment on effect of drip irrigation system (biwall, non-pressure compensating emitters or

microtubes) and planting in pits with two drippers/ pit on growth of sugarcane. Irrigation was studied on the basis of daily pan evaporation and crop growth stage. They found that the sugarcane yields were the lowest from the pit planting system (105ton/ha) with yields from other system ranging from 120 to 134t/ha. The pit planting system showed the highest water use efficiency and was 70 per cent more efficient than flood irrigation.

Hegade and Srinivas (1990) reported that there was significant increase in banana yield with drip irrigation (83.81t/ha) when compared to those with basin system (78.98t/ha) owing to significant differences in bunch weight

Thorat and Bhoite (1992) in their study of the socio-economic constraints in the use of drip irrigation, observed that drip irrigation system owners were benefited by saving of water, labour for irrigation and interculturing operations. All the farmers were satisfied with the positive response of crops to the drip irrigation system. Most of the farmers (92 per cent) had reported that the quality of the farm produce obtained after drip irrigation was superior.

Hapse et.al. (1992) studied on techno-economic evalution of drip irrigation for sugarcane crop. They revealed that B.C. ratio was2.25 and Internal Rate Return was 43.92 per cent. Summarizing that drip system was economical and investment was worth paying.

Varshney *et.al.* (1993) carried out an economic analysis of drip irrigation system at A.P.A.U. to study the feasibility of drip system to pomegranate orchard, in terms of economic benefits with and without water saving, taken in to consideration. From this analysis it was reported that the B:C ratio in pomegranate plantation varied from 1.12 to 1.31, when cost of water saving was not considered and it was 4.04, when cost of water saving was considered in the analysis.

Gete (1993) observed 60 per cent water saving due to drip irrigation in sugarcane. The production of drip sugarcane increased from 20 to 25 per cent because of this technology. Besides, there was saving of fertilizers up to 30 to 40 per cent.

Pawar et.al. (1996) undertook a study on 'Economics of drip irrigation in plantation crops. Grape and pomegranate in Western Maharashtra. The study was conducted in Solapur and Nasik districts of Maharashtra. It was observed that cropping and irrigation intensity have increased to a greater extent because of adoption of drip irrigation system, there by resulting in to increasing the water use efficiency. Because of drip irrigation method, there was considerable saving in different inputs i.e. saving in the cost of human labour, bullock labour, machinery, manures and fertilizers, plant protection and irrigation. The per hectare cost of production

for grapes in drip and conventional irrigation method worked out to Rs.1,45,870 and Rs 1,46,167, respectively.

Chitra *et.al.* (1997) evaluated the economics of ber production in and around Hyderabad city. The study revealed that per hectare total cost of establishment in the first year was Rs.7913 hectare. Total per hectare cost incurred during the maintenance was Rs.3483. The per hectare total cost of production of ber worked out to Rs.16737. The pay back period in ber cultivation was 4.42 years and the B.C. ratio was 5.25. The net present value and IRR was Rs.12061 and 73.54 per cent.

Singh and Singh (1997) studied the profitability of ber cultivation in Arid region of Haryana. The study summarized that average per hectare cost of production was Rs.6746. Net returns per hectare and per quintal cost of production worked out to Rs.4816 and Rs.114, respectively. The internal rate return and B.C. ratio was 40 per cent and 3.53, respectively with pay back period of 5 years. Hence, ber crop was economically viable.

Chopada (1997) studied an effect of drip, bubbler and surface irrigation on yield and quality of pomegranate. He reported that B:C ratio at current rate of interest (12 per cent) and inflation of 8 per cent were 2.54 per cent, 1.95 per cent and 1.26 per cent under drip, bubbler and check basin method, respectively. This indicates that the investment drip was worst

paying. Similar observations were evident from the total benefits and annual net profit.

Shiyani and Kuchhadiya (1997) reported from the study on impact of drip irrigation technology on cotton growers of Saurashtra region, that the higher yield, luxative profit, increase in labour productivity and reduction in unit cost of production were major advantages of drip irrigation system over the conventional method.

Koujalgi et.al. (1999) studied the profitability of production and marketing of pomegranate in Bijapur district of Karnataka. The study revealed that per hectare establishment cost of pomegranate orchard at the overall level, was Rs 20970, in which share of cost of drip set was 57 per cent. The average size of orchard in the study area was 0.96 hectare. The per hectare operational cost worked out to Rs.22123, in which expenditure on plant protection chemicals was the highest. The per hectare gross returns, returns over operational cost and returns over cost of production were Rs.1,50,000 , Rs.1,20,878 and Rs.80,258, respectively. The rate of return over the total cost was found Rs2.15.

Jadhav and Patole (2000) have studied per hectare and per quintal cost of cultivation for several varieties of grapes in Western Maharashtra. They revealed that the average per ha cost of cultivation was highest Rs.2,61,495 in flame seedless, followed by Rs.2,56,446 in Kismiss,

Rs.2,24,948 in Sonaka, Rs.2,09,028 in Sharad seedless, Rs.2,06,454 in Thompson seedless, Rs.1,71,061 in Tas-A-Ganesh and Rs.1,42,761 in Manik Chaman. The share of cost 'A' in the total cost ranged between 40.12 to 54.39 per cent in all varieties. The share of insecticides and pesticides was observed to be the highest and it ranged between 9.25 to 21.5 per cent followed by hired human labour days 4.55 to 14.45 per cent and manure 2.15 to 6.24 per cent. The share of cost 'B' in total cost was 94 to 97 per cent in all the varieties. The per quintal cost of production thus in Thompson seedless, Sonaka, Manik Chaman, Kismiss, Tas-a-Ganesh, Sharad seedless and flame seedless varieties of grape worked out to Rs.945, Rs.1030, Rs.849 Rs.1410 Rs.883 Rs.1044 and Rs.1065 ,respectively. The benefit cost ratio at cost 'C' worked out to 1.44 in Thompson seedless, 1.33 in Sonaka, 1.55 in Manik Chaman, 0.94 in Kismis, 1.60 in Tas-A-Ganesh, 1.90 in Sharad seedless and 2.28 in flame seedless variety.

Pawar *et.al.* (2000) conducted study on economic feasibility of drip irrigation for sugarcane in command of Mula right bank canal of Maharashtra. They observed that the total net income (Rs/ha) and B:C ratio were higher in drip irrigation with application of 'N' through drip irrigation (Rs130175 and 2.47) and drip irrigation with soil application of fertilizers (Rs96147and 2.08)as compared to surface irrigation (Rs42,700and 2.01),

The drip irrigation system has also resulted in net extra income of Rs53500 to Rs.87500 per ha over conventional method.

Firake and Kasar (2003) conducted study on economicsof micro and sprinkler irrigation. They observed that the efficient and judicious use of available water resource through micro irrigation could result into increased productivity. Experiment revealed that though micro irrigation method are costly as compared to conventional surface methods, they are technically feasible and economically viable mainly due to 1) increased crop yield. 2) additional income due to additional area cultivated due to saving in irrigation water.

2.4 Constraints in management and maintenance of drip irrigation unit

Several researchers have shown that drip irrigation technology is more advantageous because of many reasons. Thus technology is however, not totally free from any problems. Quite a few research workers have tried to find out limitations/problems associated with drip irrigation technology at the field levels.

Gibson (1978) carried out research on underground drip irrigation system in Hawai. He observed that in shallow drip irrigation

system, tubes are being destroyed during harvesting. He recommended the use of chemicals to control ants, which attacks the plastic tubes He emphasized need for sub-surface irrigation by means of tubes buried at greater depth.

Wayse and Kulkarni (1987) made survey to identify problems of drip irrigation system adopted by grape growers in Sangli district. They reported the cracking of flexible pipes and uneven distribution of water at the field level.

Shah (1990) reported that there are many constraints in adoption of drip irrigation system i.e. farmers fears of cracking of pipes, clogging of ordinary drippers, inadequate guidance to the farmers in the selection of right quality system, negligence of some farmers in running a drip system, negligence or ignorance of real cost and quality aspects complicated procedures and details in getting bank loans and subsidy. Besides this there is no regular programme for training the farmers.

Ingle and Sagane (1992) reported that important technical constraints as experienced by most of the drip adopters were clogging of drippers and microtubes (78.98 per cent), inferior quality spare parts (52.63 per cent), pipe joints leakages (36.84 per cent) and inadequacy of perfect technical information about drip irrigation system.

Puranik *et.al.* (1992) revealed that drip irrigation was very costly as responded by cent per cent drip farmers. Farmers did not get spare parts locally at reasonable rates. A majority of farmers (94 per cent) also said that drip irrigation sets required frequent repairs and cleaning of the mains, sub mains and laterals i.e. microtubes and drippers. Forty five per cent farmers found problems as regards to required water pressure for proper working of drip irrigation system there by hindering the water discharge rate to the crops.

Phadtare *et.al.* (1992) conducted study on the socio-economic constraints in use of drip irrigation system. They reported that, non availability of repair services, delay in getting loans and non availability of technical guidance in time were the major constraints in adoption of drip system. The suggestions made by the farmers for increasing area under drip irrigation were that propoganda should be made about drip irrigation through ' SHIBIRS'(Farmers Rallies) and Film Shows, at least five year guarantee should be provided by the manufacturer/company agents for drip irrigation systems. Subsidy should be given equal to all farmers in time, technical guidance and sufficient loan be provided to the farmers.

Thorat and Bhoite (1992) in their study of the socio-economic constraints in the use of drip irrigation in Baramati Tahsil of Pune district. They observed that, clumsy procedure of getting loan, lack of timely technical

guidance, inferior quality of material and irregular after sale service were the major constraints faced by the farmers.

Kalasariya *et.al* (1993) revealed that major economic constrains faced by the drip farmers were high initial cost for the installation of drip set and for maintaining adequate pressure a tank is required to be made at high attitude, uneven distribution of water, due to uneven pressure and clogging due to other impurities.

Anonymous (1997) conducted a study on social economic constrains in the use of drip irrigation under sugarcane farming in Kolhapur and Sangli area and concluded that 72.83 per cent of the respondents complained that without acid treatment drip set could not work properly. About 57 per cent of them wanted that 70 to 90 per cent of the grown up canes were lodged and delivery of water was not uniform over long laterals though drippers

Sutar (1997)conducted survey to know the constrains in adoption of new scientific technologies in grape. Suggestions invited from 150 respondents in Maharashtra state to overcome these constrains in adoption of modern grape cultivation technology revealed that 100 per cent would like subsidy on loans, and also technical guidance. More than 50 per cent suggested that irrigation facilities be made available by the government.

Eligar (1999) Studied on socia economic aspects of drip irrigation for vegetables in Nevasa tahsil of Ahmednagar district. He reported the major constraints in adoption of drip system such as high installation cost of the sets, untimed availability of financial assistance from the bank, costly spare parts and equipments, clogging of drippers, lack of technical knowledge, poor after sales service by the dealers and unavailability of the spare parts locally.

Subbih (2000) conducted study on drip and sprinkler irrigation in Viru Dhungar area. He reported that the government should provide more funds for granting subsidy for the installation of drip and sprinkler irrigation system. The district administration and the government should inform the farmers through media about the subsidy scheme available for the installation of drip and sprinkler methods

METHODOLOGY

3. METHODOLOGY

The success of any scientific investigation depends on the methodology which was adopted for systematic data collection, compilation and various types of analysis on scientific lines. The methodology adopted for the present investigation is given below under different sub-heads.

3.1 Selection of area

Maharashtra is one of the leading pomegranate growing states having large area under this fruit crop. In the Maharashtra State, Solapur is one of the leading districts in the cultivation of pomegrante which contributes 37.48 per cent area of the state in year 1996-97.

In Solapur district acreage under pomegranate is concentrated in Sangola and Pandharpur tahsils to greater extent. Besides, the farmer in these tahsils are having expertise in cultivation of pomegranate. These farmers are adopting improved package of practices in better manner as compared to others. The pomegranate growers of these tahsils also inclined to adopt various technologies and as such they are adopting drip irrigation on large scale for pomegranate cultivation, since the water is scarce resource in the district. It is, therefore, proposed to select Sangola and Pandharpur tahsils purpos ely.

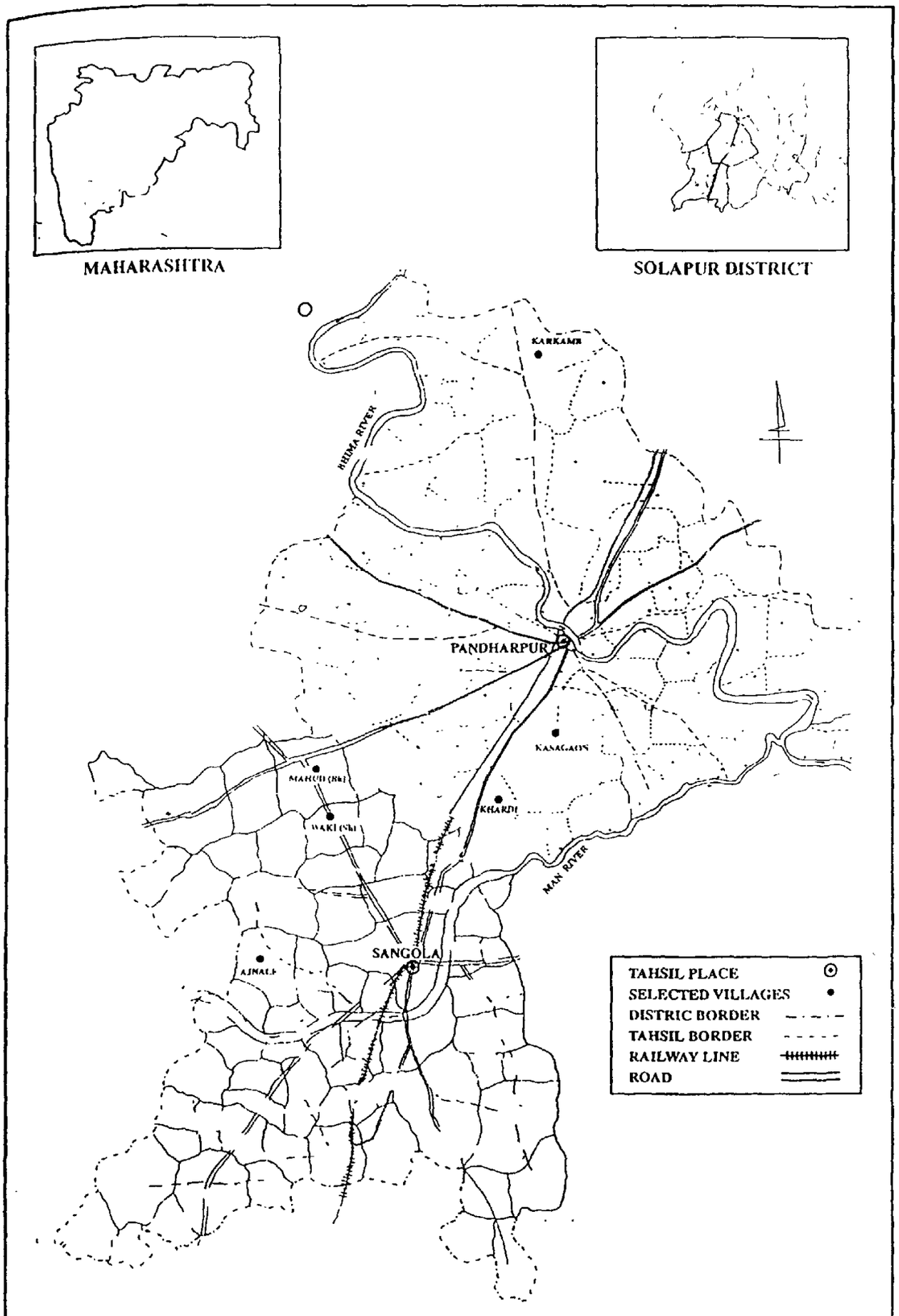


Fig. 1 Location of selected villages in the selected tahsils of Solapur district

3.2 Selection of villages

The secondary unit of the sample was villages. From Sangola and Pandharpur tahsils six villages having large acreage under pomegranate orchards were selected on area proportionate basis Ajnale, Waki (Shivane), Mahud (Budruck) villages from Sangola tahsils and Khardi, Kar-Kumb, Kasegaon villages were selected purpos -ly from Pandharpur tahsil.

3.3 Selection of sample pomegranate growers

From each selected village, list of pomegranate growers were obtained from revenue records as well as department of agriculture. But, it was difficult to identify the age of orchard from the revenue record, Therefore, help of records of department of agriculture was taken in the selected villages. From this records, less than 2 years orchard holders were deleted. The list of pomegranate growers was arranged according to the categories of operational holdings viz; small (up to 2 ha.), medium (2 to 4 ha.) and large (Above 4 ha). Then from each village 10 sample pomegranate growers of conventional (surface) method and 10 drip irrigation system from 3 categories of farms were selected randomly. Thus final 120 pomegranate growers were randomly selected from two systems of irrigation and three size of operational holding categories.

Size of operational holding	Sangola		Pandharpur		Total	
	Drip	Conventional /Surface	Drip	Conventional /Surface	Drip	Conventional /Surface
Upto 2.00 ha.	10	10	10	10	20	20
2.01 ha. to 4.00 ha.	10	10	10	10	20	20
4.01 ha. and above	10	10	10	10	20	20
Total	30	30	30	30	60	60

3.4 Designing of Interview Schedule.

On the basis of objectives of the study the schedules were designed for data collection. While preparing the schedules due care was taken to avoid quotations having dual meaning and contradictory statements. The language of schedules was simple for easy understanding by the respondents. Questions on the various aspects such as drip irrigation system adopted by pomegranate growers, resource use, cost of production, constraints faced by the farmers, were included in the schedules. Similar, aspects were covered to collect the data for the conventional method (surface irrigation).

3.5 Pretesting of schedules

The pretesting of interview schedules helped the researcher to make the modifications and alterations in order to derive the spontaneous response from the respondents. The interview schedules were pretested prior to its final use. The pretesting was carried out in order to test the schedules and to find out whether the schedules designed for data collection suit to obtain the information required for the study.

3.6 Collection of data

The data were collected with the help of personal interview from the respondents in a friendly and informal manner. An attempt was made to interview the selected sample farmers preferably at the site of field. This helped to record the responses more spontaneously and easily. The questions were asked casually during the course of discussion. Additional questions were asked in order to verify some questions regarding drip irrigation system. The replies of the respondents were recorded while the interviews were in progress.

3.7 Analysis of data

Some of the important points of the analysis of the data and the methodology adopted are elucidated below.

