Spatio-temporal changes in agricultural productivity in Ahmednagar district of Maharashtra

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GEOGRAPHY

Under the Faculty of Moral, Social and Earth Sciences

Submitted By

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Under the Guidance of

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July - 2015

DECLARATION

I hereby declare that the thesis entitled **"SPATIO-TEMPORAL CHANGES IN AGRICULTURAL PRODUCTIVITY IN AHMEDNAGAR DISTRICT OF MAHARASHTRA"** completed and written by me has not previously formed the basis for the award of any degree or other similar title of this or any other University or examining body.

Place: Pune
Date:

Mr. Wani Babasaheb Kacharu
Research Student

CERTIFICATE

This is to certify that the thesis entitled**, "SPATIO-TEMPORAL CHANGES IN AGRICULTURAL PRODUCTIVITY IN AHMEDNAGAR DISTRICT OF MAHARASHTRA"** which is being submitted herewith for the award of the Degree of Vidyavachaspati (Ph. D.) in Geography of Tilak Maharashtra Vidyapeeth, Pune is the result of original research work completed by **Mr. Babasaheb Kacharu Wani** under my supervision and guidance. To the best of my knowledge and belief the work incorporated in this thesis has not formed the basis for the award of any Degree or similar title of this or any other University or examining body.

Place: Pune
Date:

Dr. Aher Ankush Bhaguji
Research Guide

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Abstract

Spatio-Temporal Changes in Agricultural Productivity in Ahmednagar District of Maharashtra

Development in agriculture plays an important role in every national economy - weather developing, developed or in-transition. It has remained an important source of food, fodder and raw material for number of industries. In the world near about fifty percent working population still depends on agriculture for employment. In developing countries agriculture and allied activities hold the potential for providing significant employment opportunities and overall economic growth as well as socio-economic development.

The present research work is a study of measurement of agricultural productivity and its spatial and temporal changes. The choice of an area and topic under investigation has been influenced by many considerations. The study region is located in rain shadow zone of western ghat has remarkably scanty rainfall, it affects on agricultural land use as well as productivity. The district is agriculturally imbalance, the valleys of river Godavari, Bhima and its tributaries are agriculturally advanced and other parts are agriculturally backward. There is high degree of diversification in physiography and soils due to this, district have quite disparities in agricultural productivity. There is high variation in distribution and density of non physical determinants such as irrigation, traditional and modern farm implements, technological input, agricultural credits etc.

Agriculture is the leading occupation and the main stay of the people living in the Ahmednagar district which is one of developing district of Maharsashtra. The district covers an area of 17048 sq. km. (5.66 per cent of the state) and lies in between latitudes 18°20'N and 19°59'N and longitudes 73°40'E and 75°20'E. The entire district comprises 14 tehsils. The district contains population 45, 43,083 which of them 79.90 percent residing in rural area. An average density of population is 267 persons per sq. km (census, 2011).

The district experiences four seasons, namely, summer, monsoon, retreating south-west monsoon and winter. The average annual rainfall in district is 578.8 mm, out of this about 77 percent receives during south west monsoon. The average maximum temperature is 33^{o} centigrade and minimum is 18.4^{o} centigrade. Temperature shows upward trend in March due to northward movement of sun. In the

month of May maximum temperature reaches up to 39.4° centigrade which is appreciable drop in onset of rainy season. The cold season starts from November and linger till February. District appear four types of soil namely, deep black, medium black, coarse shallow and red. The study region has observed two agricultural seasons namely, *kharif* and *rabi*. The major crops in district are jowar, bajra, wheat, sugarcane, cotton, groundnut, gram, tur, fodders and verity of vegetables.

There are spatio-temporal changes in the agricultural productivity in Ahmednagar district, which is a result of geographical, economical, technological and social factors which causing spatial inequalities in the agricultural productivity is the hypothesis of present research work.

The following are main objectives of present study

1. To trace the factors responsible for the changes in the agricultural productivity in the study area.
2. To study the changes in the general land use pattern in the study area.
3. To study the changes in the cropping patterns in the study area.
4. To assess the spatial and temporal patterns of agricultural productivity and changes in the productivity pattern.
5. To delimit the areas of low, moderate and high agricultural productivity in the study area.
6. To suggest the remedial measures for reducing the regional imbalance and maximizing the production and productivity.

The present research work is based on primary and secondary data sources. The primary data collected through questionnaires, personal interviews of farmers, field observations and group discussion with farmers. The secondary data for the years 1990-91 and 2010-11 has been obtained from various sources, namely, Socio-economic abstract of Ahmednagar district, District land record office, Agriculture department of each tehsil, Agriculture department of Maharashtra state Pune, District census, Department of irrigation, District agriculture department, Indian Metrology department Pune, Panchayat Sammittee of each tehsil and Talathi office of selected villages.

The collected data analyzed by applying different statistical techniques and presented through tables and figures. The spatio temporal pattern and volume of change of non physical determinants, general land use and agricultural land use have

studied in depth. The volume of change is significant or not that has been analyzed with the help of following formula.

$$\frac{\text{Sum of positive change} - \text{Sum of negative change}}{\text{Number of Values}}$$

Output of this equation is lower than actual change and that change is positively or negatively significant, if output is higher than actual change, then that change is insignificant.

To delineation of crop regions Doi's crop combination technique was applied. According to the objectives of the study, agricultural productivity is measured for the years 1990-91 and 2010-11by applying different seven indices. In each of the seven indices the aim is to measure the agricultural productivity from different angles by using different approaches. The major crops viz. wheat, jowar, bajra, other cereals, pulses, sugarcane, cotton, fruit and vegetables, oilseeds and fodders are considered for the productivity analysis. In some methods some crops are leave out. These indices are Kendall's ranking coefficient index, Bhatia's index, Standard Nutrition Unit index, Enyedi's index, Shafi's modified index, Calorie per Capita index, Sapre and Deshpande's index. To show the spatial variation in agriculture productivity the index values divided into three different categories i.e. high, moderate and low level of productivity with the help of statistical technique i.e. range.

On the basis of these seven productivity indices composite productivity regions worked out. For this all productivity indices maps are combined together with the help of GIS software i.e. Arc GIS. It output generate a map which shows composite productivity regions i.e. high, moderate and low. It was done for the years 1990-91 and 2010-11 separately.

Correlation coefficient technique is applied to find out the correlation between agricultural productivity and selected variables. For this, twenty two variables were carefully chosen. These variables represent the physio-socio-economic environmental conditions made up by some climatic elements, level of inputs and technology and demographic characteristics.

For the purpose of case study one sample village is selected from each productivity region and studied the aspects like demography, general and crop land use, livestock, non-physical determinants, production of crops and problems faced by farmers related to agriculture.

The present research has been arranged into eight chapters. The first chapter deals with introduction, various approaches to the measurement of agricultural productivity, choice of the topic and the region, objectives, data base, methodology and review of literature. The chapter second has attempted to present the physical background of study region with respect to location, physiography, climatic characteristics, drainage pattern, types of soil and natural vegetation. Chapter third deals with density, distribution and volume of change in various non-physical determinants which are influence the agricultural productivity. In chapter four examine the spatial and temporal pattern of general landuse and volume of change from 1990-91 to 2010-11. The chapter five has assessed spatial and temporal pattern of agricultural landuse and volume of change in selected crops namely, jowar, bajra, wheat, other cereals, pulses, oilseeds, sugarcane, cotton, fruits, vegetables, condiments and spices and fodders. The chapter six has studied the measurement of agricultural productivity by applying seven productivity indices for the year 1990-91 and 2010-11. It also espouses the composite productivity regions and quantitative analysis of agricultural productivity. The chapter seven has studied the case studies of three sample villages which are representative of high, moderate and low productivity region. In last chapter summaries the observations and gives possible suggestions for planning and development.

In study region during the period of investigation, net irrigated area increased by 5.05 percent. The traditional farm implements such as iron plough, wooden plough and oil engines density per hundred hectare of net sown area was decreased by 4.07, 0.78 and 0.06 respectively while the density of modern farm implements such as tractor and electric pump was increased by 0.76 and 0.3 respectively. Irrigated parts of district recorded significant positive change in density of modern farm implements.

The percent contribution of cattle to total livestock population was decreased because of reduced demand of draught cattle in agriculture. The percentage share of buffaloes and goat and sheep in total livestock was increased by 4.46 and 8.20 percent respectively while share of other livestock declined by 6.40 percent.

Crude and physiological density of population noticed positive change in all tehsils while agricultural density of population registered negative change in Nagar tehsil and rest of the tehsils noticed positive change. The distribution pattern of population varies between tehsil to tehsil leading to inter tehsil disparities in

agricultural productivity. Northern high irrigated tehsils have used high amount of improved seeds and chemical fertilizers than south and south-western part of district.

During the period of two decades net sown area has increased by only 0.48 percent to total geographical area. This situation suggests that horizontal expansion of agriculture is not significant because of the limited area available for agriculture. Expansion of agriculture productivity is the only way for transforming agriculture of the district by applying all the modern inputs of agriculture in right quantity and at the right time.

The temporal pattern of volume change in area of sugarcane (5.94 percent), other cereals (1.03 percent), fruits, vegetables, condiments and spices (3.66 percent), cotton (7.49 percent) and fodder crops (1.33 percent) found significant positive change while significant negative change found in area of jowar (9.99 percent), bajra (1.21 percent), wheat (0.44 percent), pulses (0.97 percent) and oilseeds (6.83 percent). This change indicates that the farmers have changed their attitude from food crops to cash crops.

Crop combination result shows that number of crops in combination has increased southward to north. It means that increase the intensity of irrigation increases the number of crops in combination. This situation suggests growing variety of crops in district to fulfill the demand of growing population by increasing irrigation facility.

The results of productivity indices revealed that there are more or less similar pattern of agricultural productivity. Although changes in agricultural productivity are not uniform and there is variation among the different tehsils of district. These variations are due to the variation in the physical and non physical determinants. The availability and use of physical and non physical determinants in all the tehsils is not uniform and so is the productivity.

On the basis of composite productivity during the period of investigation seven tehsils has recorded change in their productivity level. The negative change noticed in four tehsils namely, Nagar, Shrirampur, Nevasa and Karjat while positive change found in tehsils of Shevgaon, Sangamner and Kopargaon. Rest of the six tehsils namely, Rahuri, Pathardi, Jamkhed, Shrigonda, Parner and Akole noticed no change in their productivity level.

The results of correlation coefficient technique shows that there is a significant positive correlation of agricultural productivity with various variables such as tractors,

electric pumps, irrigation, rural literacy, crude density of population, physiological density of population, agricultural density of population, chemical fertilizer, high yielding variety of seeds and agricultural credits.

Sample villages namely, Nandurkhi (Kh), Belpandhari and Jakhangaon are the representative of high, moderate and low agricultural productivity regions respectively. In village Nandurkhi (Kh) 100 percent area is irrigated while Belpandhari and Jakhangaon registered 72.10 and 34.52 percent respectively. The cropping pattern of these villages is governed by various physical and non physical variables. In *kharif* season in village Nandurkhi (Kh), Belpandhari and Jakhangaon recorded 100, 91.29 and 70.30 percent area under various crops respectively. In this season soyabean is the first ranking crop in village Nandurkhi (Kh), sugarcane and bajra recorded first rank in village Belpandhari and Jakhangaon respectively. During *rabi* season wheat take lion share in village Nandurkhi (Kh) while in village Belpandhri and Jakhangaon sugarcane and jowar are the first ranking crops respectively.

The finding of this research verifies hypothesis that the spatio-temporal changes in agricultural productivity in Ahmednagar district is a result of variation in physical and non-physical determinants.

It is hoped that, analysis and findings of present study may help to provide valuable information for further studies, planning and applications. It is also helpful to find agricultural backward area for proper agricultural planning and to increase agricultural productivity. The results of present study become useful tool to find suitable crops according to suitability and availability of physical and non physical variables.

CHAPTER-I

INTRODUCTION

1.1 General Introduction

Development in agriculture plays an important role in every national economy - weather developing, developed or in-transition. It has remained an important source of food, fodder and raw material for number of industries. In the world near about fifty percent working population still depends on agriculture for employment. In developing countries agriculture and allied activities hold the potential for providing significant employment opportunities and overall economic growth as well as socio-economic development. India's economic development substantially rests on agriculture that employs 58.5 percent of country's work force and it contributes about 20 percent Gross Domestic Product (GDP) (Shah, R. K. 2014).

Indian agriculture seems to be the three phases of where the nature of agriculture has been shifted i.e. post independence period (1950-51 to 1965-66), the green revolution and modernization of Indian agriculture (1966 to 1990) and the period of reforms and new trade agreement of WTO. The agriculture reshuffles have long term impact on the agriculture sector of the country. It can be assess through shift in cropping pattern from mono cropping to multi cropping system, crop diversification from food-grains to non-food crops. Increase in institutional irrigation facilities and the incremental flow of institutional credit to agriculture sector in general and particularly during the post green revolution period and changes in landholding and land-use pattern in the agriculture sector. These changes, both in policy and technology have contributed to increase in production and productivity of the agriculture.

The implementation of the modern technologies, use of high yielding varieties of seeds and chemical fertilizers has shifted the agriculture status from food shortage and begging bowl to food self sufficiency, buffer stock and food export (RBI, 2009). Due to this boost the agro-based industries, employment, income generation, transport and communication, education and health facilities and thereby increase in standard of living of rural masses (Naidu and Venkatalakshmi 2007). All above drastic change in agriculture is the result of change in the attitude of farmers is equally important.

In India after independence efforts has been taken to self sufficient in agriculture through five year plans. Due to the unique importance of agriculture, it gets more importance and top priority in every five year plans. Even though, agriculture is not developed evenly in country because of agricultural development

process is not properly channelized, uneven distribution of rainfall, inequalities in basic agriculture infrastructure and imbalance allocation of resources.

The green revolution is succeeded only where the irrigation facilities are available. Every possible effort taken by government through five year plans but small farmers could not get the benefit of green revolution. It creates large gap between small and big farmers and also the gap between irrigated and reinfed area (Narkhede, D. S. 2010). This situation creates the regional imbalance. To overcome this problem systematic planning in agriculture is more essential. Form this point of view the detail information of the region regarding agriculture is necessary. The research in agricultural geography can be useful to solve the problems of regional imbalance or imbalance within region and helpful to planning for sustainable agricultural development. Keeping this view present exposition has an attempt to study the spatio-temporal changes in the agricultural productivity in Ahmedanagar district for the better planning and development of agriculture.

1.2 The Concept of Agricultural Productivity

The concept of agricultural productivity is defined by several geographers and economist. In general, agricultural productivity means output per unit of input or per unit of area respectively. The growth in agricultural productivity is generally the result of a more efficient use of the variables of productions namely, physical environment, arable land, labour, capital etc. The regional differences in agricultural productivity are the result, partly of the natural advantages of abiotic environment (soil and climate) and partly of farming efficiency as controlled by cultural ecology (Chaudhuri, T. 2012).

Bhatia, S. (1967) defined 'agricultural efficiency as the aggregate performance of various crops in regard to their output per acre but the contribution of each crop to the agricultural efficiency would be relative to its share of the crop land'.

Shafi, M. (1960) defined agricultural productivity as the 'ratio of output to input in relation to land, labour, capital and overall resources employed in agriculture'

Singh, V. (1979) defined agricultural productivity as the 'quantity of return from arable land'. He argued that quantity of product denotes its intensity and the spatial expansion. The productivity of crop is a function of many factors including the physiographical, socio-economic, technical and organizational.

Above definition express different views. The agricultural productivity is a difficult theme, both in concept and in terms of measurement of its level. Therefore, any definition that is adopted is bound to suffer from certain weaknesses.

1.3 Measurement of Agricultural Productivity

Measurement of agricultural productivity is more complex because of the inter-dependence of number of factors such as physical, socioeconomic, political, institutional and organizational. However, various scholars in the field of geography have introduced different methods to measurement of agricultural productivity in India as well as in different parts of the world.

Thompson, R. J. (1926)

Thompson was the first in the field of measure the agricultural productivity. He measured relative agricultural productivity in Britain and Denmark considering gross output of crops and livestock by selecting seven parameters, these parameters are yield per acre of crops, livestock per hundred acres, gross production or output per hundred acres, proportion of arable land, number of persons employed, cost of production expressed in terms of wages and labour costs, rent or interest, price relative profitability and general economic conditions.

Ganguli, B. N. (1938)

Ganguli measured agricultural productivity by considering the area under any crop ‘x’ in a particular unit area belonging to a certain region. This area is expressed as a proportion of the total cropped area under all the selected crops. For obtain the index number of yield of a crop divided the yield per hectare for the entire region under study as the standard. This yield may be expressed as a percentage and that percentage may be regarded as the index number of yield. Then the proportion of the area under crop ‘x’ and the corresponding index number of the yield were multiplied. The product thus obtained indicates actually an index of the contribution of the crop ‘x’ to the productivity of the region considered (Hifzur, Rehman. 2003).

Kendall, M. G. (1939)

Kendall treated crop productivity measurement as a mathematical problem and identified a system of four coefficient i.e. Productivity coefficient, Ranking coefficient, Money value coefficient and Energy coefficient. For determining the productivity by productivity coefficient, money value coefficient and energy coefficient poses mathematical and practical difficulties, therefore, he evolved a

method of ranking coefficient. For the purpose of ranking coefficient, Kendall took the acre yield of selected crops. The acre yields of the selected crops were then arranged in descending order for each region/ unit and the places occupied by each region/ unit with respect to the selected crops were then averaged and thus the ranking coefficient indicating agricultural efficiency of each region/ unit was obtained. Kendall took into account only the rank of the crop according to per hectare yield, neglecting its areal strength. It is the weakness of this method.

Stamp, L. D. (1958)

Stamp measured agricultural productivity by converting the total agricultural production of different crops in calorie value. The calories intake is a measure of the general health of a person because it determines the amount of energy needed by the human body. The British Medical Association on the basis of exhaustive enquiry published a table showing a range of desirable calorie intake among adults from 2100 calories a day for a woman in sedentary occupation to 4250 calories for a man engaged in active manual work. For children, the desirable intake is calculated as 800 calories a day for infants under one year, and 3400 calories for teenage boys. Taking into consideration the age structure of the population, the range of occupation, the weight and height of the people living under climatic conditions of north Western Europe, the average is 2460 calories a day or about 9, 00,000 calories per year. Stamp called it is a 'Standard Nutrition Unit'.

Enyedi (1964)

Enyedi, while describing geographical types of agriculture in Hungary refers to a formula for determining agricultural productivity. Enyedi's method is appreciable the sense that it determines the productivity index of an area with reference to national level. However, the technique does not consider that in certain cases the productivity index is influenced by the magnitude of the area under a particular individual crop. Beside, when the district yield is less than the national yield, its productivity index is higher than the national level (Singh, J and Dhillon, S. 1989).

Sapre and Deshpande (1964)

Sapre and Deshpande introduced technique, giving weightage to the ranking order of the output per unit area with the reference share under each crop. They have, in fact, modified the ranking coefficient (Kendall's) approach by giving weightage to the area under different crops. They have used the weighted average of ranks instead of simple average of ranks. The weighted rank of various crops is proportionate to the

percentage of cropland under each crop. The weighted average of ranks seems to have an inherent weakness regional strength of crop. They applied this modified method for Maharashtra.

Shafi, M. (1960)

Shafi applied ranking coefficient technique of Kendall for measuring the agricultural efficiency of Uttar Pradesh in India. He took the per unit area yields of eight food crops grown in each of the forty-eight districts of the state. He applied this method for the years 1952 and 1957.

Bhatia, S. S. (1967)

Bhatia modified Ganguli's (1938) technique and examine the changes and trends of progress during 1953-1963 in agricultural efficiency in the districts of Uttar Pradesh.

Singh, J. (1972, 1974)

Singh, J. modified Stamp's (1958, 1967) technique, the carrying capacity of land in term of population and developed most useful technique to measure agricultural efficiency, which consist of the measurement of carrying capacity per unit area in term of population in relation to output per unit area.

Singh, J. (1976)

Singh introduced technique to measure agricultural productivity in order to assess the regional variations in the level of food production and delimit the backward areas from the point of view of agricultural production is enough to focus attention only on the important food crops of a region or country laying in the Oriental World since they are the dominant, primary and secondary crops in terms of agricultural land occupancy. The average food crop yields and proportion of these crops in the total harvested area have been used as twin-elements for measuring the index of the level of food production. For measurement of the level of agricultural productivity, the relative crop yield and concentration indices arranged in ranking order and computed into average ranking coefficients, would give a measure which one may call the crop yield and concentration indices ranking coefficient (Chaudhuri, T. 2012).

Singh, V. R. (1979)

Singh introduced advanced technique to delimiting agricultural productivity by computing intensity and spread indices of three variables. These variables are yield, grain equivalents and cropping system.

The above methods are useful for finding the agricultural productivity of region or country. It also may help to identify weaker areas for agricultural planning and finding reliable solution for sustainable agricultural development.

1.4 Choice of the Region and Topic

The choice of an area and topic under investigation has been influenced by following consideration.

a) Study region is located in rain shadow zone of western ghat has remarkably scanty rainfall, it affects on agricultural land use as well as productivity.
b) The area selected for the study is agriculturally imbalanced region. The valleys of various tributaries of Godavari and Bhima rivers agriculturally advanced and other parts are agriculturally backward.
c) From the physiography point of view, there is high degree of diversification in the district. The whole district may be conveniently divided into three physiographic region i.e. hill ranges, plateau and plains, due to this, district have quite disparities in agricultural productivity.
d) The distribution of soils in the district displays a high degree of heterogeneity. Deep black soils are distributed along with bank of major rivers and its tributaries. Medium black soils found in the plateau region, coarse shallow soils found in the hilly region and red soil is found in hilly and high rainfall area in west part of the district.
e) From the irrigation point of view, northern parts of the district have high irrigated area compare to southern parts of the district. It has considerable impact on agricultural land use and productivity.
f) Technologically there are large variation in density and distribution of modern farm implement, infrastructure facilities, use of high yielding seeds and fertilizers. This variation influence on cropping pattern as well as agriculture productivity.
g) From the population point of view, district occupied 17048 km² geographical area having population 45, 43,083 (2011). Out of this 79.90 percent population residing in rural area. Agriculture is the major claimant of workforce and source of income of rural masses.

h) This region has not so far studied deeply from the agricultural point of view by geographers and remains still untouched for proper agricultural planning as a whole.

i) Such type of study is helpful for understanding the spatio-temporal changes in agricultural productivity within the study region and also it may help in identifying advance and weaker areas for sustainable agricultural development.

Thus, due to high degree of intra district disparity as well as diversity, Ahmednagar district may be considered to be quite suitable for a study of spatio temporal changes in agricultural productivity.

1.5 The Study Area

For the present study Ahmednagar district of Maharashtra has been selected as a study area. It extends between 18° 20´ to 19° 59´ north latitudes and 73° 40´ to 75° 43´ east longitudes (fig.1.1). For administrative purpose district is divided into 14 tehsils. It situated partly in the upper Godavari basin and partly in the Bhima basin. The district is very compact in shape, north- south length of 210 km. and east-west width of 200 km. The study region is divided into three physical divisions, namely, Sahyadri hill ranges i.e. Kalsubai, Adula, Baleshwar and Harishchandragad, plateau and plains. It is bounded by Nashik and Aurangabad district to the north side, south side by Solapur and Pune district, east side by Beed and Osmanabad district and the west side by Thane and Pune district. The river Godavari, Bhima and their tributary (Pravara, Mula, Dhora, Ghod, Kukadi and Sina) are the main rivers in district. The discharge of rivers is mainly depending on high rainfall in western ghat.

The district experiences four seasons, namely, summer, monsoon, retreating south-west monsoon and winter. The average annual rainfall in district is 578.8 mm, out of this about 77 percent receives during south west monsoon season. The average maximum temperature is 33º centigrade and minimum is 18.4º centigrade. Temperature shows upward trend in March due to northward movement of sun. In the month of May maximum temperature reaches up to 39.4° centigrade which is appreciable drop in onset of rainy season. The cold season starts from November and linger till February. The district appears four types of soil, namely, deep black, medium black, coarse shallow and red soil. In study region 70.28 percent area under cultivation, out of this 29.42 percent is irrigated. The economy of the district mostly depends on agriculture.

