CHAPTER-1
INTRODUCTION

1.1 INTRODUCTION:

The Indian agriculture is traditionally promoted cereal based cropping system. However, diversification to more productive and remunerative crop becomes the new milestone needs to be achieved in Indian agriculture. A shift in favour of economically viable horticulture crops provides best alternative for such diversification drive and strategy. It is a well known fact that well established and maintained fruit orchards can offer better yields than traditional crops. So it will definitely help in improvement of individual farmer’s as well as the nation’s economy. Many policy makers, development specialist and trade analyst today realize that the horticulture sector has potential in generating the employment and earning the foreign exchange for the country. In this regard, initiatives taken by the government and horticulture scientists had impacted on the development thereby increase in production, productivity and availability of a large number of horticultural crops. One of the significant developments seen during the last few decades is that the farming community has moved from rural confine to commercial production. As a result, Indian horticulture made a rapid stride maintaining the growth rate of 5.0 to 6.0% in the last two decades (Singh H. 2009).

India is the second largest producer of fruit in the World after China. The major fruit growing states in India are Maharashtra Tamilnadu, Karnataka, Andhra Pradesh, Gujarat, Bihar and Uttar Pradesh. The edapho-climatic variations in the country practically make it possible to grow wide varieties of tropical and subtropical fruits, of which mango, banana, citrus, guava, grape, pineapple and apple are major ones. In addition, other minor fruits especially pomegranate are emerging as important crops in horticulture development of India.

About 50 years ago, India was importing pomegranate fruit from Iran, Muscat, Afghanistan. The pomegranate was considered a minor fruit crop cultivated in the nation but its cultivation increased very rapidly. Presently, India is the leading pomegranate producing country in the World. And this fruit crop had become extremely popular in drier parts of peninsular India particularly in states of Maharashtra, Karnataka and to a smaller extent in Gujarat, Rajasthan, Andhra Pradesh
and Tamilnadu. The main features responsible for its widespread cultivation are the low water requirement, versatile soil adaptability, hardy nature of tree and fruit, low maintenance cost, high yield, better storage capacity, good market prices. And most importantly, this crop has provided opportunities to the farmers even utilizing the small and barren lands.

Maharashtra occupies topmost position with respect to area (78.18%) and production (69.91%) in the total of the country. The commercial cultivation of pomegranate crop is mainly concentrated over the ‘Western Deccan Plateau’ of the state that is in rain shadow area of Sahyandri mountain ranges. It is a chronically drought prone region covering namely Solapur, Nashik, Ahmednagar, Pune, Sangali districts of the state. Among these, Nashik district ranked first contributing 38.95% of area and 21.51% of production in total of the state.

Nashik district has been already famous for grape farming that is mainly concentrated only in the canal irrigated southern potion (Godavari river area). On the other hand, northeastern part covering namely Kalwan, Satana, Malegaon, Deola, Nandgaon and Chandwad tehsils of study region is located in rain shadow area. It receives an uncertain and low amount of rainfall that leads to form it drought prone region. Moreover, seasonal river flows and existing water reservoirs do not posses an inadequate water to meet the demands of agriculture. Consequently, availability of water for irrigation is a major limitation in agricultural practices.

Because of the continuous water shortages experienced in the region, the farmers were in search of a new cash crop that could be cultivated by minimum irritation. In the due course of time, around 1985 some innovative farmers especially large landholders adopted pomegranate and ber (jejube fruit) cultivation on smaller plots. Since, these crops require low amounts of water particularly in the summer season when water irrigation potential is very low. Between these two crops, pomegranate proved more successful with respect to productivity, demands in market and returns per unit area. After the demonstration of good returns by early adopters, later on other farmers made similar efforts. The drip irrigation system based on tube wells enabled growers to cultivate the pomegranate crop. It had resulted in a real expansion and production of pomegranate fruits in low rainfall regions of the study area. Modern agro techniques gave rise to changes in agricultural typology.
Even if pomegranate cultivation is of recent origin in the study area but most striking feature is that within a span of 20-25 years, it has emerged as a main pocket of this fruit crop in the state. This achievement within short period also proves that the farmers of the study region adopted new technology and modern methods of cultivation very fast. After adopting the pomegranate crop, the agro-economic scenario of study region has been completely changed. This crop had revolutionized the agricultural economy of district in general and drought prone tehsils in particular.

Usually fruit cultivation requires more capital and labour, it makes this enterprise with less advantageous for small landholders due to their low financial potentials. Therefore, both the probability of participation and land allocation for horticultural crops decrease with the size of land holding in India. Small or medium farmers do not appear to allocate a greater share of land to the fruits. However, this general trend is not true about pomegranate fruits. All types of farmers from large holders to small and even marginal were found to practice the pomegranate orchards in the study region. Out of fifteen tehsils of district, farmers in at least ten tehsils are practicing the pomegranate crop to more or less extent excluding only high rainfall regions. Against this backdrop, the present study attempts to evaluate the pomegranate agro ecosystem in Nashik District of Maharashtra.

1.2 INTERDISCIPLINARY RELEVANCE OF THE STUDY:

The research on pomegranate fruit crop belongs to that heartland of study, which opens with the interdisciplinary approach, similar to the environment, land use, and demographic studies. The literature search on pomegranate proved that “Punicology” (pomegranate science) from the earliest time show many examples of the integration of knowledge from various research fields. In addition to the horticultural science; pomegranate research often involves participation of the economics, commerce and trade, hydro-engineering (irrigation), social innovations and extension as well as physical sciences like plant geography. And each discipline has its own experimental and analytical approaches and theoretical context that produce a unique way of thinking about a problem under study.

Present research work though geographical in nature but tried to attempt with inter-disciplinary approach. Since it takes into consideration the research works from various disciplines and integrates them in a way that produces a new conceptual
framework of study in fruit farming. For this purpose, all literature related to commercial cultivation of pomegranate crop was reviewed, which belonged to various disciplines like horticulture, economics, marketing, innovations, modern agro technology and its extension. The research methodologies, analytical procedures, results, suggestions and findings of those studies were understood in context to get more close to the topics under study. So that helped to proceed in the right direction for achieving the desired goal, in other words, it enabled to make this work more applicable in commercial cultivation of pomegranate crop.

1.3 SIGNIFICANCE OF THE TOPIC:

Even though the topic under study belongs to agriculture geography in nature but it was tried to attempt with applied geographical approach. Much work has been done on dry land horticulture development but the ‘applied geographical approach’ towards the development of dry land farming in general remains neglected and untested. The literature search also revealed that there are very few research studies exclusively on the geographical aspects of pomegranate cultivation.

The researchers and also farmers unanimously agree that pomegranate is an ideal crop for the drought prone region. It indicates some correlation between the physical factors and pomegranate fruit crop. In this view, present work tries to examine how geographical conditions of the study area are suitable for this crop.

The secondary data also revealed that there was a rapid increment in the area under pomegranate cultivation. But the data sources do not explain its causes. Therefore, present work contributes by providing a comprehensive outline of spatio-temporal variations and explains all causes responsible for changes in this fruit crop. In context to this, the attempt was made to mark the core and fringe area of pomegranate cultivation with greater precision by using concentration indices.

A significant shift towards pomegranate cultivation was evident with the rapid growth in area under this fruit crop. Since the pomegranate crop provided an excellent opportunities in raising the income of farmers even in dry tracts. In this context, the cost benefit ratio for small, medium and large pomegranate holdings was ascertained by collecting the primary data at the farm levels. In addition, the impact of biotic and abiotic factors viz. soil, altitude, variety, cropping season and age of orchards in determining the yield, cost and return structure of pomegranate crop was examined.
Besides to all above discussion, the present micro-level study is significant in three ways. Firstly, it focuses the light on the agronomic practices performed by pomegranate growers that would provide guidelines to cultivate the same crop in any other ecological regions. Secondly, it identifies the problems faced by the growers at the farm level and provides the appropriate suggestions; those are economically viable or within the capacity of growers. Thirdly, it was also tried to find out the gap between agronomical practices adopted by growers and recommendation given by the experts. In other words, the attempts are made to bring out the picture of ‘ideology verses reality’ in pomegranate cultivation that has not been attempted by any other researcher so far.