3.7.1 Tabular analysis

3.7.1.1 Items of cost of cultivation

The primary data which was collected at farmers level were processed, compiled and the total input costs of pomegranate cultivation were estimated by using standard cost concepts.

Cost 'A' : Cost 'A' includes the cost on account of hired human labour, hired plus owned bullock labour and machine labour, purchased plus owned manures, fertilizers, irrigation (by drip system), plant protection (spraying plus control of fruit moth during night), annualized establishment cost of pomegranate orchard, land revenue and cesses, depreciation on implements and machinery.

Cost 'B' : It comprises of Cost 'A' plus interest on value of owned fixed capital assets (excluding land) plus rental value of own land (net of land revenue) and rent paid for leased in land.

Cost 'C' : It comprises of Cost 'B' plus imputed value of family labour.

The methodology adopted for valuation of different items of cost in estimation of cost of cultivation is discussed in the subsequent paragraph.

1. **Human Labour** : It includes both hired and family labour. Most of the labour force engaged in crop production comes from

cultivators own family. However, the cultivators have to engage hired labour from time to time for certain operations.

Human labour cost comprises of :

a) wages actually paid to the hired labour as also those paid to the labour obtained on contract for the whole year or part thereof for various operations.

b) Imputed value of labour put in by the family members for various operations.

c) Wages paid to the attached farm servants for different operations were included in the hired labour.

The wages of male and female members of the family were calculated on the basis of wages rates of the casual labours in force from time to time for different operations.

However, for converting the female labour in to the mandays following formula was used

Mandays = Female labour days x 0.75

2 **Bullock labour** : In the case of hired bullock labour the prevailing rates of bullock labour for particular operations in the village were considered. Charges on account of owned bullock labour were

accounted on the basis of the charges paid to the hired bullock pair including the labour required for the operations like ploughing, harrowing, manuring and organization of inputs.

3 **Machine labour** : In the case of hired machine labour, the prevailing rates of machine labour (i.e. tractor) for particular operations in the village were considered. Charges on account of owned machine labour were accounted on the basis of the charges paid to the hired machine including the labour required for ploughing, harrowing, spraying organization of inputs and transport of harvested fruits within the plot.

4. **Planting material** : Pomegranate is propagated by air layering method and almost all farmers have planted the orchard with grafts prepared by this technique of propagation and purchased either from certified private nursery, government nursery or from University nursery. The prevailing rates from various sources were considered for cost of planting material. In case of few farmers, those had prepared the grafts at their own farm, prevailing market rates were considered for costing.

. **5.Manure** : the cost of farm yard manures or composts produced on the farm was evaluated on the basis of rates prevailed in the village. The cost

of manures purchased was accounted for by considering to the actual prices paid by the cultivators.

6. **Fertilizer** : The cost on account of fertilizers was worked out at the actual prices by the cultivators.
7. **Insecticides and pesticides** : The insecticides and pesticides were charged at the actual prices paid by the cultivators.
8. **Irrigation charges** : Irrigation was mostly through wells, tube/bore wells under both the systems.The pomegranate farmers have installed the drip sets on the same. The details regarding estimation of irrigation charges is given below.

Irrigation charges for sample = Pomegranate orchard (Rs.)

$$\left[\left(\frac{M_e}{WH_e}\right)\left(WH_{ep}\right)\right]$$

Where,

M_e = Total maintenance charges of electric motor (electric bill for the year plus repair charges) for the year in Rupees.

WH_e Total number of working hours of electric motor for one year. For counting the same, irrigated cropping pattern of the individual sample farmer was taken into consideration. Then points such as number of irrigations applied for individual crop

(for flow method), season, horse power of the electric motor, soil type and in case of irrigation by drip system, fruit crops grown, season, age of orchard and daily running hours of electric motor per drip sets and for different fruit crops (monthwise variation was also considered) were considered.

WH_{ep} =Total number of working hours of motor for irrigation of sample pomegranate orchard by drip method.

9. **Land revenue, cesses and taxes** : This item of cost includes land revenue, additional land revenue, cess by the Zilla Parishad, taxes on account of Employment Guarantee Scheme and educational taxes which were actually paid by the cultivators.

10. **Depreciation on implements and machinery and repairs** : Farm assets like farm buildings (whole or its part used for agricultural business purpose), implements, equipments, machinery, bore wells and other irrigation structure were evaluated at the prevailing market prices taking into consideration the conditions of the assets. Depreciation of these assets for current year was calculated using straight line method. For the purpose, the present value and remaining useful life of assets were considered and worked out with the

following formula. However, depreciation on livestock was not considered for this investigations.

$$D = \frac{(PV) - (10\ \%\ of\ PV)}{RL}$$

Where,

D = Depreciation of any asset for one year in rupees.

PV= Present value of the asset in rupees.

RL= Expected remaining life of the asset in years.

11. Interest on fixed capital : Interest on present value of fixed assets (excluding land, animals and traditional old wells) such as farm buildings, implements, equipment, machinery, bore wells, irrigation structure was charged at the rate of 10 per cent of the present value and apportioned on sample pomegranate orchard by using above formula.

12. Interest on working capital : Interest on working capital was charged at the rate of 13 per cent per annum but, for the period of six months, viz; cash or kind expenses incurred during the period of cultivations.

13. Rental value of land : Rental value forms an important part of the cost of production. In case of fruit trees, rental value during the non-bearing period goes in the establishment cost. In this investigation, it

was found that all the farmers were cultivating their own land.Hence, the rental value was worked out at the rate of 10 per cent of the estimated value of that land. The per hectare value of land was ascertained from the cultivators at the time of data collection and for the same government record was also referred. Then these costs were allocated on the basis of the area occupied by the crop. Soil type, distance from village and source of irrigation were the points considered for land valuation.

14. **Establishment cost**: In case of some fruit crops, first bearing starts after some years and farmers has to incur the cost during such non-bearing period which we called it as gestation period. Pomegranate has no exception to it. University had recommended to have the gestation period for pomegranate orchard for 3 years but, the farmers consider it for 2 years. The gestation period may ranges from 18 to 22 months for the orchards for which the farmers had taken Ambe bhar as the first bearing season. Hence, establishment cost was worked out only of two years. The expected productive life of pomegranate orchard is 20 years under the normal and well managed condition. But, now a days in the study area the orchards are suffering from die

back and the mortality rate increased severely from 10 years onwards. Hence, expected productive life was considered as 15 years.

In case of pomegranate cultivation the items of expenditure during first year were preparation of land, layout, digging of pits, filling of pits, seeding and its planting, while gap filling, pruning and training were the items of cost only during second year. Farmers have to incur some items of cost for both the years i.e., manure, fertilizers, interculturing, spraying, supervision and watching, irrigation and others Apart from these costs, some fixed costs i.e., land revenue, depreciation and repairs, interest on fixed capital and rental value of land were also considered for both the years. This total expenditure was considered as total establishment cost of the orchard and for working out annualized establishment cost, it was apportioned by considering the expected economic life of orchard i.e., 15 years.

The pomegranate growers had not taken inter-crops during the gestation period because of land used for pomegranate cultivation was very light and varkas, hence, the total establishment cost was taken as net establishment cost for working out annualized establishment cost.

The methodology adopted for valuation of different items of cost of establishment is discussed below.

i. **Preparation of land** : It includes cost of preparatory tillage operations like ploughing, harrowing, cleaning of plot and some times land leveling etc.

ii. **Layout, digging and filling of pits**: Layout for systematic planting and marketing of spot for pit. Digging of pit or some times light blasting may be done and which was also considered for costing, filling the pit with soil, manures, fertilizers etc. For the same only labour cost was considered.

iii. **Seedlings, gap filling and planting** : It includes the cost of seedlings including the cost of transport and cost of planting.

iv. **Manuring :** The cost of manures including the cost of transport and cost of application for subsequent years was considered.

v. **Fertilizers** : It includes cost of fertilizers, cost of transport and cost of its application for both the years.

vi. **Interculturing :** It includes weeding, harrowing, ploughing, debudding and stirring to soil.

vii. **Prunning and training** : It constitutes cost of pruning, training and cost of support to plants.

viii. **Spraying :** The cost on account of plant protection measures including the cost of human labour for both years. During the

period of gestation the spray pumps of the type gauter/foot spray/knapsak were used.

ix. **Irrigation layout and irrigation** : During the first year almost all farmers had irrigated their orchard by flow method and during second year except few, all the farmers had installed the drip sets but during the different months. Therefore, for both the years cost were worked out on account of irrigation (by flow) and preparation of irrigation layout as per the situation of individual farmers, while, the cost of irrigation by drip method for second year was worked out from the period of installation. The procedure for working out irrigation cost by flow as well as by drip method was same as already discussed under the irrigation cost. Cost of drip structure and its installation of all farmers were considered during third year.

x. **Supervision and Watching** : Supervision includes mandays required for supervising the orchard for diseases and pests, irrigation, etc. while watching includes watch and ward for some period during particular months.

xi. **Other costs** : It includes the cost on account of organization of inputs and other incidental costs.

xii. **Interest on working capital** Interest at the rate of 13 per cent per annum was charged for every year.

xiii. **Land revenue** : It includes all the items except educational tax which was already discussed previously.

xiv. **Depreciation, repairs and interest on fixed capital** : Procedure for working out the cost of this items is same which has already been discussed previously, but the assets position during the gestation period was taken into consideration..

xv. **Rental value of land** : The procedure is the same as already discussed earlier, but the value of land during the gestation period was considered.

3.8 **Resource use efficiency :** Resource use efficiency of individual resources were worked out with the help of marginal value and marginal cost.

3.8.1 Functional analysis

The functional analysis was done by, using C-.D type of production function and resource productivities were estimated. Moreover, under economic analysis resource efficiency and return to scale were worked out. The details are as under.

3.8.1.1 Productivity of resources.

In order to work out productivity of individual resources in pomegranate cultivation Cobb-Douglas type function was used in present investigation.

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

Where,

Y = Output of pomegranate in quintals as a dependent variable

X_1 = Human labour in mandays

X_2 = Manure in quintals

X_3 = Nitrogeneous fertilizers in Kg.

X_4 = Phosphetic fertilizers in Kg.

X_5 = Potassic fertilizers in Kg.

X_6 = Expenditure on irrigation charges in rupees.

X_7 = Expenditure on plant protection in rupees.

X_8 = Expenditure on annualized establishment cost in rupees.

a = Constant

e^u = Error term.

bi's = Elasticities of production of respective resource categories.

The functional analysis was not done for each size group for want of sufficient sample. It was attempted at the overall level considering whole sample.

The productivity of individual resources were worked by considering whole sample of pomegranate under surface and drip irrigation system. The significant test for individual resources was carried out by Student's 't' test while, the significance of the model was tested by 'F' value test. R^2 were also worked out in order to know the present variation in total production by the explanatory variables.

3.8.1.2 Economic analysis

The estimated production were used for economic analysis with regards to estimation of returns to scale and marginal productivities of individual resource factors. The differences in the values of these estimates gives an idea about the variations in the productivities of resource in production of pomegranate under surface and drip irrigation system.

a) Estimation of marginal value products

In order to compare the marginal value productivities with the marginal cost of the individual variables, the analysis was extended to work

out marginal physical products (MPPs) and marginal value products (MVPs) of the selected variables in the present study.

The marginal physical product (MPP) of individual input used in the production of pomegranate enterprises was worked out with the help of following equation.

$$MPPx_i = bi \frac{\overline{Y}}{\overline{Xi}}$$

Where,

bi = Elasticity of production for Xi

$\overline{Y}$ = Geometric mean of output

$\overline{Xi}$ = Geometric mean of input

The MPP of individual input were then converted into MVPs with the help of unit price of output.

$$MVPx_i = bi \frac{\overline{Y}}{\overline{Xi}} Py$$

Py = Per unit price of output

The efficiency of resource use was studied through the comparison of MVP of resource with its respective acquisition cost. The significance of difference between MVP of the individual resource and its acquisition cost was tested by computing 't' value.

b. Estimation of returns to scale

In the Cobb-Douglas type of production function, the returns to scale are measured by adding elasticities of all the input as given below.

$$Y = a X_1^{b1} X_2^{b2} \text{------} X_n^{bn}$$

b_1, b_2 ----- b_n are the regression co-efficients or elasticities of production and the returns to scale is

$$\sum bis = b_1 + b_2 + \text{-----} + b_n$$

Depending upon the sum of regression co-efficients as less than, equal to or greater than unity, the prevailing returns to scale may be considered as decreasing, constant or increasing, respectively.

Statistical tests of significance

1. Test of significance of deviation of sum of the elasticities ($\sum bi$) from unity

$$t = \frac{\sum bi - 1}{S.E(\sum bi)}$$

$$t = \frac{\sum bi - 1}{\sqrt{S^2 C_{11} + C_{22} + C_{33+} C_{44} + C_{55} + 2 (C_{12} + C_{13} + C_{23} + C_{24} + C_{35})}}$$

Where,

$$S^2 = \frac{\text{Sum of Squares due to error}}{\text{No. of degree of freedom}}$$

2. Test of significance of factor shares

$$t = \frac{| bi |}{S.E\,(bi)}$$

$$S.E\,(bi) = \sqrt{C_{11}\ S^2}$$

S^2 = Mean sum of square

SOCIO - ECONOMIC FEATURES OF THE STUDY AREA

4. SOCIO-ECONOMIC FEATURES OF THE STUDY AREA

4.1 Socio-economic features of the study area

Agro-climatic conditions play as a major governing factor in the agricultural production. Horticultural production is not an exception to it. Apart from the agro-climatic factors, there are some factors which, are minor but play important role in the production.

These factors are the soil type, irrigation, communication, education, credit, storage and marketing, etc. The knowledge about physical features and economic background of the study area facilitates better understanding of the problem under investigation. As mentioned earlier, Sangola and Pandharpur tahsils of the Solapur district were selected for the present study, it is intended to describe the information pertaining to Solapur district and selected two tahsils as well as background information about sample villages.

4.1.1 Location

Solapur district is one of the five districts of Pune Revenue Division situated on the South-East fringe of Maharashtra State and situated between 17^0-10' to 18^0-32' North latitude and 74^0-42' to 76^0-15' East longitude. Solapur district is surrounded by Ahmednagar district in the

North, Osmanabad district in the North and East, Sangli and Karnataka State are to the South and Sangli, Satara and Pune districts towards the West. There is no important hill system in the district. However, towards North-East fringe sparse of Balaghat ranges and towards Western fringe sparse of Mahadeo ranges and towards South-Western fringe sparse of Shukracharya ranges exist in the district. It lies in the basin of Bhima, Nira, Sina and Man rivers.

For administration purpose, the district is divided into 11 tahsils. The district has a geographical area of about 14878 sq.km

Pandharpur tahsil is situated at West side of the district headquarter on the Solapur-Kolhapur road and at a distance of 70 km from Solapur. Pandharpur tahsil is surrounded by Mohol tahsil at East, Madha at North, Malshiras at West, Sangola and Mangalwedha at South side. Bhima is the main river which flows in the direction from North-West to South-East.

Sangola tahsil is situated at South-West side of district head quarter on the Solapur-Kolhapur road, at a distance of 105 kms from Solapur. Sangola tahsil is surrounded by Mangalwedha tahsil at East, Sangli district at West and South, Pandharpur and Malshiras at North side. Man is the only river which flows in the direction from West to North-East.

4.1.2 Area, population and workers

The information relating to area, population and workers is presented in Table 4.1

It can be observed from the table that total geographical area of the Solapur district is 1487800 hectares with the population 3231 thousand in which 71.25 and 28.85 per cent were the rural and urban population respectively (1991). The population density was 218. The geographical area of Pandharpur and Sangola tahsils are 129400 and 159400 hectares with the population 317 and 230 thousand and population density was 243 and 149 respectively. Out of total population the percentage of rural and urban population was 74.76 and 25.24 per cent in Pandharpur and 90.87 and 9.13 per cent in Sangola tahsils respectively.(Census- 1991)

The percentage of total workers in total population was 31.74 per cent in the district, while it was 33.25 and 36.39 per cent for Pandharpur and Sangola tahsils respectively.

However, analysis further revealed that out of total workers percentage of workers engaged in agricultural and related field for the district, Pandharpur and Sangola tahsils were 82.00, 88.71 and 93.07 per cent respectively. Out of rural total workers 92.56, 92.88 and 94.97 per cent

respectively were engaged in agriculture and related fields while, 18.09, 32.82 and 69.05 for out of total urban workers respectively.

Table 4.1 General information regarding villages, population and workers in the district and selected tahsils(1991 Census)

Sr. No	Particulars	Solapur District	Per cent	Pandharpur Tahsil	Per cent	Sangola Tahsil	Per cent
1	Geographical area (ha)	1487800		129400		159400	
2	Population density	218		243		149	
3	Number of villages	1134		94		101	
4	Number of houses (000)	574		56		40	
5	Number of Families(000)	579		56		40	
6	Total Population (000)	3231		317		230	
	a. Male	1671		165		118	
	b. Female	1561		153		112	
	Rural population	2302	71 25	237	74.76	209	90.87
	Urban population	929	28.75	80	25.24	21	9.13
7	Total workers (000)	10255	31.74	1054	33 25	837	36 39
a	Agril. & other	8409	82.00	935	88 71	779	93 07
b	.Non-agril	1846	18.00	119	19 29	58	6.93
I	Rural workers(000)	8804	85 85	984	93 36	795	94 98
a	Agril. & other	8149	92 56	912	92 88	751	94 97
b	.Non-agril	655	7.44	72	7 12	44	5.53
II	Urban workers(000)	1459	14 23	68	6 26	42	5 02
a	Agril & other	264	18.09	23	32 82	29	69.05
b	Non-agril	1195	81 91	46	67.18	13	32 98

(Source: District Socio-economic Survey 2001-2002)

The literacy percentage was maximum in the district 46.24 per cent followed by Pandharpur (44.48 per cent) and Sangola tahsils (40.87per cent) but, male literacy percentage was maximum in Sangola tahsil (67.02 per cent) followed by district (64.26 per cent) and Pandharpur (63.83 per cent). It was noticed that even though the male literacy percentage was maximum in Sangola tahsil, the percentage of total rural population, total workers and workers engaged in agricultural and related field were also maximum in the same tahsil and it may be due to lack of not only industry but, also agro industry in the Sangola tahsil.

4.1.3 Climate

In Solapur district and selected tahsils, rainy season starts from the middle of June and lasts at the end of October. It is followed by winter season from November to February and hot weather from March to mid June. The average rainfall of this area is in the range of 50 to 60 cm.