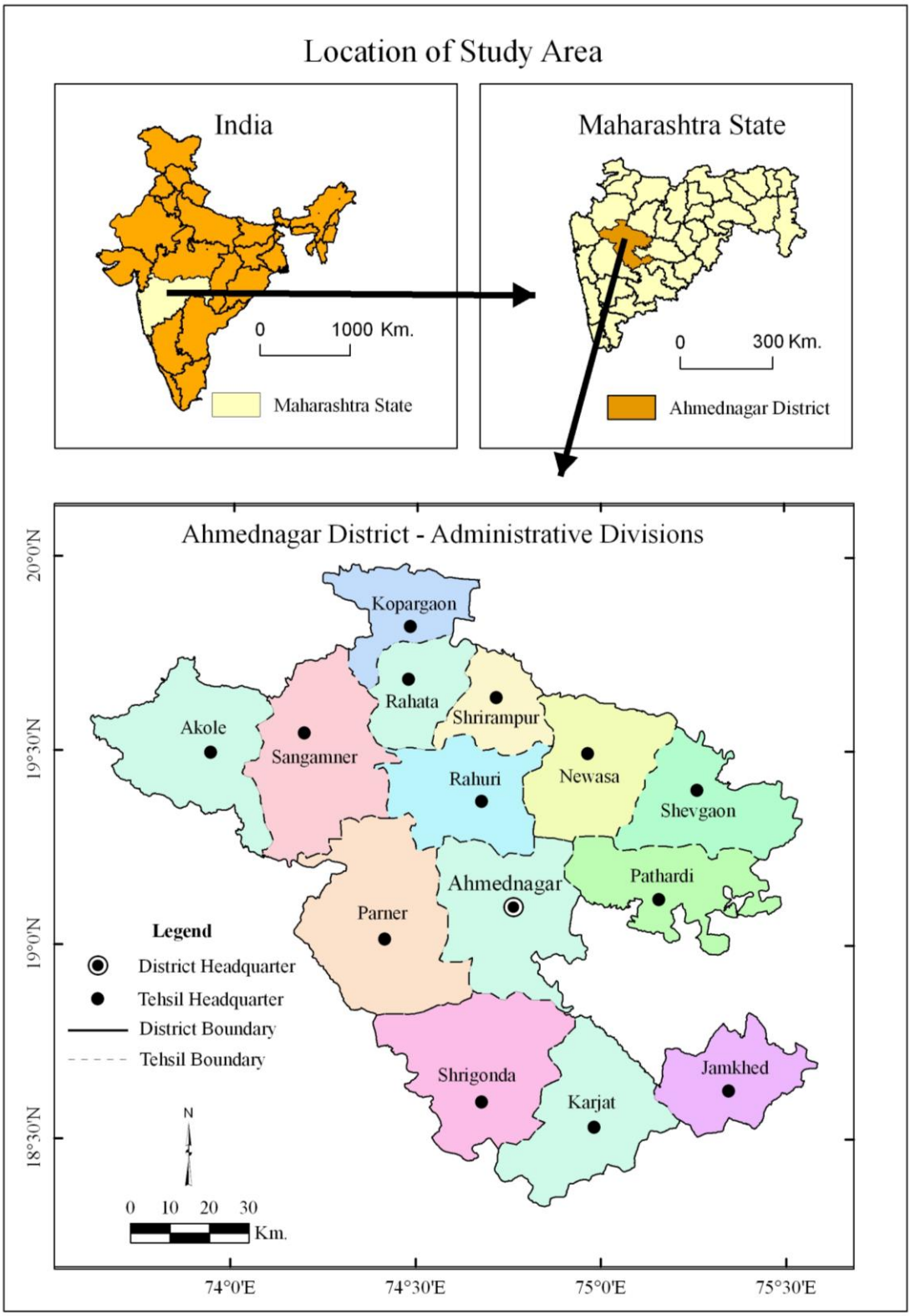

Location of Study Area
India
0
1000 Km.
Maharashtra State
Maharashtra State
0
300 Km.
Ahmednagar District
Ahmednagar District - Administrative Divisions
Kopargaon
Rahata
Shrirampur
Akole
Sangamner
Rahuri
Newasa
Shevgaon
Pathardi
Ahmednagar
Parner
Shrigonda
Karjat
Jamkhed
Legend
District Headquarter
Tehsil Headquarter
District Boundary
Tehsil Boundary
N
0 10 20 30
Km.
20°0'N
19°30'N
19°0'N
18°30'N
74°0'E
74°30'E
75°0'E
75°30'E

Fig: 1.1

Cropping pattern of district is different in irrigated and rain fed area. The rivers and its left and right canals is the source of irrigation as well as Well irrigation is commonly used. Sugarcane is the predominant crop in the rivers basin and canal command areas. In *kharif* season bajra, maize, pulses, cotton, oilseeds i.e. groundnut and soyabean, etc. are grown and wheat, jowar, maize, gram, onion, sunflower are grown in *rabi* season.

1.6 Hypothesis

There are spatio-temporal changes in the agricultural productivity in Ahmednagar district, which is a result of geographical, economical, technological and social factors which causing spatial inequalities in the agricultural productivity.

1.7 Objectives

Present research work has study the spatio-temporal changes in the agricultural productivity in Ahmednagar district. This broad objective can be broken into the following main components.

1. To trace the factors responsible for the changes in the agricultural productivity in the study region.
2. To study the changes in the general land use pattern in the study area.
3. To study the changes in the cropping patterns in the study area.
4. To assess the spatial and temporal patterns of agricultural productivity and changes in the productivity pattern.
5. To delimit the areas of low, moderate and high agricultural productivity in the study region.
6. To suggest the remedial measures for reducing the regional imbalance and maximizing the production and productivity.

1.8 Sources of Data and Methodology

The present study is based on primary and secondary sources of data. The primary data collected through questionnaires, personal interviews of farmers, field observations and group discussion with farmers. The secondary data for the years 1990-91 and 2010-11 has been obtained from various sources, namely, Socio-economic abstract of Ahmednagar district, District land record office, Agriculture department of each tehsil, Department of agriculture Maharashtra State Pune, Census (1991 and 2011), Department of Irrigation, District agriculture department, Indian

Metrology department Pune, Panchayat Sammittee of each tehsil and Talathi office of selected villages.

In the first phase of the research primary and secondary data was collected. The collected data analyzed by applying different statistical methods and is presented through tables and figures. The spatio temporal distribution pattern and volume of change of non physical determinants, general land use and agricultural land use have studied in depth.

The volume of change in spatial and temporal pattern of various non physical determinants, general and agricultural land use is significant or not, that has been analyzed with the help of following formula.

$$\frac{\text{Sum of positive change} - \text{Sum of negative change}}{\text{Number of Values}}$$

Output of this equation is lower than actual change and that change is positively or negatively significant, if output is higher than actual change then that change is insignificant.

To delineation of crop regions Doi's crop combination technique was applied. According to the objectives of the study, agricultural productivity is measured by using different seven methods i.e. Kendall's Ranking Coefficient index, Bhatia's productivity index, Standard Nutrition Unit index, Enyedi's productivity index, Shafi's modified index, Calorie per Capita index, Sapre and Deshpande's index. The index values divided into three different categories i.e. high, moderate and low productivity regions with the help of statistical technique i.e. range and maps were prepared.

These indices shows more or less similar pattern of agricultural productivity in the study region. So far as agricultural productivity is concerned there is not a single universally accepted method of measuring agricultural productivity. Therefore, it is decided to examine composite productivity regions. For this, all these productivity indices maps are combined together with the help of GIS software i.e. Arc GIS. Its output generates a map which shows composite productivity regions i.e. high, moderate and low. It is done for the years 1990-91 and 2010-11 separately.

Further correlation coefficient technique was applied to find out the correlation between agricultural productivity and selected variables. For the purpose of case study one sample village selected from each productivity region and studied

the aspects like general and crop land use, productivity and problems faced by farmers related to agriculture.

1.9 Review of Literature

The problems related to agriculture productivity attract the attention of scholars in field of agricultural geography and agricultural economics. They use different methods to work out agricultural productivity at micro or macro level to understand problems and formulating development programmes for the same.

Brij, Kishore (1981) has examine inter district regional variation in agricultural productivity of Gurgaon district of Haryana taking two period of time i.e. 1962-65 and 1972-75. This period has selected with a view to capture the effect of green revaluation on agricultural productivity. The agricultural productivity was measured in two way (a) physical productivity and (b) productivity in gross value terms. Researcher examined the role of physical environment and institutional factors in the determinants of the level and growth of agricultural productivity.

Date, V. S. and Pawar, N. S. (1988) carried micro level study of agricultural productivity with the help of two sample villages in Pune distract of Maharashtra. Correlation and multiple regression techniques were used in order to measure significance of the variables and their associations with productivity of four important crops viz. jowar, bajra, wheat and sugarcane. The productivity regions demarcate on the basis of index values and suggested suitable crop regions.

Vaid Varsha (1989) worked on spatio - temporal analysis of agricultural productivity of Maharashtra. She has used seven methods to compute agricultural productivity i.e. Kendall's ranking coefficient, Bhatia's productivity index, Shafi's modified productivity index, Standard nutrition unit index, Calories per head of total population, Money returns per hectare of crop land and Money returns per agricultural worker. She used tehsil wise data of selected crops for the period of 1972, 1978 and 1985. On the basis of statistical technique productivity index grouped into five categories to demarcate agricultural productivity regions.

Mohammad, N. and Raza, M. (1992) studied agricultural productivity in India based on agricultural metrological data. They used agricultural productivity regions worked out and delineated by Raza, M. (1981). In this study they found the positive correlation between number of metrological stations and agricultural productivity and

also suggest timely information regarding various elements of climate for better agricultural planning which lead to high agricultural productivity.

Mohammad, N. and Majeed, A. (1992) worked out agricultural productivity in twelve arid district of Rajasthan to analyze the impact of green revolution on agricultural productivity. The agricultural productivity of each district has been worked out in value added term i.e. the whole agricultural output of the district has been converted into monetary value divided by total cropped area of the district. On the basis of index values agricultural productivity regions were demarcate. To assess the contribution of various physical and non physical determinants in agricultural productivity linear regression technique has applied. Same way Mohammad, N. and Thakur, R. (1992) worked out regional variation in agricultural productivity of Bihar.

Mohammad, N. (1992) has attempted to find out the association between various non physical determinants and agricultural productivity of Uttar Pradesh. Agricultural productivity was measured by applying money value method (money value of agricultural output minus money value of agricultural input). To find the association, non physical determinants such as age composition, social position, size of holding, level of education, family size, level of innovativeness, caste and level of knowledge was considered.

Munir, A. (1992) has work on two analytical concept (i) agricultural productivity and (ii) level of regional development for four district (Deoria, Gorakhpur, Basti and Gonda) of Uttar Pradesh. The regional pattern of agricultural productivity has examined by applying five indices of productivity i.e. Bhatia's productivity index, Shafi's productivity index, Standard Nutrition Unit per hectare, Agricultural output in Rs. per hectare and Agricultural output in Rs. per agricultural workers. On the basis of productivity indices composite index of agricultural productivity worked out. The regional pattern of level of development have examined by using four variables such as agricultural development, urbanization and industrialization, infrastructure and amenities and social development with the help of this parameters composite index of level of development was worked out. On the basis of two concepts (agricultural productivity and level of development) agricultural regions demarcate. The level of agricultural productivity and level of development is tested by applying correlation and coefficient of determinants.

Patil, A. A. (2000) worked on changes in agricultural productivity in Upper Bhima and Upper Krishna basins in Maharashtra. He used six method to find out the

agricultural productivity i.e. Kendall's ranking coefficient, Bhatia's productivity index, Standard Nutrition Units, Calories per capita index, Money value index and Enyedi's index. On the basis of these productivity indices aggregate productivity and productivity regions demarcate of study region.

Gambhire, D. B. (2000) has work on agricultural productivity in Osmanabad district of Maharashtra for the period of 1980-81 to 2004-05. He applied Bhatia's index for crop concentration, Jasbir Singh's index for crop diversification and Jasbir Singh's crop yield and concentration indices ranking coefficient technique for analyze spatial and temporal variation agricultural productivity.

Hifzur, R. (2003) has studied on energy efficiency and agricultural productivity in Aligarh district of Uttar Pradesh. He has selected 122 villages belonging 17 different development blocks in 6 tehsils of the Aligarh district for collection of primary data. He worked out the crop productivity based on energy use in pre and post harvesting operations and productivity region were demarcate i.e. high, moderate and low.

Rehman, A. (2004) has worked on role of technology for sustainable agriculture development in Rohilkhand region of Utter Pradesh. He worked out productivity indices of 18 major crops in 90 development blocks of seven districts on the basis of Yang's Crop Yield index for the period of five successive years 1995-96 to 1998-99 on an average basis. Level of agriculture development determined with the help of Composite Index. Correlation technique has been used to find out the relationship between agricultural productivity and various non physical determinants. He suggested eco-friendly technology to sustainable agriculture development.

Mir, G. M. (2006) has estimated the agricultural productivity based on irrigation efficiency in central Asian states. He used correlation technique and found the positive correlation between irrigation efficiency and agricultural productivity. On the basis of findings he suggested central Asian states have much potential for improving their irrigation efficiency and have increased the crop productivity.

Munir, A. and Taufique, M. (2006) have conducted study on agricultural productivity regions of Utter Pradesh based on cereals, pulses, cash and oilseed crops. They used composite index to examine the regional disparities in agricultural productivity of selected crops.

Singh, S. B. and Kareriya, B. R. (2006) have worked on agricultural productivity of Lumbini zone of Nepal using Shafi's (1972) method. On the basis of

findings, he suggested the urgent need of proper management of natural and human resources for the increase of agricultural productivity of study region.

Hifzur, R. *et el* (2008) examine spatial variation in crop productivity of Ganga-Yamuna Doab using Yang's (1965) crop productivity index. They worked out the crop productivity and changes in productivity pattern of major crops (grouped under cereal, oilseeds, pulses, and cash crops) grown in 23 district of Ganga – Yamuna Doab during period of 1990-94 and 2000-04. To show the spatial variation in crop productivity regions index values divided into three different categories i.e. high, moderate and low and suggest remedial measures to overcome the inter-district disparities.

Navneet, S. (2008) has analyzed the spatial variation in agricultural productivity of Bulandshahr district of Utter Pradesh. He studied the general and agricultural landuse pattern and changes therein during the period of 1984-85 to 2004-05. He has used Yang's crop yield index and agricultural output per hectare of cropland (price weighted) for measurement of agricultural productivity.

Chand, Ramesh *et al* (2009) have examined regional variation in agricultural productivity of India for the period of 2003 - 04 and 2004 - 05. Researchers worked out agricultural productivity on the basis of distribution of rainfall and use of non physical determinants such as irrigation and fertilizer per hectare of net sown area. Analysis of this study highlighted that 191 and 66 district of India found low and very low productivity respectively this situation clearly calls for a regionally differentiated strategy for future better growth and development of agriculture sector of India.

Ghodke, B. D. (2009) has studied agricultural productivity in Daund tahasil of Pune district by applying Enyedi's (1964) productivity index to determine productivity of selected crop such as jowar, bajra and sugarcane. His study is bases on primary data source. He has selected six villages namely, Koregaon, Tamhanwadi, Kusegaon, Betwadi, Mergalwadi and Watluj to represent the whole tehsil. On the basis of productivity index he suggested suitable regions for each crop.

Adnaik, N. S. (2010) has worked on the spatio-temporal changes in agricultural productivity of drought prone region of Maharashtra. He used seven parameters to measure agricultural productivity i.e. Kendall's ranking coefficient index, Bhatia's productivity index, Standard Nutrition Unit, Enyedi's productivity index, Shafi's modified index, Calorie per capita index, Sapre and Deshpande's index.

On the basis of seven productivity indices aggregate productivity was worked out and productivity regions were demarcate as very low, low, medium, high and very high level of productivity.

Kasid, D. L. (2010) worked out agricultural productivity in Sindhudurg district of Maharashtra. He analyzed annual average trend of production for selected years i.e. 1981-82 to 1983-84 and 2004-05 to 2006-07 for selected crops i.e rice, ragi, vari, pulses, sugarcane, spices and condiments, fruits, vegetables, oilseeds and fodder. He measured the compound growth rate and co-efficient of variance on the basis of crop yield and shown spatial and temporal imbalances in agricultural productivity of study region.

Gangaiah, C. (2011) has analyzed linear and compound growth rate of area, production and productivity of horticulture crops in Kadapa district of Andhra Pradesh.

Saha, S. (2011) has worked on the spatio-temporal change in agricultural productivity in Birbhum district (West Bengal). He has applied Jasbir Sihgh's crop yield and concentration indices ranking coefficient index to find out spatio temporal changes and block wise disparity in agricultural productivity for the period of 2002-03 and 2007-08. He considered five major crops namely rice, wheat, potato, oil seeds and pulses which is widely grown in study region. On the basis of productivity index values study region demarcate as high, moderate, low and very low level of productivity.

Tallalli, B. G. and Nagaraj, H. (2012) have worked out the agricultural productivity of Karnataka State. The productivity index of crops for each district is worked out by Yang (1965) formula. They worked out composite index according to productivity values for showing the regional disparities in agricultural productivity.

Choudhuri, T. (2012) has worked on land use and agricultural productivity of Malda district of West Bengal. She has use Enyedi's productivity index to measure productivity of selected crops i.e. cereals, pulses and cash crops. On the basis of productivity index regions were demarcate and suggested steps has taken to increase productivity of backward tehsils.

Jena, D. (2012) has studied the agricultural productivity in Kalahandi district of Orissa by applying Composite Productivity Index (CAPI) formulated by Bhatia, S. S. (1967) for the period of 27 years (1980-81 to 2006-2007). For purpose of analysis

crop grouped in three categories i.e. cereals, pulses and oil seeds. On the basis of CAPI values the years was grouped in five categories such as very high, high, medium, low and very low productivity level.

Moteebennur, S. S. (2012) has determine tehsil wise variation in agricultural productivity of major food crops in Dharwad district of Karnataka by applying Kendall's ranking coefficient index for the year 2008-09. To demarcate productivity region index values grouped in to three categories namely, high, moderate and low on the basis of mean and standard deviation technique.

Ogle, S. B. (2013) has studied the spatio-temporal analysis of agricultural landuse and productivity in Baramati tehsil of Pune district. He used Enyedi's (1964) method to find out the productivity of selected crops i.e. jowar, wheat, bajra and sugarcane. His study is based on primary data source. He selected only six villages to represent the whole tehsil. On the basis of productivity index study region was divided into three productivity regions and suggested the areas which are more suitable of particular crops.

1.10 Out Line of Work

The thesis is divided into eight chapters. The first chapter deals with the introduction of the entire research work. It describes the conceptual framework and various approaches to the measurement of agricultural productivity, the problem, choice of the research topic and the region. It also presents the hypothesis, objectives of research work, methodology and database. A detailed review of the previous research work related to the agricultural productivity and limitation of study has been presented in the chapter.

In the second chapter physical setting of the study region is carried out. It includes location, physiography, climatic characteristics, drainage pattern, types of soil and natural vegetation of the study region.

Chapter third deals with spatio-temporal pattern and volume of change in non physical determinates such as irrigation, traditional and modern farm implements, livestock population, demographic factors i.e. literacy, population density i.e. crud density of population, physiogical density of population and agricultural density of population, high yielding variety of seeds, chemical fertilizer, Market centers, agricultural credit and Government policies related to agriculture.

Chapter four includes the study of the spatio-temporal analysis of general land use pattern and volume of change from 1990-91 to 2010-11. The general landuse

categories such as forest cover, land not available for cultivation, cultivable waste, fallow land and net sown area has been considered for present analysis.

The cropping pattern of the study region with distribution patterns of major crops (jowar, bajra, wheat, other cereals, pulses, sugarcane, oilseeds, cotton, fruits, vegetables, condiments and spices and fodder) and volume of change therein within the period of investigation has been analyzed in chapter five.

Chapter six presents the seven selected indices used for the measure of agricultural productivity in the study region for the years 1990-91 and 2010-11. It also contains the agricultural productivity regions delineated according to each of these seven indices. It also included the composite productivity region. This chapter also espouses relationship of agricultural productivity and physical, socio-economic, technical and cultural variables. The significance of these variables has been determined by the use of statistical technique i.e. correlation co-efficient.

The chapter seven is the study of land use pattern and agricultural productivity of selected sample villages. The last chapter summarizes the observations and suggestions.

1.11 Limitations of Study

The present research work is spatio-temporal changes in agricultural productivity in Ahmednagar district of Maharashtra. There are a few limitations to the present research these are, tehsil Rahata has been created in 1997 due to this changing pattern of general landuse and agricultural landuse has not shown in this tehsil. The data regarding high yielding variety of seeds and use of chemical fertilizer not available for the year 1990-91 due to this limitation researcher studied only the data of 2010-11. All principle crops are not included in some methods which are applied to measure the agricultural productivity because of non availability of complete data related to them. Beside this additional output or values of crops such as fodder and by products data not available due to this productivity of agriculture is measure by only applying yield and area data. During the sample village survey farmers were not able to give proper information of previous data regarding cropping pattern, use of inputs and output per acre / hectare hence researcher has confined sample village study for single year.

CHAPTER - II

PHYSICAL SETTING OF STUDY REGION

2.1 General Introduction

The concept of environmental determinism is better appreciated in the realm of agricultural geography than any other field of discipline. Agricultural land use and productivity of an area cannot be elaborated without knowing the geographical background of region. Geographical background consist the relief, soils, climate and hydrographic conditions. It has very important effects on the cultivation of crops and preference of a particular agricultural system (Singh, J and Dhillon, S.S. 1989). Therefore, the objective of this chapter is to examine the characteristics of relief, climate, soil, drainage and natural vegetation of Ahmednagar district, which is the most developing district of Maharashtra and heavily depends on agriculture.

2.2 Location, Site and Situation

Ahmednagar district is located partly in the upper Godavari and partly in Bhima basin which is the major river system of Maharashtra. It is the biggest district of Maharashtra state. It lies between 18^0 20´ north to 19^0 59´ north latitudes and 73^0 40´ east to 75^0 43´ east longitudes having length of 210 kilometers and 200 kilometers width occupying 5.66 percent geographical area of Maharashtra state. Geographically, the region covers 17048 square kilometer geographical area. Out of this 391.5 square kilometer is urban area and remaining 16,656.5 square kilometer is rural. It is bounded by Nashik and Aurangabad district to the north side, south side by Solapur and Pune district, east side by Beed and Osmanabad district and the west side by Thane and Pune district. Ahmednagar is the district headquarters located in the central part of the district. District comprises fourteen tehsils, namely, Nagar, Parner, Pathardi, Akole, Nevasa, Shrirampur, Shevgaon, Rahuri, Rahata, Sangamner, Kopargaon, Shrigonda, Jamkhed and Karjat (fig.1.1).

2.3 Physiography

Physiography is one of the dominant parameters of physical environment and its impact on patterns and density of agriculture is immense (Chouhan, T. S. 1987). District has vast variations in physical set up because of it is partly located in Sahyadri hilly reneges and partly in deccan plateau. It has a general slope from west to east. The western part of district (Akole tehsil) is the high elevated part of the district. The average height of this part is 760 meters above sea level. The east part of the district (Shevgaon tehsil) is plain and having height 500 meters above sea level. Topographically, district can be divided into three regions, namely, Sahyadri hilly area, plateau and plains. (fig. 2.1)

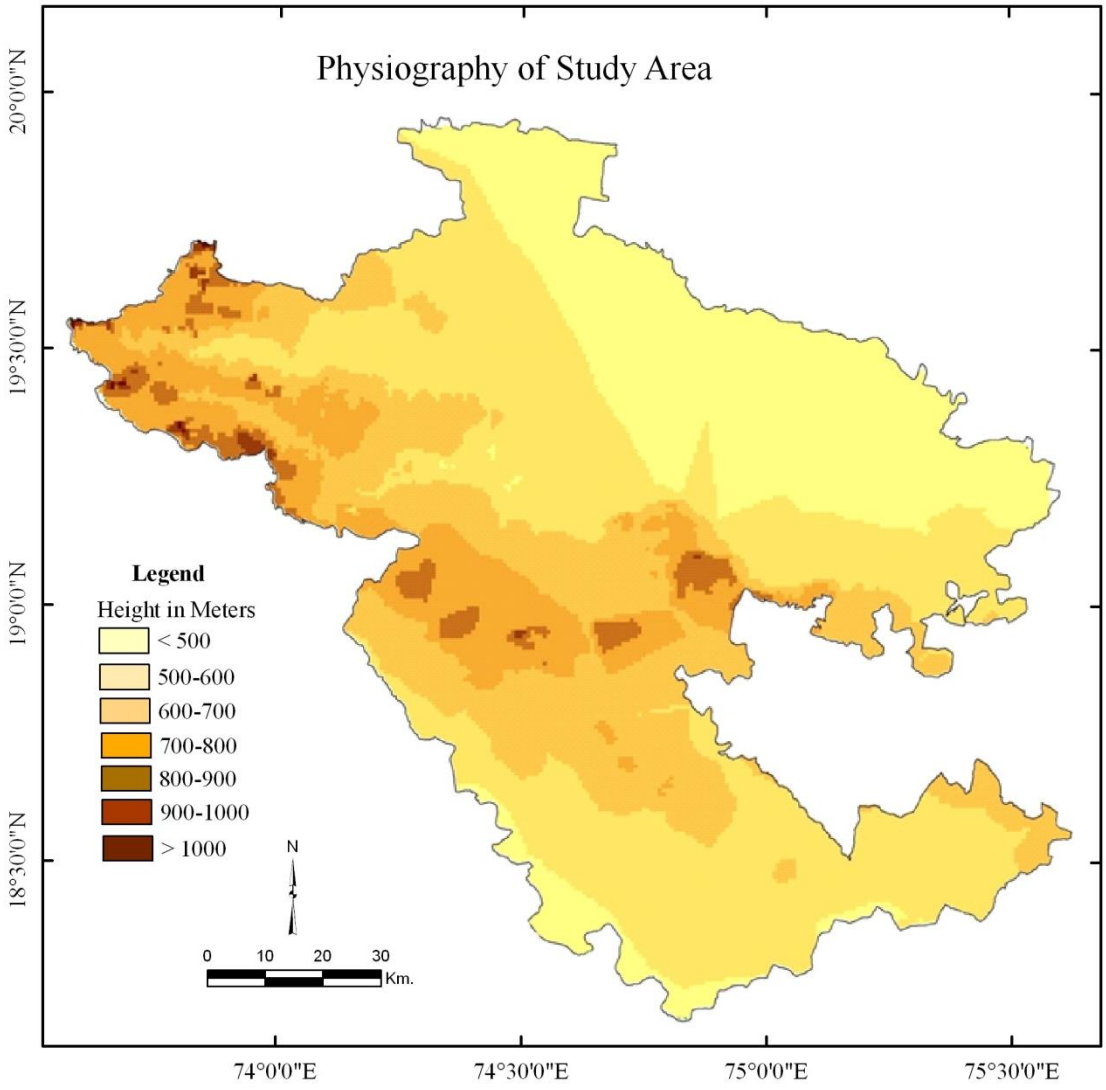

Physiography of Study Area
20°0'0"N
19°30'0"N
19°0'0"N
18°30'0"N
74°0'0"E
74°30'0"E
75°0'0"E
75°30'0"E
Legend
Height in Meters
< 500
500-600
600-700
700-800
800-900
900-1000
> 1000
N
0 10 20 30
Km.