1.4 ORIGIN OF THE RESEARCH PROBLEM:

Tawade (1980) in his book ‘Geography of fruit farming’ clears that horticultural production, by nature is location specific because of its optimum climatic requirements. Here it differs from the usual agricultural practices. The pomegranate crop is also the native of Mediterranean climate. Despite of that it is cultivated in a semi-arid climate of the study region on a large scale. Therefore, it was interesting to find out the nature of climatic conditions that made it possible to cultivate pomegranates in the study area. Equally, other factors namely socio-economic, technological and government policies need to understand in detail. Since, all those had supported to emerge pomegranate crop as a successful enterprise.

1.5 SELECTION OF THE STUDY AREA:

The pomegranate is cultivated as a cash crop in more than 17 districts of Maharashtra. However, its area, production and productivity differ widely. Therefore, preliminary analysis of the area under pomegranate cultivation was conducted by using technique of location quotient given by Bhatia (1965) to select the study region.

\[ C. I. = \frac{ag}{nsa} \]

Where,

\[ C. I. = \text{Concentration index of the crop} \]

\[ ag = \text{Area under ‘x’ crop in the district} \]

\[ AG = \text{Area under ‘x’ crop in the state} \]

\[ nsa = \text{Net sown area in the district} \]

\[ NSA = \text{Net sown area in the state}. \]
Location quotient (C. I.) more than 1 indicates a high concentration of the crop in given areal units. Based on the results of concentration indices (Table No. 1.1), Solapur and Nashik District were identified as main pockets of pomegranate cultivation in the state. However, compared to all other districts of the state, the Nashik district indicated a large temporal change in terms of C. I. from 3.26 in the year 1991 to 7.06 in year 2001 within a span of decade.

It means that the area under pomegranate cultivation in Nashik district had grown up very rapidly. And this district occupied the topmost position production of pomegranate fruits in Maharashtra. Therefore it was purposively selected for the study. This district as a whole was taken as representative unit from the high concentration zone of the pomegranate in Maharashtra for regional analysis. And its tehsils were taken as areal units for micro-level analysis.

Table No. 1.1 Maharashtra: Pomegranate crop concentration indices (C. I.)

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Solapur</td>
<td>5.09</td>
<td>1</td>
<td>4.96</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>Nashik</td>
<td>3.26</td>
<td>2</td>
<td>7.06</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>Ahmednagar</td>
<td>2.50</td>
<td>3</td>
<td>1.11</td>
<td>5</td>
</tr>
<tr>
<td>4</td>
<td>Pune</td>
<td>1.72</td>
<td>4</td>
<td>0.97</td>
<td>7</td>
</tr>
<tr>
<td>5</td>
<td>Satara</td>
<td>1.54</td>
<td>5</td>
<td>1.11</td>
<td>6</td>
</tr>
<tr>
<td>6</td>
<td>Sangali</td>
<td>1.52</td>
<td>6</td>
<td>2.84</td>
<td>3</td>
</tr>
<tr>
<td>7</td>
<td>Dhule</td>
<td>0.83</td>
<td>7</td>
<td>1.91</td>
<td>4</td>
</tr>
<tr>
<td>8</td>
<td>Others</td>
<td>&lt; 1</td>
<td>8</td>
<td>&lt; 1</td>
<td>8</td>
</tr>
</tbody>
</table>

(Source: compiled by researcher)

In addition to the above analysis, following are four facts considered for selection of Nashik District as study area.

i) The study region is located in rain shadow area of Western Ghat of Sahyandri Mountains, which receives a low amount of annual rainfall. And it is a chronically drought prone region. Therefore, availability of water from the rains along with insufficient irrigation facilities limits agricultural practices. Despite of that, the district is leading pomegranate cultivar of the state, so it
helps to demonstrate how farmers had developed their skills to sustain pomegranate production in water scarce region.

ii) Although the pomegranate fruit crop is not native to the study region but the favourable physical environment coupled with the modern agro techniques and efforts of innovative farmers are producing good quality and quantity of pomegranate fruits, those are popular in the state and national markets.

iii) The researcher is born and grown up in the study area. As a native to the region, he has shared all experiences of pomegranate farming with the growers (his relatives, friends, and neighbors) right from the time of introduction of the pomegranate fruit crop to the present situation. It helped to assess the ground realities and write those facts in the present thesis.

iv) Moreover, no any researcher has attempted the geographical analysis of pomegranate cultivation in Nashik District yet to the date.

1.6 LOCATION OF THE STUDY REGION:

This pomegranate growing district is located in the northwest part of Maharashtra. The district has the following latitudinal and longitudinal extent (Fig. 1.1).

i) Latitude - 19°35' N to 20°35' N

ii) Longitude - 73°16' E to 74°55' E.

The region is partly located in the Tapi basin (Girna) and partly in the upper Godavari basin. The district covers an area of 15582 kms² (6015 mile²) occupying 5.04% of the total area of the state. It ranks 5th in terms of areal coverage and 4th in terms of total population amongst all districts of Maharashtra state. Nashik city is the administrative headquarter of the district. Administratively, the district is divided into 15 tehsils viz. Surgana, Kalwan, Deola, Baglan, Malegaon, Nandgaon, Chandwad, Dindori, Peth, Trambak, Nashik, Igatpuri, Sinnar, Niphad and Yeola. Of these, Malegaon tehsil occupies maximum 12% while Peth tehsil covers smallest area 3.63%, the second smallest tehsil is Deola (3.81%) and all remaining 12 tehsils cover 5 to 9% area of the total district’s area.
Figure No. 1.1: Location of the study area
1.7 AIMS AND OBJECTIVES OF THE STUDY:

The main aim of this study was to analyze the geographical factors involved in pomegranate cultivation. In this view, the present work was attempted with objectives:

- To study geographical setting of Nashik district for understanding locational aspect of pomegranates.
- To investigate spatio-temporal distribution and phenomenal changes in pomegranate cultivation of study area.
- To examine the economics of pomegranate cultivation through yield, cost benefit ratio.
- To ascertain the impact of the soil, altitude, variety, cropping season and age of trees on yields and profits of pomegranates.
- To know the marketing system and profits realized in different markets.
- To identify the problems, its causes and effects on pomegranate farming as well as to give best possible suggestions for grower to adopt suitable remedies.

1.8 HYPOTHESIS:

The following were hypothesis proposed for the present study:

- Pomegranate is native of the Mediterranean region despite of that it is successfully cultivated in the study area because of the favourable environmental conditions.
- Apart from high production costs of pomegranate crop, high monetary returns had attract the farmers towards its cultivation.
- The profitability of the crop varies according to physical factors (soil type of orchard, altitude of locality) and cultural factors (age of orchards, varieties, cropping seasons).
- The growers are suffering from minor and major problems that recently hampered the pomegranate cultivation of the study area.

1.9 DATA BASE:

The approach of the study was geographical in nature so procurement of primary data for the study region was important task. It was performed in following way.
I) **Primary Data:**

Based on the field survey method, the interviews and discussions with pomegranate growers was liberally used to collect primary data. The questionnaire consisting of four sections was designed according to the objectives of present study.

- The first section of the questionnaire was related to information on the socioeconomic characteristics of pomegranate growers.
- In second section, the set of 23 main questions and further sub-questions were designed to examine agronomical practices adopted by growers for pomegranate crop.
- Third section of the questionnaire was in tabulated form designed to measure economic aspects such as cost of plantation and production, labour, yield and marketing of pomegranate.
- Fourth section of the questionnaire was devoted to statement of problems and constraints faced by pomegranate growers.