During winter the atmosphere [illegible] remains generally bright and clear with moderate to less humidity (i.e. dry winter). While, it remains clear with bright and scorching sunshine with less humidity and occasionally mild dust storms and hot winds may occur during summer season in the district and selected tahsils. Within the district in the canal irrigated areas the temperature during winter, some times may falls

below 10 degree Celsius with moderate to high humidity and in such area temperature during summer rarely increases beyond 40 degree Celsius.

Agro-climatically, the entire district except Akkalkot tahsil falls in the rainfall shadow zone. The district witnesses recurrent scarcity conditions. Irrigation Commission (1962) and the Sukhathankar Committee (1973) had recognized the entire district except areas served by the protective irrigation system as a drought prone.

4.1.4 Soils

The geographical foundation of soil prevailing in Solapur district and Pandharpur, Sangola tahsils are mainly of deccan trap of volcanic origin. The solum is underline by partially decomposed basaltic rock locally known as murum. The lime reserve is fairly high (3.5 to 10 per cent). The soils in the district can be classified into 4 main categories on the basis of depth and structure as below.

1 Very shallow soils with depth below 7.5 cm.

2 Shallow soils between 7.5 to 22.5 cm

3 Medium deep soils between 22.5 to 90 cm

4 Deep soils with depth more than 90 cm

It is broadly estimated that out of the total cultivated area, very shallow soils occupy about 10 per cent of the area, shallow soils 20 per cent, 45 per cent medium soils and deep soils 25 per cent. The shallow soils in the districts and selected tahsils are light brown or grayish black, while medium to deep soils are black. In the district and selected tahsils the soils alone along with the river banks are deep but, Sangola tahsil the river banks soils are rich in lime and locally known as ''Man''.

In the district, nearly 75 per cent soils are of shallow to medium type. Hence, crops grown in the soils gives uneconomic yield under rainfed conditions and may suffer severely during the drought conditions. Most of the soils are very shallow to shallow type in Sangola tahsil as well as in most of the villages of Pandharpur tahsil which are adjoining to Sangola tahsil. These soils are very suitable for dryland horticultural crops like pomegranate, ber and which became the dominant in traditional cropping pattern of coarse cereals and pulses in this area of Solapur district.

4.1.5 Land use pattern

Land use pattern of the study area gives an idea about proportion of land under different uses. Information relating to land use pattern in the district and selected tahsils is given in Table 4.2

Table 4.2 Land utilization in Solapur district and selected tahsils for the year 1998-99

(Area *in* ha.)

Sr No	Particulars	Solapur District	Per cent	Pandharp -ur Tahsil	Per cent	Sangola Tahsil	Per cent
1	Total geographical area	1487800	100.00	129400	100 00	159400	100.00
2	Area under forest	31900	2.14	7600	5 87	700	0 44
3	Land not available for cultivation	78600	5.28	7300	5 64	14800	9.28
	a)Land under non- agriculture	15300	1 03	1300	1 00	2400	1 51
	b) Barren & uncultivable	63300	4 25	6000	4.64	12400	7 78
4	Land not under cultivation (other than permanent. fallow)	75700	5 09	3100	2 40	18000	11 29
	a. Cultivable but not in use	33600	2 26	3100	2 40	3900	2 45
	b. Permanent pasture & grazing	37900	2.55	-	-	13100	8 22
	c Land under trees, shrubs	4200	0 28	-	-	1000	0.63
5	Total cultivable land	1301600	87 53	111400	86 09	125900	78 98
6	Fallow land (current and other	232086	-	9944	-	35364	-
7	Net area sown	1069514	91 82	101456	95 17	90536	91 83
8	Area sown more than once	95243	8.18	5146	4 83	8056	8.17
9	Gross Cropped Area	1164757	100 00	106602	100 00	98592	100 00
10	Cropping intensity (Per cent)	108 91		105 07		108 9	

(Source: District Socio-economic Survey 2001-2002)

The land use pattern of study area indicated that the proportion of area under forest was to the extent of 2.14 per cent in Solapur district, while it was 5.87 and 0.44 per cent respectively in Pandharpur and Sangola tahsil. The land not available for cultivation was 5.28 per cent in the district and in Sangola tahsil it was 9.28 per cent followed by Pandharpur tahsil (5.46 per cent). Whereas land not under cultivation was to the large extent in Sangola tahsil (11.29 per cent) and it was 5.09 per cent in Solapur district and 2.04 per cent in Pandharpur tahsil. The total cultivable land was 87.53 per cent of the geographical area in the district, while it was 86 09 and 78.98 per cent in Pandharpur and Sangola tahsil respectively. The gross cropped area was 1164757 hectares in the district where net sown area was 91.82 per cent. In case of Pandharpur and Sangola tahsil GCA was 106602 and 98592 hectares respectively with net sown area of 95.17 and 91.83 per cent, respectively. The cropping intensity was low in Pandharpur compared to Sangola and district as a whole, which may be due to higher proportion of annual crops in Pandharpur tahsil.

4.1.6 Cropping Pattern

The details of cropping pattern of Solapur district, Pandharpur and Sangola tahsils for the year 2001-2002 are presented in Table 4.3

Table 4.3 Cropping pattern in Solapur district and selected tahsil for the year 1998-99

(Area in ha)

Sr. No	Particulars	Solapur District	Per cent	Pandharp -ur Tahsil	Per cent	Sangola Tahsil	Per cent
1	Jowar (Rabi)	719580	61.78	59815	56 11	68212	69 19
2	Wheat	36048	3.09	3657	3 43	1393	1 41
3	Bajra	39377	3 38	1194	1 12	10828	10 98
4	Maize	16850	1 45	4155	3 90	1950	1 98
5	Other cereals	3376	0 29	86	0.08	127	0 13
6	Total cereals	815231	69.99	68907	64 64	82510	83 69
7	Gram	30043	2 58	2386	2 24	790	0.80
8	Tur	36732	3 15	393	0 37	571	0 58
9	Other pulses	43243	3.71	1557	1 46	7029	7 13
10	Total pluses	110018	9.45	4336	4 07	8390	8 15
11	Ground nut	36735	3.15	2986	2 80	476	0 48
12	Safflower	36492	3.13	2099	1 97	336	0 34
13	Other oilseeds	65921	5.66	1426	1 34	1353	1 37
14	Total oilseeds	139148	11.95	6511	6 11	2165	2 20
15	Fibre crops	4695	0.40	916	0 86	820	0 83
16	Fruits & vegetable	29499	2.53	8287	7.77	2960	3 00
17	Sugarcane	54687	4.70	15499	14 54	1205	1 22
18	Spices &condiments	3746	0 32	392	0.37	173	0 18
19	Medicinal plants	90	0.01	30	0 03	-	-
20	Fodder crops	7522	0.65	1724	1 62	369	0 37
21	Misce non food crop	121	0 01	30	0 03	-	-
22	Net sown area	1069514	91 82	101456	95 17	90536	91 83
23	Double sown Area	95243	8 18	5146	4.83	8056	8 17
24	Gross cropped area	1164757	100.00	106602	100 00	98592	100 00
25	Cropping intensity(%)	108 91	.	105.07		108 9	

(Source: District Socio-economic Survey 2001-2002)

It was revealed that in the district as well as selected tahsils the cropping pattern was dominated by cereals and major share of the area was under rabi jowar cultivation. Next to, in the Solapur district area under oil seed crops was to the extent of 11.95per cent of the GCA followed by pulses crop 9.45 per cent and sugarcane 4.70 per cent. The proportion of area under fruits and vegetables was to the extent of 2.53 per cent in the district. In case of Pandhapur tahsil area under cereals was to the extent of 64.64 per cent followed by sugarcane 14.54 per cent, fruits and vegetables 7.77 per cent, oil seed 6.11 per cent and pulses 4.07 per cent of the GCA. Whereas, in Sangola tahsil cereal crops occupied 83.69 per cent area, next to cereals and pulses crops were to the extent of 8.15 per cent followed by fruits and vegetables (3 per cent). From the above it can be revealed that in Pandhapur tahsil sugarcane, fruits and vegetables, were the major annual crops grown on area of 22.30 per cent of GCA. While in Sangola tahsil next to cereal and pulses fruits and vegetables were grown on considerable area. The grapes, pomegranate, ber were the major fruits grown in the selected tahsils.

4.2 Socio-economic features of the sample pomegranate growers

4.2.1 Family size

The average family size and occupation wise distribution of the sample farms using surface and drip irrigation for pomegranate cultivation is presented in Table 4.4

The average family size at the overall level was 5.45 and 5.98 members respectively on the farms growing pomegranate under surface and drip irrigation system. The family was in increasing trend on drip irrigated pomegranate farms. The proportion of male was higher in the surface irrigated pomegranate farms, while reverse was the case with drip irrigated pomegranate farms, with an exception of large size groups.

Table 4.4 Family size of sample farms with surface and drip irrigation

(No)

Particulars	Surface Irrigation farms				Drip Irrigation farms			
	Small	Medium	Large	Overall	Small	Medium	Large	Overall
Family size								
Male	1.50	1 65	2 05	1.73	1 85	1 90	2 00	1 92
	(29.41)	(29.20)	(36.61)	(31 80)	(33.94)	(30.65)	(31 75)	(32 03)
Female	1 35	1.55	1.85	1 58	1 95	2.00	1 90	1.95
	(26 47)	(27 43)	(33 04)	(29 05)	(35.78)	(32 26)	(30 16)	(32 59)
Children	2 25	2.45	1.70	2 13	1 65	2 30	2.40	2 12
	(44 12)	(43.36)	(30 36)	(39 14)	(30 28)	(37 10)	(38 10)	(35 38)
Total	**5.10**	**5.65**	**5.60**	**5.45**	**5.45**	**6.20**	**6.30**	**5.98**
	(100.00)	**(100.00)**	**(100.00)**	**(100.00)**	**(100.00)**	**(100.00)**	**(100.00)**	**(100.00)**

(Figures in parentheses indicate percentages to the total)

4.2.2 Average land use pattern of sample farms

The average land use pattern of sample farms is presented in Table 4.5

Table 4.5 Average size of holding on sample farms with surface and drip irrigation

(ha /farm)

Particulars	Surface Irrigation farms				Drip Irrigation farms			
	Small	Medium	Large	Overall	Small	Medium	Large	Overall
Total Holding	**1.24**	**2.75**	**4.92**	**2.97**	**1.31**	**3.04**	**4.91**	**3.08**
	(100 00)	(100 00)	(100.00)	(100 00)	(100 00)	(100.00)	(100 00)	(100 00)
Permanent Fallow	0.05	0.05	0.13	0 08	0.13	0.25	0 26	0 21
	(4.03)	(1 82)	(2.64)	(2 69)	(9 92)	(8.22)	(5 30)	(6 82)
Cultivable land								
1.Rainfed	0 56	1 30	2.41	1.42	0 31	0 80	1 44	0 85
	(45 16)	(47 27)	(48.98)	(47.81)	(23.66)	(26 32)	(29 33)	(27 60)
2 Irrigated	0 63	1 40	2.38	1 47	0 87	1 99	3 21	2 02
	(50 81)	(50 91)	(48.37)	(49.49)	(66.41)	(65 46)	(65 38)	(65 58)
Net sown area	1 19	2 70	4.79	2 89	1 18	2 79	4 65	2 87
	(78 81)	(91 53)	(87.25)	(87 84)	(62 77)	(55 69)	(70 78)	(64 06)
Double cropped area	0 32	0 25	0.70	0 40	0 70	2 22	1 92	1 61
	(21.19)	(8 47)	(12 75)	(12.15)	(37.23)	(44 31)	(29 22)	(35 93)
Gross cropped area	1 51	2 95	5 49	3 29	1.88	5 01	6 57	4 48
	(100 00)	(100 00)	(100.00)	(100.00)	(100 00)	(100 00)	(100 00)	(100 00)
Cropping intensity	126 89	109 26	114 61	113.84	159 32	179 57	141 29	156 10

(Figures in parentheses indicates percentages to the total)

The land use pattern of the sample farms was studied so as to understand the efficiency of sample farms in utilization of land resources. It

was observed that average size of holding was 3.08 hectares of drip irrigated pomegranate farms and 2.97 hectares of surface irrigated pomegranate farms. The proportion of permanent fallow land was more in the former compared to later. The proportion of irrigatable cultivable land was more on drip irrigated pomegranate farms, as a result double cropping was more on these farms. The average GCA was 3.29 hectares on surface irrigated pomegranate farms and it was 4.48 hectares drip irrigated pomegranate farms. The intensity of cropping was to the extent of 156.10 per cent at the overall level on drip irrigated farms and it was 113.84 per cent on surface irrigated farms. From the above it can be concluded that the drip irrigated pomegranate cultivating farms were found to be more intensive than surface irrigated pomegranate farms.

4.2.3 Average per farm investment in assets

The details of average per farm investment made for land building,implements,machinery and livestock are presented in Table 4.6

Average per farm investment on capital assets was more on the drip irrigated pomegranate farms (Rs.581757) compared to surface irrigated pomegranate farms (Rs.514269). The investment on capital assets was in increasing trend with increasing size of holding on both types of irrigated

farms. The land cost was major item of investment followed by machinery, farm building, irrigation structure, livestock and storages structure and cattle

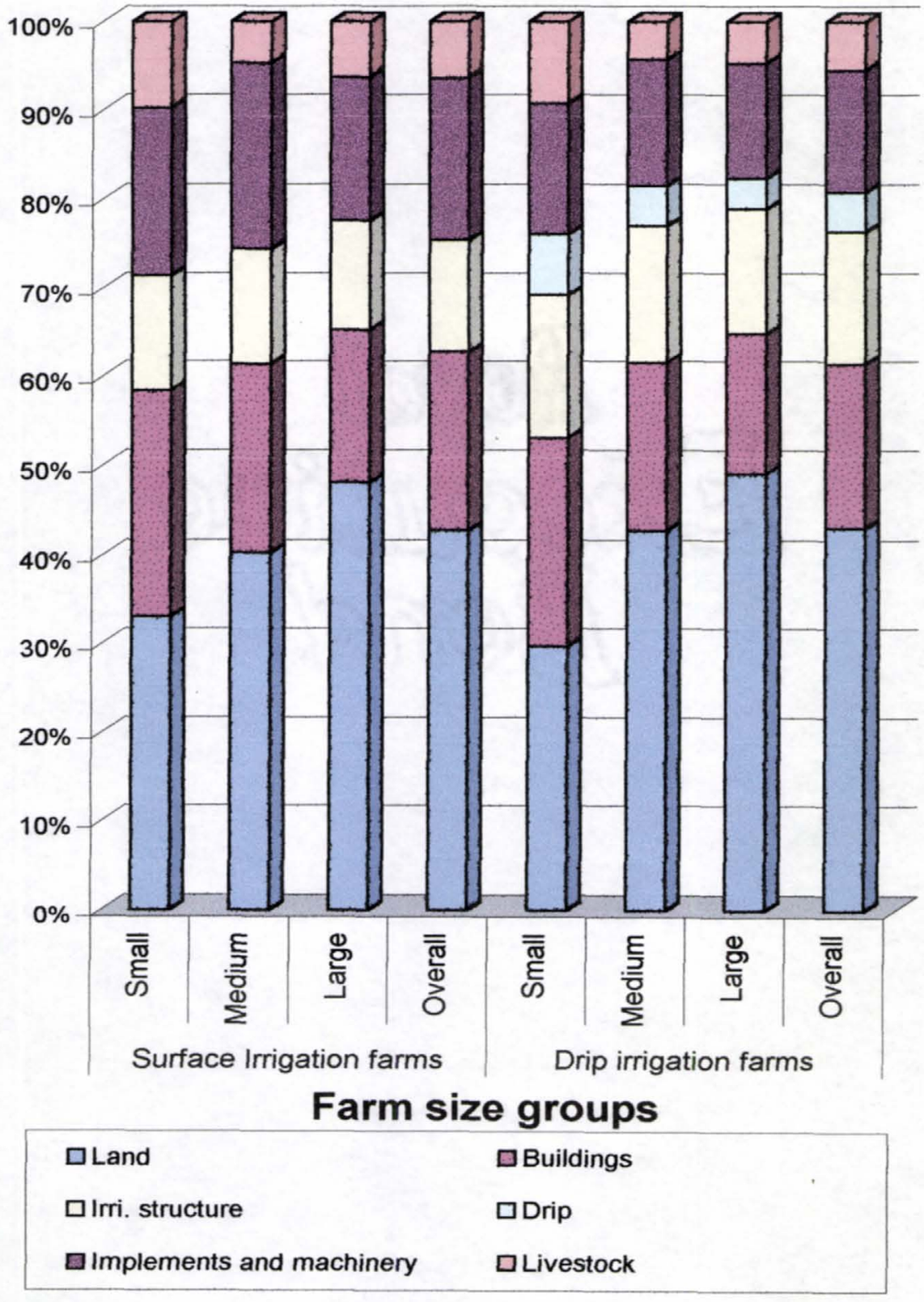
Table 4.6 Average per farm investment on capital assets on sample farms

(Rs./farm)

Assets	Surface Irrigation farms				Drip irrigation farms			
	Small	Medium	Large	Overall	Small	Medium	Large	Overall
Land	92610.00	206645 00	360745.00	220000.00	104425.00	246965.00	401765.00	251051 67
	(33 05)	(40.29)	(48.12)	(42.78)	(29.73)	(42.82)	(49 16)	(43 15)
Farm building	50800 00	73500 00	86500.00	70266 67	60350 00	83250.00	96500 00	80033 33
	(18.13)	(14.33)	(11.54)	(13.66)	(17.18)	(14.44)	(11 81)	(13 76)
Storage structure	12700.00	25162.50	28250 00	22037.50	12300.00	18550.00	24562.50	18470.83
	(4.53)	(4.91)	(3.77)	(4.29)	(3.50)	(3.22)	(3.01)	(3.18)
Cattle shed	7750.00	9790.00	14460.00	10666.67	9710.00	6575.00	7750.00	8011.67
	(2.77)	(1.91)	(1.93)	(2.07)	(2.76)	(1.14)	(0.95)	(1 38)
Irri. structure	36472.50	67110 00	92375.00	65319.17	56612 50	89150 00	115250.00	87004 17
	(13.01)	(13.09)	(12 32)	(12.70)	(16.12)	(15.460	(14.10)	(14 96)
Drip	0 00	0.00	0.00	0 00	24046.10	26092.10	27774.60	25970 93
	-	-	-	-	(6.85)	(4.52)	(3.40)	(4 46)
Implements	1669.25	5502.50	7323.00	4831 58	2183.50	7449.50	6530 00	5387.67
	(0.60)	(1.07)	(0.98)	(0.94)	(0.62)	(1.29)	(0.80)	(0.93)
Machinery	50800.00	100650.00	113000.00	88150 00	49200.00	73950.00	98250.00	73800 00
	(18.13)	(19.63)	(15.07)	(17.14)	(14 01)	(12.82)	(12 02)	(12 69)
Livestock	27435.00	24485 00	47073.00	32997.67	32455.00	24740.00	38885.00	32026.67
	(9.79)	(4 77)	(6 28)	(6.42)	(9.24)	(4.29)	(4 76)	(5 51)
Total	280236.75	512845.00	749726 00	514269 25	351282 10	576721 60	817267 10	581756 93
	(100 00)	(100.00)	(100.00)	(100 00)	(100.00)	(100 00)	(100.00)	(100 00)

(Figures in parentheses indicate percentages to the total)

Fig.1 Distribution of capital investment on farmsize groups with surface and drip irrigation



structure on the surface irrigated farms. Whereas, drip irrigated pomegranate farms land cost was the major item followed by drip irrigation structure, farm building, machinery, livestock, drip system and storage structure. The proportion of investment in drip irrigation structure was more on the small farms followed by medium and large farms. By and large, investment on irrigation structure was observed on both types of farms and it was in the range of 12 to 16 per cent of the total investment. The investment on drip unit was in the range 3.40 to 6.85 per cent of the total investment on drip irrigated pomegranate farms.