Fig: 2.1

Western Hilly Region

The western hilly region can be divided into three ranges, namely, Kalsubai-Adula range in north, Baleshwar range in middle and Harishchandra range in south. Kalsubai is the highest peak in Sahyadri having 1646 meters height from sea level. This area has elevation between 800 to 1500 meters above sea level. The Adula hill branch of Kalsubai runs southward having average height 900 meters. The Baleshwar range is water divider between river Pravara and Mula. It passes through Akole and Sangamner tehsils. It is second grade spur of Sahyadri having length of 11 km. The third range, namely, Harishcandragad it is water divider between river Godavari and Bhima. The river Mula flows between Harishchandragad and Baleshwar ranges. This ranges form the boundary between Ahmednagar and Pune districts.

Central Plateau Region

Plateau region is continues belts lies north-western to southern parts of district It is located in between Baleshwar and Harishcandra ranges having slope west to east. The average elevation of this region is 900 meters in west part and 600 meter in east part. It comprises parts of five tehsils namely, Parner, Nagar, Sangamner, Shrigonda and Karjat.

Northern and Southern Plain Region

The average elevation of this region is about 500 meter. This region occupied northern and southern parts of district. The northern parts occupied by river Godavari and its tributary Pravara, Mula and Dhora. It comprises tehsil namely, Kopargaon, Rahata, Shrirampur, Rahuri, Nevasa, Shevgaon and Pathardi. The southern parts occupied by river Bhima and its tributary Ghod, Kukadi and Sina. Parts of the Shrigonda, Karjat and Jamkhed tehsils are included in this region.

2.4 Drainage

Drainage is a comprehensive expression in geography. It includes surface as well as underground water flow. It is the result of a combination of numerous factors including climate particularly precipitation, insolation, humidity, cloudiness, wind force and direction, structure and types of rocks, vegetation, soil and human utilization.

Drainage pattern of Ahmednagar district is covered by two major rivers namely, Godavari and Bhima (fig. 2.2). The whole northern parts of district are drain by river Godavari. The tehsils Akole, Sangamner, Rahata, Kopargaon, Shrirampur, Nevasa, Shevgaon, Pathardi and parts of Parner and Nagar comes under Godavari

basin. It rises near holy place Trimbakeshwar in Nashik district of Maharashtra. It enters in Ahmednagar district at northwest corner in Kopargaon tahsil as a considerable stream and then flows southeast up to village Puntamba in Kopargaon tehsil. From village Puntamba to Paithan tehsil in Aurangabad district it forms the boundary between Ahmednagar and Aurangabad districts of 100 km. It is non perennial and having water in only monsoon season. River Godavari receives water from Pravara, Mula and Dhora rivers. Basin of Godavari comes under drought prone region of Maharashtra state (FCC, 1973).

River Pravara is the major tributary of Godavari. It rises between Kulang and Ratangad ranges in Akole tehsil and flows through the rugged valley in Akole tehsil and then it enters in plain in Sangamner tehsil. Total length of Pravara is 180 km. it enters in rivers Godavari at village Toka in Nevasa tehsil. Pravara receives water from rivers Adula and Mhalungi. River Adula raises in north part in Akole tehsil and meets Pravara 3km. west near town Sangamner. Total length of this river is 45 km. Mahlungi is the second major tributary of river Pravara. It raises between ranges Patta and Aundha and enters in Nashik district and then re-enters in Ahmednagar district meets to Pravara near town Sangamner.

Mula is the major tributary of Pravara rises between Ratangad and Harishchandragad on eastern slope of Sahaydri. The upper portion of this river is deep bed and rugged valley and enters plain after town Rahuri. Mula dam is constructed on this river in Rahuri tehsil. Water of the Mula is used for irrigation, drinking and industrial purpose. The total length from its origin to its meeting with Pravara at village Pravarasangam is about 145 km.

The river Dhora rises near town Ahmednagar and flows north-easterly. It covers the parts of Shevgaon and Nevasa tehsils and join to Godavari near town Paithan in Aurangabad district. The total length of this river is 56 km.

The whole southern parts of the district come under Bhima basin. The river Ghod, Kukadi and Sina is the major tributary of Bhima. River Bhima rises in Sahyadri range near holy place Bhimashankar in Pune district and enter in Shrigonda tehsil of Ahmednagar district. River Ghod is the major tributary of Bhima, rises on eastern slope of Sahyadri in Junner tehsil of Pune district. This river forms the boundary between Pune and Ahmednagar districts for 75 km. River Kukadi flows through Parner and Shrigonda tahsils. River Sina rises near town Ahmednagar after flowing some distance it form boundary between Ahmednagar and Beed district and enter in

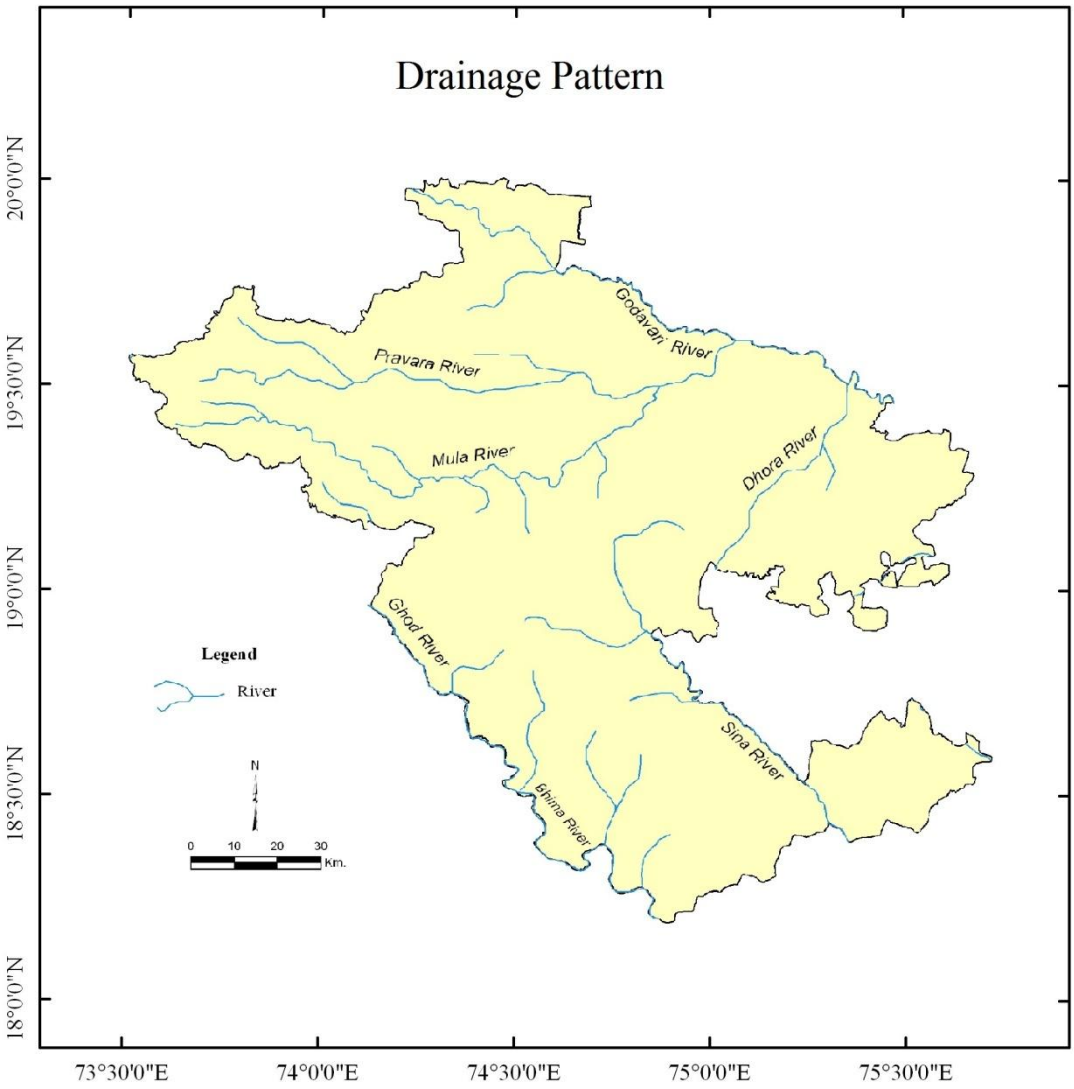

Drainage Pattern
20°0'0"N
19°30'0"N
19°0'0"N
18°30'0"N
18°0'0"N
73°30'0"E
74°0'0"E
74°30'0"E
75°0'0"E
75°30'0"E
Pravara River
Godavari River
Mula River
Dhora River
Ghod River
Sina River
Bhima River
Legend
River
N
0 10 20 30
Km.

Fig: 2.2

Solapur district. Besides these rivers many smaller streams intersect the district, but they contain water only during the monsoon.

2.5 Soil Types

Soils provide nutrients, water to the plants and support the growth of roots. The crops growth depends on soil structure, colour, thickness and texture. It is the loose surface soil and subsoil which promote infiltration of rain or irrigation water, stores it and provides to plants when require. The soil development in any region depends on parent rock, climate, physiography, living organisms and time. There are four types of soil found in Ahmednagar district, namely, deep black soil, medium black soil, coarse shallow soil and red soil (fig 2.3).

Deep Black Soils

This soil is distributed along with bank of major rivers and its tributaries. It found in parts of Sanganmer, Kopargaon, Rahata, Shrirampur, Nevasa, Shevgaon, Pathardi, Shrigonda, Karjat and Jamkhed tehsils. It appears as dark brown to grayish black colour. This soils particle is very fine and it make pasty in rainy season. A depth of this soil varies from seven to fourteen feet. It develops cracks in summer season. Maximum water holding capacity of this soil is between 200 to 300 mm (Wani, B. K. 2009). Due to high water holding capacity, this soil is more secure for crops in rainfall or irrigation failure condition. In irrigated zone, crops growing like sugarcane, cotton, wheat, soyabean, maize and gram. Sugarcane is a dominant crop in irrigated area and in rain fed area this soil is more suitable for jowar and gram.

Medium Black Soils

This soil found mainly in some parts of Rahata, Sangamner, Rahuri, Nevasa, Pathardi, Parner, Shrigonda, Karjat and Nagar tehsils. It is relatively less fertile than deep black soil. Maximum water holding capacity of this soil is 150 to 200 mm. It is good in contents of potash and phosphate but low in organic matter. Bajra, soyabeen, maize and sugarcane grow in *kharif* season and wheat, gram, jowar and onion in *rabi* season. This soil belts is irrigated by Godavri, Pravara, Mula and Kukadi rivers and its right and left bank canals.

Coarse Shallow Soil

The shallow soil is observed in some parts of the Akole, Sangamner, Nagar, Parner, Pathardi, Karjat, Shrigonda and Jamkhed tehsil. Locally this soil is known as '*Bardi*'. This soil content is coarse sand and silt. It water holding capacity varies from 50 mm to 100 mm. It is poor in phosphorus and nitrogen. Irrigation is more essential

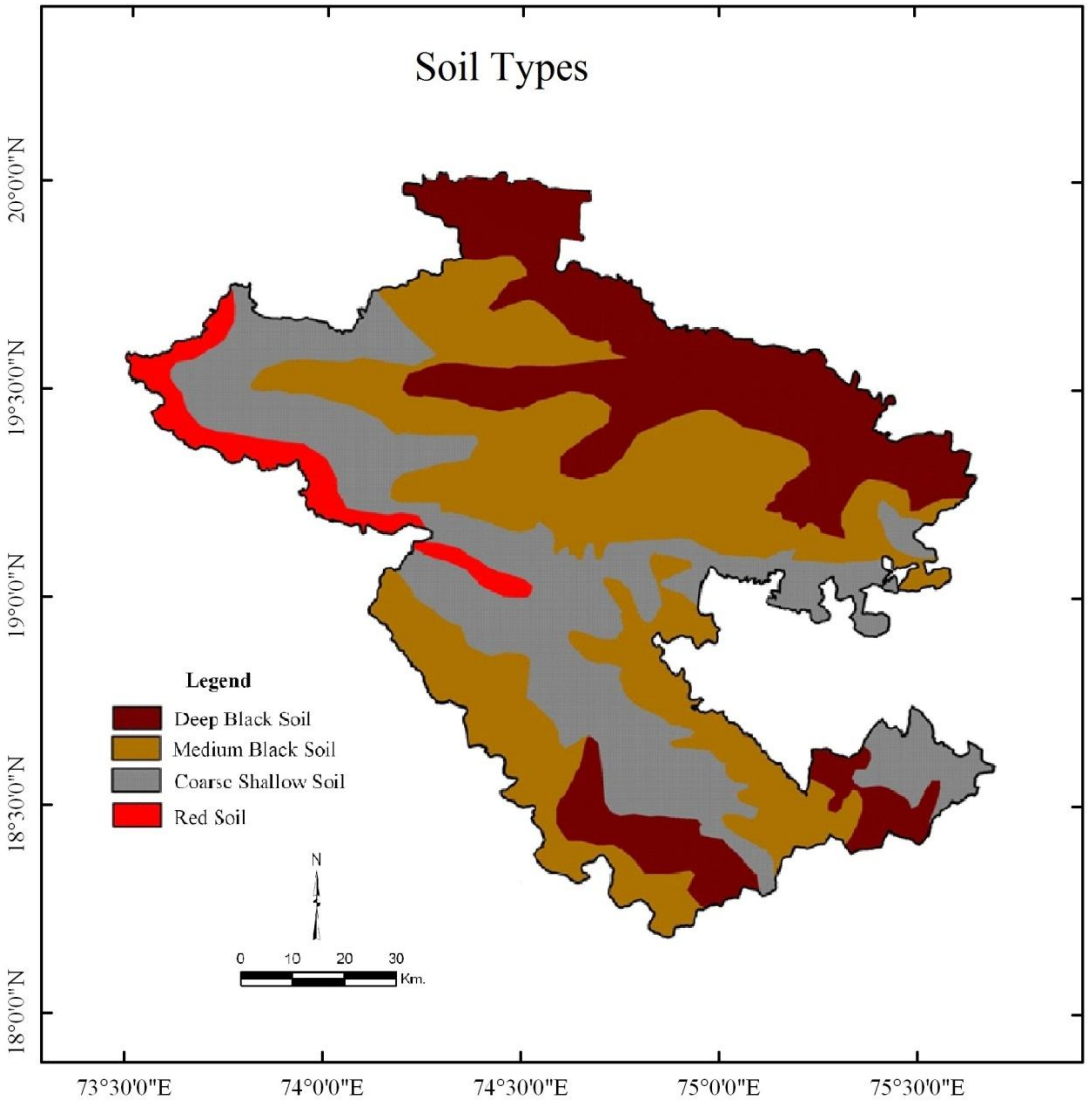

Soil Types
20°0'0"N
19°30'0"N
19°0'0"N
18°30'0"N
18°0'0"N
73°30'0"E
74°0'0"E
74°30'0"E
75°0'0"E
75°30'0"E
Legend
Deep Black Soil
Medium Black Soil
Coarse Shallow Soil
Red Soil
N
0 10 20 30
Km.

Fig: 2.3

of this soil in condition of monsoon failure. Productivity of this soil is very less compare to other soil types. Bajra, jowar, onion and pulses are the major crops in this soil.

Red Soil

Red soil is found in hilly and high rainfall area in west parts of district in some parts of tehsil Akole, Sangamner and Parner. Red soil formed in the area of high rainfall and alternate wet and dry period and it is suitable for cultivation of dry paddy, ragi, pulses and fruit plants.

2.6 Climate

The study region experiences four seasons, namely, summer, monsoon, retreating south-west monsoon and winter. The summer season start from month of March and ends in first week of June. The period of southwest rainy season is from June to September and retreating monsoon season experiences in October and November. Winter season begins in December and ends February.

2.6.1 Rainfall

The most parts of district come under rain shadow zone of Sahyadri. District receives 578.8 mm average annual rainfall, out of this about 77 percent receives during south west monsoon season in the month of June to September (table 2.1). The distribution of rainfall is most uneven from place to place and bears some relationship with relief. Near the Kalsubai hills the rainfall is higher than any other parts of district. This area is forest covered and mountainous parts of district. Lowest rainfall occurs in the areas covering eastern part of the district (fig.2.4).

Table-2.1 Average Annual Rainfall in Study Region

Months	Rainfall in mm	Months	Rainfall in mm
January	4.28	July	94.45
February	1.24	August	82.02
March	4.16	September	169.83
April	8.6	October	66.74
May	22.54	November	31.88
June	116.07	December	8.48

Source: Indian Meteorological department, Pune

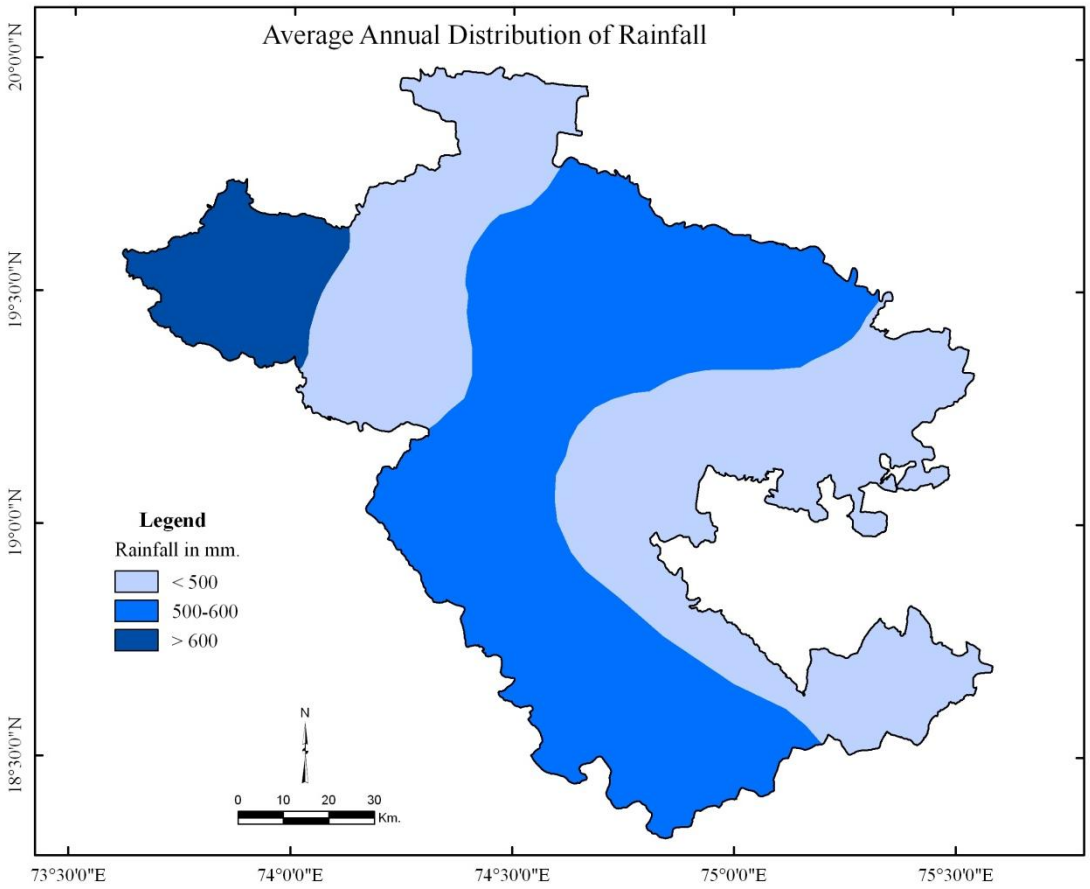

Average Annual Distribution of Rainfall
20°0'0"N
19°30'0"N
19°0'0"N
18°30'0"N
73°30'0"E
74°0'0"E
74°30'0"E
75°0'0"E
75°30'0"E
Legend
Rainfall in mm.
< 500
500-600
> 600
N
0 10 20 30
Km.

Fig: 2.4

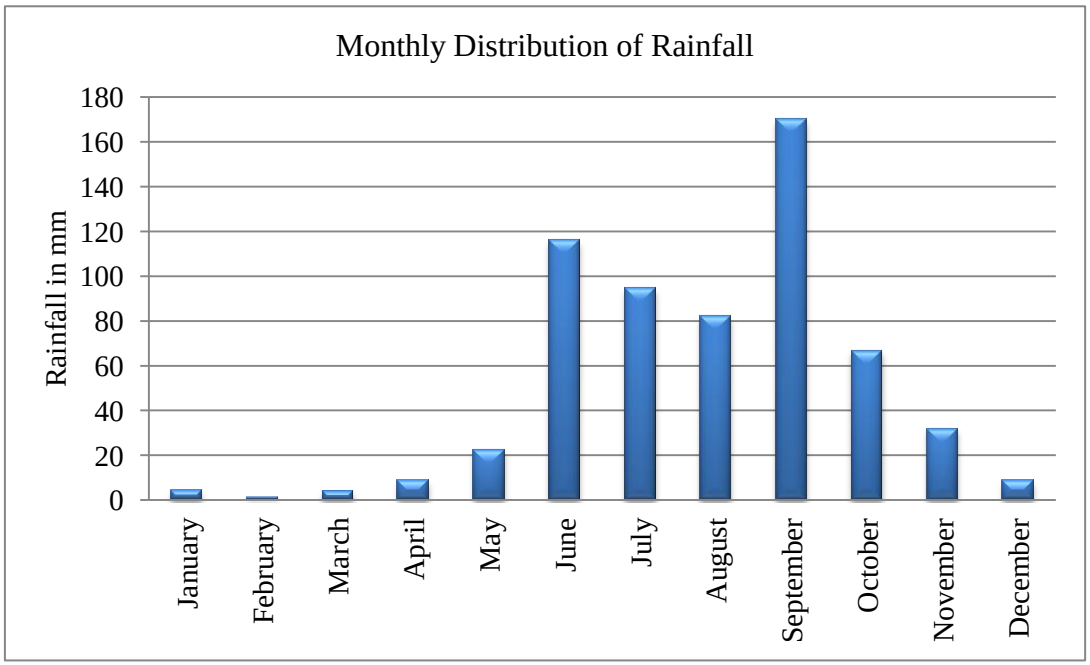

Monthly Distribution of Rainfall
Rainfall in mm
180
160
140
120
100
80
60
40
20
0
January
February
March
April
May
June
July
August
September
October
November
December

Fig: 2.5

Monthly distribution of rainfall is quite uneven. The monthly rainfall graph (fig.2.5) shows monsoon rainfall starts from June and after September it goes on decreasing. September is the rainiest month of the year. It means that in study region highest rainfall receives during beginning of *rabi* season.

2.6.2 Temperature

Temperature is one of the prominent factors for crop and vegetation growth. The characteristic feature of temperature of the district is the extremity. In Ahmednagar district seasonal variation in temperature is quite large (table 2.2). The average maximum temperature is 33º centigrade and minimum is 18.4º centigrade.

Table 2.2 Temperature (in º centigrade) at Ahmednagar (2011)

Months	Maximum	Minimum	Months	Maximum	Minimum
January	30.5	12.4	July	30.1	21.6
February	33.2	14.3	August	29.3	20.8
March	36.6	18.1	September	30.8	20.2
April	39.1	21.9	October	32.5	19.1
May	39.4	22.9	November	30.9	15.4
June	34.1	22.3	December	30.0	11.7

Source: Indian Meteorological department, Pune

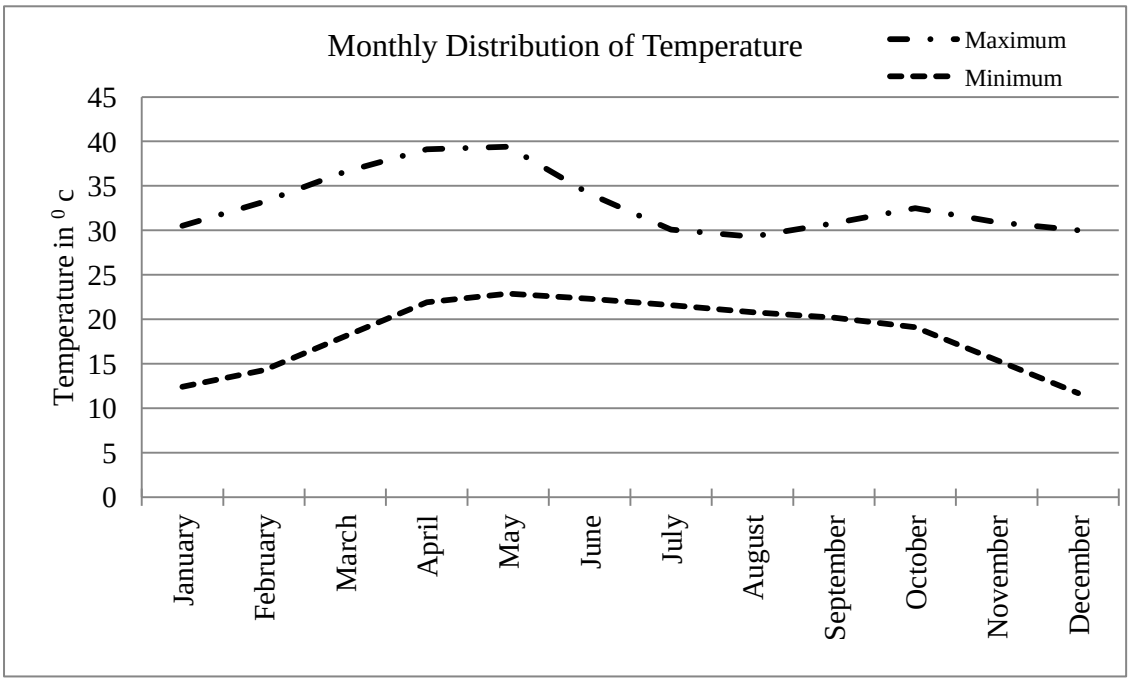


Fig: 2.6

In summer season day temperature continuously increases and the nights remain comparatively cool. Temperature shows upward trend in March due to northward movement of sun. In the month of May maximum temperature reaches upto 39.4° centigrade which is appreciable drop in onset of rainy season (fig.2.6). The cold season starts from November and linger till February. In November mornings and evenings are very cold. In December and January the temperature goes down and nights are very cold. In February nights are cold but the days are warmer till March. Generally one or two cold waves occur during the winter season when mean temperature falls considerably. Low temperature and frost occurs during *rabi* season causing damage of fruit and vegetable crops.