In addition to sample growers, the discussions were also made with experts progressive farmers, crop consultants, traders, agro input dealers and extension staff at the State Agriculture University namely MPKV, Rahuri (MS).

It is worth mentioning that the qualitative and quantitative analysis made in the present research work is mostly based on primary data collected from explorative interviews of growers through extensive field survey work. Since, Govt. Officials or NGO does not record the data at farm level on aspects like production costs, yields and marketing of pomegranates. Hence, the interview of growers was the only source to work out for the purpose of economic analysis.

II) **Secondary data:**

To begin with the present study, the secondary data were procured from various sources as mentioned below.

i) Office of Superintendent of Agriculture, Nashik District.
ii) District Agriculture Sub-divisional Offices
iii) Annual socio-economic reviews of Nashik district
iv) Government Soil Conservation Department, Nashik
v) Government Water resource and Irrigation department, Nashik
vii) The Directorate of Horticulture, Pune
viii) Maharashtra State Agricultural Marketing Board (MSAMB), Pune.
ix) Maharashtra Pomegranate Growers and Research Association, Pune.

Besides, the data were also obtained from reviewing books, research journals and reports, published magazines, newspapers and Dalimbvritta Magazine (Marathi).

1.10 METHODOLOGY:

The methodology adopted for the present investigation can be separated into three parts as:

I) Selection of the villages
II) Selection of sample growers
III) Data analysis

I) Selection of the sample villages:

The spatio-temporal analysis of pomegranate crop revealed the high, medium and low crop concentration zones in the study area. Therefore, the stratified random sampling method was adopted for the selection of villages. Those formed primary unit of sampling. Since the study aims at geographical analysis, the area under cultivation and the altitude of the pomegranate growing village was the two criteria applied for selection of sample villages.

a) Based on area under cultivation:

A list of pomegranate growing villages for each tehsil of the district was prepared from secondary data of agriculture offices (GoM). And out of total, 5% villages having highest acreage under this crop were selected for field survey.

b) Based on the altitude from mean sea level:

The altitude of village was another criteria applied to select the sample villages, with a view to find out the impact of this abiotic factor on yield and profits of the pomegranate crop. The Global Positioning System (G P S instrument with accuracy up to 7 - 9 meters) was extensively used during field survey to record the values of latitude, longitude and altitude of sampled villages and sampled orchards. Finally, all sampled villages and orchards were grouped into 6 altitude zones with an interval of 50 meter (Table No. 1.3).
Table No. 1.2 Distribution of Sample Villages and Farmers According to Altitude

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Name of Zone</th>
<th>Altitude range (meter ASL)</th>
<th>No. of sample villages</th>
<th>Number of sample orchards</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Small farmers</td>
</tr>
<tr>
<td>1</td>
<td>A zone</td>
<td>330 – 450</td>
<td>04</td>
<td>27</td>
</tr>
<tr>
<td>2</td>
<td>B zone</td>
<td>451 – 500</td>
<td>05</td>
<td>22</td>
</tr>
<tr>
<td>3</td>
<td>C zone</td>
<td>501 – 550</td>
<td>15</td>
<td>66</td>
</tr>
<tr>
<td>4</td>
<td>D zone</td>
<td>551 – 600</td>
<td>17</td>
<td>63</td>
</tr>
<tr>
<td>5</td>
<td>E zone</td>
<td>601 – 650</td>
<td>10</td>
<td>32</td>
</tr>
<tr>
<td>6</td>
<td>F zone</td>
<td>650 – 735</td>
<td>05</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>TOTAL</td>
<td>56</td>
<td></td>
<td>225</td>
</tr>
</tbody>
</table>

(Source: Compiled by researcher)

II) Selection of sample pomegranate growers:

The secondary unit of the sampling was the pomegranate growers. A list of pomegranate growers for each sample village was obtained from village revenue records. Then out of total growers in that respective sample village, 5% growers on the basis of ‘pomegranate holding’ were selected for the purpose of the interview.

The pomegranate orchards are characterized by high financial inputs and outputs. Therefore, in the present study the farmers more than 2 hectares of pomegranate holding are considered as large farmers. Then, less than 2 hectares but more than 1 hectare is considered as medium farmer. While less than 1 hectare categorized as small farmers. Those were divided into 3 groups according to size of holding for inter farm comparison; as below.

- i) Small farmers (less than 1 Ha) = 225 (50%)
- ii) Medium farmers (1.1 to 2 Ha) = 134 (30%)
- iii) Large farmers (more than 2 Ha) = 095 (20%)

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TOTAL = 454 (100%)

In brief, this thesis had grown up by collecting the primary data from 454 sample growers scattered in 56 samples villages of 10 pomegranates growing tehsils of Nashik district (Table No. 1.4).
Table No. 1.3: Selection of Sample Pomegranate Growing Villages and Sample Growers

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Name of tehsil</th>
<th>Total Number of Villages</th>
<th>Total Pomegranate growing villages</th>
<th>Total pomegranate growers</th>
<th>Number of growers in sample villages</th>
<th>Number of sample villages Based on cultivated Area</th>
<th>Number of sample villages Based on altitude</th>
<th>Total</th>
<th>No. of Sample growers</th>
</tr>
</thead>
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<tr>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>S</td>
</tr>
<tr>
<td>Strata – I : High Concentration Zone</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Baglan</td>
<td>167</td>
<td>136</td>
<td>10187</td>
<td>2894</td>
<td>07</td>
<td>03</td>
<td>10</td>
<td>65</td>
</tr>
<tr>
<td>2</td>
<td>Malegaon</td>
<td>147</td>
<td>138</td>
<td>7677</td>
<td>2726</td>
<td>07</td>
<td>03</td>
<td>10</td>
<td>80</td>
</tr>
<tr>
<td>3</td>
<td>Deola</td>
<td>49</td>
<td>46</td>
<td>3218</td>
<td>1256</td>
<td>04</td>
<td>04</td>
<td>08</td>
<td>37</td>
</tr>
<tr>
<td>Strata – II : Medium Concentration Zone</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Nandgaon</td>
<td>87</td>
<td>56</td>
<td>393</td>
<td>226</td>
<td>03</td>
<td>01</td>
<td>04</td>
<td>4</td>
</tr>
<tr>
<td>5</td>
<td>Sinnar</td>
<td>130</td>
<td>63</td>
<td>359</td>
<td>118</td>
<td>03</td>
<td>01</td>
<td>04</td>
<td>12</td>
</tr>
<tr>
<td>6</td>
<td>Kalwan</td>
<td>152</td>
<td>34</td>
<td>181</td>
<td>109</td>
<td>03</td>
<td>02</td>
<td>05</td>
<td>8</td>
</tr>
<tr>
<td>7</td>
<td>Chandwad</td>
<td>108</td>
<td>58</td>
<td>263</td>
<td>100</td>
<td>03</td>
<td>01</td>
<td>04</td>
<td>3</td>
</tr>
<tr>
<td>8</td>
<td>Yeola</td>
<td>122</td>
<td>59</td>
<td>163</td>
<td>37</td>
<td>03</td>
<td>02</td>
<td>05</td>
<td>7</td>
</tr>
<tr>
<td>Strata – III: Low concentration Zone</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Niphad</td>
<td>129</td>
<td>24</td>
<td>135</td>
<td>50</td>
<td>02</td>
<td>02</td>
<td>04</td>
<td>5</td>
</tr>
<tr>
<td>10</td>
<td>Dindori</td>
<td>142</td>
<td>10</td>
<td>16</td>
<td>8</td>
<td>01</td>
<td>01</td>
<td>02</td>
<td>3</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>1233</td>
<td>624</td>
<td>22592</td>
<td>7524</td>
<td>36</td>
<td>20</td>
<td>56</td>
<td>224</td>
</tr>
</tbody>
</table>

(Source: compiled by researcher)
Figure No. 1.2 Nashik District: Location of Sample Villages with altitude zones
III) **Data Analysis:**

The obtained field survey data pertaining to the year 2009-10 were sorted according to size of pomegranate holding of the growers. Then for economic analysis, the sampled orchards were further micro grouped according to altitude zones, soil types, cropping seasons, varieties and age group of the orchard.

a) **Statistical techniques:**

Arithmetic average, percentage, correlation co-efficient, straight line regression equations, volume of change, location quotient and cost benefit analysis helped to identify certain relationship between environmental factors and pomegranate crop. Elaborate description of the same is specified in the respective chapters.

b) **Cartographic techniques:**

In order to have an overview of study region distribution maps were prepared by the Geographical Information System (GIS) i.e. Autodesk Map 2004, Illwis 3.7 and Arc View 3.2 computer software were used for preparing maps of the study region. All other significant information is represented by charts and graphs where ever mapping was not possible.

c) **Interpretation of analysis:**

The results of primary and secondary data analysis are summarized in the form of findings, suggestions and conclusions.