4.2.4 Cropping pattern

The cropping pattern focuses on nature of farming. The nature of cropping pattern indicates the economic condition of the cultivator. The information regarding the area under different crops of the sample farms is shown in Table 4.7

From the cropping pattern of the sample farms given in table 4.7 it was observed that on the sample farms cereal crops were grown on 38.39 per cent area of GCA fallowed by pluses (18.30 per cent), pomegranate (17.19 per cent) and sunflower (8.48 per cent) in case of drip irrigated pomegranate farm at the overall level. Among the size groups on

specific trend was noticed in case of proportion of area under various crops. However the proportion of area under pomegranate crop was highest (32.45 per cent) on small drip irrigated pomegranate farms followed by medium and large drip irrigated pomegranate farms. In case of surface irrigated farms

Table 4.7 Cropping pattern of surface and drip irrigation adopting sample farms (ha.)

Crops		Surface Irrigation farms				Drip Irrigation farms			
		Small	Medium	Large	Overall	Small	Medium	Large	Overall
Cereals		0 60	1.19	2.31	1.36	0.49	2.02	2.65	1.72
		(39.74)	(40 34)	(42.08)	(41.34)	(26.06)	(40.32)	(40.33)	(38.39)
Pulses		0.43	0.61	0.74	0.59	0.32	1.11	1 05	0.82
		(28.48)	(20.68)	(13.48)	(17.93)	(17 02)	(22.16)	(15.98)	(18.30)
Sunflower	Dry	0.12	0.12	0.31	0.18	0.30	0.40	0.45	0.38
		(7.95)	(4.07)	(5.65)	(5.47)	(15.96)	(7.98)	(6.85)	(8.48)
Sugarcane	Irri	0.02	0.11	0.28	0.14	-	0.12	0.27	0 13
		(1.32)	(3.73)	(5.10)	(4.26)	(0.00)	(2.40)	(4.11)	(2.90)
Vegetable	Irri	0.07	0.09	0.22	0.13	0.02	0 05	0.35	0.14
		(4.64)	(3.05)	(4.01)	(3 95)	(1 06)	(1.00)	(5.33)	(3.13)
Onion	Irri	0.02	0.14	0.21	0.12	0.04	0.11	0.14	0.10
		(1.32)	(4 75)	(3.83)	(3.65)	(2.13)	(2 20)	(2.13)	(2 23)
Pomegranate	Irri	0.13	0 31	0.66	0.37	0.61	0.81	0.90	0 77
		(8.61)	(10.51)	(12.02)	(11.25)	(32.45)	(16.17)	(13.70)	(17.19)
Ber	Irri	0.02	0.03	0.07	0.04	0.01	0.12	0.19	0.11
		(1.32)	(1.02)	(1.28)	(1.22)	(0.53)	(2.40)	(2.89)	(2.46)
Grape	Irri	0.01	0.06	0.18	0.08	0.03	0.03	0.06	0.04
		(0.66)	(2.03)	(3.28)	(2.43)	(1.60)	(0.60)	(0.91)	(0.89)
Fodder	Irri	0.05	0.12	0.21	0 12	0.02	0 08	0.05	0.05
		(3 31)	(4.07)	(3.83)	(3 65)	(1.06)	(1 60)	(0.76)	(1.12)
Other crop	Irri	0.02	0.09	0.20	0.10	-	0 06	0 17	0.08
		(1 32)	(3.05)	(3.64)	(3.04)	(0.00)	(1 20)	(2.59)	(1.79)
Gross Cropped area		1.51	2.95	5 49	3 29	1.88	5.01	6.57	4 48
		(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)

(Figures in parentheses indicate· percentages to the total)

cereals occupied 41 34 per cent area at the overall level, followed by pluses (17.93 per cent) pomegranate (11.25 per cent) and sunflowers (5.47 per cent). The proportion of area under other cash crops was more under surface irrigated farms compared to drip irrigated farms. From the above it can be revealed that the pomegranate farmers under drip irrigated system were more diversified compared to surface irrigated farms. This may be because of more availability of water for irrigation due to adoption of drip irrigated system.

RESULTS AND DISCUSSION

5. RESULTS AND DISCUSSION

The present study aims at finding out economic efficiency of drip irrigation in pomegranate production in the area of Solapur district. The drip irrigation technology has been introduced in the area mainly to irrigate commercial crops like pomegranate and other fruit crops. Prior to the adoption of drip irrigation, the farmers used to irrigate pomegranate crop by surface irrigation method. The installation of drip irrigation unit requires additional capital investment. At the same time, the farmers use to follow improved methods of cultural practices for pomegranate and other crops. It was experienced that there was water and labour saving on account of adoption of drip irrigation technology. Obviously, there was change in costs and returns structure of pomegranate and other crops to a greater extent as a result of adoption of this new technology.

In the present chapter, efforts are made to delineate in details all the changes resulting from use of drip irrigation system for pomegranate cultivation. Mostly, the surface and drip irrigation approaches have been adopted in the analysis in order to find out economic efficiency of drip irrigation in pomegranate cultivation in the study area.

5.1 Investment in irrigation structure

It is said that improved technology require high investment. The improved technology has potential to get comparatively more returns. The irrigation technology involves more investment. Recently the pomegranate fruit crop was cultivated by various categories of farmers with flood irrigation method since last decade. However, due to scarcity of irrigation water, the technology of drip irrigation system was adopted by the pomegranate growers. In order to know investment in drip irrigation in pomegranate, the following estimates were made.

1) Average per farm investment in irrigation structure
2) Average per hectare investment made for irrigation structure in drip irrigation method.

5.1.1 Average per farm investment in irrigation structure

The irrigation structure includes well, electric motor, pipe line and drip set for the sample farms. The details of average per farm investment made for irrigation structure in surface irrigation method and drip irrigation method are presented in Table 5.1

The total investment made in irrigation structure for surface irrigation for pomegranate farm was Rs.65319.17 and for drip irrigation was

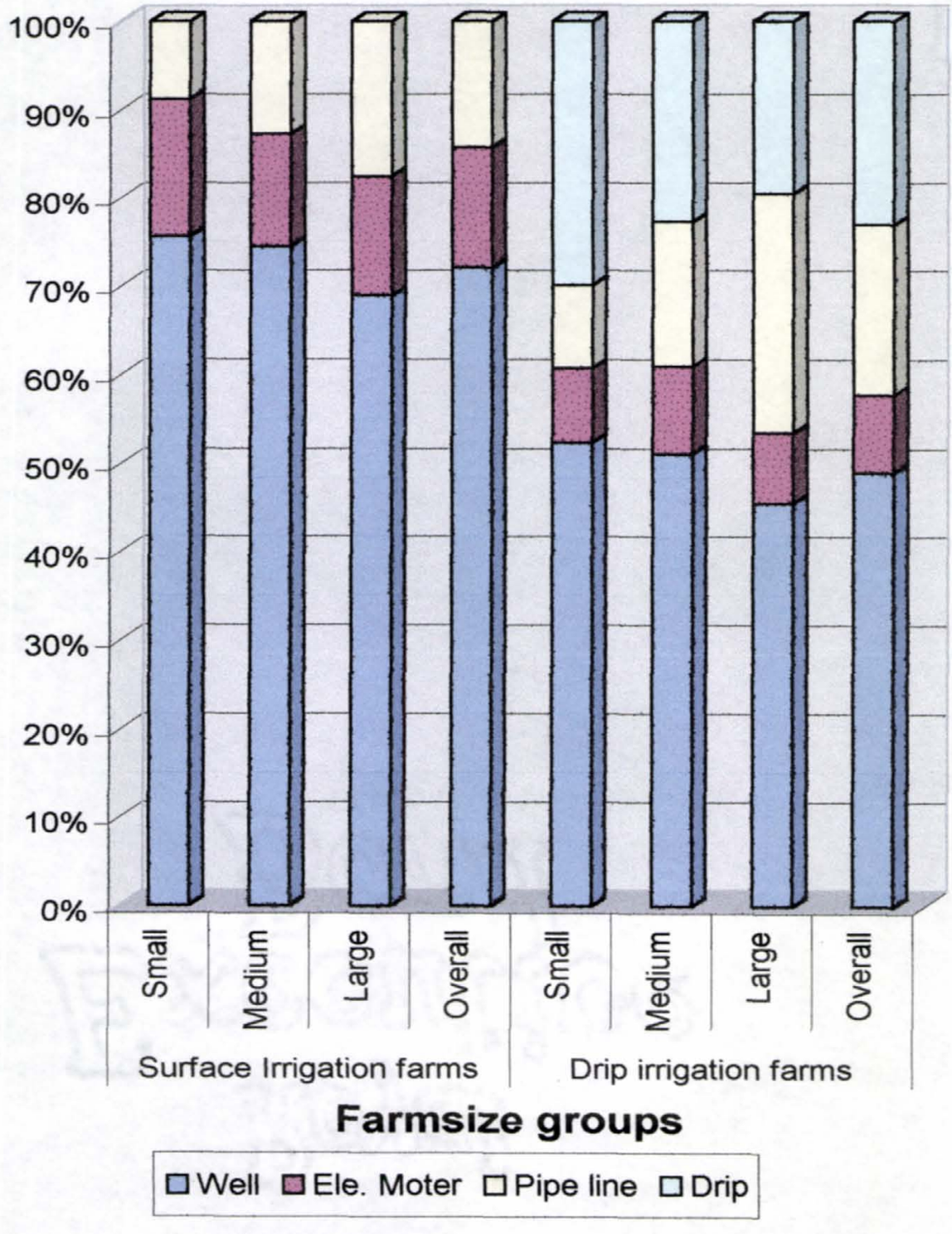
Table 5 1 Per farm investment in irrigation structure on sample farms (Rs /farm)

Irrigation structure	Surface Irrigation farms				Drip irrigation farms			
	Small	Medium	Large	Overall	Small	Medium	Large	Overall
Well	27575 00	50000 00	63750.00	47108.33	42325 00	59000 00	65250.00	55525 00
	(75.60)	(74.50)	(69.01)	(72.12)	(52.47)	(51.20)	(45.62)	(49.15)
Eel Moter	5690 00	8610 00	12525 00	8941 67	6725 00	11325 00	11450.00	9833 33
	(15.60)	(12.83)	(13 56)	(13.69)	(8.34)	(9 83)	(8.01)	(8.70)
Pipe line	3207.50	8500.00	16100 00	9269 17	7562.50	18825 00	38550.00	21645 83
	(8.79)	(12.67)	(17.43)	(14 19)	(9.38)	(16.34)	(26.95)	(19.16)
Drip	00	00	00	00	24046.10	26092 10	27774.60	25970.93
	00	00	00	00	(29.81)	(22.64)	(19.42)	(22.99)
Total	36472.50	67110.00	92375 00	65319.17	80658.60	115242 10	143024 60	112975.10
	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)

(Figures in parentheses indicate the percentages to the total).

Rs.112975.10 at the overall level. Out of total cost, the cost of well was 72.12 per cent and 49.15 per cent for surface and drip irrigation system, respectively. This was followed by drip component with 22.99 per cent share and then pipe line having 19.16 per cent of total irrigation investment for drip irrigated farms. Whereas, pipe line sharing 14.19 per cent cost of total and electric motor (13.69 per cent) were major items of cost for surface irrigated farms. The investment on drip irrigation was 72.95 per cent more than surface method at the overall level. Among the size groups per farm

Fig. 2 Farmsize groupwise distribution of investment in irrigation for surface and drip system



investment in irrigation indicate increasing trend with increase in size of holding. This indicated that large size holders invested to large extent.

5.1.2 Average per hectare investment made for irrigation structure in drip irrigation method.

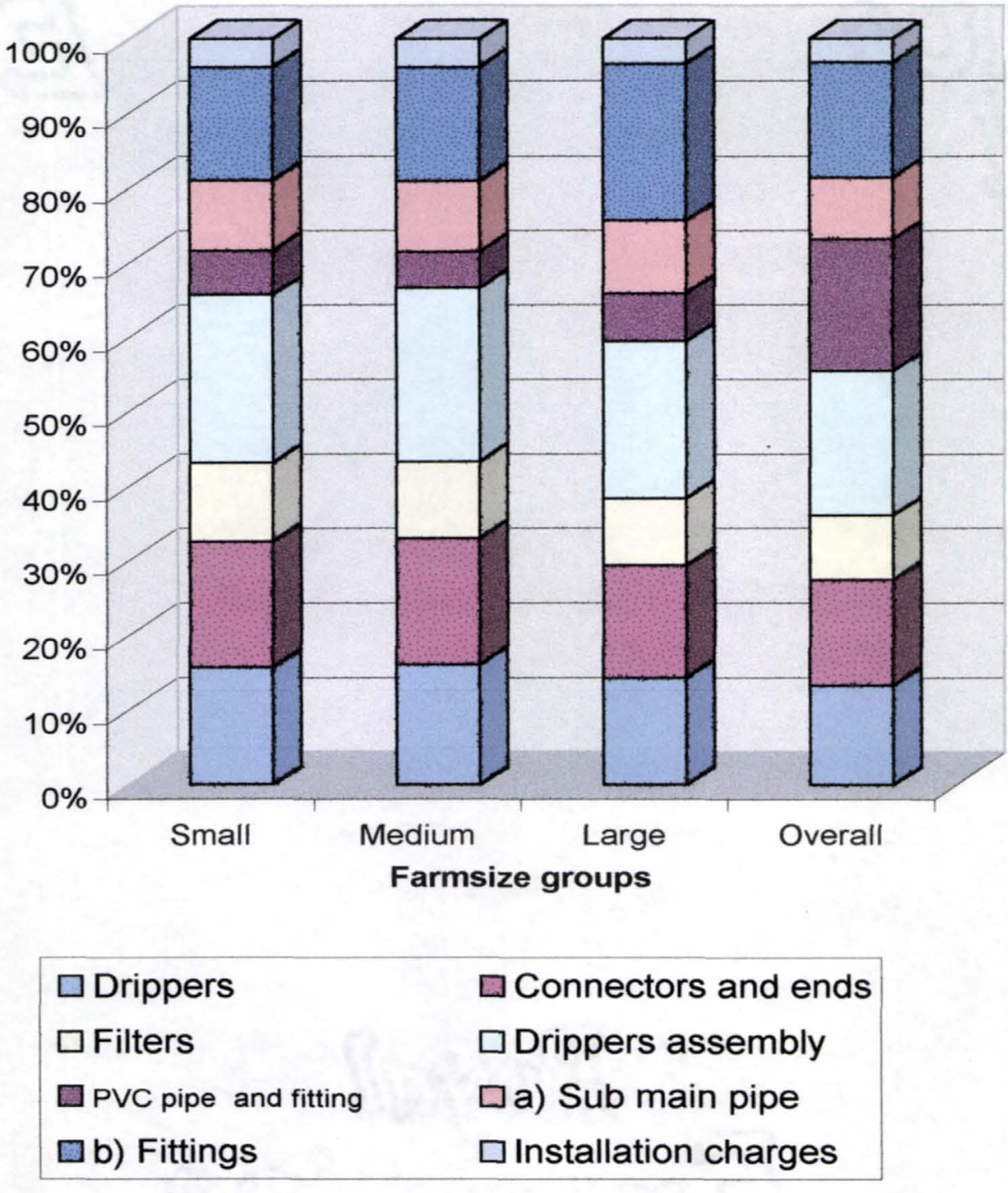
The major components of the drip irrigation unit are the main pipe line, sub-main pipe, lateral pipe line, drippers, screen filters and PVC

Table 5.2 Average per hectare cost of installation of drip irrigation system

(Rs./ha.)

Particulars	Drip adopting farms							
	Small	Per cent	Medium	Per cent	Large	Per cent	Overall	Per cent
Av No, of plants	750		750		750		750	
Drippers	4966 72	15.71	5027.95	16.07	5029.61	14.31	5012.39	15.38
Start connectors	4802 13	15.19	4791.93	15.32	4787.71	13.62	4792.99	14.71
Strait connectors	457.97	1.45	444.10	1.42	436.31	1.24	444.75	1.36
Ends	79.19	0.25	81.18	0.26	77.68	0.22	79.30	0.24
Screen filters	90.35	0.29	88.93	0.28	87.33	0.25	88.69	0.27
Sand filters	3262 71	10.32	3124.22	9.99	3096.09	8.81	3149.97	9.67
Drippers assembly	7101.06	22.47	7294.41	23.32	7387.15	21.02	7279.17	22.34
PVC pipe and fitting	1881.97	5.95	1514.60	4.84	2245.25	6.39	1641.93	5.04
a) Sub main pipe	2978.99	9.42	2972.05	9.50	3449.16	9.81	3133.40	9.61
b) **Fittings**	4788.63	15.15	4765.84	15.23	7374.30	20.98	5781.85	17.74
Sub total	30409 73	96.21	30105.20	96.23	33970.60	96.64	31404.44	96.36
Installation charges	1199 18	3.79	1180.75	3.77	1179.89	3.36	1185.29	3.64
Total	31608 91	100.00	31285.95	100.00	35150.49	100.00	32589.74	100.00

Fig. 3 Farmsize groupwise investment in components of drip irrigation system



accessories etc. The details of capital investment for the drip irrigation unit are presented in Table 5.2.