2.6.3 Humidity

Amount of relative humidity present in the air also varies with changing seasonal environment. The transition month of May recorded the lowest (less than 20 percentage) humidity, which marks change of season from winter to summer. The humidity remains highest in monsoon season, it reaches up 80 percent. Humidity declines after September witnessing 35 to 55 percent. Annual average humidity in district is about 30 percent (IMD, Pune).

2.6.4 Winds

Winds vary in their directions, consistency and velocity according to seasonal changes of temperature and pressure. In the latter half of the summer season the speed of wind speed increases while rest of the period it is generally light to moderate. The direction of winds during the rainy season is south-west. In the post monsoon season and winter the winds blow from north to north-east. During March the winds are north-westerly to westerly. During summer season winds become strong and flow from west.

2.6.5 Clouds

The skies are heavily clouded to overcast during the rainy season while rest of the year it is clear. The clouds rapidly decrease in the post monsoon month.

2.7 Natural Vegetation

In Ahmednagar district 1894.34 sq. km. area under forest. Out of which 994.9 sq. km. are reserved forest and 18.07 sq. km. as protected forest. The type of forests in the district is "Southern Tropical Dry Deciduous". Density of forest depends on relief, distribution of rainfall and soil types. In mountain and valley region dense forest are observed. The highest area under forest is found in Akole tehsil because of heavy

rainfall and mountainous topography. The hilly region of Rahuri tehsil has 15 percent area under forest. In Parner, Karjat, Shrigonda and Nagar tehsils found 7 to 14 percent while remaining eight tehsils have less than 7 percent area under forest. The major species in forest are, namely, teak, *neem, babool*, sandalwood, khair, etc. Among other trees are *hiwar, herkal, amoni and apta*. Due to the scanty rains and shallow soil the vast tropical grasslands are common in non-irrigated part in district. Some evergreen species has found in western ghat in Akole tahsil while in dry area has shrub forest consisting of *karvand*, *tarwad* and many types of cactus.

Resume

This chapter has examined the physiography of Ahmednagar district. Ahmednagar is the biggest district of Maharashtra state and occupying central position in western Maharashtra. It lies between 18^0 20´ north to 19^0 59´ north latitudes and 73^0 40´ east to 75^0 43´ east longitudes having length of 210 kilometers and 200 kilometers width. Physiographically district has three major divisions, which is western hilly region, central plateau region and northern and southern plain region. Sahyadri mountain range lies along western boundary of district. Sahyadri has three offshoots, namely, Kalsubai-Adula range in north, Baleshwar range in middle and Harishchandra range in south. The district is mainly drained by two rivers Godavari and Bhima. The river Pravara, Mula and Dhora is major tributaries of Godavari and river Ghod, kukadi and Sina is the tributary of Bhima. These rivers provide water for drinking and irrigation purpose. The study area has four types of soils i.e. deep black, medium black, coarse shallow and red soils.

The district experiences four seasons, namely, summer, monsoon, retreating south-west monsoon and winter. The summer season starts from month of March and ends in first week of June. The period of southwest rainy season is from June to September, retreating monsoon season experiences in October and November. Winter season begins in December and ends February. District receives 578.8 mm average annual rainfall, out of this about 77 percent receives during the month of June to September. The distribution of rainfall is most uneven from place to place and bears some relationship with relief. District appears "Southern Tropical Dry Deciduous" types of forest. Density of forest depends on relief, distribution of rainfall and soil types. The highest area under forest found in the western tehsils of Akole, Rahuri and Parner.

CHAPTER - III

NON-PHYSICAL DETERMINANTS

3.1 General Introduction

In the previous chapter discussion regarding varying physical condition responsible for variations in regional patterns of agricultural phenomenon. However, the differential degree of combinations in institutional, biotechnological, demographic and infrastructural factors influences agricultural patterns and productivity. Experience of recent years has shown that the key factors affecting agriculture are irrigation and modern inputs such as farm implements, farm power (human and mechanical), use of high yielding varieties and chemical fertilizer (Singh, J and Dhillon, S. 1989). However, supporting measures such as soil conservation, agricultural credits, market facility, transport facility, agricultural research, market price of agricultural commodities and government policies have also influenced agricultural pattern, growth and productivity (Hussain, M. 1996).

This chapter discuss the spatial and temporal variation of various non-physical determinants viz. irrigation, farm implements (traditional and modern), demographic factors, livestock, high yielding variety of seeds, use of chemical fertilizer, market facilities, transport facilities, agricultural credit and government policy.

3.2 Irrigation

According to Sinha, U. P., (2011) irrigation is the process of artificially applying water to the soil for rising crops. Irrigation helps in fulfilling moisture deficiency in soils during the crops season so as to ensure proper and sustained growth of crops. In additional land use second or third crop being raised on the land having irrigation facilities which could otherwise may not be cultivated. It ensures the benefits to farmers by reducing the risk of crop failure, increasing the average yields and permitting multiple cropping.

The need of irrigation is very much connected with the nature of soils. Coarse shallow soil has less retentive capacity of moisture, need frequent watering. On the other hand deep black and medium black soils have higher water holding capacity and require less irrigation. Level and lowland areas require less watering than sloppy surface and highland areas.

Irrigation is the most important input required for the successful cultivation of high yielding varieties (Pawar, A. N. 2007). The new seeds require water at specific periods of growth, development and flowering. The timings of irrigation and the quantity of water supplied are decisive for the performance of the crops (Todkari, G.U. 2012). So without assured irrigation agricultural production is a risky venture.

Thus, irrigation is the main axis around which the whole agricultural activity revolves. The distribution of rainfall in the study area is very less and erratic in nature so irrigation becomes the most important controlling factor of cropping pattern and agricultural productivity.

3.2.1 Irrigation Projects in District

In Ahmednagar district for the purpose of irrigation and drinking water many major, medium and minor irrigation projects are constructed. Wilson dam near Bhandardara in Akole tehsil is constructed on river Pravara. This dam impounded about 11 thousand million cubic feet of water behind the dam. The storage feeds two canals, the Pravara right and left bank, taking off from a pick-up weir 90 km. downstream of the dam at village Ozar. These canals irrigates an area about 32000 hectares mainly in the tehsils of Sangamner, Rahuri, Rahata, Shrirampur and Nevasa.

Table 3.1 Irrigation Projects in Ahmednagar district

Tehsils	Major Projects	Medium Project	Minor Project	Percolation Tank	KT Weir	Storage Tank
Nagar	0	0	14	224	6	78
Rahuri	1	0	0	44	6	27
Shrirampur	0	1	15	18	0	48
Nevasa	0	0	2	12	10	58
Shevgaon	0	1	1	41	0	58
Pathardi	1	3	11	142	4	131
Jamkhed	0	1	1	99	3	49
Karjat	0	0	3	141	0	76
Shrigonda	0	1	2	200	1	49
Parner	3	1	2	346	2	80
Akole	4	3	3	144	20	208
Sangamner	0	0	46	171	17	126
Kopargaon	0	0	0	32	5	39
Rahata	0	0	0	0	0	24
District	**9**	**11**	**90**	**1584**	**74**	**1051**

Source: Socio-economic abstract of Ahmednagar district (2010-11)

Baragaon Nandur dam in Rahuri tehsil on river Mula is the second major project of the district. The storage of this dam is about 30,000 million cubic feet of water and irrigates 52,000 hectares of land through left and right bank canals mainly in the tehsils of Rahuri, Nevasa and some part of Pathardi and Shevgaon.

The Ghod project comprises an earthen dam across the river Ghod at Chinchani village in Sirur tehsil of Pune district. Its left bank canal irrigates 17,000

hectares land of Parner and Shrigonda tehsils. However, river Godavari left and right bank canal irrigates the land of Kopargaon and Rahata tehsil.

Devthana dam on the river Adhala, Mandohal dam in Parner tehsil and Pargaon Ghatsheel dam in Pathardi tehsil are some of other dams in the district. Their irrigation capacity depends on amount of precipitation in catchment area. The percolation and storage tank was constructed on the tributaries of major rivers in the district. It is useful to increase groundwater level. Kolhapur type dam (KT weir) is constructed in river bank of Godavari, Pravara, Mula, Sina and Kukdi. The small lakes constructed for the purpose of percolation and seasonal irrigation. The major lakes are Visapur, Bhatodi, Musalvadi and Gunvadi in district. The co-operative sugar factories and farmers co-operative societies provide lift irrigation facility from river and canals.

3.2.2 Sources of Irrigation

Based on the accessibility of surface and groundwater, relief, soli and climatic characteristics varying sources of irrigation are utilized in study region. These sources are classified in two categories i.e. surface irrigation and underground irrigation. In present study the distributional aspects of irrigation in Ahmednagar district are analyzed by means of two different approaches. First is the study of tehsil wise share of surface and underground irrigation to total irrigated area and second is to study the spatial variation of net irrigated area. Tehsil wise percentage share of surface and underground irrigation to total irrigated area was worked out by the following formulae as adopted by Sinha, U. P. (2011).

$$\text{Share of } i^{th} \text{ source} = \frac{\text{Total irrigated area of } i^{th} \text{ source of } j^{th} \text{ tehsil}}{\text{Total irrigated area in } j^{th} \text{ tehsil}} \times 100$$

3.2.2 A Surface Irrigation

The area irrigated by rivers, lakes, canals and small dams are the sources of surface irrigation. In surface irrigation canals are the major source of irrigation in study region. During 1990-91 surface irrigation was 29.53 percent of the total irrigated area (table 3.2). North part of the district have high share than the south part. The tehsils of Nevasa registered highest share (60.02 percent) followed by Rahuri, Karjat and Kopargaon while lowest share recorded in tehsils of Shevgaon (0.77 percent) followed by Nagar, Jamkhed and Pathardi.

During the year 2010-11 percentage share of surface irrigation was 31.41 percent of total irrigated area. Highest share was recorded in tehails of Kopargaon Shrirampur, Rahuri and Akole located in Mula Pravara and Godavari basin (table 3.2) where as it was low in tehsils of Pathardi and Nagar.

During the period of investigation share of surface irrigation increased by 1.88 percent of total irrigated area. On the basis of previous discussed methodology (Chapter -I) the spatial pattern of volume change in area under surface irrigation registered significant positive change in tehsils of Rahuri, Shrirampur, Jamkhed, Shrigonda, Akole and Kopargaon while tehsils Nevasa, Karjat and Sangamner noticed significant negative change. Tehsils of Nagar, Shevgaon, Pathardi and Parner noticed insignificant change in area under surface irrigation. There is an increase in surface irrigation in these tehsils due to Government of Maharashtra has take efforts to repair and constructed canal water distributaries under the scheme of *Rojgar Hami Yogna.*

The excess use of surface water for irrigation by canals has resulted into the depletion of physical and chemical properties of fertile soils (Isitekhale, H. *et al* 2014). The flatness of the relief, high water table, arid and semi-arid climate and an excess amount of soluble salts brought in by irrigation in the canals command area, converts the productive land to agriculturally poor land i.e. saline and alkaline soils. However, in canals command area farmers grown high water require crop i.e. sugarcane, it has adverse effects on soil productivity due to this, year by year per hectare yield of sugarcane is declined (Patil, K. K. 2007).

3.2.2 B Underground Irrigation

Wells and Tub-wells are the principal source of underground irrigation. Introduction of oil engines and electric pump in place of traditional method of water lifting has helped rapid development of underground irrigation in last two decades. Well irrigation is popular and wide spread in whole district. It is a major source of irrigation particularly in low depth of ground water. However, tube well is mostly confined in the areas of comparatively high depth of ground water. When there is failure of monsoon, crop can be raised only by providing water from underground sources. In the study region underground water irrigation share is high than the surface irrigation.

Table 3.2 Irrigated Area in Ahmednagar District

Tehsils	% share of surface irrigation to total irrigated area		Volume of Change in %	% share of underground irrigation to total irrigated area		Volume of Change in %	Net irrigated Area in %		Volume of Change in %
	1990-91	**2010-11**		**1990-91**	**2010-11**		**1990-91**	**2010-11**	
Nagar	1.44	2.98	1.54	98.56	97.02	-1.54	21.31	14.62	-6.69
Rahuri	43.85	48.52	4.67	56.15	51.48	-4.67	50.93	73.66	22.73
Shrirampur	25.33	60.14	34.81	74.67	39.86	-34.81	48.17	82.84	34.67
Nevasa	60.02	35.85	-24.17	39.98	64.15	24.17	33.79	45.38	11.59
Shevgaon	0.77	3.72	2.95	99.23	96.28	-2.95	19.38	18.29	-1.09
Pathardi	3.50	1.00	-2.5	96.5	99	2.5	13.82	13.87	0.05
Jamkhed	1.86	14.66	12.8	98.14	85.34	-12.8	8.78	10.86	2.08
Karjat	39.13	24.98	-14.15	60.87	75.02	14.15	21.15	19.51	-1.64
Shrigonda	35.75	54.88	19.13	64.25	45.12	-19.13	26.53	20.06	-6.47
Parner	28.03	29.11	1.08	71.97	70.89	-1.08	13.59	14.23	0.64
Akole	28.51	46.33	17.82	71.49	53.67	-17.82	14.22	15.11	0.89
Sangamner	16.81	8.50	-8.31	83.19	91.5	8.31	26.81	30.7	3.89
Kopargaon	35.09	44.44	9.35	64.91	55.56	-9.35	37.82	39.87	2.05
Rahata	--	21.78	--	--	78.18	--	--	95.82	--
District	**29.53**	**31.41**	**1.88**	**70.47**	**68.59**	**-1.88**	**24.37**	**29.42**	**5.05**

Source: Socio economic abstract of Ahmednagar district (1990-91 and 2010-11)

During the year 1990-91 surface irrigation accounted 70.47 percent of the total irrigated area in district. Spatial distribution pattern reveals the maximum share recorded in those tehsils where surface irrigation share is lowest. During the year 2010-11 share of underground irrigation is recorded 68.59 percent (table 3.2). It share has decline by 1.88 percent during the period of investigation.

Volume of change in underground irrigation sources has noticed significant positive change in tehsils of Nevasa, Karjat and Sangamner while significant negative change found in tehsils of Rahuri, Shrirampur, Jamkhed, Shrigonda, Akole and Kopargaon. In study region ground water sources become dry in summer season it adverse effects on agriculture. This calls for rational use of available water through proper water management techniques.

3.2.3 Net Irrigated Area

Table 3.2 revealed net irrigated area and volume of change during the year 1990-91 and 2010-11. Net irrigated area divided into four different categories namely, very low, low, moderate and high having range below 20, 20 - 40, 40 - 60 and above 60 respectively. During the year 1990-91 net irrigated area was 24.37 percent tehsil wise it ranged from as low as 8.78 percent to high as 50.93 percent (fig. 3.1/A). Jamkhed tehsil of south parts of district, Pathardi and Shevgaon tehsils of eastern parts of district and Parner and Akole tehsils of western parts of district found very low net irrigated area whereas six tehsils namely, Nagar, Nevasa, Karjat, Shrigonda, Sangamner and Kopargaon was noticed low net irrigated area. Tehsils Rahuri and Shrirampur registered moderate category while high category was not found in any tehsils of district during this year.

Spatial distribution of net irrigated area of the year 2010-11 has show in fig. 3.1/B. During this year net irrigated area was 29.42 percent and varies from 10.86 to 95.82 percent. Very low net irrigated area was recorded in seven tehsils namely, Nagar, Jamkhed, Karjat, Shevgaon, Pathardi, Parner, Akole while low net irrigated area registered in southern tehsil Shrigonda and northern tehsils Sangamner and Kopargaon. Tehsil Nevasa registered moderate category whereas high category was noticed in northern part of district consisting tehsils of Rahata, Rahuri and Shrirampur.

An analysis shows a marked increase net irrigated area by 5.05 percent during two decades. Spatial pattern of volume change in net irrigated area registered

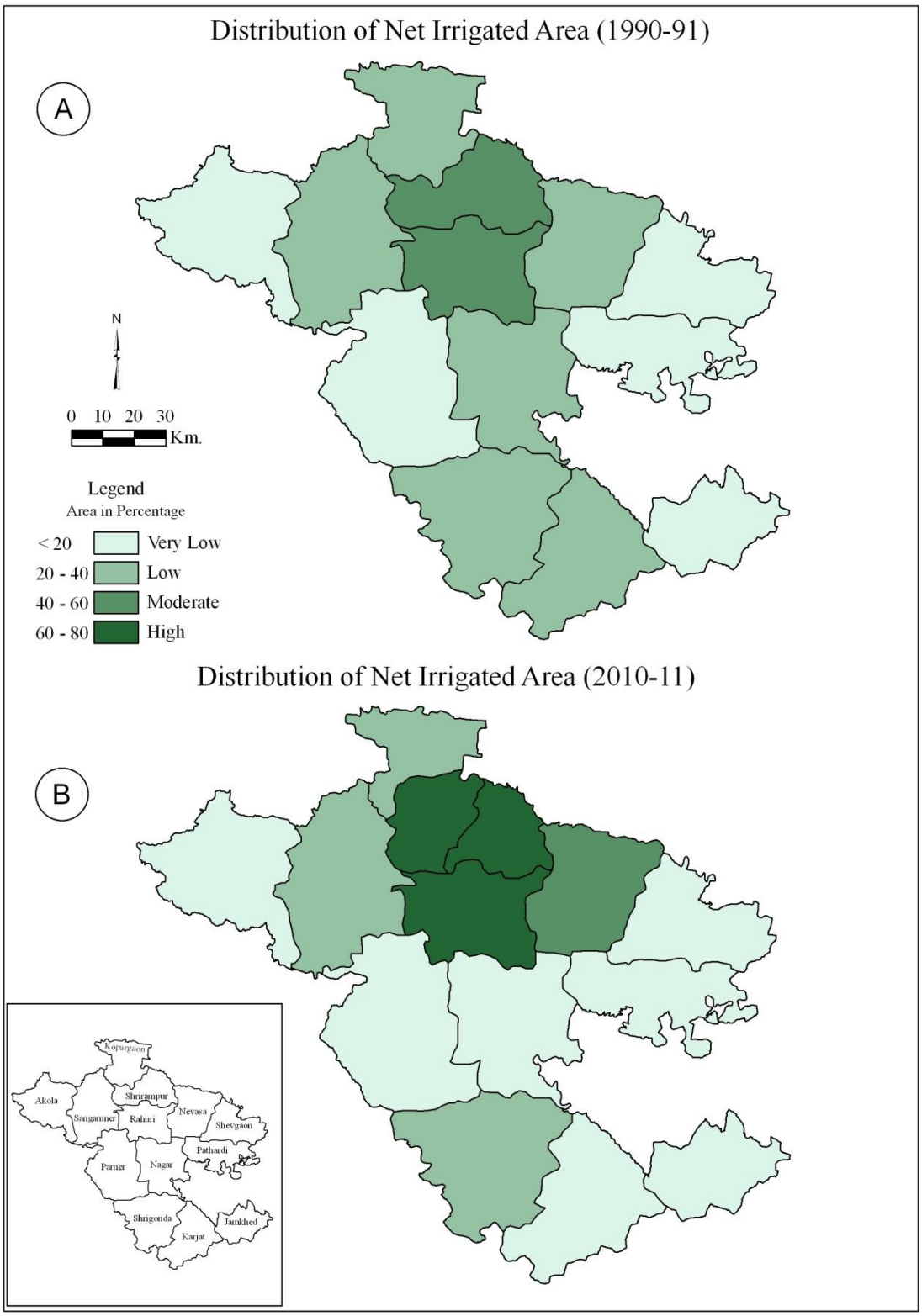

Distribution of Net Irrigated Area (1990-91)
A
N
0 10 20 30
Km.
Legend
Area in Percentage
< 20 Very Low
20 - 40 Low
40 - 60 Moderate
60 - 80 High
Distribution of Net Irrigated Area (2010-11)
B
Kopargaon
Akola
Shrirampur
Nevasa
Sangamner
Rahuri
Shevgaon
Pathardi
Parner
Nagar
Shrigonda
Jamkhed
Karjat

Fig: 3.1 A & B

significant positive change in tehsils of Rahuri, Shrirampur and Nevasa while significant negative change recorded in tehsils of Nagar and Shrigonda and rest of the tehsils found insignificant change.

3.3 Farm Implements

The agricultural potential is not only achieved through human and animal power but by the use of modern agricultural implements. It is very essential to increase agriculture production per unit area and new land has to bring under multiple cropping with improved quality of agricultural operation. Local relief and climatic conditions largely govern the use of agricultural implements (traditional and modern) (Singh, J and Dhillon, S. 1989). In addition, the quantum of irrigation available, the size of holding, the degree of intensiveness in farming, the subsistence or commercial character of agriculture and present way of life further determine the use of farm implements.

For the cultivation of agriculture various traditional and modern implements are use by farmers. The traditional implements are blade harrow (*Kulaw*') wooden plate (*Pata*), local seed drill's (*Tiphan'*) wooden plough (*baliram*), mould board plough, small hand tools and carts for transportation purposes. Due to mechanization these traditional implements rapidly declined in recent year.

The major agricultural implements are wooden plough, iron ploughs, tractors, carts, oil engines and electric pumps. In the present study per hundred hectare density of each implement were worked out by dividing total number of each type of implements by net sown area multiplied by hundred hectare (Chouhan, T. S. 1987) .

$$\text{Density of } i^{th} \text{ implement} = \frac{\text{Total number of } i^{th} \text{ implement in } j^{th} \text{ tehsil}}{\text{Net sown area in } j^{th} \text{ tehsil}} \times 100 \text{ hectare}$$

3.3 A Wooden Ploughs

The wooden plough is a traditional agricultural implement use in the entire study region. It is made by the local carpenters using locally available wood. It is easy to handle to framer as well as to bullocks. Its production and repairing cost is very low. Wooden ploughs are in use where farmers still practice traditional framing on small and medium operation holdings.

Table 3. 3 Density of Farm Implement Per Hundred Hectares of Net Sown Area

Tehsils	Wooden Ploughs		Volume of Change	Iron Ploughs		Volume of Change	Tractors		Volume of Change
	1990-91	2010-11		1990-91	2010-11		1990-91	2010-11	
Nagar	2.64	0.34	-2.3	6.95	1.12	-5.83	0.08	0.34	0.26
Rahuri	0.84	1.52	0.68	8.91	2.87	-6.04	1.64	1	-0.64
Shrirampur	1.41	0.68	-0.73	9.35	2.02	-7.33	1.38	1.1	-0.28
Nevasa	2.63	1.15	-1.48	5.45	3.84	-1.61	0.39	1.21	0.82
Shevgaon	1	0.42	-0.58	8.03	0.94	-7.09	0.17	0.18	0.01
Pathardi	0.48	1.38	0.9	7.25	3.67	-3.58	0.07	0.54	0.47
Jamkhed	0.8	0.7	-0.1	4.1	3.88	-0.22	0.16	0.54	0.38
Karjat	0.37	0	-0.37	6.66	2.66	-4	0.31	0.71	0.4
Shrigonda	0.61	0.61	0	8.89	2.46	-6.43	0.38	0.21	-0.17
Parner	4.72	4.67	-0.05	10.04	7.16	-2.88	0.18	0.63	0.45
Akole	14.1	6.74	-7.36	6.0	6.6	0.6	0.14	0.58	0.44
Sangamner	3.53	0.91	-2.62	11.69	1.43	-10.26	0.41	2.84	2.43
Kopargaon	0.18	0.3	0.12	8.93	1.75	-7.18	1.58	5.98	4.4
Rahata	-	0.5	--	-	3.65	--	-	2.7	--
District	**2.56**	**1.88**	**-0.68**	**7.96**	**3.89**	**-4.07**	**0.47**	**1.23**	**0.76**

Source: Socio economic abstract of Ahmednagar district (1990-91 and 2010-11)

Continue ……..