1.11 **LIMITATIONS OF THE STUDY:**

In an attempt to make a micro-level study of pomegranate fruit crop, the researcher faced some difficulties in obtaining the data required for analysis.

i) The present study was restricted to only pomegranate crop cultivated in Nashik district of Maharashtra state. That is based on 454 sample pomegranate growers selected from 56 sample villages distributed over 10 tehsils. Therefore, the findings of study will have to be tested in other localities with higher sample size to judge its wider applicability and validity on a large scale.
ii) The findings of this investigation are based on the expressed responses of pomegranate growers. Very few of them maintained the detail record of inputs. But they are able to remember gross expenditure on inputs like fertilizer bags, labour employed, total production cost, prices realized and more accurately gross returns. Under such circumstances, these gross values were taken for analysis. And if doubtful, the information given by illiterate grower was confirmed with literate and experienced pomegranate growers in the same sampled village.

The only sources for collection of secondary data were government offices. In this context there were some limitations in availability of data.

iii) The Nashik District was formed in 1869 consisting of 13 tehsils. In addition, the government announced two more tehsils namely Deola and Trambakeshwar on 26th June 1999. Hence, separate data on pomegranate crop for these tehsils was available after 2001. To overcome on this problem, 13 tehsils in the first decade (1990 - 2000) and 15 tehsils were attempted in the second decade (2001-2010) in spatio-temporal analysis.

iv) Pomegranate was minor fruit crop cultivated in the study region. Hence, authentic data on the cultivated area under pomegranate is not available before the year 1991 at any government offices. In such situation, the study period is restricted to 20 years (1991- 2010).

v) The secondary data obtained from government officials on area under pomegranate were largely incomplete, unreliable, and faulty. Hence, this data was used as guidelines to proceed for field survey.

vi) The country wise updated, accurate data on area, production and productivity is not available for uniform period of time from any authentic source. It had created difficulties in presenting World scenario of pomegranate cultivation. This difficulty was overcome by collecting the information for individual country from different research articles and project reports. In this context, most reliable source was International Symposiums on Pomegranate published by the International Society of Horticulture (ISHS).
1.12 APPLICABILITY OF THE STUDY:

It is hoped that the study would be useful for improvement of pomegranate crop from field to district level.

i) Contributions to the society:

In a broader view, it would satisfy the social needs in four ways.

• Firstly, based on knowledge obtained through the reviewed literature and shared experiences of pomegranate growers during field survey the researcher is interested in lab to land extension of this research work. Therefore, in the future, I am planning to open up the ‘Pomegranate Consultancy’ in my college premises. The sole intention is to provide proper guidelines to farmers for this promising fruit crop of the drought prone area.

• The status of lab to land extension of research and technology were investigated by interviewing the pomegranate growers. It is with a view to identify the gap between “Ideology” (recommendations given by pomegranate experts) verses “Reality” (implementation by pomegranate growers) at the farms. Thus, constraints in improved production process generally faced by growers were understood. It enabled me to give possible suggestions, which are economically viable or within the capacity pomegranate grower.

• The idea of existing physical conditions in favor of particular crop is required as a base for the formulation of specific schemes. So the extension workers Department of Agriculture (GoM) may get the guidelines from this study to focus their resources for achieving horticulture development in the dry lands.

• Moreover, the pomegranate fruit crop is cultivated in at least 17 districts of Maharashtra, the suggestion based on results of the present study would also be applicable to such other semi-arid regions of the state where similar ecological conditions prevail.

ii) Contributions to the Subject:

There are very few research studies exclusively on geographical aspects and pomegranate crop. In context to this, effort was directed towards geo-economical analysis of pomegranate farming at the micro-level. This work also represents the spatial organization of pomegranate crop by demarcating core and fringe area by
using concentration indices. It might be a first regional approach for pomegranate crop cultivated in the Nashik district. The research methodology and findings may be useful for researchers working in the field of “Geography of Fruit Farming”.

1.13 FRAMEWORK OF THE STUDY:

The present study was organized into eight chapters, each deal with specific objectives of the study.

- The first chapter was devoted to the introduction of entire research work. It includes an introduction, interdisciplinary relevance, significance, origin of the problem, selection of the study region, hypothesis, objectives, methodology, applicability and framework of the study. It also includes review of literature at international and national level.

- Second chapter describes the determinants of pomegranate cultivation. First part of it examines the suitability of physical factors for pomegranate cultivation. And second part gives an account of socioeconomic and technological determinants in favour of pomegranate crop.

- Third chapter provides information on cultivation and production processes of pomegranate in the study area. It highlights the general features of pomegranate fruit and the cultural practices adopted by the growers to cultivate this fruit crop.

- Fourth chapter has examined the spatio-temporal changes of pomegranate cultivation of the study region. It also identifies high, medium and low concentration zones of pomegranate crop and elaborates the causes of variability.

- Fifth chapter assessed the economics of pomegranate cultivation. It evaluates cost per hectare of pomegranate orchard for all three categories of farmers. The impact of environmental variables viz. Soil type, altitude, variety, age of the orchard and cropping season on per hectare yield and profit of pomegranate is also examined.

- Sixth chapter has evaluated the marketing of pomegranates in the study area by present methods of sale, market types and intermediaries, market channels
and constraints in export. The marketing cost of local, state, national markets and subsequently profits to growers were assessed.

- Seventh chapter identified the problems and prospects of the pomegranate fruit crop in the study area. The explanations also highlight on the prospects of pomegranate farming in changing agro scenario of the study area.

- Eighth concluding chapter contains the findings of the present investigation and the thesis ends by a bibliography.
Figure No. 1.3 Schematic diagram of the study
1.14 LITERATURE REVIEW:

Pomegranate crop, as a field of study has attracted many Indian as well as Foreign scholars. The interdisciplinary nature of topic allowed the researcher to attempt an extensive search of literature concerned with pomegranate cultivation. Those research contributions closely concern to geographical aspects cannot be ignored and the literature that pertains to objectives of the present study was referred.

1.14.1 International review:

‘Pome culture’ means growing of pomegranates began in Mediterranean region so it became native crop of this region. Hence most of the research work was carried out in countries viz. Turkey, Spain, Israel, Iran, Afghanistan and U.S.S.R. Along with spread of commercial cultivation of this fruit the studies were also undertaken in other parts of World namely USA, India and China.

i) Turkey:

Turkey is one of the native lands of pomegranate, where wild pomegranates are spread in every area such as in the coastal as well as mountainous areas. Esin and Ulku (2007) studied ecology and economics of pomegranate cultivation in Turkey. According to them, pomegranate can be grown in the mid-latitudes in various conditions of climate and soil. The plant needs an average of 500 mm rain yearly. The plant is considerably temperature tolerant that can survive in low temperature down to -10°C and high temperature up to 45°C. The plant can be cultivated in various types of clay soil, sand and even over rock as well as high altitudes up to 1000m above sea level. Commercially it is cultivated in the climatic conditions of Mediterranean, Aegean and Southeast Anatolia regions in Turkey. Author concludes that dry weather conditions during the maturation period of the fruit help to obtain best quality fruits.