The average per hectare total capital investment for the drip irrigation unit was Rs.37589.74 of which dripper assembly constituted 22.34 per cent followed by PVC pipe and fitting (5.04 per cent), fittings (17.74 per cent), dripper (15.38 per cent). Start connectors and sand filters were the other important components of drip irrigation system contributing 14.71 per cent and 1.36 per cent of total cost, respectively. The average per hectare investment among the size groups, was ranged from Rs.31608 to Rs.35150. This has indicated that all size categories have invested in drip irrigation to considerable extent.

5.2 Costs and Returns

The costs and returns under surface and drip system irrigation may vary due to various factors. The estimates of costs and returns form pomegranate were made on 1) Cost on establishment and 2) Cost of cultivation. The latter estimates were further calculated so as to understand the differences in labour and input levels under drip and surface irrigation systems. This was facilitated to indicate saving in labour and input use due to drip irrigation system. Therefore costs and returns were worked out

1) Cost of establishment of pomegranate.

2) Cost of cultivation of pomegranate by surface and drip irrigation

3) Per hectare yield /returns.

5.2.1 Cost of establishment of Pomegranate :

The magnitude and structure of cost of establishment of pomegranate crop under surface irrigation and drip irrigation method varied in accordance with the differentials in use levels of various inputs for cultivating crop. The per hectare cost of establishment of pomegranate grown under different methods of irrigation is composed of expenses incurred on various items such as preparation of land, digging and filling of pits planting material for planting in first year and for gap filling, installation of drip sets, pruning and training only for second year. The items like manuring, fertilizers, irrigation layout and irrigation, interculturing, spraying supervision and watching and imputed costs like interest on working capital, interest on fixed capital, depreciation and repairs, rental value of land were the items of costs had to be incurred for both the years. Itemwise per hectare establishment cost (includes both material as well as labour cost) for both the years and for different size groups of holding and at the overall level, for surface irrigation and drip irrigation is given in Table 5.3

Table 5.3 : Per hectare cost of establishment of pomegranate orchard

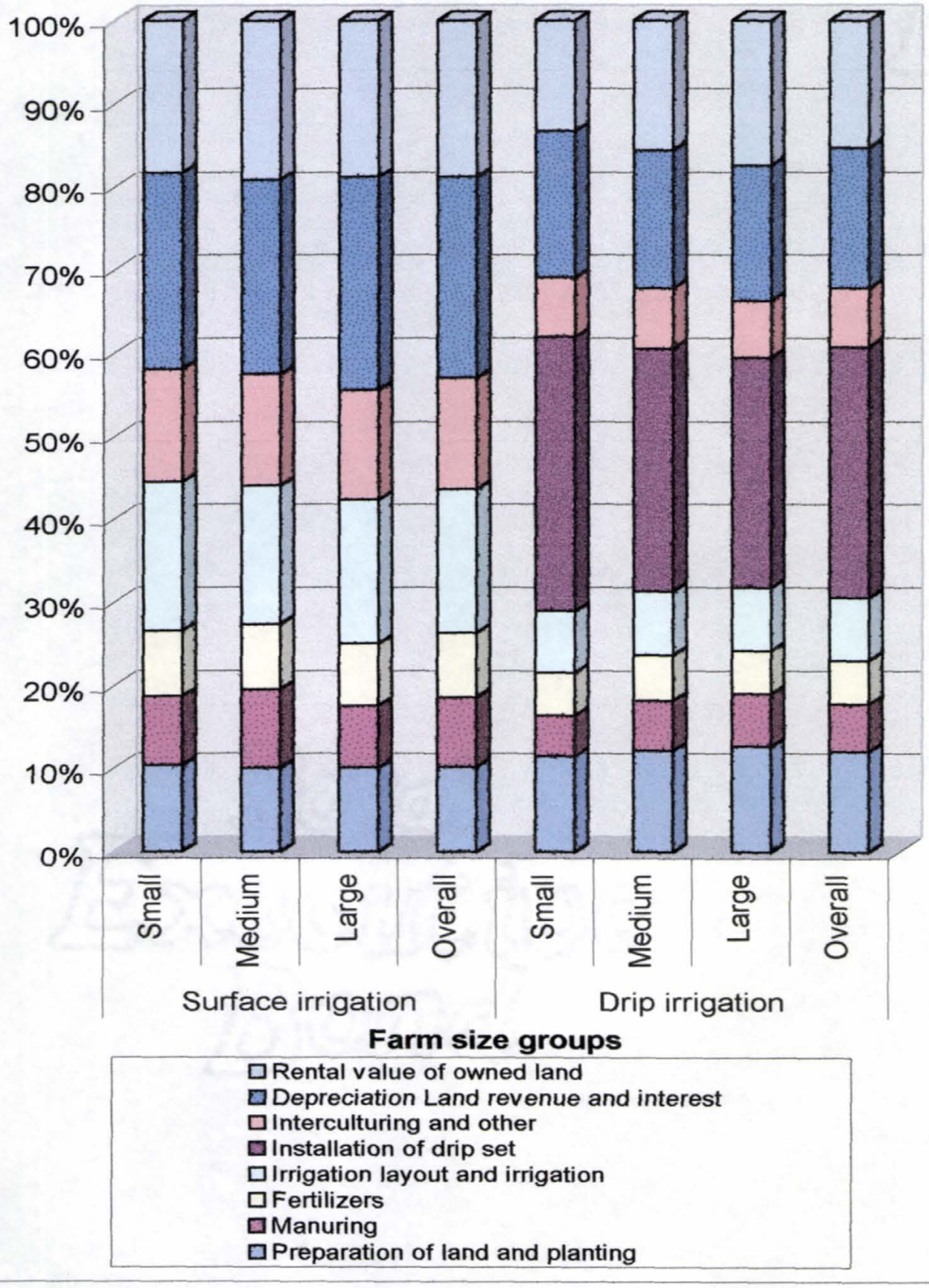
(Rs /Ha)

Particulars	Surface irrigation			
	Small	Medium	Large	Overall
Preparation of land	316 25 (0 47)	389 80 (0 53)	327 19 (0 47)	344 41 (0 49)
Layout, digging & filling of pits	3286 90 (4 89)	3426 75 (4.69)	3472 18 (4 96)	3395 28 (4.84)
Seeding and planting	3190 78 (4 74)	3380.40 (4.62)	3093 64 (4 42)	3221 61 (4 60)
Gap filling	140 86 (0 21)	155.45 (0 21)	140 86 (0 20)	145 72 (0 21)
Manuring	5684 72 (8 45)	6981.63 (9 55)	5294 44 (7 57)	5986 93 (8 54)
Fertilizers	5274 89 (7 84)	5708.01 (7 80)	5214.35 (7 46)	5399 08 (7 70)
Irrigation layout & irrigation	12008 47 (17 86)	12167 36 (16 64)	12038 34 (17 21)	12071 39 (17 22)
Installation of drip set	0 00	0.00	0 00	0 00
Interculturing	6669 06 (9 92)	7049.41 (9 64)	7318 46 (10 46)	7012 31 (10.00)
Prunning and training	224.35 (0 33)	211 60 (0 29)	174 88 (0.25)	203 61 (0.29)
Sparying	909 90 (1.35)	1044.82 (1 43)	894 83 (1.28)	949.85 (1 35)
Supervision and watching	740.05 (1 10)	894 85 (1 22)	311.70 (0.45)	648 87 (0 93)
Other	603.39 (0 90)	671 09 (0 92)	608.39 (0.87)	627 63 (0 90)
Working capital	39049.62 (58 07)	42081 16 (57 54)	38889.25 (55 60)	40006 68 (57 06)
Interest on working capital	5076.45 (7 55)	5470.55 (7.48)	5055 60 (7.23)	5200 87 (7 42)
Land revenue	77 04 (0.11)	80 24 (0 11)	84 76 (0 12)	80 68 (0 12)
Depreciation and repairs	7547.30 (11 22)	5062 54 (6.92)	3417 90 (4.89)	5342 58 (7 62)
Interest on fixed capital	3230 66 (4 80)	6435 38 (8 80)	9352 54 (13.37)	6339 53 (9 04)
Rental value of owned land	12266 22 (18 24)	14009 82 (19 15)	13141 90 (18 79)	13139 31 (18 74)
Total cost	67247 29 (100 00)	73139 70 (100.00)	69941 96 (100 00)	70109 65 (100 00)
Annualised cst cost	4483 15	4875 98	4662 80	4673 98

Particulars	Drip irrigation			
	Small	Medium	Large	Overall
Preparation of land	2570 37 (2 52)	2451 32 (2 71)	1597 85 (1 90)	2206 51 (2 39)
Layout, digging & filling of pits	4703 88 (4 61)	4461 46 (4 93)	4733 05 (5 62)	4632 80 (5 02)
Seeding and planting	4197 97 (4.11)	3944 40 (4.36)	4211 48 (5 00)	4117 95 (4 47)
Gap filling	257 99 (0 25)	162 82 (0 18)	123 23 (0 15)	181 35 (0 20)
Manuring	5034.85 (4 93)	5502 91 (6 08)	5406 97 (6 42)	5314 91 (5 76)
Fertilizers	5277 51 (5 17)	4919 16 (5 44)	4322 55 (5.14)	4839 74 (5 25)
Irrigation layout & irrign	7494 56 (7.34)	6914 06 (7.64)	6338 92 (7 53)	6915 85 (7 50)
Installation of drip set	33701.88 (33.03)	26457.27 (29 24)	23336 83 (27.73)	27831 99 (30 18)
Interculturing	3167.10 (3.10)	2971 75 (3 28)	2549.97 (3 03)	2896 27 (3 14)
Prunning and training	355.36 (0.35)	420.38 (0.46)	310.20 (0.37)	361 98 (0 39)
Sparying	2687.16 (2.63)	2513 51 (2.78)	2493 55 (2.96)	2564.74 (2.78)
Supervision and watching	791.32 (0 78)	429.27 (0.47)	271.68 (0.32)	497 42 (0.54)
Other	297.60 (0.29)	214.83 (0.24)	123 43 (0.15)	211 95 (0 23)
Working capital	70537.55 (69 13)	61363.14 (67.82)	55819.71 (66.32)	62573.47 (67 85)
Interest on working capital	9169 88 (8.99)	7977 21 (8.82)	7256 56 (8.56)	8134 55 (8 82)
Land revenue	74 48 (0.07)	78 92 (0.09)	88.26 (0 10)	80 55 (0 09)
Depreciation and repairs	4522.63 (4.43)	3513 35 (3 88)	3226.33 (3.83)	3754 10 (4 07)
Interest on fixed capital	4224 78 (4.14)	3520 10 (3.89)	3165.58 (3.76)	3636 82 (3 94)
Rental value of owned land	13510 (13.24)	14026 (15.50)	14606 (17.35)	14047 33 (15 23)
Total cost	102038 86 (100.00)	90478.72 (100.00)	84162 44 (100.00)	92226.67 (100.00)
Annualised est. cost	6802 62	6031.91	5610,83	6148 45

(Figures in parentheses indicate the percentages to the total)

Fig. 4 Distribution of items of establishment cost of pomegranate with surface and drip irrigation



It is revealed that at the overall level average per hectare total cost of establishment was Rs.70109.65 for surface irrigated pomegranate farms and Rs.92226.67 for drip irrigated pomegranate farms. In the total establishment cost the maximum share was contributed by installation of drip set 30.18 per cent followed by rental value of land 15.23 per cent on drip irrigated pomegranate farms. In case of surface irrigated pomegranate farms rental value of land was the major item (18.74 per cent) followed by irrigation layout and irrigation 17.22 per cent and interculturing 10.00 per cent.

The total cost of establishment was distributed over economic life period of pomegranate i.e.15 years. Thus the per hectare annualized establishment cost of pomegranate orchard was Rs.4673.98 for surface irrigation method and Rs.6148.45 for drip irrigation method. The farm size groups showed variation in the cost of establishment of pomegranate. The highest costs was required on small size farms Rs.102038.86 for drip irrigation methods followed by medium Rs.90478.72 and large size farm Rs.84162.44. Thus the decreasing trend of establishment cost was noticed. While there was no any trend in case of surface irrigated farm. The medium size farms required the largest cost Rs.73139.70 followed by large size farm Rs.69941.96 and small farms Rs.67247.29. The annualized establishment

cost ranged from Rs.4483.15 (small) to Rs.4875.98 (medium) for surface irrigated farms and from Rs.5610.83 (large) to Rs.6802.62 (small) in case of drip irrigated farms. The pattern of itemwise share in cost of establishment of pomegranate garden among size groups was similar to the overall level

The average per hectare establishment cost of pomegranate garden under drip irrigation system was 31.54 per cent higher at the overall level, over surface irrigation, and it was 51.73, 23.70 and 20.33 per cent higher in small, medium and large size farms. From the above it can said that there was no much expenditure required for installation of drip irrigation system, since additional cost on installation of drip was compensated by saving in expenses on irrigation layout and irrigation as well as interculturing.

5.2.2 Cost of cultivation of pomegranate by surface and drip irrigation.

The cost of cultivation of pomegranate was estimated by following standard cost concepts. An attempt was made to ascertain to whether drip irrigation system help to save labour requirement and expenses on labour and material inputs. In view of this comparative estimates of labour and material inputs between surface and drip irrigation systems are indicated below.

a) Per hectare operationwise labour use

b) Per hectare family and hire labour use

c) Per hectare cost of cultivation

d) Per hectare yield and returns

a) Operationwise per hectare labour use for surface and drip irrigation.

Operationwise per hectare total human labour, bullock labour and machinery labour required for cultivation of pomegranate in different size groups with surface irrigation and drip irrigation are presented in Table 5.4

It can be revealed from the table that at the overall level, the total human labour required in mandays were 383.25 for surface irrigation and 327.23 for drip irrigation. Operationwise human labour use in case of surface irrigation was highest for interculturing (27.49 per cent) followed by harvesting (18.66 per cent), irrigation (16.66 per cent), management (16.27 per cent), plant protection (9.79 per cent), manuring (5.60 per cent) and fertilizer application (5.53 per cent). In case of drip irrigation the operationwise labour use was highest for interculturing (22.16 per cent) followed by harvesting (20.12 per cent) management (15.02 per cent),

Table 5.4 Operation wise human, bullock and machine labour use in pomegranate cultivation with Surface and drip irrigation

(Mandays/ha)

Farm	Surface irrigation				Drip irrigation			
Operation	Small	Medium	Large	Overall	Small	Medium	Large	Overall
Interculturing	128 36	102 94	101 71	105.37	69.44	75 31	72 14	72.53
	(29 30)	(28.65)	(26 55)	(27 49)	(20 48)	(22.27)	(23 32)	(22.16)
Manuring	29 53	25 00	18.14	21.48	34.82	42 69	30.68	35.96
	(6 74)	(6.96)	(4.74)	(5.60)	(10 27)	(12.62)	(9.92)	(10.99)
Fert. Application	42 55	22.18	16.27	21.19	35.94	30.28	24 20	29.42
	(9 71)	(6 17)	(4.25)	(5 53)	(10.60)	(8.96)	(7.82)	(8.99)
Irrigation	69 82	50.56	68.85	63.85	47.91	38 82	42.79	42.76
	(15 93)	(14.07)	(17.97)	(16.66)	(14 13)	(11 48)	(13.83)	(13.07)
Plant Protection	37.82	31.29	40 36	37.51	32 13	31 30	31.40	31.56
	(8 63)	(8.71)	(10.54)	(9 79)	(9.48)	(9.26)	(10.15)	(9.64)
Harvesting	62 82	51.07	82.95	71.51	73 78	62 30	63 58	65.83
	(14.34)	(14.21)	(21.65)	(18.66)	(21.76)	(18 43)	(20 55)	(20.12)
Management	67.27	76.29	54 76	62.35	45.04	57 41	44.55	49.16
	(15.35)	(21.23)	(14.30)	(16.27)	(13.28)	(16.98)	(14.40)	(15.02)
Total Human	438 17	359 33	383.05	383.25	339.08	338.11	309.35	327.23
	(100 00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)
Bullock labour								
Interculturing	7.64	3.87	4.05	4.44	6.74	6.56	6.30	6.51
	(58.33)	(44.44)	(64 00)	(56.73)	(94.28)	(98 14)	(96.57)	(96 47)
Manuring	5 45	4.84	2 28	3 39	0.41	0.12	0 22	0.24
	(41.67)	(55.56)	(36.00)	(43.27)	(5.72)	(1.86)	(3.43)	(3.53)
Total Bullock	13 09	8 71	6.32	7 83	7.15	6 68	6 52	6.75
	(100.00)	(100.00)	(100 00)	(100.00)	(100.00)	(100.00)	(100.00)	(100 00)
Machine labour Tractor								
Interculturing	1.05	0 95	0.78	0.86	0.71	0 71	0 73	0 72
	(88.46)	(58.02)	(70.69)	(68.16)	(42.24)	(42 45)	(46.15)	(43.85)
Manuring	0.14	0.69	0.32	0.40	0.97	0.96	0.85	0.92
	(11 54)	(41.98)	(29.31)	(31.84)	(57.76)	(57.55)	(53.85)	(56.15)
Total Tractor	1.18	1 63	1.10	1.26	1.68	1.67	1 58	1.64
	(100.00)	(100.00)	(100 00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)
Eletric motor								
Irrigation	266.55	267.27	267.07	267.06	197.96	185.40	161 90	179.62
	(99.47)	(99.56)	(99 71)	(99 64)	(99.65)	(99.76)	(99 75)	(99 72)
Plant Protection	1 41	1 19	0.78	0.97	0 70	0 45	0 41	0 50
	(0 53)	(0 44)	(0.29)	(0.36)	(0.35)	(0 24)	(0.25)	(0 28)
Total ele Motor	267.95	268.46	267.85	268 03	198.65	185 85	162 30	180 12
	(100.00)	(100 00)	(100.00)	(100.00)	(100.00)	(100 00)	(100.00)	(100 00)

(Figures in parentheses indicate the percentages to the total)

irrigation (13.07 per cent), manuring (10.99 per cent), plant protection (9.64 per cent) and fertilizer application (8.99 per cent) at the overall level.