Table 3. 3 Density of Farm Implement Per Hundred Hectares of Net Sown Area

Tehsils	Carts		Volume of Change	Oil Engines		Volume of Change	Electric Pumps		Volume of Change
	1990-91	2010-11		1990-91	2010-11		1990-91	2010-11	
Nagar	2.01	1.22	-0.79	0.37	0.01	-0.36	5.2	1.68	-3.52
Rahuri	6.65	3.25	-3.4	0.04	0.09	0.05	2.71	9.47	6.76
Shrirampur	7.69	2.49	-5.2	0.02	0	-0.02	19.98	8.26	-11.72
Nevasa	2.94	4.62	1.68	0.26	0.41	0.15	8.28	8.63	0.35
Shevgaon	4.63	1.56	-3.07	0.51	0.17	-0.34	7.61	14.58	6.97
Pathardi	5.84	4.09	-1.75	0.28	0.77	0.49	11.96	5.18	-6.78
Jamkhed	2.94	4.74	1.8	0.64	0.96	0.32	7.02	6.39	-0.63
Karjat	4.05	1.82	-2.23	1.3	0	-1.3	4.13	4.99	0.86
Shrigonda	3.65	3.63	-0.02	0.97	0.39	-0.58	4.2	4.48	0.28
Parner	4.95	5.46	0.51	1.35	1.57	0.22	5.54	7.07	1.53
Akole	1.86	3.96	2.1	1.26	0.45	-0.81	3.35	6.11	2.76
Sangamner	4.86	5.35	0.49	0.41	0.51	0.1	8.82	9.12	0.3
Kopargaon	7.53	1.96	-5.57	0.08	0.15	0.07	11.04	10.69	-0.35
Rahata	-	4	--	-	0.04	--	-	21.43	--
District	**4.45**	**4.54**	**0.09**	**0.62**	**0.56**	**-0.06**	**7.37**	**7.68**	**0.31**

Source: Socio economic abstract of Ahmednagar district (1990-91 and 2010-11)

The density of wooden ploughs per hundred hectares was worked out and divided into three different categories i.e. low (below 3), moderate (3 - 6) and high (above 6). It was 2.56 and 1.88 per hundred hectares of net sown area during the years 1990-91 and 2010-11 respectively (table 3.3).

During the year 1990-91, low density registered in tehsils of Kopargaon, Karjat, Shrigonda, Jamkhed, Pathardi, Rahuri, Shrirampur, Nevasa, Pathardi and Nagar (fig. 3.2/A) while moderate density was registered in western part of the district consisting tehsils of Sangamner and Parner. High density found in only Akole tehsil.

During the year 2010-11, low density of wooden plough per hundred hectare of net sown area was recorded in tehsils of Nagar, Shevgaon, Kopargaon, Shrigonda, Shrirampur, Jamkhed, Rahata, Sangamner, Rahuri, Nevasa and Pathardi (table 3.3), where as moderate density registered in Parner tehsils. Tehsil Akole registered high density (fig. 3.2/B).

During the period of investigation density of wooden ploughs was declined by 0.68 per hundred hectare of net sown area (table 3.3). It significant negative change found in Nagar, Nevasa, Akole and Sangamner tehsils while rest of the tehsils noticed insignificant change.

3.3 B Iron Ploughs

Iron plough is a modification of wooden plough. Iron ploughs have always enjoyed popularity in those regions where more receptive farmers and intensive arable farming appear to dominate the agricultural landscape. It has facilitated deep ploughing as compared to wooden ploughs. According to their capacity for deep ploughing it has drawn either by two, three or four pairs of bullocks depending on the type of soils. It is preferred in medium to deep black and alluvial soil.

The density of iron ploughs per hundred hectares of net sown area was work out and divided into four different categories having range i.e. under 5, between 5-7, 7-9 and above 9 which can be represented very low, low, moderate and high density. The temporal pattern shows it was 7.96 and 3.89 ploughs per hundred hectares during 1990-91 and 2010-11 respectively (table 3.3).

During the year 1990-91, very low category was observed in tehsil Jamkhed (fig. 3.3/A) while tehsils of Nagar, Nevasa, Karjat and Akole was recorded low density. Tehsils of Rahuri, Shevgaon, Pathardi, Shrigonda and Kopargaon was recorded moderate density while tehsil namely, Shrirampur, Parner, Sangamner was recorded high density.

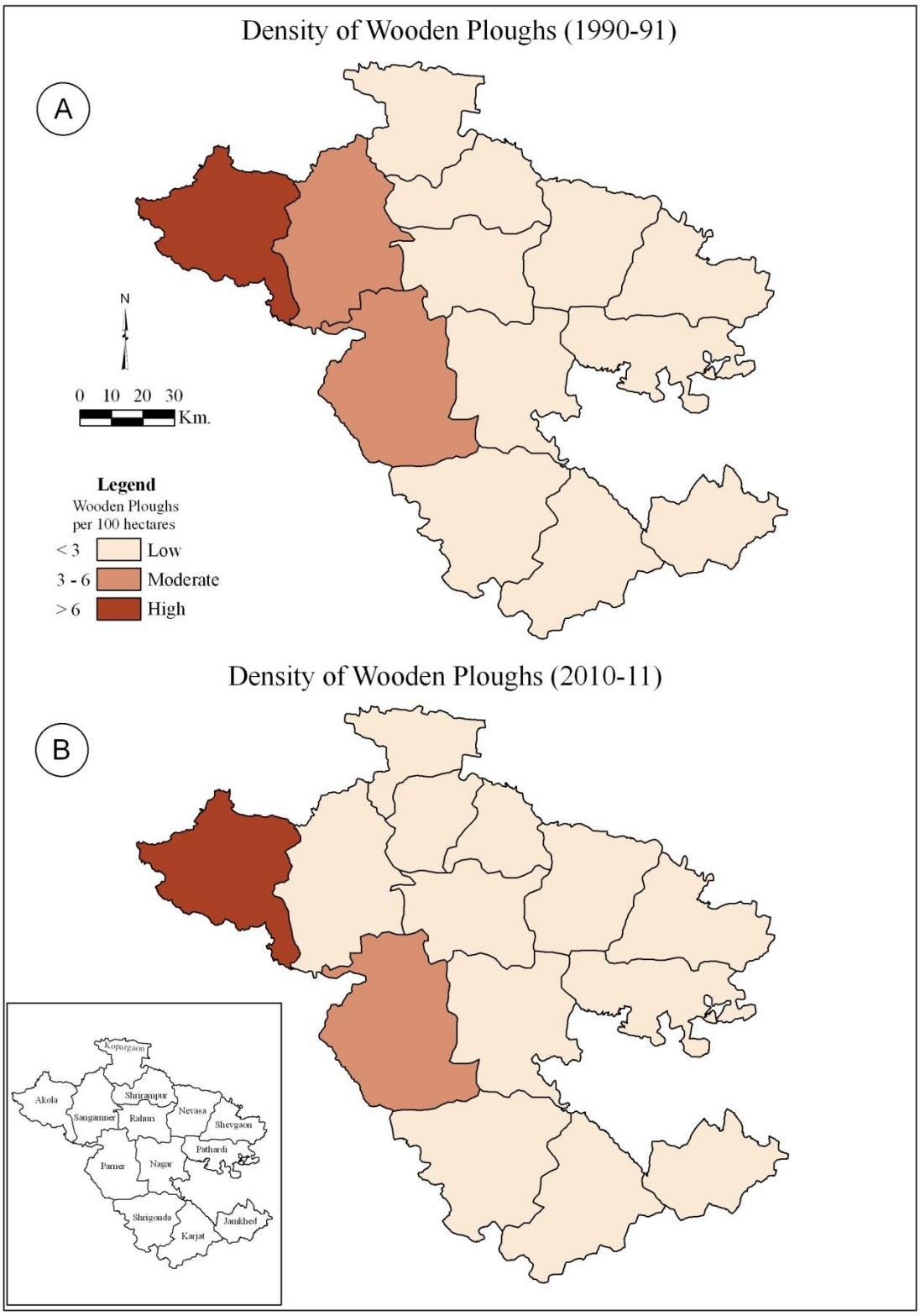

Density of Wooden Ploughs (1990-91)
A
N
0 10 20 30
Km.
Legend
Wooden Ploughs
per 100 hectares
< 3 Low
3 - 6 Moderate
> 6 High
Density of Wooden Ploughs (2010-11)
B
Kopargaon
Akola
Shrirampur
Nevasa
Sangamner
Rahuri
Shevgaon
Pathardi
Parner
Nagar
Shrigonda
Jamkhed
Karjat

Fig: 3.2 A & B

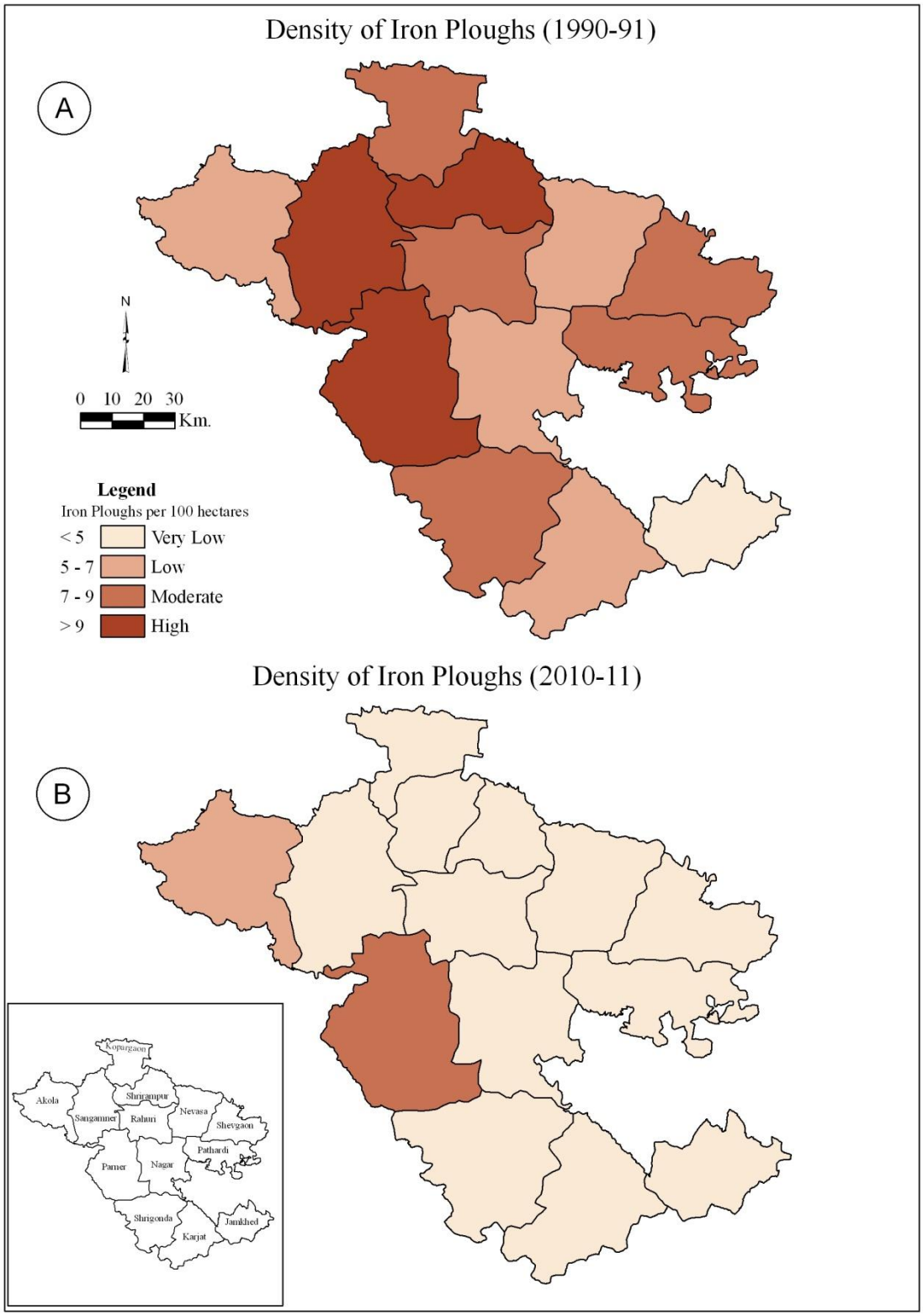

Density of Iron Ploughs (1990-91)
A
N
0 10 20 30
Km.
Legend
Iron Ploughs per 100 hectares
< 5 Very Low
5 - 7 Low
7 - 9 Moderate
> 9 High
Density of Iron Ploughs (2010-11)
B
Kopargaon
Akola
Shrirampur
Nevasa
Sangamner
Rahuri
Shevgaon
Pathardi
Parner
Nagar
Shrigonda
Jamkhed
Karjat

Fig: 3.3 A & B

During the year 2010-11, tehsils of Nagar, Rahuri, Shrirampur, Nevasa, Shevgaon, Pathardi, Jamkhed, Shrigonda, Sangamner, Kopargaon, Rahata and Karjat registered very low category (fig. 3.3/B). The western part of the district, tehsil Akole observed low category while tehsil Parner was recorded moderate density. During this year high density was not found in any tehsils of district.

During the period of two decades the density of iron ploughs decreased by 4.07 per hundred heater of net sown area. Spatial pattern of volume change registered significant negative change in tehsils of Nagar, Rahuri, Shrirampur, Shevgaon, Shrigonda, Sangamner and Kopargaon while rest of the tehsils noticed insignificant change in use of iron plough.

3.3 C Tractors

The use of tractor not only save time, reduces the cost of production and also increases agricultural productivity. It replaces the animal and human power and performs various works of agriculture ranging from ploughing, showing, harvesting and transportation. It makes farming operation very quick. It can change appreciably the cropping patterns, cropping intensity and crop combinations resulting in to high agricultural returns. After introduction of high yielding varieties along with adequate use of irrigation tractors have been widely use. The farm size and economic condition of farmers influence on use of tractors.

The density of tractors per hundred hectares of net sown area was worked out (table 3.3) and divided into four different categories namely, very low, low, moderate and high having the values under 0.50, 0.50-1.0, 1.0-1.50 and above 1.50 respectively. Density of tractors was 0.47 and 1.23 per hundred hectares of net sown area during the years 1990-91 and 2010-11 respectively.

During the year 1990-91, tehsil of Akole, Sangamner, Pathardi, Nevasa, Shevgaon, Nagar, Parner, Jamkhed, Shrigonda and Karjat was observed very low density while low density was not found in any tehsils. Tehsil Shrirampur recorded moderate density whereas tehsils Rahuri and Kopargaon was recorded high density (fig. 3.4/A).

During the year 2010-11, high density was found in three tehsils viz. Kopargaon, Rahata and Sangamner (fig. 3.4/B) while north-east parts of district comprised tehsils Shrirampur and Nevasa recorded moderate density. Akole, Rahuri, Parner, Pathardi, Karjat and Jamkhed tehsils found low density whereas rest of the tehsils recorded very low density.

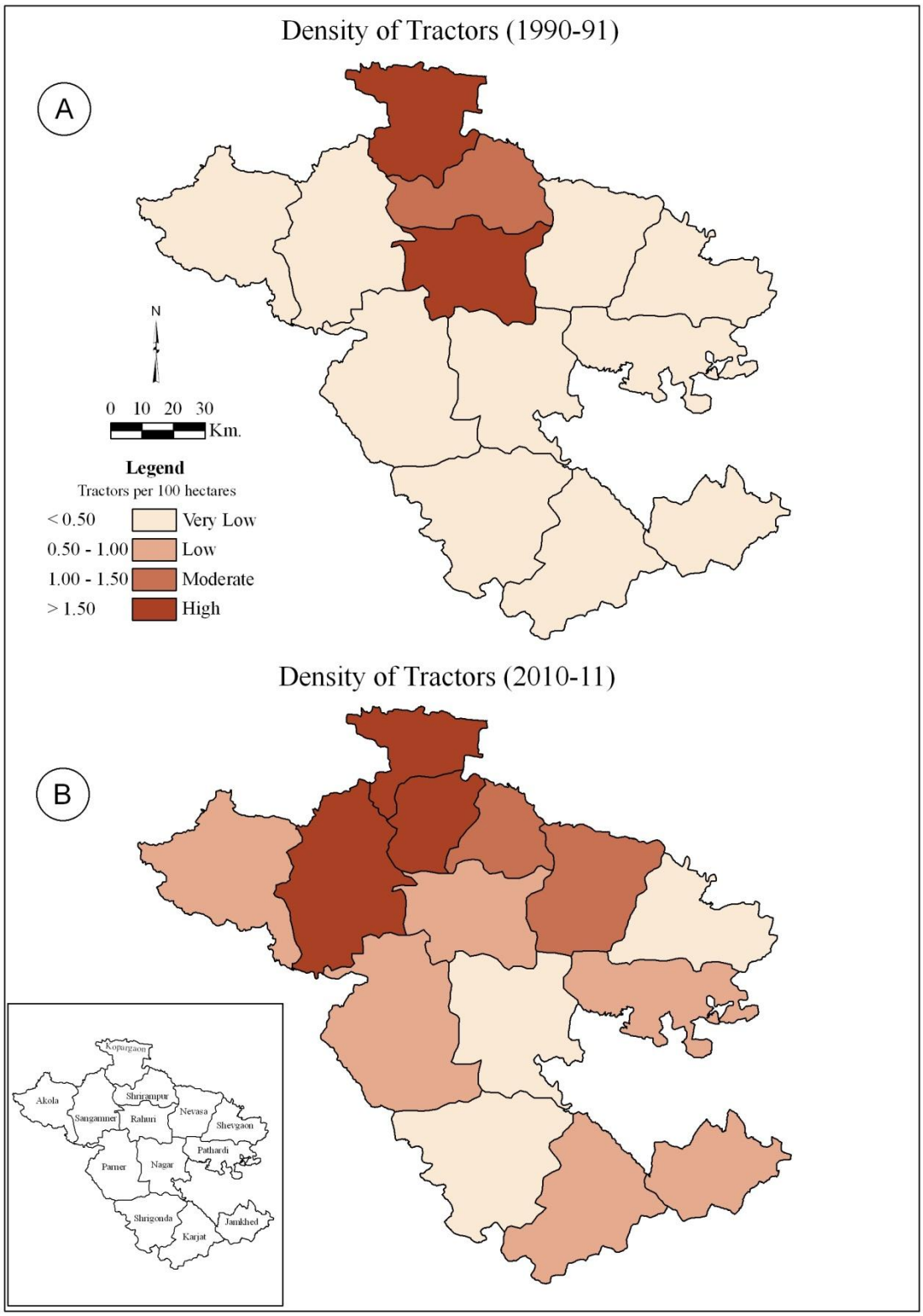

Density of Tractors (1990-91)
A
N
0 10 20 30
Km.
Legend
Tractors per 100 hectares
< 0.50 Very Low
0.50 - 1.00 Low
1.00 - 1.50 Moderate
> 1.50 High
Density of Tractors (2010-11)
B
Kopargaon
Akola
Shrirampur
Sangamner
Rahuri
Nevasa
Shevgaon
Pathardi
Parner
Nagar
Shrigonda
Jamkhed
Karjat

Fig: 3.4 A & B

In Ahmednagar district irrigated areas have high density of tractors than rain fed area. During the period of investigation tehsils Nevasa, Sangamner and Kopargaon recorded significant positive change while rest of the tehsils registered insignificant change in use of tractors.

3.3 D Carts

It is very old farm implement it is use for the purpose of transportation of goods and agricultural implements, raw material from field to field and place to place. The density of carts per hundred hectares was work out (table 3.3) and divided into three different categories i.e. high, moderate and low having the range under 3, 3-5 and above 5 respectively. It was 4.45 and 4.54 during 1990-91 and 2010-11respectively.

Fig. 3.5/A and table 3.3 revealed that during the year 1990-91, low density was registered in four tehsils namely, Akole, Nagar, Nevasa and Jamkhed while moderate density was noticed in five tehsils namely, Sangamner, Parner, Shrigonda, Karjat and Shevgaon (fig. 3.5/A). North and north- east parts of district comprised tehsils of Kopargaon, Shrirampur, Rahuri and Pathardi noticed high density of carts.

During the year 2010-11, low density of carts registered in tehsils of Nagar, Shrirampur, Shevgaon, Karjat and Kopargaon. The moderate density was found in the tehsils of Rahuri, Nevasa, Pathardi, Jamkhed, Shrigonda, Akole, and Rahata, while high density recorded in tehsil of Sangamner and Parner (fig. 3.5/B).

During the period of investigation negligible change recorded in density of carts in district (table 3.3). It significant negative change recorded in tehsils Rahuri, Shrirampur, Shevgaon, Pathardi, Karjat and Kopargaon. Three tehsils namely, Nevasa, Jamkhed and Akole recorded significant positive change while rest of the tehsils found insignificant change.

3.3 E Oil Engines

It is a modern farm implement and use for lifting of water from well. It is operated either from diesel or from petrol. Its water lifting capacity is tremendous more than traditional method, due to this there is an increase in area under irrigation as well as productivity of agriculture.

The density of oil engines per hundred hectares of net sown area was worked out and divided into four different categories namely, very low, low, moderate and high having the range below 0.40, 0.40-0.80, 0.80-1.20 and above 1.20 respectively.

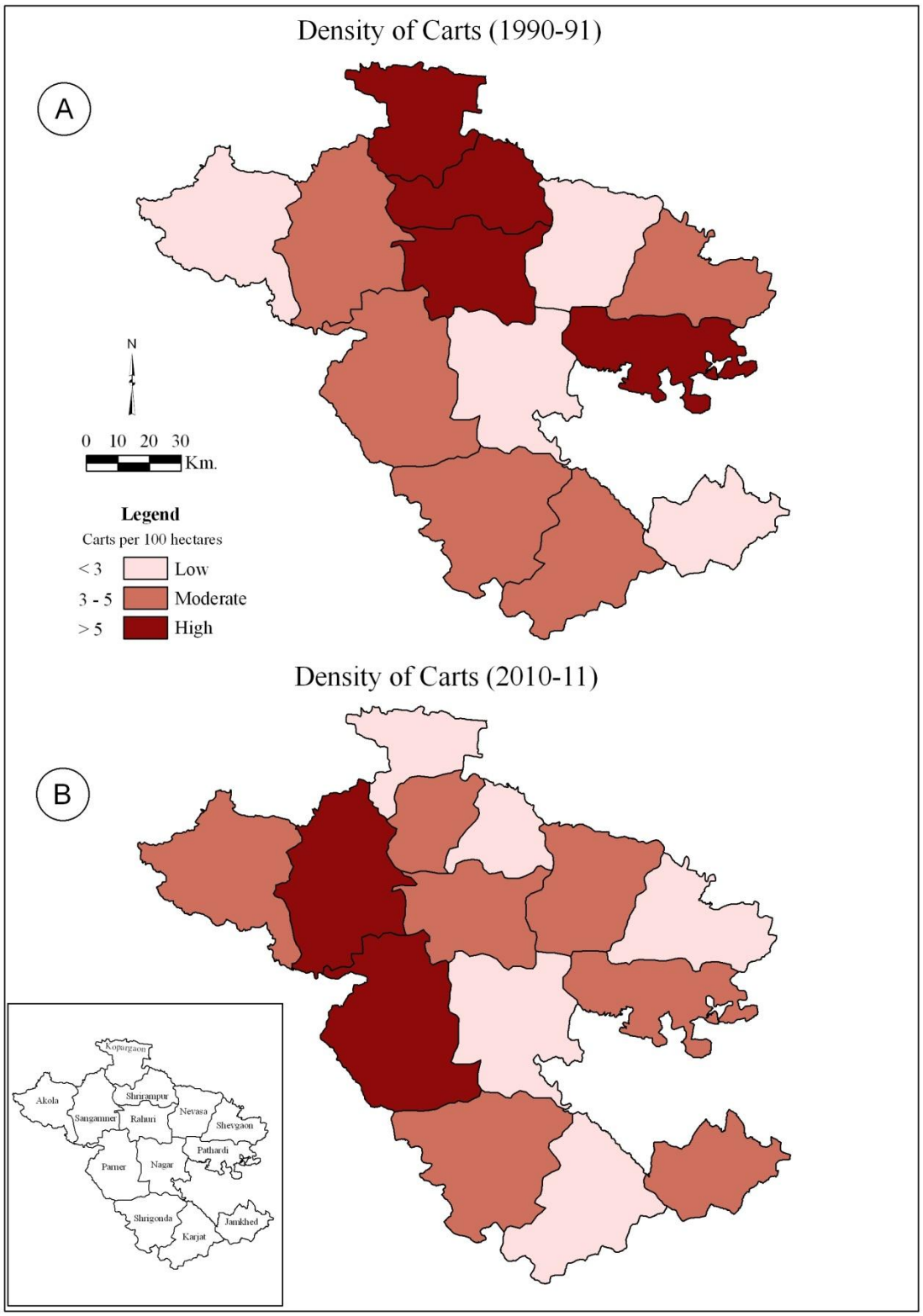

Density of Carts (1990-91)
A
N
0 10 20 30
Km.
Legend
Carts per 100 hectares
< 3 Low
3 - 5 Moderate
> 5 High
Density of Carts (2010-11)
B
Kopargaon
Akola
Shrirampur
Sangamner
Rahuri
Nevasa
Shevgaon
Pathardi
Parner
Nagar
Shrigonda
Jamkhed
Karjat

Fig: 3.5 A & B

The density of oil engines in district was 0.62 and 0.56 per hundred hectares during 1990-91 and 2010-11 respectively (table 3.3).

During the year 1990-91, very low density of oil engines noticed in tehsils of Kopargaon, Shrirampur, Rahuri, Nevasa, Nagar and Pathardi while low density was registered in tehsils of Sangamner, Shevgaon and Jamkhed. Moderate density found in the tehsil Shrigonda while high density found in three tehsils namely, Akole, Parner and Karjat (fig. 3.6/A).