Sezai Ercisli and et all (2009) stated that although pomegranate cultivation is concentrated in subtropical regions of Turkey but there are some special areas in temperate region where pomegranate grows well such as ‘Coruh valley’. Here, pomegranates are found in mix cultivation with other fruits e.g. fig, walnut.

Hepaksoy Seera and et all (2006) determined the effect of irrigation levels on physical disorder i.e. fruit cracking in 6 pomegranate varieties grown in Turkey. The response of three irrigation levels on cracking a) reached to field capacity (100%) b) only 40% and c) non application during at an interval of 20 days. The study concluded
that the problem of fruit cracking was higher with fluctuating amounts of irrigation water.

Yazici and Kaynak (2006) determined the effect of temperature, relative humidity and solar radiation on fruit skin i.e. sunburn damage on the pomegranate variety ‘Hicaznar’ in the year 2003-04. Finding of their research stated that maximum air temperature in some days of July, August and Sept (Mediterranean summer) was positively correlated with maximum Fruit Surface Temperature (FST). The fruit surface temperature that caused sunburn varied between 41˚C to 47˚C. The ratios of relative humidity around 70% to 80% revealed inverse correlation with fruit surface temperature.

Similarly, Pala H. and et all (2006) surveyed a number of orchards from the blossoming stage up to the harvest and detected that fruit cracking, sunburn and hail damage were common abiotic diseases caused by extremities in weather.

ii) Spain:

Spain is biggest exporter country in the World. Therefore, most of the research works done in this country are attributed to economics and trading of pomegranates. Costa Y. and Melgarejo P. (2000) analyzed the production costs in the cultivation of two pomegranate varieties namely ‘Valencia’ and ‘Mollar de Elche’ in the province of Alicante (Southeast Spain) grown under very poor soil conditions. The results suggested that the pomegranate crop could be economically viable to cultivate even under worst conditions of the soil. But the profitability increases in more favourable soil conditions.

iii) Israel:

The country mainly contributed in growing methods by using drip irrigation. The purified salty water along with improved management control enabled them to reach the average yield of 25.35 ton/ha i.e. higher by 20-30% relative to other countries. Holland and Irit (2008) stated that due to global warming phenomenon, water shortages are experienced in many arid and semi-arid regions of the World; those are most suitable regions for pomegranate growth. Finally, concluded that despite of the advance in pomegranate production and processing, the technologies are still needed to exploit pomegranates and develop this field with full potential. Perhaps the most challenging of all will be production of high quality fruit with an
attractive appearance that will contain relatively healthy ingredients, free of fungicides and pesticides.

Rymon (2006) attempted inter-country comparative economic analysis of pomegranate production costs in four countries viz. Australia, Israel, Spain and the USA. The economic structure was assessed in two main parts of cultivation i) the investment period and ii) Typical full bearing year (six year). In order to overcome on the technical difficulties (different currencies) for valid inter-country comparison, the cost composition was expressed in proportions (percents). However, the major limitation of this analysis was lack of comparable yield data so cost to output was not correlated. For valid comprehensive analysis, the author emphasized the need of a specifically designed study supported by an international entity like Food and Agriculture Organization can produce the data for several countries.

iv) Iran:

Pomegranate is one of the valuable orchard products cultivated in most parts of Iran particularly in Irano - Turanian climatic region since ancient times. Selavarzi and et. al. (2009) attempted the bio-index study for extremities of weather conditions especially unexpected chilling and freezing (-25°C) temperature conditions occurred during winter season in 2008. They concluded that freezing temperature last for a day entirely affected and severely damaged the pomegranate orchards of Ferdows city in Iran. This region is located in the northwest of South Khorasan province (near the deserts) although produces high quality pomegranates but always suffers from climatic injuries.

Pomegranate orchards are considered as an economic orchard because its habitats are usually located in central semi-arid of Iran. In this view, Nasri (2006) investigated geographical distribution of pomegranate in Iran. And ecological needs, varieties and different irrigation methods of pomegranate crop were described. He stated that the application of traditional methods of irrigation resulted in the fine production quantity.

The pomegranate tree is not only drought resistant tree but also soil salinity tolerant. In this view, Tabatebaei and Sarkhosh (2006) analyzed and compared salinity tolerance of 10 Iranian pomegranate varieties during 2002-03. Irrigation water, soil, root, stem and leaves of pomegranate were analyzed for their sodium,
chlorine and potassium contents. The ‘Vashike-e-Saravan’ was the most resistant pomegranate variety to salinity followed by Malas-e-Yazdi and Tab-o-Larz.

Mehdi and Mohammad (2006) investigated the influence of irrigation and mineral nutrients (N, Mg, K, Fe and Zn)) on growth, yield and quality on commercial varieties of pomegranate fruit in the year 2003-04. The investigation proved that the soil nitrogen was positively correlated with the yield at 30-60 cm depth. Potassium application increased fruit weight and yield.

v) Afghanistan:

The Investigation made by Samadi (2009) stated that commercially pomegranates can be grown at higher altitudes. And pomegranate growing areas in Afghanistan are situated in 700 meter to 1500 meter ASL. However, in his study injuries to pomegranate due to low temperatures at higher altitudes (above 1000 meter) were reported from Balkh province. And many growers in this country prefer the multi-trunk system since one or two trunks are often damaged by climatic injury like frost. But single stem training is common in warm areas where there is no risk of cold winter.

Finetto (2009) explained the commercial aspects significant to Afghanistan pomegranate viz. Location, area, production, varieties, agronomical practices, marketing channels, middlemen, packing process and post harvest technology. The major problems observed were low productivity, poor seedlings and farming practices and reduced access to irrigation water in some areas. He concluded that the pomegranate acreage was reduced during 1996 - 2003 due to wars droughts in Afghanistan.

vi) U. S. S. R:

Gregory Levin (1980), the World’s foremost Punicologist (pomegranate scientist) devoted 40 years of continuous research based at the ‘Garrigala Agricultural Research Station’ in Turkmenistan (former USSR). In search of rare endangered and mysterious wild species of pomegranates, he trekked across central Asia and the Trans-Caucasus region and built up the huge collection of pomegranate varieties from 64 to 1,117 at the above station. For this achievement of thousands of pomegranate varietal collection, he deserves outstanding research work on pomegranate in the World.
According to Burmistov Leonid (1993), the wild pomegranate trees exist in Transcaucasia, Kopetdag and Pamir-Alai mountain ranges in the former Soviet Union. And pomegranate appears to be a much wider Mediterranean distribution of clear “Gondwanan origin”. The wild pomegranate trees are found in Transcaucasia, Asia Minor and central Asia, Iran and Afghanistan.

Along with commercial cultivation of this fruit crop, the studies were also undertaken in other countries namely USA, India and China.

vii) U. S. A.:

Kevin and Winkins (2009) described that pomegranates have been grown in California (USA) since before 1972, but commercial production began from 1986. Pomegranate is one of the most recent examples of evolution as a commercial crop in California’s modern farming era. Scientists and researchers from other countries identified the medical benefits of pomegranate juice during the 1990’s. Those findings have recently raised interest of scholars in the USA as well as in European countries for research on the health benefits of pomegranate

viii) Australia:

Lye Colin (2008) prepared report on pomegranate potentials in Australia. He concluded that pomegranate as a new crop have potentials to develop in dry climatic areas like St. George, Titree and Alice, Carnarvon, Menindee, MIA Hillston, Murray regions. In view of the global pomegranate fruit market, he concluded that there is potentially a counter season opportunity (March to July) for growers and exporters of Australia sending fresh fruit into European and other countries i.e. when the pomegranate production season is off in the Northern Hemisphere.

ix) Bangladesh:

Rahim and Haq (2006) dealt with present status and scope of pomegranate production. Recent technologies e. g. tree management and post harvest have been developed in Bangladesh to exploit agro climatic conditions for pomegranate.