Among the farm size groups the highest human labour use was on small size farms followed by medium and large size farms for drip and surface irrigated farms. It ranged between 309.35 (large) to 339.08 (small) mandays per hectare under drip irrigation and under surface irrigated farms it was ranged between 359.33 (medium) to 438.17 (small) mandays per hectare. The operationwise human labour use was highest for interculturing operations followed by harvesting, irrigation, management, fertilizer application, manuring and plant protection for drip irrigated farms. Whereas, for surface irrigated farm interculturing and irrigation was followed by management, harvesting, plant protection except small farm fertilizer application and manuring. From this it can be revealed that the per hectare labour requirement was less under drip irrigated pomegranate garden than surface irrigated pomegranate garden.

It regards to the bullock labour use, machine labour use and electric motor use it was noticed that under drip irrigation there was little reduction in bullock labour use for manuring operations and use of electric motor for irrigation. The motor use for interculturing and manuring was found to be more in drip irrigation system compared to surface irrigation

system. Machine labour use i.e. tractor use was more under drip because of more use of tractor by the pomegranate growers adopting drip irrigation system. The tractor use for interculturing operation was found to be reduced which may be because of less intensity of weed due to drip irrigation system. From the above it can be revealed that the labour use for various tillage practices was found to be reduced because of adoption of drip irrigation system in pomegranate. The interculturing operations were perform with the bullock labour use under drip irrigation system mainly by reducing the tractor use while, reverse was true under surface irrigation. In regards to the bullock labour use for manuring was more under surface irrigation and reduced under drip irrigation. However, machine labour use for manuring was increased under drip irrigation.

b)Per hectare total family and hired human labour

The information pertaining to total family and hired labour of male and female worker is presented in Table 5.5

From the information on own and hired labour use it was observed that both family and hired labour use was found to be less under drip irrigation system compared to surface irrigation system at the overall level. Hired male labour use was little reduced under drip irrigation but family male labour used was increased.The reverse was true in case of female

Table 5.5 Family and hired labour use in pomegranate cultivation with Surface and drip irrigation (days/ha)

Category	Surface irrigation				Drip irrigation			
	Small	Medium	Large	Overall	Small	Medium	Large	Overall
Own								
Male	148.35	95 97	100 34	105 08	105 07	100 62	90 56	97 90
	(57.39)	(56.05)	(60.58)	(58.79)	(62.75)	(62.39)	(62 15)	(62.41)
Female	110.13	75.24	65.29	73 65	62 36	60 65	55 14	58.97
	(42.61)	(43.95)	(39.42)	(41.21)	(37.25)	(37.61)	(37.85)	(37 59)
Family Total	258 48	171.21	165.63	178 73	167.43	161 27	145 70	156.87
	(100 00)	(100.00)	(100.00)	(100.00)	(100.00)	(100 00)	(100 00)	(100.00)
Hired								
Male	128 18	129 76	132.96	131.47	95.50	101 30	96 70	97.99
	(54 88)	(55 77)	(49.74)	(51.88)	(42.13)	(46.94)	(46.07)	(45 28)
Female	105 38	102 90	134.37	121 95	131.19	114.53	113.21	118.43
	(45.12)	(44.23)	(50.26)	(48.12)	(57.87)	(53.06)	(53.93)	(54 72)
Hired Total	233.56	232.66	267 33	253.42	226.70	215.84	209.92	216 42
	(100.00)	(100.00)	(100.00)	(100 00)	(100.00)	(100.00)	(100.00)	(100.00)
Total male (F+H)	276.54	225.73	233.30	236.55	200.57	201.93	187.26	195.89
	(56.20)	(55.89)	(53.89)	(54.74)	(50.89)	(53.55)	(52.66)	(52.48)
Total female (F+H)	215.51	178.15	199 66	195.60	193 56	175.19	168.35	177.40
	(43.80)	(44.11)	(46 11)	(45.26)	(49 11)	(46.45)	(47.34)	(47.52)
Grand total	492.04	403.87	432.96	432 15	394.13	377 11	355.61	373 29
	(100.00)	(100.00)	(100.00)	(100 00)	(100.00)	(100.00)	(100.00)	(100.00)

(Figures in parentheses indicate the percentages to the total)

labour. As indicated above there was in general reduction in human labour use due to adoption of drip irrigation system.

c) Per hectare cost of cultivation of pomegranate

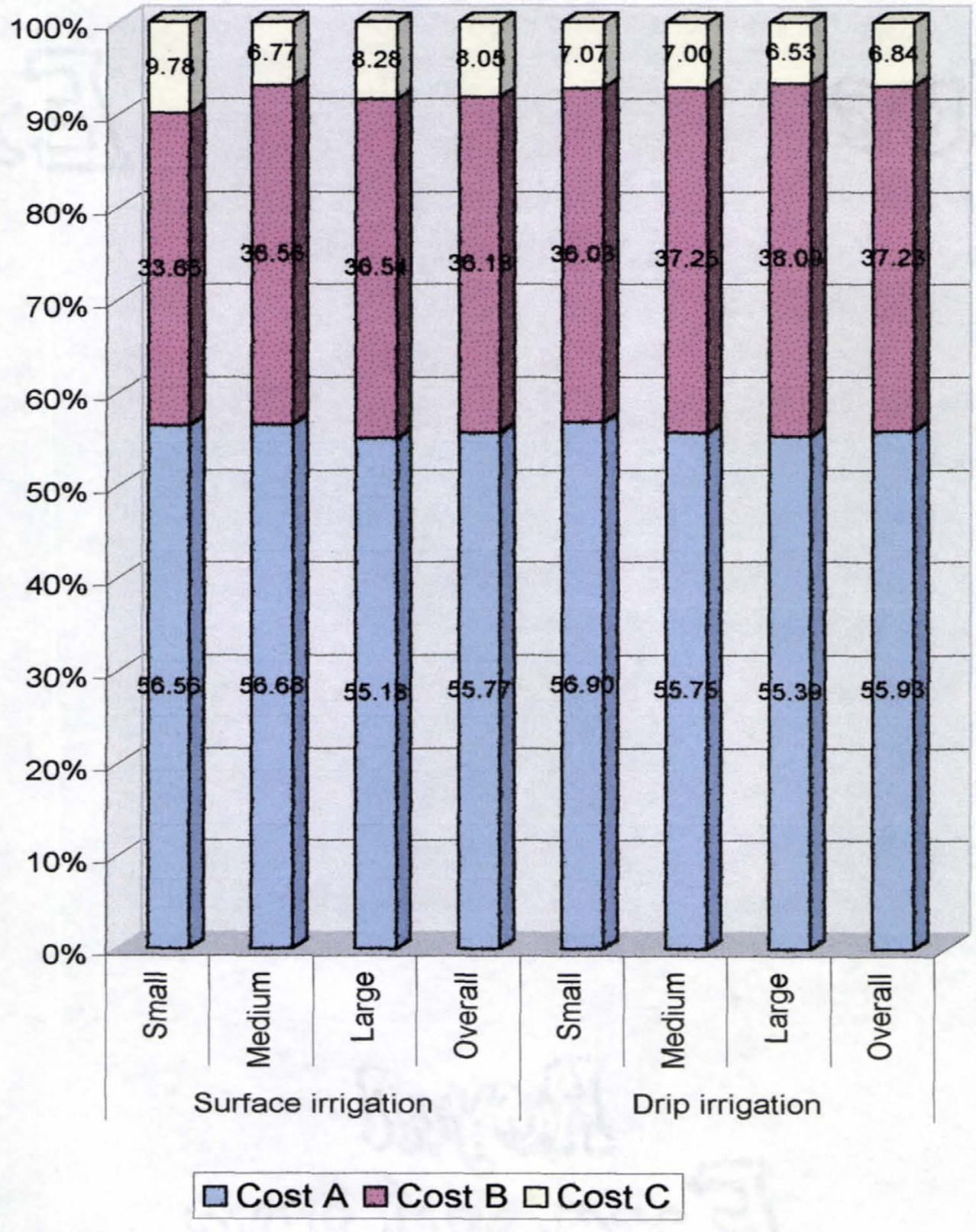
Per hectare cost of cultivation of pomegranate was worked out by using standard cost concepts. It includes fixed as well as variable costs.

Table 5 6 Average per hectare cost of cultivation of pomegranate under surface irrigation and drip irrigation system (Rs./ha)

Cost Items	Surface irrigation				Drip irrigation			
	Small	Medium	Large	Overall	Small	Medium	Large	Overall
Area	2 75	6.20	13.18	22.13	12.23	16.10	17 90	46.23
Hired Male	6118 18	6060 08	6781.31	6496 85	5737 12	6380.43	5816.20	5991.78
	(5 34)	(5.45)	(6.06)	(5.79)	(4.77)	(5.54)	(5.21)	(5.21)
Hired Female	3936 73	3716.13	5638 47	4888.43	5782.71	4974.53	3946.93	4790.45
	(3.43)	(3.34)	(5.03)	(4.36)	(4.81)	(4.32)	(3.54)	(4.16)
Bullock	3690.91	2322.58	1828.53	2198.37	2003.27	1881 99	1826.82	1892.71
	(3 22)	(2.09)	(1.63)	(1 96)	(1.67)	(1.63)	(1.64)	(1.64)
Machine	5563.64	5250.00	4066.77	4584.27	6938.68	6566.21	6442.29	6616.76
	(4 85)	(4.72)	(3 63)	(4.09)	(5.77)	(5.70)	(5.77)	(5 75)
Mannure	4018.18	4483.87	3957.51	4112.52	4405.56	3807.45	3192.18	3727.45
	(3.50)	(4.03)	(3.53)	(3.67)	(3.67)	(3.31)	(2.86)	(3 24)
Fertilizers	9421.45	11279.19	9813.23	10175.25	11324.61	11964.72	11850.34	11751.09
	(8.22)	(10.14)	(8.76)	(9.07)	(9.42)	(10.39)	(10 62)	(10.21)
Irrigation	2457.09	2307.90	2305 31	2324.90	2851.35	2781.37	2759.78	2791.52
	(2.14)	(2.07)	(2.06)	(2.07)	(2.37)	(2.41)	(2.47)	(2.43)
Drip Maintainence	0 00	0.00	0 00	0.00	1095.67	940.99	854.75	948.52
					(0.91)	(0.82)	(0.77)	(0.82)
Pl. Chemicals	15709.09	14975 81	15569.04	15420.24	11545.38	11242.24	12312.01	11736 64
	(13.70)	(13.46)	(13.90)	(13.75)	(9.61)	(9.76)	(11.03)	(10.20)
Annu cost	4483.15	4875.98	4662.80	4700.20	6802.62	6031.91	5610.83	6072.76
	(3.91)	(4.38)	(4.16)	(4.19)	(5.66)	(5.24)	(5.03)	(5.28)
Working capital	55398.42	55271.54	54622.97	54901 04	58486.96	56571.85	54612 12	56319.69
	(48.31)	(49.67)	(48.77)	(48.96)	(48.67)	(49.12)	(48.94)	(48.93)
Intrest on working capital	6647.81	6632.59	6554.76	6588.12	7018.44	6788.62	6553.45	6758.36
	(5.80)	(5.96)	(5.85)	(5.88)	(5.84)	(5.89)	(5.87)	(5.87)
L.R & cess	310.91	310.16	310.09	310.21	323.22	330.31	334.41	330.02
	(0.27)	(0.28)	(0.28)	(0 28)	(0.27)	(0.29)	(0.30)	(0.29)
Depreciation/ repairs	2499.11	858.06	311.28	736 34	2553.06	516.97	309.96	975.46
	(2 18)	(0.77)	(0.28)	(0.66)	(2.12)	(0.45)	(0.28)	(0.85)
Cost A	64856.25	63072.35	61799 10	62535.72	68381.68	64207.75	61809.95	64383.53
	(56.56)	(56.68)	(55.18)	(55.77)	(56.90)	(55 75)	(55.39)	(55.93)
Interest on fixed capital	1615.33	3217.69	4676.27	3887.26	3771.24	3068.70	2740.84	3127.61
	(1 41)	(2.89)	(4.18)	(3.47)	(3.14)	(2.66)	(2.46)	(2 72)
Rental value of land	36981.82	37463.71	36248.10	36679 85	39529.71	39829.81	39762.48	39724 35
	(32.25)	(33.66)	(32.37)	(32.71)	(32.89)	(34.58)	(35.63)	(34 51)
Cost B	103453 4	103753 8	102723 5	103102 8	111682 6	107106 3	104313 3	107235 5
	(90.22)	(93.23)	(91.72)	(91.95)	(92.93)	(93.00)	(93.47)	(93 16)
Family Male	7149.60	4694.35	5177 54	5287.23	5731.40	5379.50	4772.07	5237 40
	(6.23)	(4.22)	(4.62)	(4.72)	(4.77)	(4.67)	(4.28)	(4.55)
Family Female	4071.27	2836.29	4092 19	3737.73	2764.10	2685.56	2514.53	2640.11
	(3.55)	(2.55)	(3 65)	(3.33)	(2.30)	(2.33)	(2.25)	(2.29)
Cost C	114674 3	111284 4	111993 2	112127 8	120178 1	115171 3	111599 9	115113 0
	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)

(Figures in parentheses indicate the percentages to the total)

Fig. 5 Farmsize groupwise proportion of cost A, costB and costC in cost of cultivation of pomegranate under surface and drip irrigation



Item wise cost of cultivation of pomegranate for different size groups of holdings by surface and drip irrigation methods is presented in Table 5.6

The average per hectare cost of cultivation of pomegranate at the overall level, was to the tune of Rs.112127.79 for surface irrigated pomegranate garden in which maximum share was contributed by rental value of land (32.71 per cent) followed by plant protection chemicals (13.75 per cent), hired human labour (10.15 per cent), fertilizers (9.07 per cent), owned human labour (8.05 per cent) and interest on working capital (5.88 per cent). Where as under drip irrigated pomegranate, the per hectare cost of cultivation at the over all level was Rs.115113.01, it was more than surface irrigation. The major items were rental value of land (34.51 per cent), fertilizers (10.21 per cent), plant protection chemicals (10.20 per cent), hired human labour (9.37 per cent), owned human labour (6.84 per cent), machine (5.57 per cent), interest on working capital (5.87 per cent) and annualised establishment cost (5.28 per cent).

Among the size group the average per hectare cost of cultivation of pomegranate was highest on small sized farms under both the

system followed by large and medium sized farm. By and large similar trend in regards to the items of expenditure was noticed. The proportion of cost 'A' was 55.93 per cent under drip irrigation and it was 55.77 per cent under surface irrigation. The proportion of 'B' was 93.16 per cent and 91.95 per cent respectively, at the overall level. The average per hectare cost of cultivation was more by 2 66 per cent under drip irrigation compared to surface irrigation at the overall level. This indicates that there was no much expenditure due to adoption of drip irrigation.

d) Per hectare yield returns

The per hectare yield, gross returns and returns at different costs are shown in Table 5.7

It was noticed that the pomegranate yield obtained under drip irrigation method was more than under surface irrigation method on all the farm size groups. At the overall level, per hectare yield of pomegranate was 133.85 qtls. on surface irrigated farm and on drip irrigated farm it was 171.71 qtls. Among the farm size groups the highest yield was obtained on medium farms (135.16 qtls.) under surface and drip irrigated (172.61 qtls.) followed by large farms (133.85 qtls. and 171.56 qtls. respectively) and small size farms (131.64 qtls. and 170.73 qtls. respectively) .

Table 5.7 Average per hectare gross return of pomegranate under surface and drip irrigation

Items	Surface irrigation			
	Small	Medium	Large	Overall
Yield qtls	131 64	135.16	133 69	133 85
Gross returns	188472 73	190104 84	189110 39	189309 76
Returns at cost A	123616 47	127032 49	127311.29	126774.04
Returns at cost B	85019 33	86351 09	86386.92	86206.94
Returns at cost C	73798 45	78820.44	77117 19	77181 98
B C ratio at cost A	2 91	3 01	3 06	3.03
B C ratio at cost B	1 82	1 83	1.84	1 84
B C ratio at cost C	1 64	1 71	1.69	1.69

Items	Drip irrigation			
	Small	Medium	Large	Overall
Yield qtls.	170.73	172.61	171.58	171.71
Gross returns	249262.47	250282.61	251341 62	250295.57
Returns at cost A	180880 79	186074 85	189531.67	185912.03
Returns at cost B	137579 84	143176.34	147028.36	143.60.07
Returns at cost C	129084 34	135111.28	139741 77	135182.56
B:C ratio at cost A	3 65	3.90	4 07	3 89
B C ratio at cost B	2 23	2 34	2.41	2.33
B.C ratio at cost C	2 07	2 17	2 25	2.17

The per hectare gross return at the overall level was Rs.250295.57 for drip irrigation farm and Rs.189309.76 for surface irrigated farms. The per hectare gross returns were increased with increase in size group holdings under drip system, while under surface system highest gross

returns were on medium sized farm followed by the large and small sized farms. The returns at cost 'A', 'B' and 'C' indicated an increasing trend under drip system, while under surface system similar trend was noticed incase of returns to cost 'A' and 'B'.

At the overall level B:C ratio was 2.17 under drip irrigation and 1.69 under surface irrigation system. This has indicated that the adoption of drip irrigation system for pomegranate cultivation was more profitable than surface irrigation system. From the above it can be said that pomegranate cultivation under drip system of irrigation was more profitable compared to surface irrigated system. The additional returns at the costs 'A', 'B' and 'C' under drip irrigation were 46.65 per cent, 65.95 per cent and 75.15 per cent more than surface irrigation system at the overall level.

5.3 Resource use productivity and efficiency

5.3.1 Resource use structure

In cost of cultivation studies it is very necessary to know the resource use level. It will help to quantify, whether the use of particular resource is minimum, optimum or maximum. The information regarding use of resources is presented in Table 5.8

Table 5.8 Average per hectare resource use under surface and drip irrigation for pomegranate

Cost Items	Surface irrigation				Drip irrigation			
	Small	Medium	Large	Overall	Small	Medium	Large	Overall
Area (ha)	2.75	6.2	13 18	22.13	12.23	16 10	17 90	46 23
Mandays	438 17	359.33	383 05	383 25	339 08	338 11	309 35	327 23
Mannure Qtls.	100 73	112.10	98.94	102 85	110.14	110.56	105.92	108 65
Ferti. N Kg.	279.12	280.00	289.72	285.68	350.70	365.22	352 63	356 50
Ferti. P Kg.	303.17	305.65	226.53	258.22	330.50	334 78	299 05	319 81
Ferti. K Kg.	200.85	281.13	245.69	250.04	267.38	269 16	299 30	280 36
Irrigation Rs.	2457.09	2307.9	2305.31	2324 9	3947.02	3722 36	3614 53	3740 04
Pl. prote. Rs	15709 1	14975.8	15569	15420.2	11545.4	11242 2	12312	11736 6
Annu.Invest.Rs.	4483.15	4875.98	4662.8	4700.2	6802.62	6031 91	5610.83	6072.76

It was revealed that the use of human labour and plant protection expenses was higher for surface irrigated farms than that of drip irrigated farms at the overall level. Whereas, the quantity of manure, fertilizers (N,P,K) and irrigation expenses, annualized investment (establishment cost of garden) was higher for drip irrigated farm than surface irrigated farms. Similar trend was observed among farm size groups. The resource use structure under surface and drip irrigation did not indicate contribution of each input. Therefore, an attempt was made to work out influence of inputs by adopting functional analysis.