Table 3.3 and fig. 3.6/B revealed that during the year 2010-11, very low density of oil engines registered in the tehsils of Kopargaon, Rahata, Shrirampur, Rahuri, Nagar, Shevgaon, Karjat and Shrigonda while low density found in the tehsils of Akole, Sangamner, Nevasa and Pathardi. Moderate density noticed in Jamkhed tehsil whereas high density was recorded in Parner tehsil.

During the period of investigation use of oil engines significantly decrease in tehsils of Nagar, Shevgaon, Karjat, Shrigonda and Akole whereas significantly increase in Nevasa, Pathardi, Jamkhed and Parner tehsils. Rrest of the tehsils registered insignificant change.

3.3 F Electric Pumps

It is a modern implement use for lifting water from wells, tube-wells, river, canal, tank etc. As a result of electrification the oil engines place take by electric pumps. Its water lifting capacity is greater than oil engine. By use of electric pumps farmers are success to lift the water for more distance from source of water. Due to this dry and fallow land come under irrigation and shows the positive change in agricultural productivity (Kathare, H. N. 2012). The use of electric pumps for agricultural purpose has been increasing day by day in the study region.

The density of electric pump per hundred hectares of net sown area for each tehsil and district was worked out. Four different categories namely, very low, low, moderate and high were formed (fig. 3.7 A & B). It is revealed that district have 7.37 and 7.68 density of electric pumps per hundred hectares of net sown area during the years 1990-91 and 2010-11respectively (table 3.3).

During the year 1990-91, very low density registered in tehsils of Rahuri, Karjat, Shrigonda and Akole whereas low density registered in tehsils of Nagar, Nevasa, Shevgaon, Jamkhed, Sangamner and Parner. Two tehsils namely, Pathradi and Kopargaon found moderate density while high density recorded in Shrirampur tehsil (fig. 3.7/A).

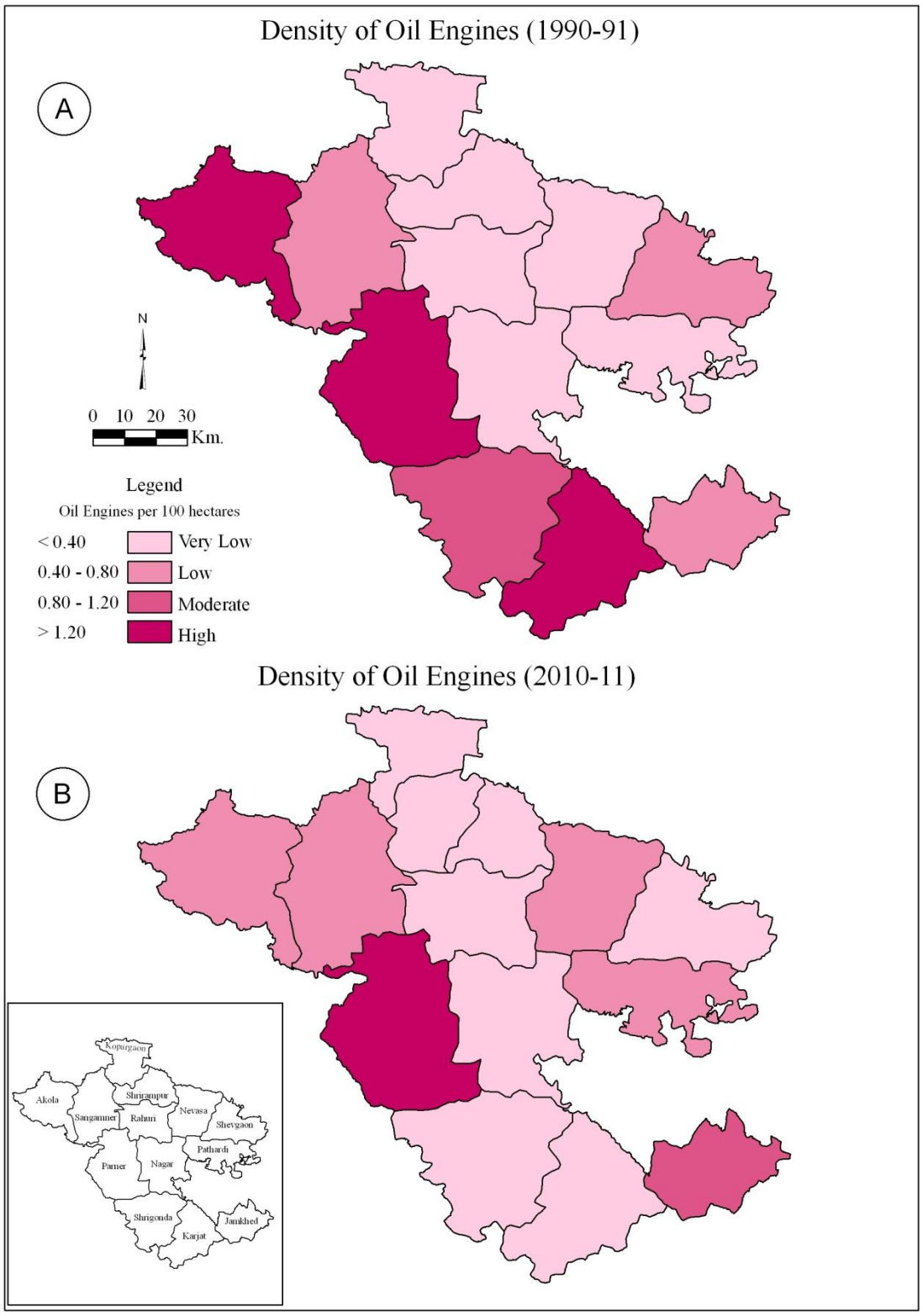

Density of Oil Engines (1990-91)
A
N
0 10 20 30
Km.
Legend
Oil Engines per 100 hectares
< 0.40 Very Low
0.40 - 0.80 Low
0.80 - 1.20 Moderate
> 1.20 High
Density of Oil Engines (2010-11)
B
Kopargaon
Akola
Shrirampur
Sangamner
Rahuri
Nevasa
Shevgaon
Pathardi
Parner
Nagar
Shrigonda
Jamkhed
Karjat

Fig: 3.6 A & B

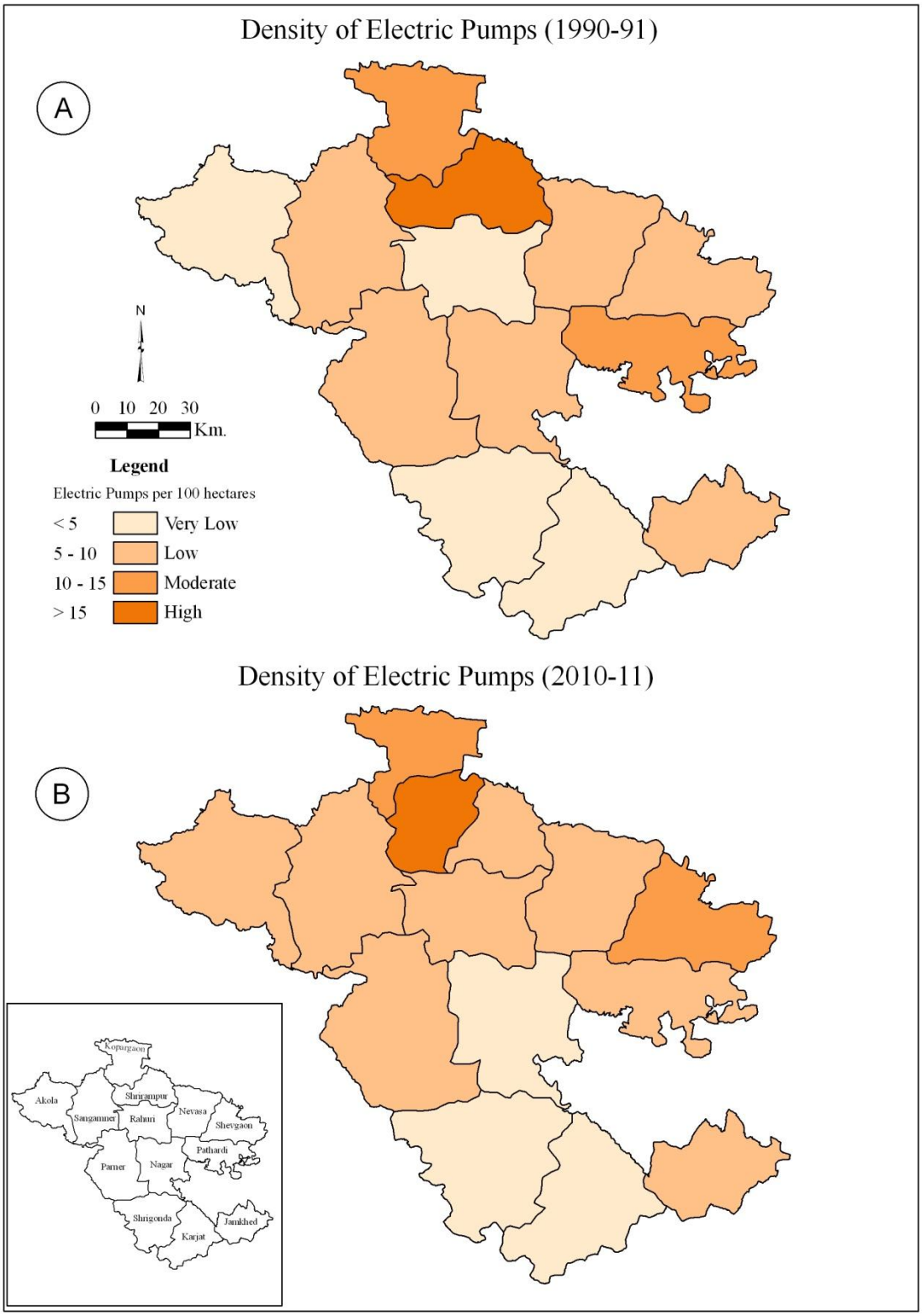

Density of Electric Pumps (1990-91)
A
N
0 10 20 30
Km.
Legend
Electric Pumps per 100 hectares
< 5 Very Low
5 - 10 Low
10 - 15 Moderate
> 15 High
Density of Electric Pumps (2010-11)
B
Kopargaon
Akola
Shrirampur
Nevasa
Sangamner
Rahuri
Shevgaon
Pathardi
Parner
Nagar
Shrigonda
Jamkhed
Karjat

Fig: 3.7 A & B

During the year 2010-11, very low density of electric pumps found in south part of district confined the tehsils of Nagar, Karjat and Shrigonda (fig. 3.7/B) while low density was recorded in the tehsils of Akole, Sangamner, Parner, Rahuri, Shrirampur, Nevasa, Pathardi and Jamkhed. Two tehsils namely, Shevgaon and Kopargaon found moderate density while high density was recorded in Rahata tehsil.

During the period of investigation change in density of electric pumps per hundred hectares of net sown area registered significant positive change in tehsils of Nagar, Shrirampur, Pathardi, Jamkhed and Kopargaon while significant negative change found in tehsils of Rahuri, Nevasa, Shevgaon, Karjat, Shrigonda, Parner, Akole and Sangamner.

3.4 Livestock

Livestock plays important role in the rural economy in supplementing the income of rural masses, particularly the marginal, small farmers and landless labours. It also provides subsidiary occupation in rural areas and more so far people residing in hilly and rain fed areas where modern agriculture is not suitable and agricultural output may not sustain the family (Chouhan, T. S. 1987).

Developing countries like India the poor and marginal framers agricultural operations are based on livestock and they are the chief source of power and manure. The most of the agricultural operation from ploughing to harvesting is carried out by draught animals. Livestock sector not only provides essential protein and nutrition but also plays an important role in the utilization of non-edible agricultural byproducts. It also provides raw material and byproducts such as hides and skins, blood and bone etc. In present study percent contribution of each type of livestock to total livestock population for each tehsil and for district was worked out by applying the following formula (Chouhan, T. S. 1987).

$$\text{Share of } i^{th} \text{ type of livestock} = \frac{\text{Number of } i^{th} \text{ type of livestock in } j^{th} \text{ tehsil}}{\text{Total livestock in } j^{th} \text{ tehsil}} \times 100$$

3.4 A Cattles

In the category of cattle, bullocks, cows, young stock of cows and bullocks are included. Cows are use for milk and reproduction purpose while bullocks for draught purpose. For the aim of agricultural practices and transportation small and medium farmers depends on bullocks.

Table 3.4 Category wise and Tehsil wise Percentage Share of Livestock to Total Livestock in Ahmednagar District

Tehsils	Cattles		Volume of Change	Buffaloes		Volume of Change	Goats and Sheeps		Volume of Change	Other livestock		Volume of Change
	1990-91	2010-11		1990-91	2010-11		1990-91	2010-11		1990-91	2010-11	
Nagar	36.32	33.61	-2.71	8.57	14.69	6.12	47.28	50.72	3.44	7.83	0.97	-6.86
Rahuri	34.86	14.43	-20.43	2.83	5.02	2.19	54.83	77.47	22.64	7.49	3.08	-4.41
Shrirampur	45.73	29.82	-15.91	4.97	9.93	4.96	39.82	56.48	16.66	9.48	3.77	-5.71
Nevasa	43.03	36.17	-6.86	6.6	15.66	9.06	43.09	47.09	4	7.28	1.08	-6.2
Shevgaon	42.68	42.34	-0.34	7.36	11.13	3.77	40.11	44.11	4	9.84	2.42	-7.42
Pathardi	42.67	38.21	-4.46	7.64	11.91	4.27	43.58	49.45	5.87	6.1	0.42	-5.68
Jamkhed	47.75	45.6	-2.15	6.53	15.59	9.06	38.23	38.1	-0.13	7.48	0.7	-6.78
Karjat	35.33	31.95	-3.38	3.15	6.58	3.43	54.94	55.8	0.86	6.57	5.68	-0.89
Shrigonda	37.05	38.22	1.17	7.65	13.36	5.71	47.98	47.26	-0.72	7.31	1.17	-6.14
Parner	33	32.09	-0.91	2.94	5.86	2.92	57.68	61.43	3.75	6.39	0.62	-5.77
Akole	58.06	50.43	-7.63	10.96	10.79	-0.17	25.48	38.45	12.97	5.49	0.33	-5.16
Sangamner	38.83	22.98	-15.85	1.91	2.88	0.97	51.43	73.88	22.45	7.84	0.26	-7.58
Kopargaon	43.35	36.42	-6.93	4.84	9.7	4.86	38.34	49.8	11.46	13.46	4.07	-9.39
Rahata	-	14.95	--	-	7.96	--	-	76.61	--	-	0.49	--
District	**40.09**	**33.65**	**-6.44**	**5.34**	**9.97**	**4.63**	**46.72**	**54.92**	**8.2**	**7.86**	**1.46**	**-6.4**

Source: Socio economic abstract of Ahmednagar district (1990-91 and 2010-11)

The percent contribution of cattle to total livestock population was worked out for each tehsil and district as whole (table 3.4) and divided into five different categories namely, very low, low, moderate, high and very high having the range below 35, 35-40, 40-45, 45-50 and above 50 respectively. Cattles occupy second rank out of total livestock in district. The total cattle population was 1134532 (40.09 percent) in 1990-91 and 771122 (33.65 percent) in 2010-11.

Table 3.4 and fig. 3.8/A revealed that during 1990-91, very low category was found in the tehsils of Rahuri and Parner whereas low category was observed in Sangamner, Nagar, Shrogonda and Karjat tehsils. Moderate category was found in Kopargaon, Nevasa, Shevgaon and Pathardi tehsils while high category was recorded in Shrirampur and Jamkhed tehsils. Very high category was found in Akole tehsil.

During the year 2010-11, very low category was found in Rahata, Shrirampur, Sangamner, Rahuri, Parner, Nagrar and Karjat tehsils whereas low category was found in Kopargaon, Nevasa, Pathardi and Shrigonda tehsils. Moderate category was found in Shevgaon tehsil while high category registered in Jamkhed tehsil. Very high category was found in Akole tehsil.

During the study period percentage share of cattle in total livestock was decline by 6.44 percent in district. It significant negative change noticed in tehsils of Rahuri, Shrirampur, Nevasa, Akole, Sangamner and Kopargaon while rest of the tehsils found insignificant change.

3.4 B Buffaloes

Female buffaloes is domesticate mainly for milk and reproduction while male buffaloes are mainly used for insemination and draught animals in certain parts of the district. The proportion of buffaloes to total livestock population for each tehsil and for district was worked out. Three different categories namely, low, moderate and high were formed having range less than 5, 5-10 and above 10. It is revealed that district have 5.34 and 9.97 percent share of buffaloes in total livestock during the years 1990-91 and 2010-11 respectively.

During the year 1990-91, low category was recorded in Rahuri, Shrirampur, Karjat, Parner, Sangamner and Kopargaon tehsils while moderate category was found in Nagar, Nevasa, Shevgaon, Pathardi, Jamkhed and Shrigonda tehsils. Western part of district comprised tehsil Akole noticed high category (fig.3.9/A).

Table 3.4 and fig. 3.9/B reveals percentage share of buffaloes to total livestock during the year 2010-11. Low category recorded in only Sangamner tehsil while

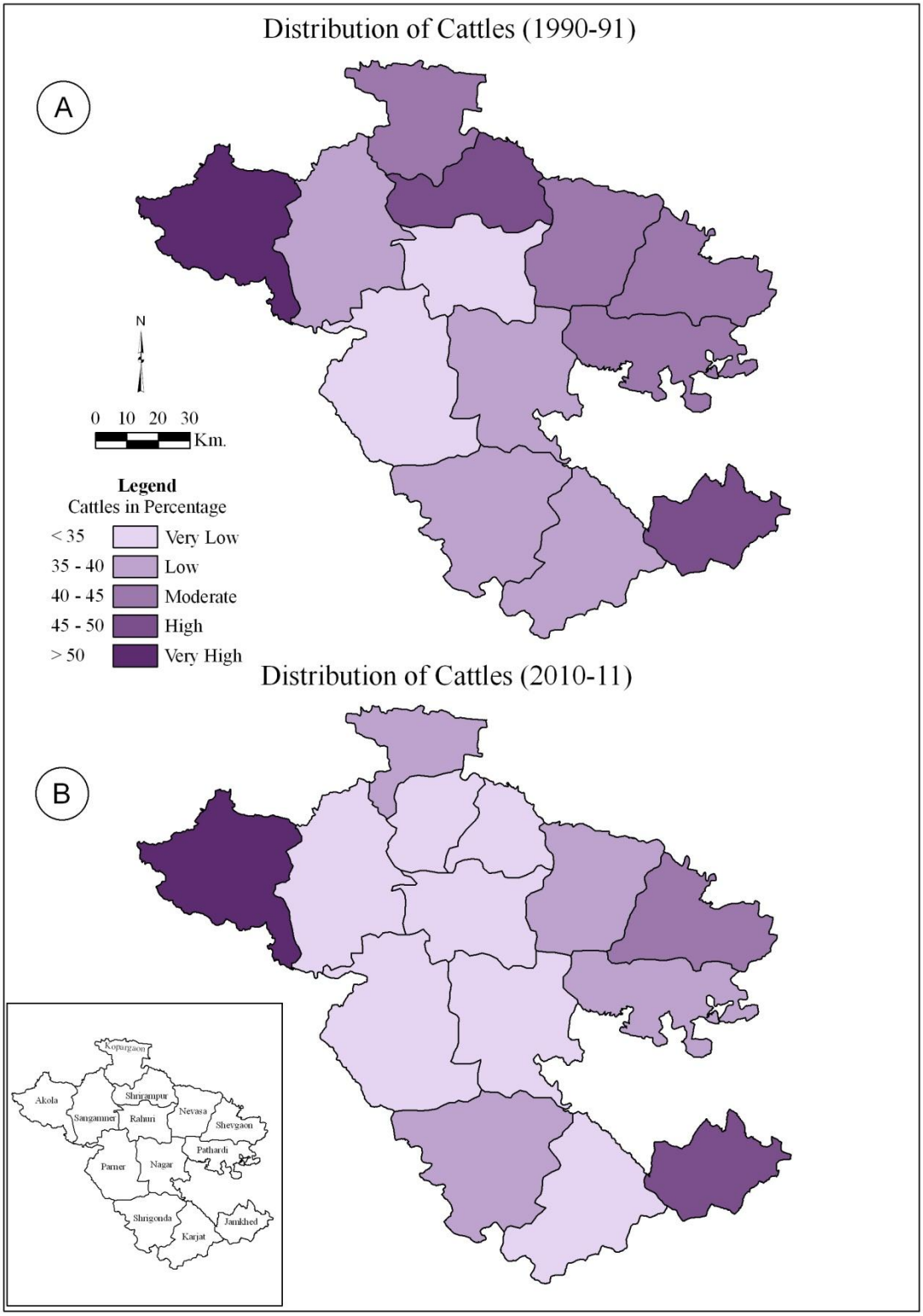

Distribution of Cattles (1990-91)
A
N
0 10 20 30
Km.
Legend
Cattles in Percentage
< 35 Very Low
35 - 40 Low
40 - 45 Moderate
45 - 50 High
> 50 Very High
Distribution of Cattles (2010-11)
B
Kopargaon
Akola
Shrirampur
Nevasa
Sangamner
Rahuri
Shevgaon
Pathardi
Parner
Nagar
Shrigonda
Jamkhed
Karjat

Fig: 3.8 A & B

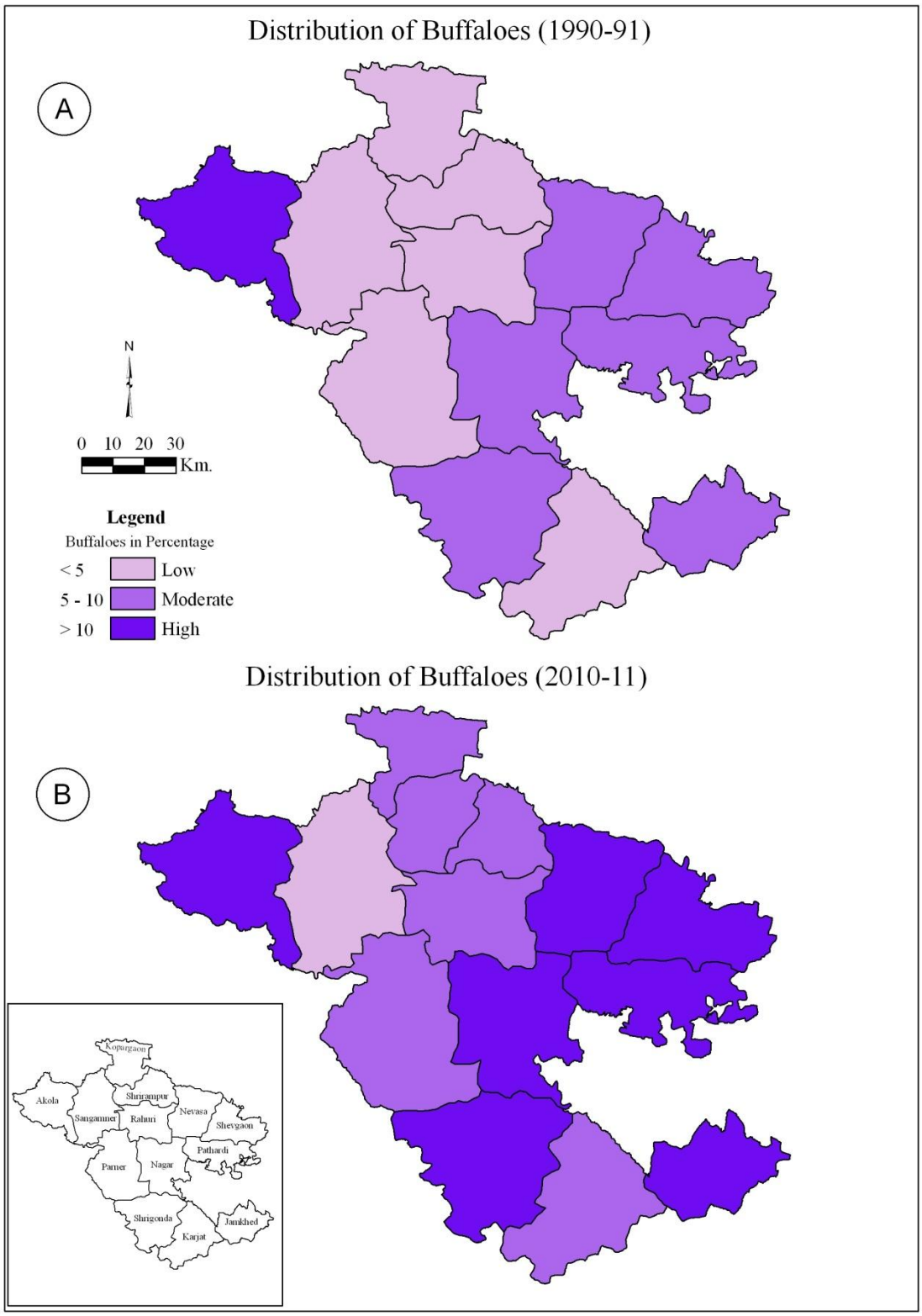

Distribution of Buffaloes (1990-91)
A
N
0 10 20 30
Km.
Legend
Buffaloes in Percentage
< 5 Low
5 - 10 Moderate
> 10 High
Distribution of Buffaloes (2010-11)
B
Kopargaon
Akola
Shrirampur
Sangamner
Rahuri
Nevasa
Shevgaon
Pathardi
Parner
Nagar
Shrigonda
Karjat
Jamkhed

Fig: 3.9 A& B

moderate category was found in Rahuri, Shrirampur, Karjat, Parner, Kopargaon and Rahata tehsils. High category was marked in Nagar, Nevasa, Shevgaon, Pathardi, Jamkhed, Shrigonda and Akole tehsils.