1.14.2 Indian Scenario:

Pomegranate research in India is hardly four decades old. With the development of pomegranate cultivation in the country research activities were undertaken at various institutional levels. Late Dr. G. S. Cheema (The father of Indian
Pomegranate) developed the popular pomegranate variety “Ganesh” in 1971 through his extensive research carried at Regional Fruit Research center, Ganeshkhind Gardens, Pune (M.S). It was considered as a major revolutionary technological factor in expansion of pomegranate cultivation in India.

1.14.2.1 Research Institutes:

The research initiatives for pomegranate fruits was started by ICAR in 1976 (6th five year plan period) with a view to develop fruit growing technology in the arid regions of the country. (Singh H 2009)

i) National Research Center on Pomegranate (NRCP):

Recently, ICAR taken steps to strengthen research on pomegranate crop and established the ‘National Research Center on Pomegranate’ (NRCP) at Solapur, (Maharashtra) on 25th June 2005 in the 10th plan period. It is noteworthy that it is the only institution perhaps in the World that solely works on pomegranate crop. Moreover, Indian Institute of Horticulture Research (IIHR) Bangalore, Karnataka and Central Institute for Arid Horticulture (CIAH) Bikaner, Rajasthan are also involved in research on pomegranate.

ii) State Agriculture Universities (SAU):

As the area under pomegranate crop increased at a rapid space particularly in Maharashtra and Karnataka state during the last three decades, The Mahatma Phule Krishi Vidyapeeth (MPKV), Rahuri, (Dist. Ahmednagar), Maharashtra and University of Agriculture Sciences (UAS), Dharwad, Karnataka are two major institutions addressing the research issues on pomegranate.

It is meritorious to mention that MPKV has made valuable contributions in the field of pomegranate over the last 3 decades. This university had developed most popularly cultivated varieties of pomegranate viz. ‘Mridula’ and ‘Aarakta’ as well as internationally demanded ‘Bhagawa’. Moreover, the researchers from this university are supporting the fast expanding culture of pomegranate crop by working on various aspects of cultivation practices like standardize spacing of plants, micro-system of irrigation, manuring program, crop load (No. of fruits), cropping season and control measures for pests and diseases, tissue culture techniques etc.
1.14.2.2 Individual contributions:

The individual efforts of research scholars also helped to improve the quality and quantity of pomegranate crop by adopting new methods and ideas through their own field of activity. Those contributions concerned to objectives of study were reviewed and classified into six groups according to the topics under study.

I) Physical Determinants:

The technological advancement especially evolution of agro-climate specific pomegranate varieties made it possible to cultivate it in wide range climatic conditions. In this context, several research studies indicate that pomegranate fruit crop is not very particular about its climatic requirements, which can be cultivated in cold as well as hot or arid environments.

a) Climate:

In the view of the global warming phenomenon, Meena and Kumar (2008) studied the phenomenon of climate change especially rising temperature and its impact on shifting in cropping pattern in ‘Kullu valley’ of Northern Himachal Pradesh. Finally concluded innovative farmers of Kullu valley had converted threat of climate change into an opportunity by adopting options like other fruit crops e.g. kiwi and pomegranate in spite of their traditional ‘apple’ fruit crop. The temperate varieties of pomegranate (Kandahari, Hansi and Sindhuri) were found suitable for cultivation in this region.

Kumar and et. al. (2009) evaluated the performance of 16 pomegranate varieties in the mid-hill zone of Himachal Pradesh. Based on 5 years yield record authors concluded that the ‘Kandahari Kabuli’ was found best variety for this region. Similarly, Sharma and et. al. (2006) studied fruit characteristics of the ‘wild pomegranate’ growing in the intermediate zone of Jammu and Kashmir (Rajouri and Poonch District) at the lower and upper hills of the western Himalayas. They found globular fruits in size having red yellowish green rind in colour.

Samadia and Pareek (2006) investigated fruit quality features of 25 pomegranate varieties under ‘hot arid zones’ of India. The prevalence of extremely high temperature for long periods (April to September) in the atmosphere of arid zones during fruit development period resulted in fruit cracking.
The efforts were made by Asrey and et. al. (2007) to test the feasibility of pomegranate cultivation in north western semi irrigated region of Punjab. The varieties viz. Mridula, Ganesh, G-137, White Muscat and Jalore seedless were planted in year 2000 for assessing performance in above varieties. The Mridula performed well and founded suitable variety. The growers from Muktsar, Ferozpur, Sri-Ganganagar and Sirsa districts in Punjab were inspired by this experiment, subsequently, planted ‘Mridula’ variety and planting material was brought from Nashik and Rahuri. So that also indicates the popularity of the study region for pomegranate production at the national level.

b) Soils:

Pomegranate is grown in India in semi-arid tropics with widely ranging soil characteristics. But the performance of this crop varies according to physical and chemical properties of each soil type. In this context, Edward Raja (2006) identified the important micronutrient disorders in three soil type viz. inceptisol, alfisol and vertisol affecting the commercial pomegranate cultivation in Maharashtra and Karnataka. Finally, the study concluded that healthy pomegranate crop can be grown in inceptisol of Maharashtra with clay loam texture, high organic matter and a pH of 7.2. However, the course textured alfisol and heavy vertisol have limitations.

The nutritional survey of ‘aridosols’ in extreme arid irrigated orchards in the canal command area of Bikaner district of Western Rajasthan was carried out by Bhanger Prerrak and et. al. (2009) to investigate fruit quality parameters. The results revealed the immense scope and potential of pomegranate variety ‘Ganesh’ in irrigated aridosol by adopting suitable doses of fertilizers and irrigation.

Although pomegranates can be grown in aridosol dry regions but they are saline in nature. Furthermore reclamation of salt affected soil is not practically feasible due to inadequate leaching. Hence, the only alternative left to the farmers is to grow salt tolerant crops (Kulkarni 1998) investigated the reaction of Mridula pomegranate variety to soil salinity. He concluded that Mridula is moderately salt tolerant and can be grown in saline soils up to Ece 6 dsm$^{-1}$ (ds$m^{-1}$ = Deci Siemens per meter). However it was severely hampered at Ece 9 ds$m^{-1}$ salinity level. And he suggested that further studies within the range of 6 to 9 Ece will help to decide the correct salt tolerance level of pomegranate.
Mulching plays a very important role in soil moisture conservation, reduction of weeds, and nematode control especially in pomegranate orchards. This practice is well documented and proves the advantages of this technique. Chattopadhyay and Patra (1997) studied the effect of different mulches i.e. black polythene, banana trash and saw dust on soil temperature and soil moisture in pomegranate. In general, soil covering with black polythene had shown beneficial effect in reducing soil temperature. Banana trash and saw dust also influenced soil temperature but to a less extent compared to polythene.

II) Spatio-temporal analysis:

Pawar and Phule (2001) assessed the levels of development of fruit cropping in Solapur district of Maharashtra. The temporal growth and areal variation in fruit farming was examined by the Composite Index of Development (C.I.D.). The analysis revealed areal variations at tehsil level are remarkable so as five fruit farming zones were identified. Rahane and et al (2000) studied the performance of fruits and vegetables in Maharashtra both at the state and regional level for the period of 1994 to 1998. Annual compound growth rates were worked out to examine the region wise performance of major fruits and vegetables grown in Maharashtra by fitting the exponential function. And it was concluded that area and production of pomegranate crop had increased while guava, papaya and mango decreased.

III) Cultural practices of pomegranate:

Although quality parameters of pomegranate fruits are controlled by genetically but agricultural practices like the use of fertilizers, irrigation, pruning operations etc. are important modifiers.

a) Irrigation:

The water requirement of pomegranate crop depends on season, soil type and the age of the orchard. Meshram and et. al. (2009) calculated water requirement of 5 year old pomegranate orchards in Solapur district of Maharashtra with help of crop evapo-transpiration model (ET). The investigation finally revealed that seasonal water requirement during kharip season (from leaf initiation to the maturity period of pomegranate) varied from 9.6 to 65.75 liters / tree / day.