5.3.2 Resource productivities

In order to examine the relationship between the output of pomegranate crop cultivated under surface irrigation and drip irrigation Cobb-Douglas type production function was fitted to the sample data. The details regarding specification of the model and variables used have already been given under methodology. The results of the estimated production functions are presented in Table 5.9

It was revealed that the variables included in the production function explained 98.12 per cent variation in production of pomegranate under surface irrigation and 93.56 per cent variation in pomegranate output under drip irrigation. Under surface irrigation the coefficients of mandays (X_1) manure (X_2) and irrigation (X_6) were highly significant indicating that these inputs influenced the yield of pomegranate. In case of drip irrigation the three variable, viz; mandays (X_1) manure (X_2) and nitrogen (X_3) were positive and highly significant. The coefficient of irrigation (X_6) plant protection (X_7) and annualized capital investment (X_8) turn to be positively significant at ten per cent level.

The 'P' fertilizer was negatively significant indicating negative influence on yield of pomegranate. Under drip irrigation the elasticities of production of almost inputs were higher under drip than surface irrigation.

Table 5.9 Results of Cobb-Douglas production function for pomegranate production with surface and drip irrigation

Particulars	Surface irrigation				Drip irrigation			
	X Coeff.(s)	Std.Err of Coeff.	Cal t	Significance	X Coeff. (s)	Std Err of Coeff	Cal t	Significance
Y Yield	0.3325	0.0442	7.5226		1 3082	0 0533	24.5441	
X_1 Mandays	0 5068	0.1707	2 9683	***	1.2052	0 2443	4 9343	***
X_2 Manure	0.1602	0.0426	3 7619	***	0 2709	0 0720	3 7608	***
X_3 N	-0.0315	0.0376	-0.8378	NS	0.3681	0 1202	3.0624	***
X_4 P	-0.0420	0.0424	-0.9900	NS	-0.2826	0 1187	-2.3815	**
X5 K	0.0208	0.0370	0.5630	NS	-0.0105	0.0490	-0.2134	NS
X_6 Irrigation	0 5045	0.1397	3.6121	***	0.8966	0 4168	2.1508	**
X_7 Pl. Prote.	0.0745	0.1350	0.5515	NS	0.0559	0 0233	2.3979	**
X_8 Annu. Inve.	-0.1842	0.1400	-1.3155	NS	0.3109	0.1291	2 4079	**
R^2	0.9812				0.9356			

From the above it can be revealed that almost all inputs influenced the output of pomegranate significantly due to adoption of drip irrigation system. This may be because of proper use of improved irrigation technology for pomegranate cultivation.

5.3.3 Returns to scale in pomegranate production

The regression coefficients in Cobb-Douglas type production function are the production elasticities of the respective resource variables and their sum indicates the type of returns to scale. The returns to scale are

increasing, constant and decreasing according to sum of regression coefficients i.e. the sum of coefficients is greater than, equal to or less than unity. The sum of regression coefficients derived from the regression equation estimated for pomegranate cultivation under surface irrigation was1.0092 and under drip irrigation the sum of regression coefficient was 2.8145. The significance of deviation of sum of elasticities from unit was tested. The sum of elasticity under surface and drip irrigation were found to be significant, which means there was increasing returns to scale in cultivation of pomegranate under both system of irrigation.

5.3.4 Resource use efficiency

On the basis of elasticities, the marginal returns to individual resources were estimated at their geometric mean for comparison with the unit cost of input for knowing the use efficiency of different factors. The MVPs of human labour, manure, N fertilizer, irrigation plant protection and annualized establishment cost were greater than the respective MCs, under drip system of irrigation. This indicated that inefficiencies in use of these inputs was observed. There exists scope to increase use level of these inputs for obtaining higher returns from cultivation of pomegranate under drip system of irrigation. While, MVP of P fertilizer were found to be less than MC, as such the use level of P fertilizer need to be curtailed. Whereas, under

surface irrigation inefficency in use of human labour, manure and irrigation was observed, since the MVPs of these inputs exceeded the respective MCs The use level of these resources can also be increase for obtaining returns in cultivation of pomegranate under surface irrigation.

From the above it can be revealed that there exists inefficiency in resource use in cultivation of pomegranate under both system of irrigation. There is grater scope to increase the resource use under drip irrigation system compared to surface irrigation system in cultivation of pomegranate.

Table 5.10 Resource use efficiency in pomegranate production under surface and drip irrigation

Particulars	Surface irrigation			Drip irrigation		
	MVP	MC	Difference	MVP	MC	Difference
X_1 Mandays	553.65	52.51	501.14	1541.45	49.82	1491.65
X_2 Manure	246.68	39.99	206 69	438.59	34.35	404 24
X_3 N	-38.45	13.42	-25 03	467.90	13.42	454 48
X_4 P	-50.28	17.00	-33.28	-365.61	17.00	-348.61
X5 K	26.51	7.00	119.51	-13.93	7.00	-6 93
X_6 Irrigation	401.75	1.00	400.51	512.05	1 00	511.05
X_7 Plant Protection	46.04	1.00	45.04	43.32	1.00	42 32
X_8 Annual establishment	-80.14	1.00	-79.14	166.88	1.00	165 88

5.4 Economic benefits of drip irrigation method for pomegranate

The new irrigation technology for pomegranate i.e drip irrigation method has proved to be more profitable for the cultivators over surface irrigation method. The sample farmers using drip irrigation system for pomegranate could save labour cost and expenses on plant protection and irrigation charges also. And could obtain higher output and returns from pomegranate orchard as discussed below.

Due to adoption of drip irrigation system there is possibility of reduction in tillage operation due to relatively less intensity of weed. As such an attempt was made to estimate the operationwise saving in labour units in cultivation of pomegranate crop under drip irrigation over the surface irrigation. Besides, this the saving in cost of human labour. Bullock labour and cost of inputs were also attempted . Moreover, the exercise was made to workout additional costs and additional returns due to adoption of drip irrigation system in cultivation of pomegranate. The estimates of economic benefits considering above parameters are explained below.

5.4.1 Per hectare operationwise labour saving in cultivation of pomegranate in drip system of irrigation over surface irrigation.

The information in regards to operationwise saving of human labour, bullock labour, machine labour and electric motor is indicated in Table 5.11

It is observed from the table, that due to adoption of drip irrigation system in cultivation of pomegranate crop, the pomegranate growers could able to save labour units required for interculturing, irrigation, plant protection, management etc. And at the overall level, the saving of labour units were 31.17, 33.02, 15.85 and 21.15 per cent respectively. The overall saving in units of human labour in cultivation of pomegranate were to the extent of 14.62 per cent at the overall level. Among the size groups no specific trend in human labour saving was noticed. The saving in use of bullock labour in manuring operation was 92.98 per cent at the overall level, which may be due to the use of machine labour for this operation. The saving of machine labour (tractor) was noticed in interculturing operations. Similarly, saving in hours of electric motor use for irrigation and plant protection major was also observed in cultivation of pomegranate under drip irrigation system. At the overall level, the saving in

Table 5 11 Operationwise labour saved in pomegranate cultivation using drip Irrigation (Figures in percentage)

Particulars	Per cent saving			
	Small	Medium	Large	Overall
Human labour				
Interculturing	45.90	26 84	29 07	31 17
Manuring	-17 93	-70 75	-69 12	-67 42
Fert. Application	15.53	-36.53	-48.72	-38 84
Irrigation	31.37	23.23	37.85	33.02
Plant Protection	15.03	-0 04	22.22	15 85
Harvesting	-17.46	-21.99	23.35	7 94
Management	33.04	24.74	18 64	21.15
Total	22.61	5.91	19 24	14 62
Bullock labour				
Interculturing	11.74	-69 47	-55.72	-46 52
Manuring	92.50	97.43	90 18	92.98
Total Bullock	45.39	23.26	-3.19	13.84
Machine labour				
Tractor				
Interculturing	32.09	25 07	6.13	16 14
Manuring	-612.05	-40.45	-164.21	-129 91
Total Tractor	-42 24	-2.43	-43 79	-30 36
Electric motor				
Irrigation	25.73	30.63	39.38	32 74
Plant Protection	50 68	62.14	47.92	48.79
Total electric Motor	25.86	30.77	39.40	32.80

use of electric motor was to the extent of 32.74 and 48.79 per cent respectively. From the above it can be summarized that the adoption of drip

irrigation system for pomegranate cultivation helped to reduced the requirement of human labour, bullock labour, machine labour and electric motor to the considerable extent, over surface method of irrigation. This may be because of less weed intensity and efficient use of irrigation with minimum energy.

5.4.2 The saving in labour cost and input cost in cultivation of pomegranate with drip irrigation system over surface irrigation system.

The information in regards to saving in cost of human labour, bullock labour, manure, pesticides etc. is given in Table 5.12

From the table it was noticed that there was saving in cost of hired male and female labour, bullock labour as well as family male and female labour in cultivation of pomegranate in drip irrigation system over surface irrigation system. At the overall level, saving in cost of hired human labor, family labour and bullock labour was 9.77, 80.31 and 13.90 per cent respectively. Similarly there was a saving in manures and pesticides in cultivations of pomegranate in drip irrigation system and at the overall level saving was 9.36 and 23.89 per cent respectively. The saving in manures may be due to spot application, while saving in pesticides may be due to less infestation of disease and pest in cultivation of pomegranate, under drip

irrigation system. From the above, it can be revealed that use of drip irrigation system in cultivation of pomegranate can help to reduce the cost of labour as well as manures and plant protection chemicals over surface irrigation.

Table 5.12 The saving in labour cost and input cost in cultivation of *pomegranate* with drip irrigation system over surface irrigation (Rs./Ha.)

Cost items	Size groups			
	Small	Medium	Large	Overall
Hired Male	381.06 (6.23)	-320 35 (-5 29)	965 11 (14 23)	505 07 (7 77)
Hired Female	-1845 98 (-46.89)	-1258.41 (-33.86)	1691.54 (30.00)	97 98 (2.00)
Bullock	1687.64 (45 72)	440.59 (18 97)	1 71 (0.09)	305 66 (13 90)
Mannure	-387.38 (-9.64)	676.42 (15 09)	765.33 (19.34)	385 07 (9.36)
Pesticides	4163 71 (26.51)	3733.57 (24 93)	3257.03 (20 92)	3683 60 (23.89)
Family Male	1481 20 (19 84)	-685.15 (150.73)	405.47 (7 83)	49 83 (0.94)
Family Female	1307.17 (32 11)	150.73 (5.31)	1577.66 (38 55)	1097 62 (29.37)

(Figures in parentheses indicates the percentages to the total)

5.4.3 Per hectare additional costs and returns in cultivation of pomegranate with drip irrigation system

The additional costs and addition returns presented in Table 5.13 indicates that the additional cost was involved in cultivation of pomegranate under

Table 5.13 Per hectare additional cost and returns in cultivation of pomegranate with drip irrigation system over surface irrigation system

Particulars	Size groups			
	Small	Medium	Large	Ovrall
Cost 'A'	3525.43	1135.40	10.85	1847.81
	(5.43)	(1.80)	(0.017)	(2.95)
Cost 'B'	8229.63	3352.52	1589.79	4132.67
	(7.95)	(3.23)	(1.54)	(4.00)
Cost 'C'	5503.86	3886.93	-393.35	2985.22
	(4.79)	(3.49)	(-0.35)	(2.66)
Yield (qtls.)	39.09	37.45	37.88	37.86
	(29.70)	(27.71)	(28.33)	(28.29)
Gross returns	608789.74	60177.77	62231.23	60985.81
	(32.25)	(31.66)	(32.91)	(32.21)
Returns at				
Cost 'A'	57264.31	59042.37	62220.38	59137.99
	(46.32)	(46.48)	(48.87)	(46.65)
Cost 'B'	52560.51	56825.25	60641.44	56853.14
	(61.82)	(65.81)	(70.20)	(65.95)
Cost 'C'	55285.58	56290.84	62624.57	58000.58
	(74.91)	(71.42)	(81.21)	(75.15)
B:C ratio	0.43	0.46	0.56	0.49

(Figures in parentheses indicate percentages to the total)

drip irrigation over surface irrigation system. At the overall level 2 to 4 per cent additional cost in cost A, B, C was required in cultivation of pomegranate with drip irrigation system. The additional cost required was more in small size groups and indicated decreasing trend with increasing

size of holdings. Even though additional cost was involved in adoption of drip irrigation system, the additional returns were realized to the considerable extent. At the overall level 28.29 per cent additional yield pomegranate was obtained with an additional returns of Rs.60985.81 (32 21 per cent). Per hectare additional returns over cost 'A', 'B' and 'C' realized at the overall level were Rs.59137.99, Rs.56853.14 and Rs.58000.58, respectively. The additional returns over cost 'A' was in the range of 46.32 to 48.87 per cent among the size groups, while cost 'B' and 'C' were in the range of 61.82 to 70.20 and 71.42 to 81.21 per cent, respectively. The benefit cost ratio was found to be more in drip irrigation system over surface irrigation system in cultivation of pomegranate. From the above it can be revealed that use of drip irrigation system involved additional cost to little extent, However, considerable amount of additional returns can be obtained. In short, adoption of drip irrigation system was more profitable over surface irrigation system.

5.5 Management and maintenance constraints in use of drip irrigation system

After having the comparative analysis of pomegranate cultivation by surface and drip irrigation method, to promote the adoption of drip irrigation system by other farms, the study of constraints in drip

irrigation system becomes pre-requisite. Therefore, the present investigation studies the management and maintenance constraints faced by the pomegranate growers in use of drip irrigation system. The constraints were grouped into three categories viz; A) Economic B) Technical and C) General

The details of constraints faced by the pomegranate growers regarding purchase and management of drip irrigation system are presented in table 5.14.

5.5.1 Economic constraints

The data presented in Table 5.14 indicated that the majority of drip adopter expressed high initial investment as their main constraints in adoption of drip irrigation system (81.67 per cent). Three-fourth of respondents expressed that the financial assistance from the Government was delayed. Almost all of the drip adopters indicated that the spare parts of the system were costly. This indicated that farmers with low economic status faced more economic constraints compared to other.

About 80 per cent of the farmers felt the inadequate of credit supply. Among the reasons of inadequate finance, scale of finance and limited allocation of funds by the government were reported by 75 per cent respondents. Whereas, political intervention for sanction of loan was reported necessary by the 81.67 per cent drip users. Also the complicated

method of sanction of loan proposals requiring many visits, credit worthiness, support and repayment of overdues needed was reported by 71.67 per cent, 60.00 per cent, 73.33 per cent and 58 33 per cent sample farms.

5.5.2 Technical constraints

The constraints like clogging in pipe due to urea application through water was perceived as most important constraint by majority of drip adopters (85.00 per cent) followed by non-availability of chemical for cleaning (81.67 per cent), inadequate knowledge and difficult cleaning 75 00 per cent, feel less need to clean (71.67 per cent).

The irregular supply of electricity and low voltage was experience of almost all sample farms. The difficulty in availability of spare parts at local place which need to travel through distance places was reported by above 80 per cent drippers. Whereas all the respondents were aware of requirement of water for pomegranate cultivation.

5.5.3 General constraints

The observed data indicated that requirement of regular maintenance of system was expressed by majority of respondents (90.00 per cent) followed by problem of rodents and cracking of laterals(90.00 per cent), difficult in interculturing (86.67 per cent), lack of immediate repairing

Table 5.14. Economic, technical and general constraints in adoption of drip irrigation

Sr. No.	Particulars	Size group of holding				
		Small	Medium	Large	Total No	Per cent
A.	**Economic constraints**					
	1. High installation cost	20	17	12	49	81.67
	2. Timely financial assistance from Govt.	15	18	12	45	75.00
	3. Spare parts are costly	20	20	20	60	100.00
	4. Per ha. finance for drip system Rs.					
	5. Proportion of subsidy in finance					
	6. Inadequate credit	14	11	13	48	80.00
	7. Reasons for inadequate finance					
	a. Scale of finance	18	15	12	45	75.00
	b. Limited funds available	18	13	14	45	75.00
	c. Purposive and political intervention	12	14	10	35	60.00
	8. Disbursement of credit need					
	a. Many visits	16	15	12	43	71.67
	b. Credit worthiness	12	14	10	36	60.00
	c. Support	15	16	13	44	73.33
	d. Clearance of overdues	12	13	10	35	58.33
	e. Fear of repayment	10	18	11	49	81.67

B.	**Technical constraints**					
	1. Urea application through water create clogging in pipe(tubes)	15	18	18	51	85.00
	2. Timely cleaning of valve and nozel.	10	18	15	43	71.67
	a. It is difficult	18	12	15	45	75.00
	b. Non-availability of chemical	16	15	18	49	81.67
	c. No knowledge of cleaning	18	12	15	45	75.00
	d. No need of cleaning	16	12	15	43	71.67
	3. Spare parts not available at village	18	16	17	51	85.00
	4. Spare parts available at distant place	18	15	16	49	81.67
	5. Irregular electric supply	20	20	20	60	100.0
	6. Inadequate voltage	20	20	20	60	100.0
	7. Per day electric supply availability Hrs.	6-8	6-8	6-8	6-8	
	8. Knowledge of requirement of water	20	20	20	60	100.0

C	**General**					
	1. Problem of rodents	18	18	18	54	90.00
	2. Cracking of laterals	19	18	17	54	90 00
	3. Difficulty in interculturing	18	17	17	52	86.67
	4. Lack of after sale service from dealer	14	12	12	38	63.33
	5. Lack of immediate repairing service at local level	15	16	15	46	76.67
	6. Frequent maintenance is required	19	18	17	54	90.00

service available at local place and lack of after scale service from dealer (63.33 per cent).

The pomegranate growers were facing technical, economical, infrastructural constraints as well as general problems in adoption of drip irrigation system for pomegranate cultivation. Therefore, the necessary measures are required to be taken so as to overcome their constraints and problems in adoption of drip irrigation system for pomegranate cultivation. Besides this the trainings, result demonstration as well as infrastructure development for technical guidance and maintenance at village level need to be attained which can minimize the constraints of pomegranate growers in use of drip irrigation system.