During the period of investigation percentage share of buffaloes in total livestock population was increased by 4.63 percent (table 3.4). It percentage share significantly increased in tehsils of Nagar, Shrirampur, Nevasa, Jamkhed, Shrigonda and Kopargaon while rest of the tehsils recorded insignificant change.

3.4 C Goats and Sheeps

In India about five million households are engaged in rearing of sheep and goats (India, 2012). In Ahmednagar district some small and marginal farmers' rear goat and sheep for their livelihood. Sheep is rear for the purpose of milk, mutton, hair and skin while goat for milk, skin and mutton. In study area sheep and goat occupied first rank in total livestock.

The percent contribution of goat and sheep to total livestock was worked out (table 3.4) and divided into four different categories i.e. very low (below 40) low (40-45) moderate (45-50) and high (above 50). It is revealed that district have 46.72 and 54.92 percent contribution of goat and sheep in total livestock population during the years 1990-91 and 2010-11 respectively.

During the year 1990-91, very low category was found in Akole, Jamkhed, Kopargaon and Shrirampur tehsils while low category registered in Shevgaon, Nevasa and Pathardi (fig. 3.10/A). Moderate category was found in Shrigonda and Nagar tehsils whereas high category was observed in Sangamner, Rahuri, Karjat and Parner tehsils.

Fig. 3.10/B and table 3.4 reveals that during the year 2010-11, very low category was found in Akole and Jamkhed tehsils whereas low category was observed in Shevgaon tehsil. Moderate category was recorded in Kopargaon, Nevasa, Pathardi and Shrigonda tehsils while high category was found in Rahuri, Rahata, Sangamner, Parner, Shrirampur, Karjat and Nagar tehsils.

During the period of investigation in district percentage share of goat and sheep to total livestock was increased by 8.20 percent (table 3.4). Five tehsils viz. Rahuri, Shrirampur, Akole, Sangamner and Kopargaon recorded significant positive change while rest of tehsils noticed insignificant change.

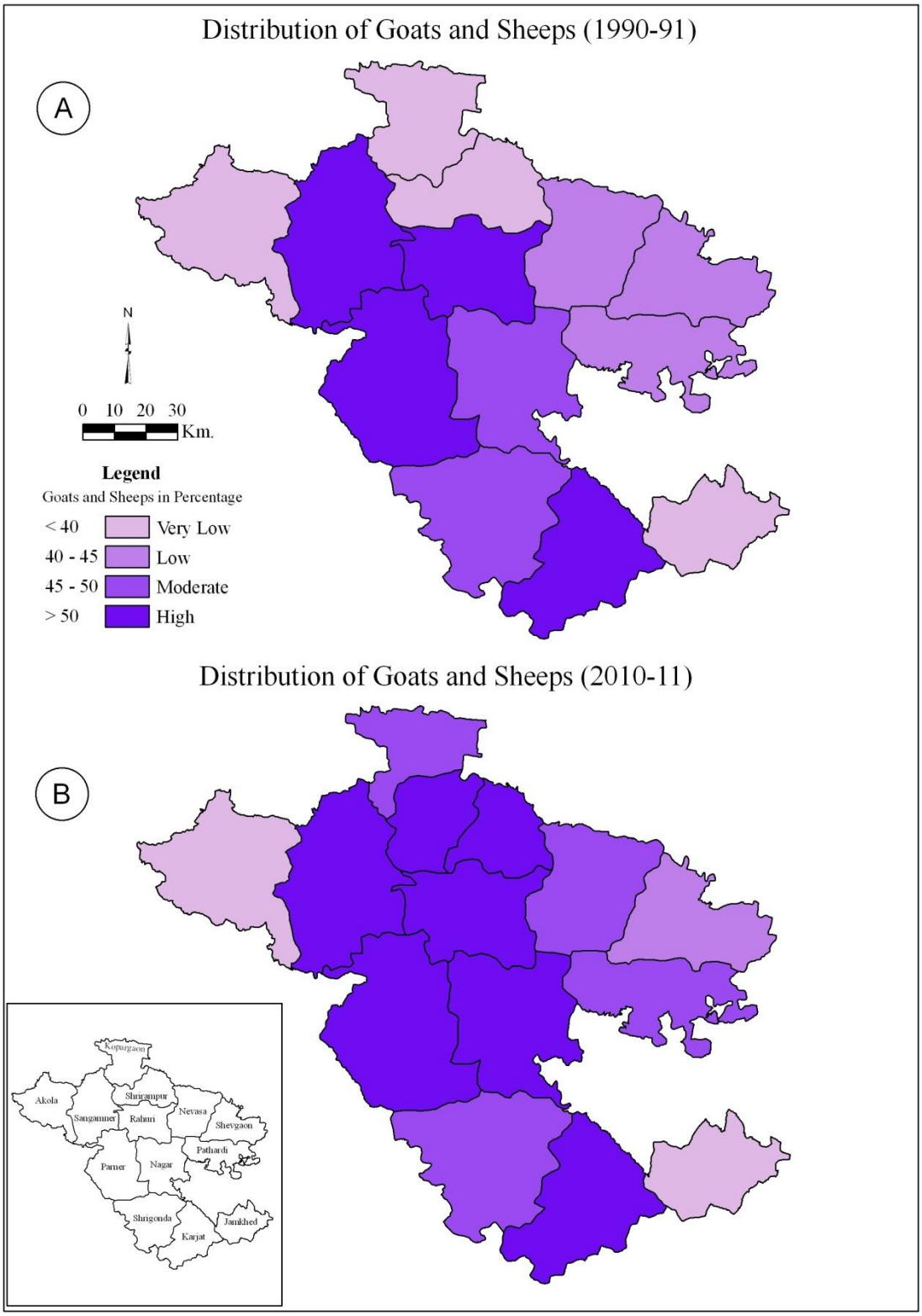

Distribution of Goats and Sheeps (1990-91)
A
N
0 10 20 30
Km.
Legend
Goats and Sheeps in Percentage
< 40 Very Low
40 - 45 Low
45 - 50 Moderate
> 50 High
Distribution of Goats and Sheeps (2010-11)
B
Kopargaon
Akola
Shrirampur
Nevasa
Sangamner
Rahuri
Shevgaon
Pathardi
Parner
Nagar
Shrigonda
Jamkhed
Karjat

Fig: 3.10 A & B

3.4 D Other Livestock

In the category of other livestock horses, donkeys and other pet animals are included. The percent share of other livestock in total livestock was worked out (table 3.4) and divided into four different categories namely, very low (less than 3), low (3 to 6), moderate (6 to 9) and high (above 9). It is revealed that district have 7.86 and 1.46 percent contribution of other livestock in total livestock during the years 1990-91 and 2010-11 respectively.

Fig. 3.11/A revealed percentage share of other livestock in total livestock during the year 1990-91. It shows that very low category was not found in any tehsil while low category was registered in Akole tehsil. Moderate category was found in Nagar, Rahuri, Nevasa, Pathardi, Jamkhed, Karjat, Shrigonda, Parner and Sangamner tehsils while high category was marked in Shrirampur, Shevgaon and Kopargaon tehsils.

Table 3.4 and fig. 3.11/B shows the percentage share of other livestock in total livestock during the year 2010-11. Very low category was registered in Nagar, Nevasa, Shevgaon, Pathardi, Jamkhed, Shrigonda, Parner, Akole, Sangamner and Rahata tehsils while low category was marked in Rahuri, Shrirampur, Karjat and Kopargaon tehsils. Moderate and high categories were not observed during this year.

During the study period percentage share of other livestock to total livestock was declined by 6.40 percent in district (table 3.4). All tehsils registered negative change. Significant negative change was marked in tehsils of Nagar, Nevasa, Jamkhed, Shrigonda, Sangamner and Kopargaon while rest of the tehsils was found insignificant change.

3.5 Demographic Factors

The human resource is the basic resource for the overall development of any region. He is not only the beneficiary of the entire process of resource development and utilization but also is the most potent and dynamic agent of the production (Zimmerman, 1951). Human resource and agricultural development of any particular region are primarily based on the socio economic facilities with their location at appropriate places serve the people and play an important role in the development of particular geographical area (Singh and Singh, 1987).

Keeping the above views, researcher focuses on distributional pattern of rural urban population, literacy, man land ratio/ density such as crude, physiological and

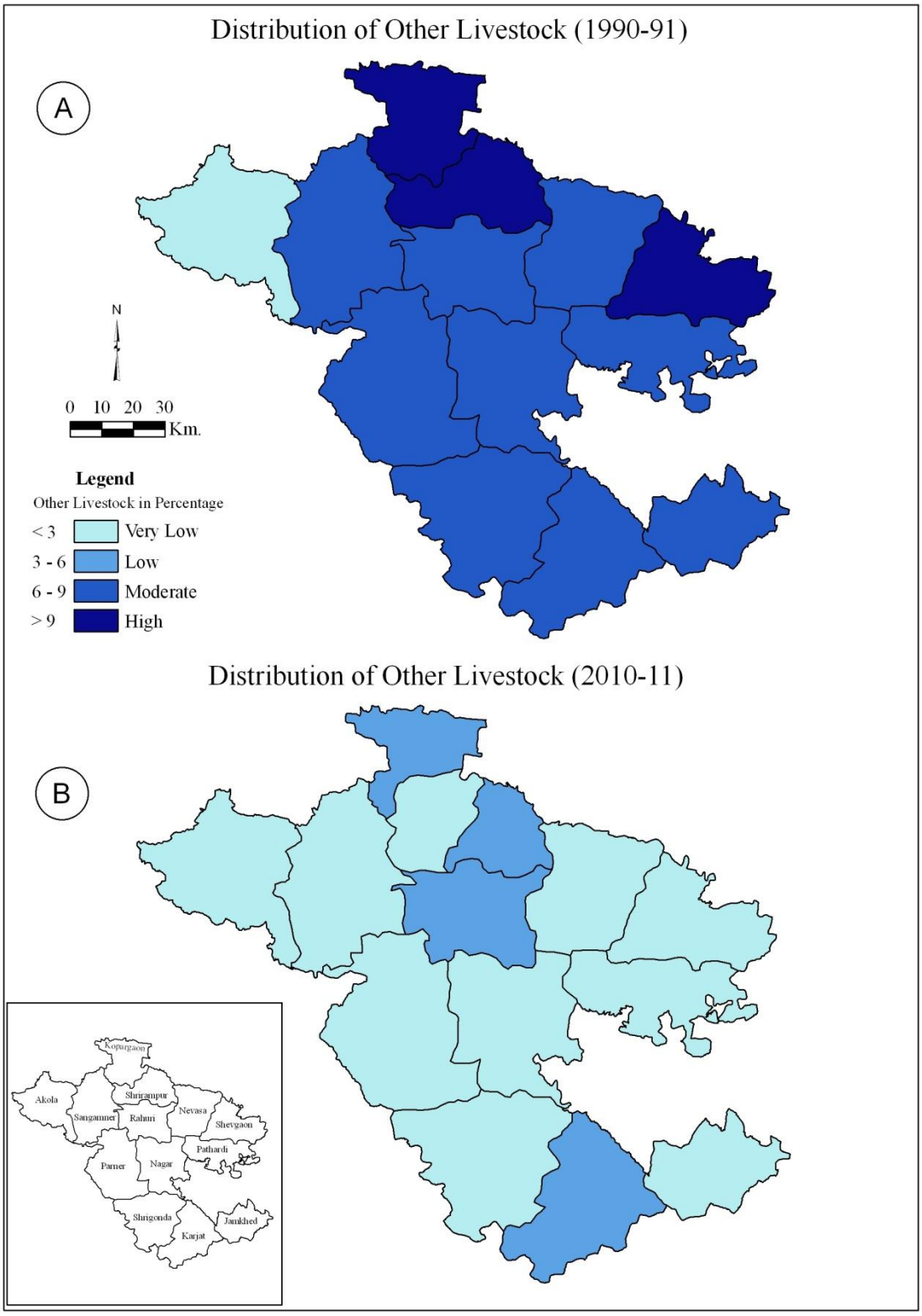

Distribution of Other Livestock (1990-91)
A
N
0 10 20 30
Km.
Legend
Other Livestock in Percentage
< 3 Very Low
3 - 6 Low
6 - 9 Moderate
> 9 High
Distribution of Other Livestock (2010-11)
B
Kopargaon
Akola
Shirampur
Nevasa
Sangamner
Rahuri
Shevgaon
Pathardi
Parner
Nagar
Shrigonda
Jamkhed
Karjat

Fig: 3.11 A & B

agricultural. The above demographic factor examined that how far human resource's impact on agricultural development in Ahmednagar district.

3.5 A Distribution of Rural - Urban Population

The development of agriculture of any region is based on combination of rural urban population. The urban population is customer of agricultural goods and rural is the customer as well as workforce of agriculture. Percentage share of rural and urban population to total population for tehsils and district was worked out and shown in table 3.5 and fig. 3.12 A&B.

Table 3.5 Rural - Urban Population in Ahmednagar District (Values in %)

Tehsils	Rural Population		Volume of Change	Urban Population		Volume of Change
	1991	2011		1991	2011	
Nagar	54.01	37.38	-16.63	45.99	62.62	16.63
Rahuri	78.73	78.34	-0.39	21.27	21.66	0.39
Shrirampur	76.77	68.96	-7.81	23.23	31.04	7.81
Nevasa	100	100	0	0	0	0
Shevgaon	100	100	0	0	0	0
Pathardi	89.49	89.44	-0.05	10.51	10.56	0.05
Jamkhed	100	78.55	-21.45	0	21.45	21.45
Karjat	100	95.05	-4.95	0	4.95	4.95
Shrigonda	90.82	90.14	-0.68	9.18	9.86	0.68
Parner	100	100	0	0	0	0
Akole	100	96.56	-3.44	0	3.44	3.44
Sangamner	86.17	82.02	-4.15	13.83	17.98	4.15
Kopargaon	73.81	78.42	4.61	26.19	21.58	-4.61
Rahata	--	81.75	--	--	18.25	--
District	**81.18**	**79.9**	**-1.28**	**18.82**	**20.10**	**1.28**

Source: Census, Ahmednagar district (1991 and 2011)

In Ahmednagar district during the year 1991, 81.18 percent population was residing in rural area while 18.82 percent residing in urban area. Rural population distributed in 1536 varying size villages. Table 3.5 and fig. 3.12/A revealed 100 percent rural population recorded in tehsils of Nevasa, Shevgaon, Jamkhed, Karjat, Parner and Akole. Tehsil Nagar recorded lowest (54.01 percent) rural population while rest of the tehsils marked more than 70 percent population residing in rural area. It means that dependency of agricultural is on higher side in district.

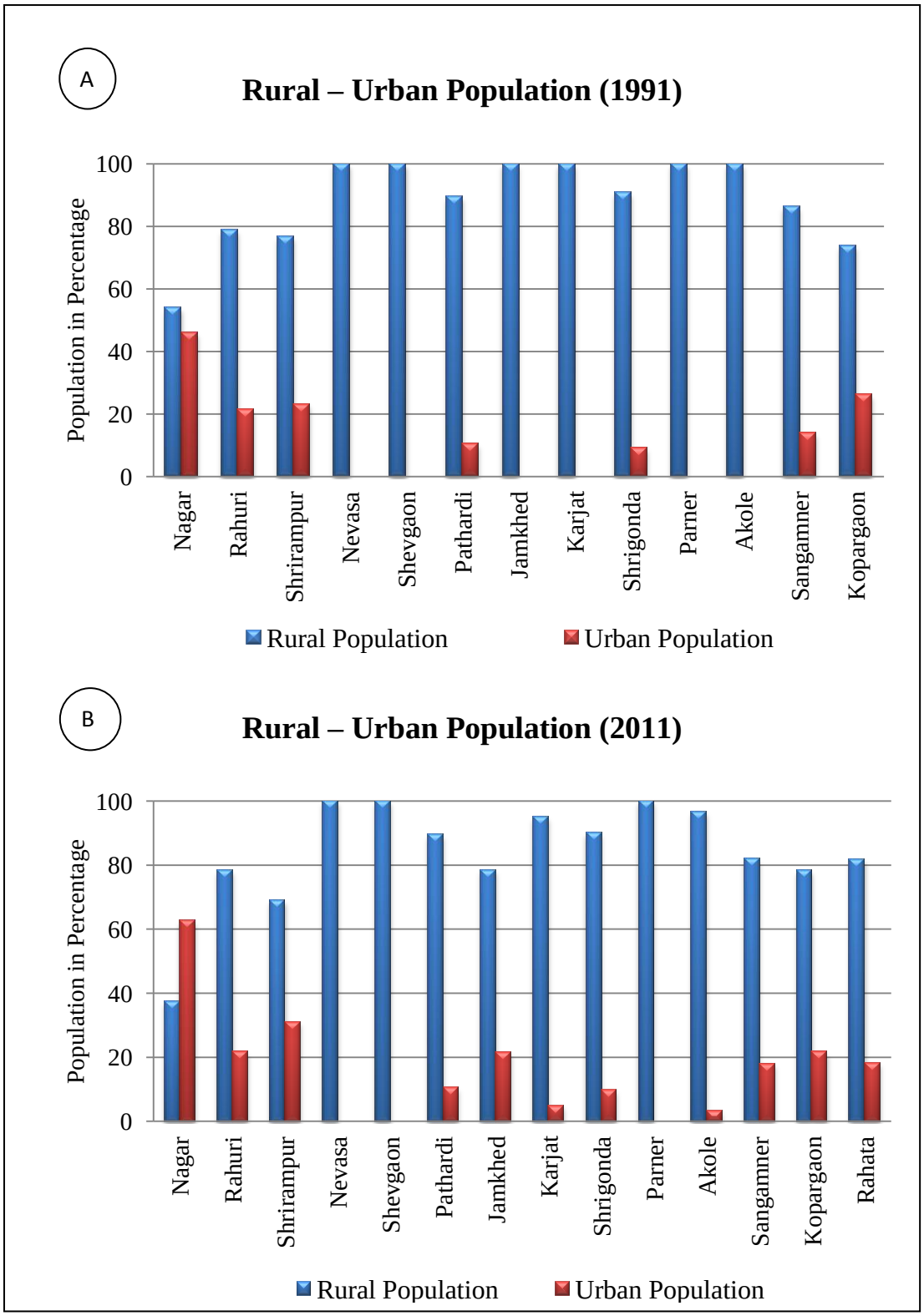

A
Rural – Urban Population (1991)
Population in Percentage
100
80
60
40
20
0
Nagar
Rahuri
Shrirampur
Nevasa
Shevgaon
Pathardi
Jamkhed
Karjat
Shrigonda
Parner
Akole
Sangamner
Kopargaon
Rural Population
Urban Population
B
Rural – Urban Population (2011)
Population in Percentage
100
80
60
40
20
0
Nagar
Rahuri
Shrirampur
Nevasa
Shevgaon
Pathardi
Jamkhed
Karjat
Shrigonda
Parner
Akole
Sangamner
Kopargaon
Rahata
Rural Population
Urban Population

Fig: 3.12 A & B

According to census 2011, in district out of 45, 43,083 population, 36, 30,012 population (79.90 percent) was residing in rural area where as 9, 13,071 population (20.10 percent) was residing in urban area. Lowest rural population recorded in tehsil Nagar (37.38 percent) and Shrirampur (68.98 percent) while rest of the tehsils recorded more than 75 percent population residing in rural area (3.12/B).

During two decades rural population was decreased by 1.28 percent in district (table 3.5). Volume of change in rural population registered except Kopargaon tehsil rest of the tehsils found negative change but it was significant in tehsils of Nagar, Shrirampur and Jamkhed. This situation shows that dependency of agriculture is slightly decreased.

3.5 B Literacy

The concept of literacy varies from country to country. According to Census of India a person who can both read and write with understanding in any language is known as literate. Literacy indicates the quality of manpower. Education helps human being in many ways to develop various skills. So, literacy is a necessity for all those who wish to practice the agricultural occupation on modern line. Literate population adopts new agricultural technology, which have positive effects on agricultural productivity. Therefore, it is effective instrument of agricultural development where population pressure on land is higher (Sing and Kareriya, 2006).

Tehsil wise percentage share of total literate and rural literate to total population of the years 1991 and 2011 was worked out and shown in table 3.6 and fig. 3.13 A & B. During the years 1991 and 2011 total literate in district has 61.03 percent 70.37 percent respectively. During the period of two decades total rural literacy rate increased 9.70 percent while rural literacy rate increased by 9.54 percent.

During the year 1991, total literacy rate was 61.03 percent whereas rural literacy was 57.81 percent. Fig 3.13/A shows that below 50 percent literacy was recorded in Akole tehsil where as 50 to 60 percent was registered in tehsils of Jamkhed, Pathardi, Shrigonda, Karjat, Parner, Nevasa and Shevgaon. Tehsils Rahuri, Shrirampur, Sangamner and Kopargaon have found 60 to 70 percent. Due to urban centre and district place Nagar tehsil literacy rate was above 70 percent.

According to census 1991, rural literacy rate varies from 64.96 percent in Nagar tehsil to 49.66 percent in Akole tehsil. Tehsils Shevgaon, Pathardi, Jamkhed and Karjat have recorded 50 to 55 percent rural literacy while 55 to 60 percent found

in tehsils of Nevasa, Shrigonda, Parner and Sangamner. Tehsils of Nagar, Rahuri, Shrirampur and Kopargaon registered above 60 percent rural literacy.

Table 3.6 and fig. 3.13/B reveals literacy rate of the year 2011. Nagar tehsil recorded highest literacy (78.21 percent) while 65 to 70 percent literacy registered in tehsils namely, Jamkhed, Shevgaon, Pathardi, Karjat, Akole, Shrigonda, Parner and Nevasa. Tehsils Rahuri, Shrirampur, Sangamner, Kopargaon and Rahata have found 70 to 75 percent.

During this year rural literacy rate varies from 70.68percent (Nagar) to 61.29 percent (Jamkhed). It was above 70 percent in Nagar and Rahata tehils while 65 to 70 percent in tehsils of Rahuri, Shrirampur, Nevasa, Shrigonda, Parner, Akole, Sangamner and Kopargaon. Below 65 percent recorded in tehsils of Shevgaon, Pathardi, Karjat and Jamkhed,

Table 3.6 Literacy in Ahmednagar District (Values in Percentage)

Tehsils	**1991**		**2011**	
	Total Literacy	**Rural Literacy**	**Total literacy**	**Rural Literacy**
Nagar	73.73	64.96	78.21	70.68
Rahuri	62.81	60.61	70.49	68.23
Shrirampur	66.77	64.86	73.33	69.96
Nevasa	57.09	57.09	68.02	68.02
Shevgaon	54.72	54.72	64.13	64.13
Pathardi	54.01	51.76	66.55	64.22
Jamkhed	51.51	51.51	65.23	61.29
Karjat	53.34	53.34	66.76	64.74
Shrigonda	58.24	56.90	67.92	66.35
Parner	56.46	56.46	67.22	67.22
Akole	49.66	49.66	67.09	65.44
Sangamner	61.39	58.21	71.28	68.24
Kopargaon	64.88	62.45	71.34	68.35
Rahata	-	-	73.55	71.67
District	**61.03**	**57.81**	**70.73**	**67.35**

Source: Census, 1991 and 2011

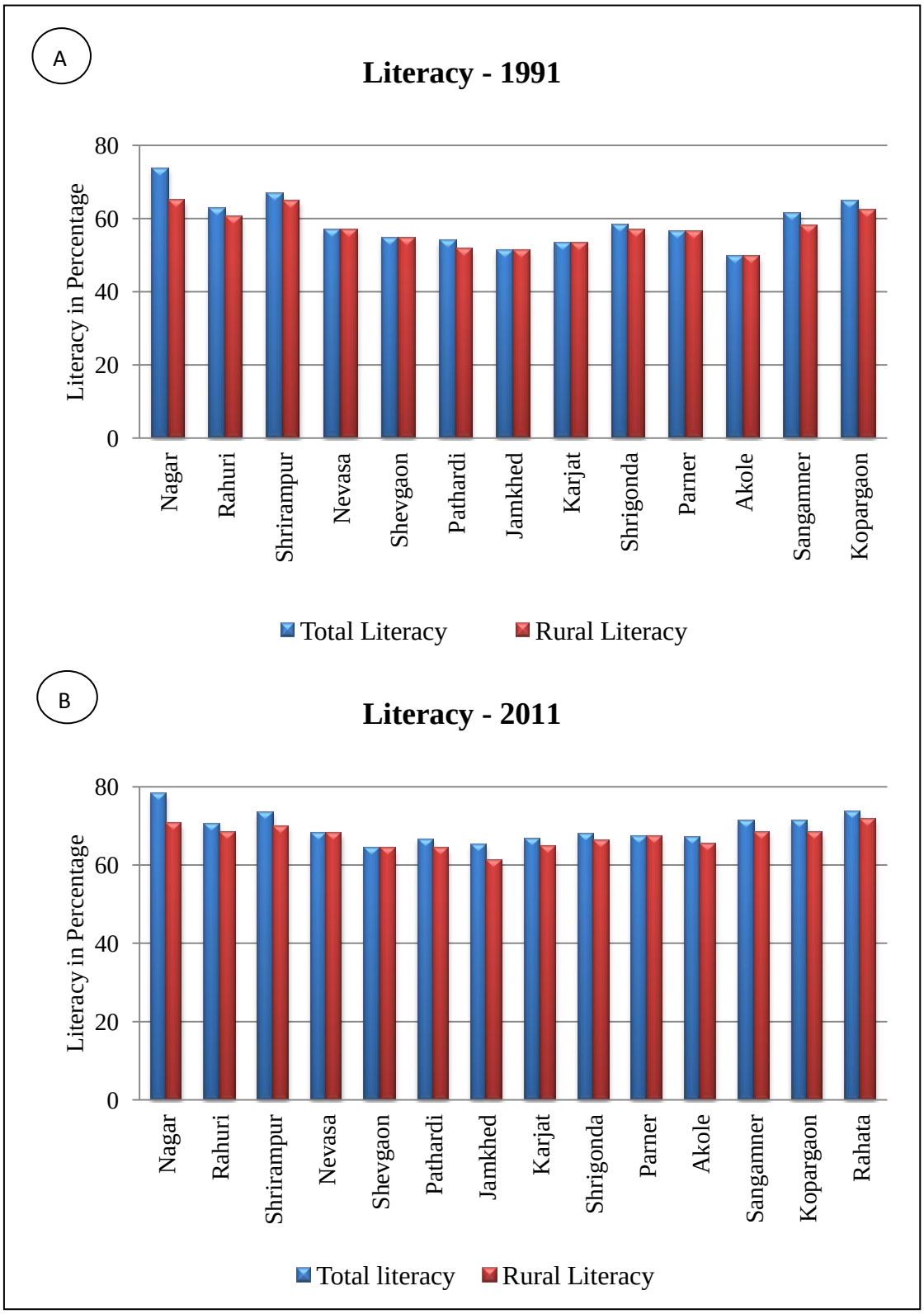

A
Literacy - 1991
Literacy in Percentage
80
60
40
20
0
Nagar
Rahuri
Shrirampur
Nevasa
Shevgaon
Pathardi
Jamkhed
Karjat
Shrigonda
Parner
Akole
Sangamner
Kopargaon
Total Literacy
Rural Literacy
B
Literacy - 2011
Literacy in Percentage
80
60
40
20
0
Nagar
Rahuri
Shrirampur
Nevasa
Shevgaon
Pathardi
Jamkhed
Karjat
Shrigonda
Parner
Akole
Sangamner
Kopargaon
Rahata
Total literacy
Rural Literacy

Fig: 3.13 A & B

3.5 C Population Density

Population density means pressure of population on land, the density of population have analyzed by different point of view in different disciplines. Geographical point of view it measuring various way, i.e. crude or surface density, rural density, physiological density, agricultural density, nutritional density and economic density. Such type of study is essential to determine extent of population pressure on land and changes therein for making a plan for optimum use of land for sustainable development. Population density over an area is largely depends on physical, economic and social factors. An area where productivity is limited supports low density of population. In the present study crude, physiological and agricultural density of population was worked out for examine the pressure of population on agricultural land.

i) Crude Density of Population (Arithmetic Density)

Crude density means ratio between total population and total geographical area. It depicts only very general condition of population pressure. According to 2011 census crude density of district was 267 persons per square kilometer which is less than Maharashtra (365) and India (382).