Shrinivas (1995) concluded that in sandy clay loam soils excess irrigations resulted in wastage of water and leaching of nutrients beyond the effective root zone.
The field experiment conducted by Meti and et all (2008) for 7 years (1996 to 2003) indicated the water requirement of pomegranate during Kharif, Rabbi, and summer season is 11, 17 and 22 liters / plant / day respectively in vertisols of Karnataka.

Likewise, Prasad and et all (2003) conducted an experiment during flowering and fruiting period with irrigation levels i.e. 4, 8 and 12 liter / hour through drip system and compared with the basin irrigation system. This trial was conducted for six years old trees of pomegranate. The results indicated that irrigation at 8 liter / hour (for 3 hrs / day) increased the quality of fruits (weight, size, juice) and yield from 15 kg to 28 kg per tree with considerable reduction in problem of fruit cracking.

Agrawal and Agrawal (2007) conducted a field experiment on sandy loam soil. It was proved that water through drip irrigation recorded the highest yield (48.46 quintals ha\(^{-1}\)) as compared to surface irrigation (31.12 quintals ha\(^{-1}\)). Similarly, the cost benefit ratio of drip (1: 2.85) was higher than surface irrigation (1: 1.95). Chopade (1997) evaluated the economic feasibility of drip, bubbler and check basin irrigation methods for pomegranate crop. The yield contributing characters like average number of fruits per tree and yields were satisfactory in favour of drip irrigation treatments. And the highest cost benefit ratio was recorded in drip method ranged from 1: 1.84 to 1: 2.69 followed by bubbler (1: 1.48 to 1:2.09) and check basin (1: 0.94 to 1: 1.33) irrigation. This indicates that investment under drip is worth paying.

b) **Fertilization:**

Application of fertilizers and irrigation water are vital input in pomegranate production to obtain good yield, size and high quality of the fruits and restore soil fertility. Sheikh and Rao (2006) analyzed the effect of split application of nitrogen and potassium on fruit quality parameters of Ganesh variety. The highest number of fruits and weight, thicker skin, high juice percent, TSS, acid ratio also observed maximum in four split doses of fertilizers.

Dhillon and et. al. (2009) investigated the effect of NPK on growth, yield and quality of pomegranate variety Kandahari. The individual plants were fertilized on a nutrient basis for the period of 3 years. Overall nitrogen (40 gm / tree / year), phosphorous (20 gm / tree / year) and potash (20 gm / tree / year) treatments shown good results as far as fruit weight, yield and quality are concerned.
The use of liquid or water soluble fertilizers through drip irrigation are now commonly practiced for pomegranate orchards. In this regard, Kumbhar (1997) studied the effects of solid soluble fertilizers (SSF) applied through the drip system on yield and quality of pomegranate. He concluded that optimum application of fertilizer dose of 70% nitrogen, 80% phosphorus and 80% potash gave maximum net income and also saved 30% fertilizers as compared to the traditional chemical fertilizers.

In order to minimize production cost and chemical residues in the end product (fruit) and to avoid health risks of consumers; the nutrient requirement of the plants can be fulfilled through organic manures. A systematic study on the effect of different organic nutrient on pomegranate was examined under “organic farming” by Singh A (2009). He concluded that the application of about 20 kg vermi-compost or 30 kg cattle dung manure (CDM) per plant or combination of 50% CDM + 50% RDF (N P K) improved the fruit yield and quality of pomegranate in vertisols.

c) Pruning and Training:

Pruning of pomegranate tree is a fundamental practice for improvement of fruit quality and to minimize the pest and disease population. An ideal training system is one that gives annual production of high sustainable yields. Gill and et. al. (2009) concluded that the average number of fruits was decreased with increasing stem height of plants so also yield followed the same trend. Hence ‘bush trained plants’ improves the productivity of pomegranate and offers the possibility to obtain high quality fruits. Pawar (1993) suggested that pruning could be followed in pomegranate to improve the fruit grade, fruit size, and to lower down the incidence of internal breakdown and sun-scorching. Based on the estimated net money returns, 40 cm pruning of main stems are the best.

d) Planting distances:

Recently high-density planting of pomegranate orchards has drawn considerable attention of growers. Because densely populated orchards not only gives good net return especially during the first 5 to 7 years but also facilitates more efficient use of fertilizers and water. However, it has certain disadvantages e.g. lack of aeration, sunlight penetration etc. In this regard, Prasad and et. al. (2003) determined an ideal planting density by considering the factors viz. soil fertility, variety, management practices and economics. The four planting distance i.e. 5 X 2, 5 X 3, 5
X 4 and 5 X 5 meter were kept. The trees were maintained under uniform cultural operations. Finally, the spacing of 5 X 5 meter observed to be optimal under drip irrigation.

e) Pests and Diseases:

The pomegranates are susceptible to a large group of insect pest and pathogens inflicting moderate to heavy losses. Kulkarni and Dethe (2006) examined the correlation between weather parameters and the occurrence of pest and diseases in pomegranate. The weekly meteorological data were recorded during the period of observation (July 2005 to June 2006) covering 3 bahars of pomegranate. Relatively Mrig Bahar (rainy season) was favourable to the infestation of fruit borer and thrips and higher incidences of aphids in Hasta Bahar were noticed. But infection of mealy bug and white flies were inclined in Aambe Bahar.

Kotikal and et. al. (2009) also made same correlation studies for developing pest-weather forecast models. A fixed plots survey conducted at five locations revealed the presence of aphid, thrips, hood, white flies, mealy bugs and mites. The study found that if the morning ‘relative humidity’ increases then the population of above sucking pests could be higher during next two weeks.

Jalikop and et all (2006) explained that the increase in day temperature (38.6 °c) and afternoon relative humidity of 30.4% along with cloudy weather, intermittent rainfall favoured the bacterial blight disease initiation and further spread of disease. Further they stated that a search of resistant clones forms the basis for successful management of this disease in the future.

Benagi and Ravikumar (2009) studied present status and management of bacterial blight disease and suggested that the use of organic fertilizers like neem cakes, vermicompost, farm yard along with micro-nutrient and rest period of 4-6 months will minimize disease problems.

iv) Economics of pomegranate cultivation:

Taking into consideration the involvement of pomegranate crop in improving the socioeconomic status of agrarian society; the economist also took interest in assessing viability of this crop. Phule (2002) attempted the geo-economical analysis of pomegranate cultivation in Sangola tehsil of Solapur district. He concluded that net returns from pomegranate farming increases with altitude of orchards as well as found
higher in shallow and medium soil type than deep soils. But the role of cultural factors e. g. variety of pomegranate, cropping season and age of orchard in determining the cost benefit ratio was not taken into account by above researcher. So that has been attempted in present research work. He further stated that the study of fruit farming with the specific fruit crop is comparatively young field in geography.

Khunt and et. al. (2003) studied the economics of production and marketing of pomegranate of the Bhavnagar district, which has the largest area under major fruit crops in the Saurashtra region of Gujarat. The cost of cultivation was calculated for two periods pre-bearing (up to 3 year) and bearing (4 to 20 years) period. The disposal pattern revealed that 59.01% has sold off the fruits in local market (Bhavnagar city), which lead to the problem of low prices. Therefore, he emphasized the need of fruit cooperative marketing organization in present days.

Jagtap (2000) studied economics of production and marketing of pomegranate in Phaltan tehsil of Satara District (M.S.). Their findings in brief can be summarized as: i) Average establishment cost was ` 60486.86 ha⁻¹ but it decreased with the increase in land holding. ii) The major items in cultivation cost were human labour and fertilizers. iii) Average productivity as well as high prices and returns were realized in Aambe Bahar as compared to that in Mrig and Hasta Bahar. iv) Highest prices for all grades of fruits were realized for pomegranates sold in upcountry markets. v) Finally, concluded that its cultivation in 3 size groups of holding was in profitable proposition.