SUMMARY AND CONCLUSION

6. SUMMARY AND CONCLUSIONS

Among the various inputs required for crop production, water is the most important and basic input besides land for growing crops. Also, water is the vital need of man for his various activities. If water is not controlled and managed properly, water creates problems such as flood hazards, soil quality deterioration, ill health, environmental degradation etc. which are serious in respect of living conditions of the people and natural resource conservation. In India, agriculture as the major occupation has been rendered hazardous periodically by scarcity of rainfall in large areas and erratic rainfall monsoon elsewhere. Irrigation helps the farmers greatly by decreasing risk in growing a crop and there by increasing the average yield.

In effect, irrigation is the key input to increase agricultural production in virtually all of India. The available empirical evidence reveals that near about 40 per cent of irrigation potential has remained to be exploited at the national level. Due to the inefficient irrigation water management practices at the various levels, the problems like water logging, soil quality deterioration of land and environmental degradation have

become major obstacles in enhancing crop output. Owing to limitation on availability of irrigation water, there is tendency among the farmers of diverting available water resources in favour of high pay-off crops and also using water by illegal means. The losses of water are also through conveyance, evaporation, percolation and seepage by using traditional methods of irrigation.

Among the fruit crops grown in Maharashtra, pomegranate is the most important fruit crop. The productivity of pomegranate, in Maharashtra is not increased in proper proportion as actually needed due to improper use of water for irrigating the crop. The conventional method of irrigating pomegranate is characterized by uneven distribution of water, which results in poor yields. Over irrigation results into gradual built-up of water logging and progressive built-up of salinity, making soils unsuitable for cultivation. Due to inefficient irrigation water management practices at the farm levels, the productivity of pomegranate was found to be declining.

In this context, the technology of applying water to root zone of pomegranate through drip irrigation system seems to be advantageous to the farmers. The advantages of drip irrigation technology in terms of having control over optimum combinations of irrigation water with other yield

increasing inputs and saving water to bring additional cropped area under irrigation are well recongnised by large number of farmers. The other advantages of drip irrigation technology includes reduction in soil erosion, minimal weed growth, decreased water losses through transpiration, labour saving for intercultural and plant protection operations and minimal incidence of pests and diseases. It is possible to obtain better yields and quality products with the use of drip irrigation method.

In Solapur district the pomegranate was cultivated by the farmers on limited irrigation facilities successfully. The pomegranate growers of the of district were become progressive in cultivating the crop and obtaining greater returns. Due to limited irrigation pomegranate growers tried to utilize available water irrigation more efficiently by adopting improved irrigation technology. With the encouragement from the Government pomegranate growers in the selected area could adopt drip irrigation system to large extent successfully. In order to know the comparative economics of pomegranate cultivation under drip vis-à-vis conventional method of irrigation a study was undertaken with the following specific objectives :

1) To study per hectare investment for drip and conventional methods for pomegranate orchard.
2) To estimate comparative cost and return structure of drip and conventional method of irrigation
3) To estimate and compare resource use productivity and efficiency.
4) To estimate economic benefits of drip irrigation method.
5) To study constraints faced by pomegranate growers and obtained feed back points.

The study was based on the farm level data relating to various aspects of the use of drip irrigation in pomegranate production. The data was collected for the year 2001-2002 by survey method. The farm level information on various aspects of capital investment, production costs, output, gross returns and net returns of pomegranate and other crops grown on the farms of the participating farmers was obtained from the sample of 120 pomegranate growing farmers in the district. Out of these 120 pomegranate growing farmers, 60 farmers were using drip irrigation system and 60 farmers were using conventional irrigation system.

The data on various aspects of pomegranate production with or without drip irrigation technology were obtained from sample farms by

survey method through personal interview with the help of a questionnaire specially designed for the purpose.

The data thus collected were compiled and analysed statistically in order to obtain estimates of additional costs and additional returns of drip irrigation technology in pomegranate production with the help of standard cost A, cost-B, cost-C concepts. The relative efficiency of drip irrigation and conventional irrigation method was studied through output-input analysis. The Cobb-Douglas type of production function was used for estimating the efficiencies of the resources. The result of the study are summarized below

6.1 Summary

1) The average size of holding was 2.97 and 3.08 hectares, respectively on the surface and drip irrigated pomegranate farms. The proportion of permanent fallow land was more in case of farmer compared to later. The average GCA was 4.48 and 3.29 hectares, respectively at the overall level. The proportion of double cropping was more on drip irrigated pomegranate farms with average intensity of 156.10 per cent, while it was to the extent 113.84 per cent on surface irrigated farms.

2) The cropping pattern of the pomegranate growers was more diversified with high cropping intensity under drip irrigated compared to surface irrigated system, which may be because of more availability of water for irrigation due to adoption of drip system of irrigation.

3) The average per farm investment on capital assets was more on drip irrigated pomegranate farms (Rs.581757) compared to surface irrigated pomegranate farms (Rs.514269). Land was the major item of investment followed by machinery, farm building, irrigation structure under surface irrigated farms while under drip irrigation system land cost was the major item followed by investment on irrigation structure and drip irrigation unit, farm building machinery etc. The investment on irrigation structure was in the range 12 to 16 per cent of total investment on the both types of pomegranate growing farms. The investment on drip unit was in the range 3.40 to 6.85 per cent of the total investment on drip irrigated pomegranate farms.

4) The average farm investment in irrigation structure was Rs.65319 at the overall level on surface irrigated farms, while it was Rs.87004 on drip irrigated farms. The investment on drip unit was to the extent of Rs.25971 per farm on the drip irrigated pomegranate farms at the

overall level. As such per farm investment on irrigation structure and drip irrigation units in case of drip irrigation units in case of drip irrigated pomegranate growers was Rs.112975. The average per hectare total capital investment for drip irrigation unit was Rs. 37590 of which dripper assembly was to the extent 19.36 per cent followed by PVC pipeline and fittings (17.67 per cent), fittings (15.88 per cent), dripper (13.33 per cent) start connector (12.75 per cent) and sand filter (8.38 per cent).

5) At the overall level, per hectare average cost of establishment of pomegranate farms was Rs.70110 for surface irrigated pomegranate farms and Rs.92227 for drip irrigated pomegranate farms. The establishment cost was 31.54 per cent higher over the surface irrigation and it was 51.73, 23.70 and 20.33 per cent higher in small, medium and large sized pomegranate farms. The major items of establishment cost were installation of drip set (30.18 per cent) followed by rental value (15.23 per cent) on drip irrigated pomegranate farms. In case of surface irrigated pomegranate farms rental value of land was the major item (18.74 per cent) followed by irrigation layout (17.22 per cent) and interculturing (10 per cent). The average per hectare

annualised establishment cost of pomegranate orchard was Rs.46.74 and Rs.61.48, respectively on the surface irrigated pomegranate farms and drip irrigated pomegranate farms at the overall level. The per hectare annualized establishment cost showed decreasing trend with increasing size of holding. From the above it can be said that there was no much expenditure required for installation of drip irrigation system, since saving in expenses on irrigation layout and irrigation as well as interculturing compensated additional cost on installation of drip.

6) It was revealed that the operation wise per hectare labour requirement was less under drip irrigated pomegranate garden than surface irrigated pomegranate garden. In regards bullock labour use machine labour use and electric motor use it was noticed that under drip irrigation there was reducing in bullock labour for manuring operation and use of electric motor for irrigation. From the above it can be concluded that in general there was reduction in human labour use due to adoption of drip irrigation system. The average per hectare cost of cultivation of pomegranate at the overall level was to the tune of Rs.1121.28 for surface irrigated pomegranate garden, while it was

Rs.115113 under drip irrigated pomegranate garden. The proportion of cost 'A' was 55.93 per cent under drip irrigation and it was 55.77 per cent under surface irrigation. The per hectare cost of cultivation was more by 2.66 per cent under drip irrigation compared to surface irrigation at the overall level. This indicates that there was no much expenditure due to adoption of drip irrigation.

At the overall level, per hectare yield of pomegranate was 133.85 qtls. on surface irrigated farm and on drip irrigated farms it was 171.71 qtls. The per hectare gross return at the overall level was Rs.250296 under drip irrigated farms and Rs.189310 for surface irrigated farms. The increasing trend in regards to gross returns was noticed with increase in size of holding under drip irrigation system. At the overall level B:C ratio was 2.17 under drip irrigation and 1.69 under surface irrigation system. This indicated that adoption of drip irrigation system for pomegranate was more profitable than surface irrigation system.

7) The use of human labour and plant protection expenses was higher for surface irrigated farm than that of drip irrigated farms, it means there was saving in human labour use and plant protection annualized

investment cost positively influence the output of pomegranate, significantly due to adoption of drip irrigation system, which may be because of improved irrigation technology. The sum of elasticities under surface and drip irrigation system were found to be significant, it means there was increasing return to scale in cultivation of pomegranate in both the systems. The inefficiency in resources use in cultivation of pomegranate was noticed under both the systems. There was scope to increase the resource use under drip irrigation system compare to surface irrigation system in cultivation of pomegranate. The overall saving in units of human labour in cultivation of pomegranate were to the extent of 14.62 per cent, while saving in hours of electric motor use for irrigation and plant protection was to the extent of 32.74 and 48.79 per cent, respectively. The saving in use of bullock labour in manuring operations was 92.98 per cent at the overall level, which may be due to the use of machine labour. The saving of machine labour was noticed in interculturing operation (16.14 per cent). From the above it can be summarized that the adoption of drip irrigation system for pomegranate cultivation helped to reduced the requirement of human labour, bullock labour, machine labour and electric motor to considerable extent over surface method

of irrigation. This may be because of less weed intensity and efficient use of irrigation with minimum energy. The saving in manures was noticed which may be because of spot application. The saving in pesticide was noticed which may be due to less infestation disease and pest in cultivation of pomegranate in drip irrigation system. It can be revealed that use of drip irrigation system in cultivation of pomegranate can help to reduce cost of human labour, manures and plant protection chemicals over surface irrigation system. Even though additional cost involved in drip irrigation system, the additional returns were realized to the considerable extent. The B:C ratio was found to be more drip irrigation system over surface irrigation system. It means drip irrigation was more profitable over surface irrigation system.

8) The pomegranate growers were facing technical, economical, infrastructural constraints as well as general problems in adoption of drip irrigation system for pomegranate cultivation. Therefore, the necessary measures are required to be taken, so as to overcome their constraints and problems in adoption of drip irrigation system for pomegranate cultivation. Besides this the trainings, result

demonstration as well as infrastructure development for technical guidance and maintenance at village level need to be attained, which can minimize the constraints of pomegranate growers in use of drip irrigation system.

6.2 Conclusions

In the light of the empirical evidence brought out by the study, the following conclusions could be drawn.

1) The cost of establishment of pomegranate garden under drip irrigation method was higher than that under conventional irrigation method. It is mainly because of higher investment for installation of drip set, depreciation of drip set and interest on drip set etc. But for establishment of pomegranate garden under drip irrigation system, there was saving in human labour, plant protection charges, bullock labour charges of etc.

2) For cultivation of pomegranate, there was saving in labour both human and bullock to greater extent due to adoption of drip irrigation technology. The requirement of men labour under the new technology was observed to be lower than that of conventional irrigation method

because there was saving of labour for irrigating the crop and fertilizer application. The weed growth was checked and due to this labour requirement for intercultivation was lower than that of conventional irrigation method.

3) The adoption of drip irrigation method for pomegranate, the farmers could get more benefit than that of conventional irrigation method. The B:C ratio of drip irrigation method worked out to 2.17 and that of conventional irrigation method worked out to 1.69.

4) It can be concluded that drip irrigation system for pomegranate cultivation was more profitable than surface irrigation system

6) The pomegranate growers were facing technical, economical, infrastructural constraints as well as general problems in adoption of drip irrigation system for pomegranate cultivation. Therefore, the necessary measures are required to be taken so as to overcome their constraints and problems in adoption of drip irrigation system for pomegranate cultivation. Besides this, the trainings, result demonstration as well as infrastructure development for technical guidance and maintenance at village level need to be attained which

can minimize the constraints of pomegranate growers in use of drip irrigation system.

6.3 Policy implications.

The present success of drip irrigation system for pomegranate depended mainly on the efforts innovative of farmers, scientists and the government. The result of this study helped to provide guidelines for policy makers, water management scientists, manufacturer and dealers of drip system for bringing about desirable changes in this recently introduced technology for getting more successful results. The following measures could prove to be useful.

1) For adoption of this new technology on a wider scale, the government should make available adequate funds at the reasonable rate of interest to the farmers. More over, for the installation of drip set high cost involved, therefore loans should be made easily available that too in time with easy sanction procedure to over come the problem of complicated procedure expressed by the respondents.

2) The drip adopter faced major constraints regarding repairs of the system, lack of availability of spare parts locally, technical knowledge and lack of effective after sales service facilities either by government or dealers, Therefore necessary infrastructure need to be developed.

3) The participating farmers need to be trained about the mechanism, maintenance, precautions and repairing practices of drip set so as to enable them to participate in the proper maintenance of the system to the highest extent possible. Moreover, result demonstration need to be organized

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APPENDIX

8. Appendix

Questionnaire for the farmers

Title- Economics of Drip irrigation vis-à-vis Conventional Method of Irrigation for pomegranate cultivation in Solapur District.

1. **Name of the pomegranate grower: Shri.** .....

   Village ..... Tahsil ....

   Dist. .....

2. **Age (Years)** .....

3. **Education** ..... **Literate/ illiterate**

4. **Occupation**

   a. **Main occupation**

   b. **Other occupation**

5. **Information of family members**

Sr. No.	Name of family members	Relation with the head of family	Age (years)	Education	Occupation

6. **Information about the land**

(Area ha.)

Survey No.	Types of land	Total Area	Land				Land revenue (Rs.)	Addi L.R. (Rs.)	Z.P. cesses (Rs.)	Edu. Tax (Rs.)	E.G.S. Tax (Rs.)	Total L.R. (Rs.)	Present value of land
			Irrigated	Rainfed	Fallow	Total							

7. Information about capital investment

A. Information about farm houses

Sr. No.	Name	Area Length x width	Type of construction	Establishment of year	Purchase value (Rs.)	Present value (Rs.)	Remaining life period (yrs.)	Repairs (Rs.)
A.	House							
1	Living house							
I.	In village							
II	On farm							
2.	Storage house (Godown)							
3.	Cattle shed							
4	Engine house							
5.	Other							

B. Irrigation Facility

Sr. No.	Name	Establishment / Purchase		Present value (Rs.)	Repair value (Rs.)	Remaining life period (yrs)
		Year	Value (Rs.)			
1.	Well					
2	Electric pump/engine					
3.	Pipeline					
4	Bore well					
5	Drip set					
6	Sprinkler set					
7	Other					

C. Machineries and Implements

Sr. No.	Name	Number	Purchase		Present value (Rs.)	Repairs value (Rs.)	Remaining life period (Yrs.)
			Year	Value (Rs.)			
I.	**Machineries**						
1	Tractor						
2	Sprayer						
3	Oil engine						
4.	Duster						
5.	Electric Motor						
6.	Spray Pump						
7.	Other						
II.	**Implements**						
1.	Bullock cart						
2.	Iron plough						
3.	Wooden plough						
4.	Harrow						
5.	Hoe						
6.	Seed drill						
7.	Tractor drawn implements						
8.	Other						

8. Livestock

Sr. No.	Type	Breed	No.	Purchase		Present age (yrs.)	Present value (Rs.)	Remaining life (yrs.)
				Year	Value (Rs.)			
1	Draft animals							
2.	Milch animals							
a	Cow-local crossbreed							
b.	Buffaloes							
3	Breeding bulls							
4	Calves							
5.	Goat							
6.	Sheep							
7	Poultry birds							

9. Information about cropping pattern

Sr. No.	Season	Area (ha.)	Whether sole/mixed intercrop	Variety	Irrigated/Dry
1	Kharif				
2.	Rabi				
3.	Summer				
4.	Annual				
5	Perennial				

10. Details of Drip Set

Sr. No.	Details	No.	Purchase		Present value (Rs.)	Remaining life (Yrs.)	Repair value (Rs.)
			Year	Value (Rs.)			
1	Pump						
2.	Filter (Sand/screen)						
3	Mainline						
4	Sub-main line						
5	Laterals						
6	Drippers						
7	Chemicals used for cleaning						
8.	Fertigation						
9	Pressure regulator						
10.	Other						

11. On what terms do you purchase the drip set ?

a Cash payment

b. Credit

c Partial payment

12. What is the brand name of drip set used by you ?

13. Why you preferred this brand name of drip set ?

14. Cost of establishment of pomegranate garden

Variety: Age: Planting month and year

Area: No. of plants: (Drip set Year)

Spacing.

Sr. No.	Particulars	Labour required (days)						Wages paid (Rs.)			Machinery days			Material used		
		Family			Hired											
		M	F	B	M	F	B	M	F	B	Own	Hired	Rs.	Name	Qty.	Value Rs.

i. Preparatory tillage and planting

1) Leveling
2) Ploughing
3) Harrowing
4) Clod crushing
5) Digging of pits
6) Manures and fertilizers
7) Filling of pits
8) Cost of seedling transport
9) Planting
10) Irrigation and its layout
11) Others

ii Interculturing (first year)

1 Ploughing
2 Harrowing
3 Weeding
4 Stirring
5 Debudding
6. Prunning
7 Spraying
8. Gap filling
9. Fertilizers
10 Mannures
11. Irrigation
12 Watching
13. Installation of drip set
14. Others (specify)

iii. Interculturing (second year)

(same as point ii above 1 to 14)

17. Cost of cultivation of pomegranate garden

Age of garden (yrs)

Sr. No.	Particulars	No. of times	Labour required (days)						Wages paid (Rs.)			Machinery days			Material used		
			Family			Hired											
			M	F	B	M	F	B	M	F	B	Own	Hired	Rs.	Name	Qty.	Value Rs.

1. Ploughing
2. Harrowing

3 Weeding
4 Stirring
5 Prunning
6 a Spraying
b Control of fruit fly
7 Debudding
8 Thinning
9 Irrigation
10 Manuring
11 Fertilizer
12 Watching and supervision
13. Harvesting
a Picking
b. Transport within plot
14 Maintenance of drip set
15. Others

16. Constraints

1. Economical constraints
2. Technical constrains
3. General

VITA

9. VITA

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