Several efforts were also taken to test financial feasibility of this crop in study area. Rakibe (2009) analyzed the production and marketing of pomegranate in Nashik District. The study concluded that the establishment cost for the acre pomegranate orchard in a decade increased by 60% from ` 30920.0 in 1995 to ` 48900.0 in 2005. The total cost of crop including maintenance, growing season and marketing was ` 97000.0 acre⁻¹. The net return realized by growers from pomegranate orchard was ` Rs. 99240.0 acre⁻¹ in 2004-05. Author also assessed the impact of pomegranate crop on agronomic upliftment of study area in general and the livelihood of growers in particular.

The micro-level economic analysis undertaken by Deore (2008) revealed that pomegranate production has made positive changes in living standards of farmers as
well as this crop generated employment opportunities to labour, agro service center, transport sector, packing material shops etc. in Malegaon tehsil of the study area.

Pawar (2007) examined various economical aspects of pomegranate cultivation in Satana tehsil of Nashik district. The average productivity of 20 tons ha$^{-1}$ was recorded. The cost of production was reported to ₹ 119,602.85 ha$^{-1}$ and net returns were about ₹ 7142.29 ton$^{-1}$ of fruits. Moreover, the researcher stated that the Nashik District co-operative bank provided more financial support as compared to nationalized banks.

All above studies are based on common economic aspects. However, the investigators had not taken into account the role of variety, Bahar and age of orchard in determining yield and profits from pomegranates. Therefore, in the present study the sincere efforts have been made to test the economic viability of the pomegranate crop by considering all yield affecting and profit determining environmental factors.

v) Studies on marketing of pomegranate fruits:

The fruit prices are determined by the performance and efficiency of different market functionaries involved in various channels. In this context, Ladaniya and et all (2003) studied marketing channels in major pomegranate growing areas viz. Malegaon tehsil (Nashik), Sangola tehsil (Solapur) and Rahuri tehsil (Ahmadnagar) of Maharashtra state. The study indicated that over 90 percent produce was marketed through 3 major channels and the marketing and transportation costs increased with the market distance from the production area. And the packing, transport and commission charges were 90% of marketing cost. Retailer’s margin was 38.50 to 56.33 % in the price paid by consumer.

Pawar and Misal (2005) studied the behavior of prices and arrivals of pomegranate based on secondary data collected for a decade (1991 -2000) from the APMC market, Solapur (MS). The co-efficient of correlation between arrivals and prices exhibited negative correlation ship. It was found that maximum arrivals of fruit were during July, Aug, Sept and Dec months and minimum in May and the highest prices for pomegranate were fetched in April. Trends of fruit arrival revealed growth at 9.80 % annum$^{-1}$ and prices hiked by 8.20 % annum$^{-1}$.

Patil (1995) stated that average return from pomegranate was Rs. 5 to 6 kg$^{-1}$ higher by exporting pomegranates in Hong Kong, Saudi Arabia and London (global)
markets. He emphasized the need of guidance and governmental support to give incentives for increasing the export of pomegranate.

Hosamani and et. al. (2009) demonstrated higher growth in the pomegranate export during pre-WTO (1988 to 1996) period than the post-WTO (1997 to 2007) period but still the quantity exported is less than 3% of its total production.

Moreover export studies clears that although Spain produces only 5% of the World’s pomegranate but ranks first by exporting its 95% produce. In contrast, India is the largest pomegranate producer in the World, exports are only 5% of its total production (Nichit 2007).

Asrey Ram (2006) concluded that in India more than 90% produce is utilized as fresh for table purpose and the rest is in processing industry i.e. consumed locally due to high populations. Other reasons for lesser export from our country are poor appearance and color of fruit, fluctuations in the export prices and poor post harvest handling practices like absence of standard packaging. Pomegranates are cultivated in large area in arid and semi-arid tropics of India where high temperature and low humidity prevails. But lack of cold storage facility in above regions is yet constraints in maintaining the export quality of fruits. One of the major problems in exporting pomegranate fruits from India to European countries is the over limit of chemical residues in the fruits.

According to Shlomo (2009) serious restrictions imposed either by regulation or by market authorities are expected to put more limits on pesticide based plant protection in the future. Hence, for the long run, we should consider ‘organic production’ which eliminates the chemical control. The organic pomegranates we find at present in the market are mainly products of small farms, who cannot afford to spray costly chemicals. Unfortunately high yielding plantation at medium and large farms finds this system very difficult to achieve from a commercial point of view.

vi) Problems and constraints:

Several analysis made by researchers indicate that growers were facing different kinds of problems while producing the pomegranate fruits. Manjula and et. al. (2009) analyzed the constraints in pomegranate cultivation in the surrounding area of Bijapur district of Karnataka state. Finally, it was found that about 88.33% growers were affected by bacterial blight disease. And 81.66% respondents stated
higher costs of material inputs e.g. insecticide, fungicide and liquid fertilizers. Moreover, timely supply of electricity was problem in production for greater extent of growers (65%). Likewise the high transportation cost (78.33%), no guaranteed prices (65%) and high rate of commission (48.33%) were the problems in marketing of fruits.

Similarly, Kharat (1996), Kote (1992) and Bhosale (2000) reported a variety of problems in adoption, plantation, production and marketing of pomegranate fruits.

But different from above, Dhemare and et all (2009) examined the knowledge of growers regarding pomegranate production technology. It was observed that high technical knowledge required for plant spacing, nutrient and irrigation management was not known to the 48% growers and partly known to 52% farmers. About 37% growers were lacking in knowledge of post-harvest management and 36% growers were unable to identify pests and diseases. The details of insecticides and fungicides, their concentration was not fully known to 64% growers.

Besides to research articles, the valuable information on pomegranate is provided in the books of International repute written by Indian authors. Remarkable of them are as below.

a) Tropical Horticulture: Vol I\textsuperscript{st} (Mitra 1999)

b) Fruits: Tropical and Subtropical: Vol. II\textsuperscript{nd} (Patil and et all 2002)

c) ‘Pomegranate’ (Sheikh 2006)


All these books follow standard contents on origin, botanical characteristic, climate and soil requirements, area and distribution, uses and composition, varieties, fertilizer requirements, growing seasons, pest and diseases, harvest and yield, organic farming, post harvest handling and processed products etc. Those fundamental aspects in pomegranate cultivation practices were described in detail.

In view of the providing valuable guidelines for the pomegranate growers many authors from the Maharashtra state provide the useful information in regional language Marathi through published sources e.g. newspapers, magazines and books. The most popular books are Marathi: ‘Dalimb Shetiche Yashsvi Tantra’ (Sonawane 2007) is an excellent text for the growers since they can seek technical information in
Marathi language. In true sense, the text is unusual i.e. wrote by a grower for the growers. In addition, other notable contributors in regional language Marathi are ‘Maharashtratil Falzhade’ (Patil and Karale 2000), ‘Dalimb bag’ (Bhujbal 2005), ‘Kalpvriksh Dalimb Lagwed Aani Prakriya’ (Raul 2006), Dalimbasaathi Thibaksinchan’ (Kadam 1997)

In a nutshell, the preceding review of World wide literature suggests the study of pomegranate crop with a geographical approach remained much neglected subject. Since the study of fruit farming with the specific fruit crop is comparatively young field in geography (Phule 2002). Against this background, Geo-economical analysis of pomegranate crop was undertaken for present study that focuses light on varying physical factors (climate, soil type and altitude) as well as cultural factors (socio-economic, technological and institutional). Additionally, the comparative appraisal of soil types, altitude zones, cropping seasons, varieties and age group of orchard in determining yield and profits from pomegranate is attempted at micro level.