The crude density of population was worked out (table 3.7) and divided into four different categories i.e. very low, low, moderate and high having the range of below 200, 200-300, 300-400 and above 400 respectively (fig. 3.14/A). Very low density marked in western, south and eastern parts of district consisting the tehsils of Akole, Parner, Shrigonda, Karjat, Jamkhed, Shevgaon and Pathardi while low density was found in northern parts of district confined the tehsils of Sangamner, Rahuri and Nevasa. Moderate density was recorded in Kopargaon and Nagar tehsils while high density was found in Shrirampur tehsil.

According to census 2011, very low density marked in Jamkhed, Akole, Parner, Karjat, and Shrigonda tehsils while low density was found in four tehsils namely, Sangamner, Nevasa Shevgaon and Pathardi (fig.3.14/B). Moderate category was registered in Rahuri tehsil whereas high category was marked in Kopargaon, Rahata, Shrirampur and Nagar tehsils.

Accessibility, irrigation facilities and fertile soil which is the major determining factors of population density in Ahmednagar district. In northern parts of district have high density compare to south parts of district because of plan topography, availability of irrigation facilities and concentration of sugar industries.

Table 3.7 Density of Population in Ahmednagar District

Tehsils	Crude Density		Volume of Change	Physiological Density		Volume of Change	Agricultural Density		Volume of Change
	1991	2011		1991	2011		1991	2011	
Nagar	322	456	134	454	598	144	245	223	-22
Rahuri	248	317	69	386	537	151	304	421	117
Shrirampur	414	568	154	547	691	144	420	477	57
Nevasa	211	276	65	265	301	36	261	295	34
Shevgaon	157	226	69	232	296	64	226	291	65
Pathardi	155	215	60	189	279	90	169	249	80
Jamkhed	136	181	45	172	295	123	168	232	64
Karjat	124	158	34	185	265	80	178	252	74
Shrigonda	147	197	50	197	285	88	179	257	78
Parner	115	147	32	169	198	29	160	211	51
Akole	148	194	46	285	303	18	279	293	14
Sangamner	211	291	80	351	452	101	302	371	69
Kopargaon	315	429	114	394	588	194	291	461	170
Rahata	-	467	0	0	651	0	0	532	532
District	**198**	**267**	**69**	**284**	**380**	**96**	**242**	**303**	**61**

Source: Compiled by researcher

Note: (i) Crude density – Persons per sq. km.

(ii) Physiological density – Persons per hundred hectares net sown area

(iii) Agricultural density – Persons per hundred hectares net sown area

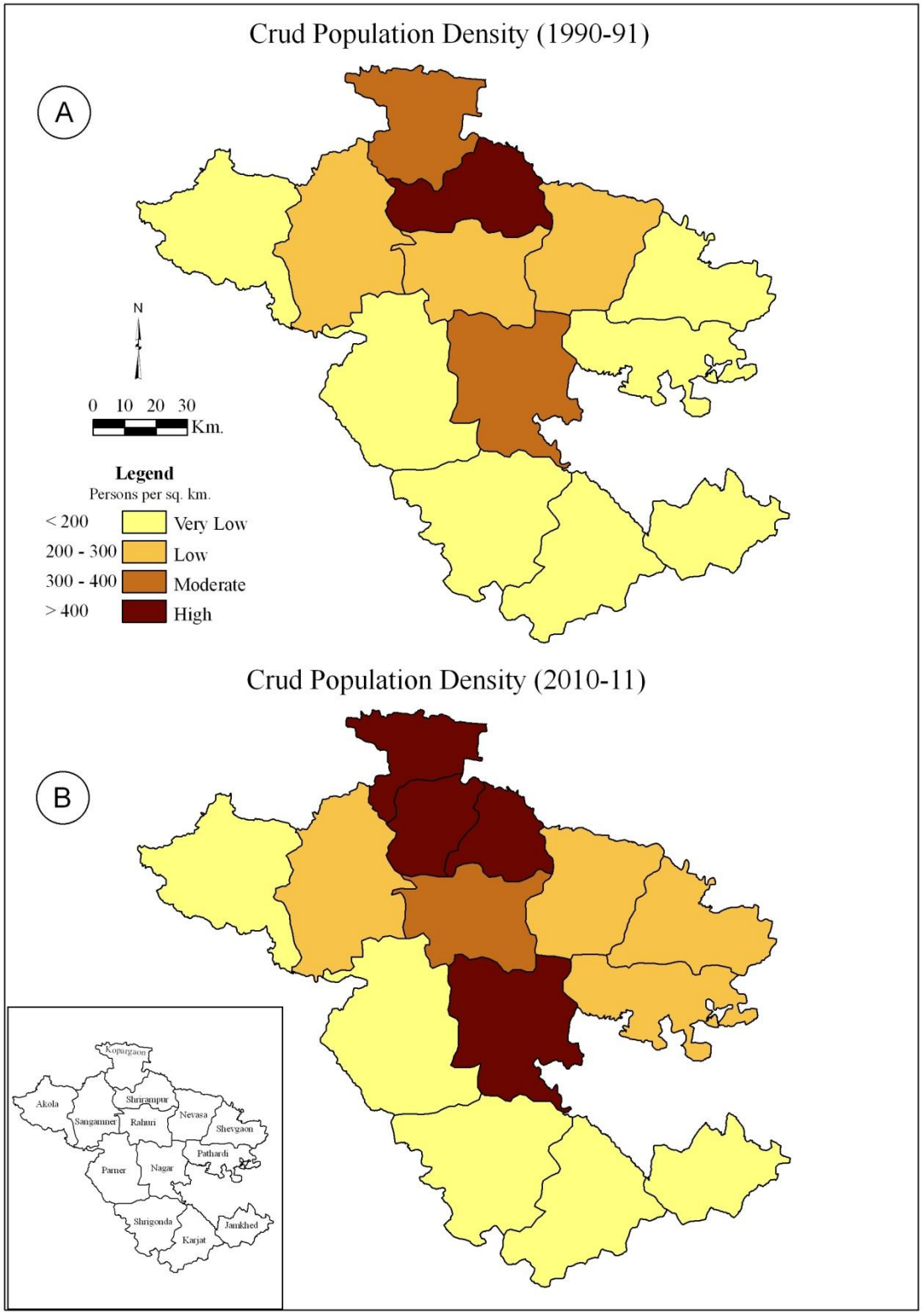

Crud Population Density (1990-91)
A
N
0 10 20 30
Km.
Legend
Persons per sq. km.
< 200
Very Low
200 - 300
Low
300 - 400
Moderate
> 400
High
Crud Population Density (2010-11)
B
Kopargaon
Akola
Shrirampur
Sangamner
Rahuri
Nevasa
Shevgaon
Pathardi
Parner
Nagar
Shrigonda
Jamkhed
Karjat

Fig: 3.14 A & B

During the period of investigation tehsils of Nagar, Shrirampur, Sangamner and Kopargaon noticed significant positive change in crude density of population.

ii) Physiological Density of Population

Physiological density of population means ratio between total population and cultivated land, another word it is also called as man soil density. It is work out by total population divided by net sown area in a particular region (Trewartha, G. T. 1953). The crude density shows only population pressure on total geographical area but in agricultural point of view it is misleading. Thus the physiological density is felt as it gives rather a more concrete picture.

Physiological density of population was worked out and divided into four different categories i.e. very low, low, moderate and high having the range of below 200, 200-400, 400-600 and above 600 respectively. In district physiological density was 284 and 380 persons per hundred hectares net sown area in 1991 and in 2011 respectively.

Table 3.7 revealed during the year 1991 very low density was found in Pathardi, Jamkhed, Karjat, Shrigonda and Parner tehsils while low density was marked in Rahuri, Nevasa, Shevgaon, Akole, Kopargaon and Sangamner tehsils. Moderate density was found in Shrirampur and Nagar tehsils and high category was not found in any tehsil of district.

Table 3.7 and fig 3.15/ B revealed physiological density of population of the year 2011. During this year very low density found in Parner tehsil while low category was marked in Nevasa, Shevgaon, Pathardi, Jamkhed, Karjat, Shrigonda, Parner and Akole tehsils. Moderate density was recorded in tehsils namely, Rahuri, Sangamner, Kopargaon and Nagar while high density found in Shrirampur and Rahata tehsil.

The spatial distribution pattern clearly shows that the agriculturally advanced tehsils have high physiological density of population. During the period of two decades all tehsils recorded positive change in physiological density of population but it was significant in Nagar, Rahuri, Shrirampur, Jamkhed, Sangamner and Kopargaon tehsils.

iii) Agricultural Density of Population

Agricultural density means the ratio between agricultural population and agricultural land i.e. net sown area (Kashid, D. L. 2010). The crude and physiological density fails to shows the actual pressure of agricultural population on net sown area.

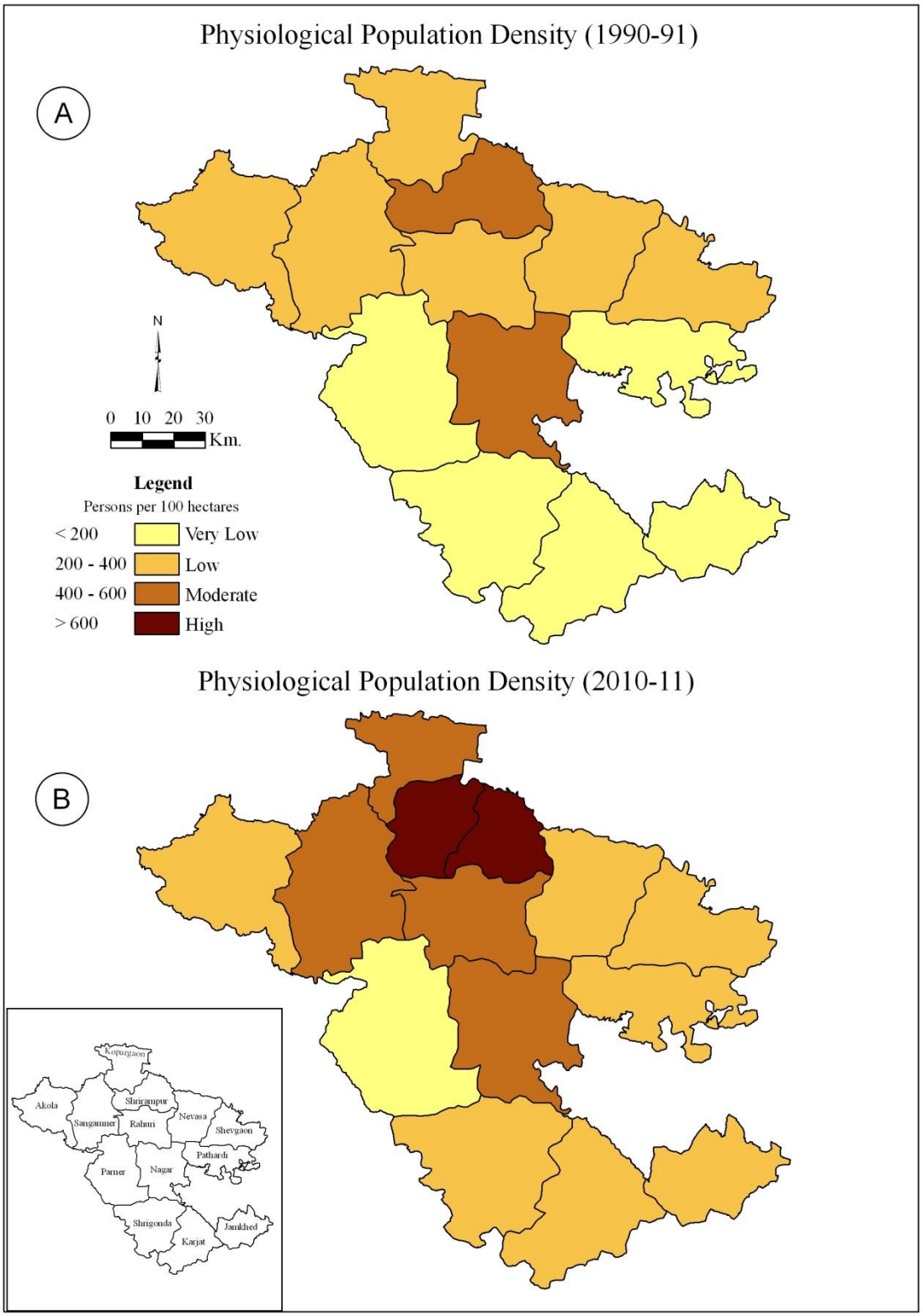

Physiological Population Density (1990-91)
A
N
0 10 20 30
Km.
Legend
Persons per 100 hectares
< 200 Very Low
200 - 400 Low
400 - 600 Moderate
> 600 High
Physiological Population Density (2010-11)
B
Kopargaon
Akola
Shrirampur
Sangamner
Rahuri
Nevasa
Shevgaon
Pathardi
Parner
Nagar
Shrigonda
Jamkhed
Karjat

Fig: 3.15 A & B

To overcome this problem agricultural density of population for tehsils and district was worked out of the years 1991 and 2011 and divided into four different categories namely, very low, low, moderate and high having the range under 250, 250-350, 350-450 and above 450. Table 3.7 shows tehsil wise agricultural density of population, it was 242 and 303 persons per hundred hectares net sown area during the years 991 and 2011 respectively.

According to census 1991, very low density was found in Nagar, Shevgaon, Pathardi, Jamkhed, Karjat, Shrigonda and Parner tehsils while low density was marked in Rahuri, Nevasa, Akole, Sangamner and Kopargaon tehsils. Tehsil Shrirampur recorded moderate category whereas high category was not found in any tehsil (fig 3.16/A).

Fig 3.16/B reveals agricultural density of population of the year 2011. Very low density was found in low irrigated area comprised tehsils of Nagar, Pathardi, Jamkhed and Parner while low density was marked in Nevasa, Shevgaon, Karjat, Shrigonda and Akole. Rahuri and Sangamner tehsils registered moderate density while high density was found in northern parts of district comprised Shrirampur, Kopargaon and Rahata tehsils.

During the period of two decades except Nagar tehsil rest of the tehsils recorded positive change in agricultural density of population (table 3.7). But it was significant in tehsils of Rahuri, Pathardi, Karjat, Shrigonda, Sangamner and Kopargaon. By considering the agricultural density of population in Ahmednagar district those tehsils recorded significant positive change their population pressure on agriculture is increased. Due to this there is need to do agriculture on modern line and increase the productivity of agriculture to fulfill the need of growing population.

3.6 High Yielding Varieties (HYV) of Seeds

The HYV seeds have played vital role in augmenting agricultural production. These seeds not only help in increasing agricultural production by 10 to 20 percent but introducing new characteristic in the biological structure of the plant like, quick maturing, higher yield and resistant to insects, diseases and drought. In India the success of green revolution is partly associated with the use of HYV seeds (Singh, I and Singh, S, 2006). The adoption of HYV of seed does not require any special skill and farmers of various socio-economic and cultural backgrounds can adopt the new seeds easily.

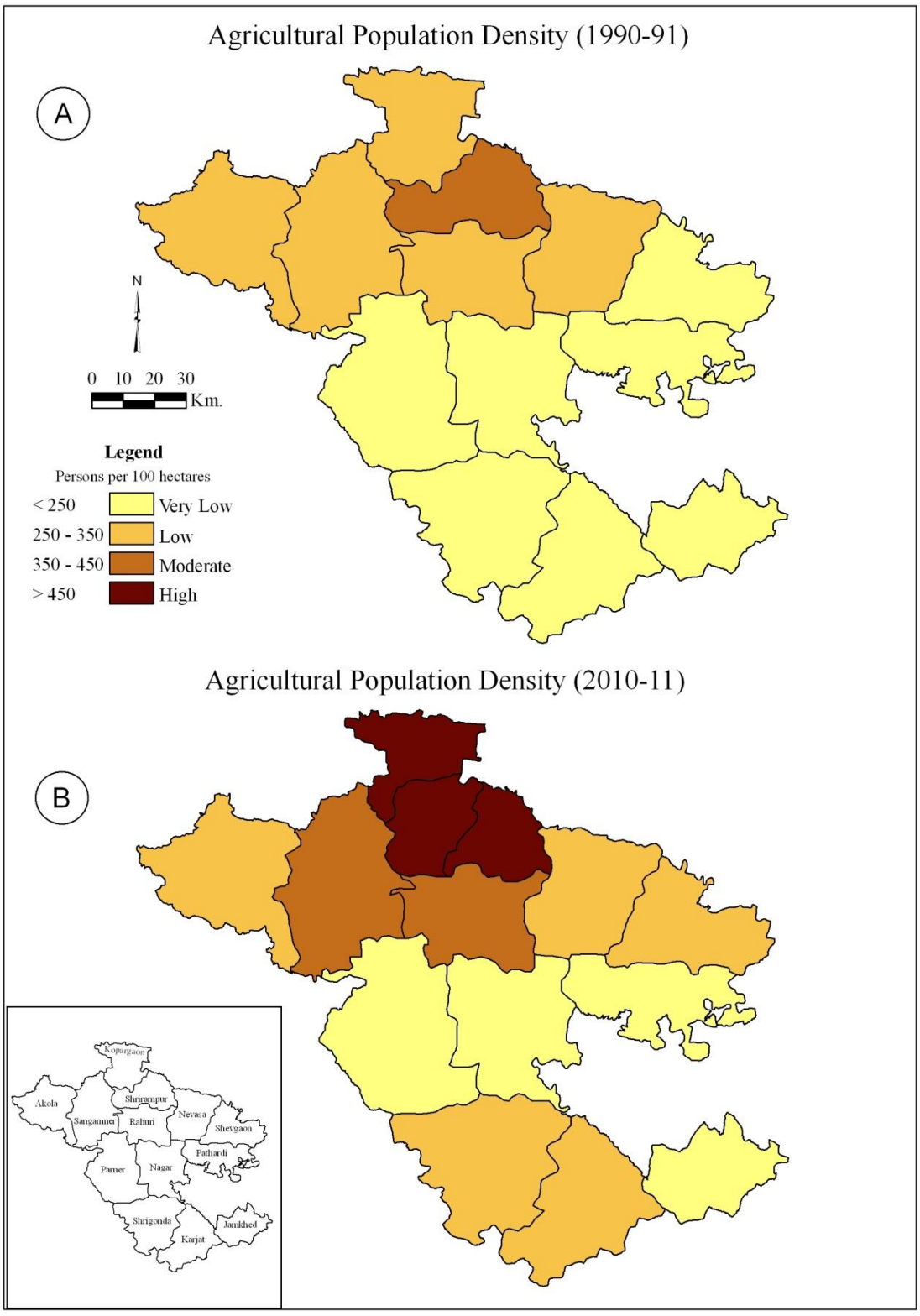

Agricultural Population Density (1990-91)
A
N
0 10 20 30
Km.
Legend
Persons per 100 hectares
< 250
Very Low
250 - 350
Low
350 - 450
Moderate
> 450
High
Agricultural Population Density (2010-11)
B
Kopargaon
Akola
Shrirampur
Sangamner
Rahuri
Nevasa
Shevgaon
Pathardi
Parner
Nagar
Shrigonda
Jamkhed
Karjat

Fig: 3.16 A & B

The success of green revolution in the study region is also closely related to the use of HYV of seeds particularly of wheat, bajra, jowar, sugarcane, oilseeds, cotton, pulses, vegetable and other crops. The Government of India proclaimed the new policy on seed development in October, 1988. The thrust of this policy is to protect for the Indian farmer high quality seed available anywhere in the country with a view to maximize the crop yields, boost agricultural productivity and farm income. In study region tehsil Panchyat Sammittee and private distributers distribute the HYV seeds. Panchyat Sammittee of each tehsil is supervising the distribution system of HYV seeds.

Share of HYV seeds per hundred hectares of total cropped area was worked out with the help of following formula (Chouhan, T. S. 1987).

$$\text{Share of HYV Seeds} = \frac{\text{Total use of HYV seeds in } j^{th} \text{ tehsil}}{\text{Total cultivated area in } j^{th} \text{ tehsil}} \text{ x 100 hectare}$$

The use of HYV seeds data for the year 1990-91 was not available so researcher interpreted only data of the year 2010-11. During this year 27212 and 58552 thousand ton HYV seeds used in *kharif* and *rabi* season respectively (excluding sugarcane and fodder). Change the attitude of farmers, intensive minor irrigation schemes and use of chemical fertilizers has supported the increased use of HYV seeds in district.

Use of HYV seeds per hundred hectare of total cultivated area (excluding area under sugarcane and fodder crop) was worked out and divided into four categories very low, low, moderate and high having the range below 40, 40-50, 50-60 and above 60 respectively.

Table 3.8 and fig. 3.17 revealed very low category was marked in Parner tehsil while Akole, Shevgaon, Nevasa, Pathardi, Nagar, Shrigonda and Karjat tehsils noticed low category. Moderate category was registered in Jamkhed and Rahata tehsils while high category was found in northern high irrigated parts of district comprised tehsils of Kopargaon, Sangamner, Rahuri and Shrirampur. The northern high irrigated tehsils have used high amount of HYV seeds per hundred hectares to total cropped area compared to south and south-western part of the district. It means that the use of HYV seeds is largely depends on availability of irrigation.

Table 3.8 Percentage Share of High Yielding Varity Seeds and Chemical Fertilizers (2010-11)

Tehsils	HYV seeds	Chemical fertilizers
	Share per hundred hectare to total cultivated area(ton)	Share per hundred hectare to net sown area(ton)
Nagar	47.00	19.80
Rahuri	65.62	60.89
Shrirampur	69.31	51.37
Nevasa	49.20	43.49
Shevgaon	47.50	37.30
Pathardi	46.88	38.84
Jamkhed	52.97	38.04
Karjat	48.63	32.60
Shrigonda	44.16	24.22
Parner	27.53	19.14
Akole	41.89	21.50
Sangamner	67.77	46.55
Kopargaon	62.11	52.22
Rahata	58.65	54.78

Source: Panchyat Sammittee of each tehsil (2010-11)

3.7 Chemical Fertilizers

Fertilizer is the key input for increasing the agricultural production. Its use depends on the availability of soil moisture either natural or artificial, the physical and chemical properties of soils and type of crop. Soil productivity is reducing because of the repeated use of the same land every year and sometime doubles or triple in a year. Due to this farmers apply biological and chemical fertilizer to improve the soil fertility. The HYV seeds required more fertilizer for increasing yield. Farmers make compost fertilizer by traditional way by farmyard manure which are prepared by using dung, urine of cattle, ash and other refuse. But it is not enough to requirements of farmers. The cultivators, therefore, have started applying the chemical fertilizers extensively to enhance the crop production. The chemical fertilizer includes, Ammonium sulphet, Super Phosphate, Nitrogen Phosphate, Fertilizer Mixture, Urea etc.

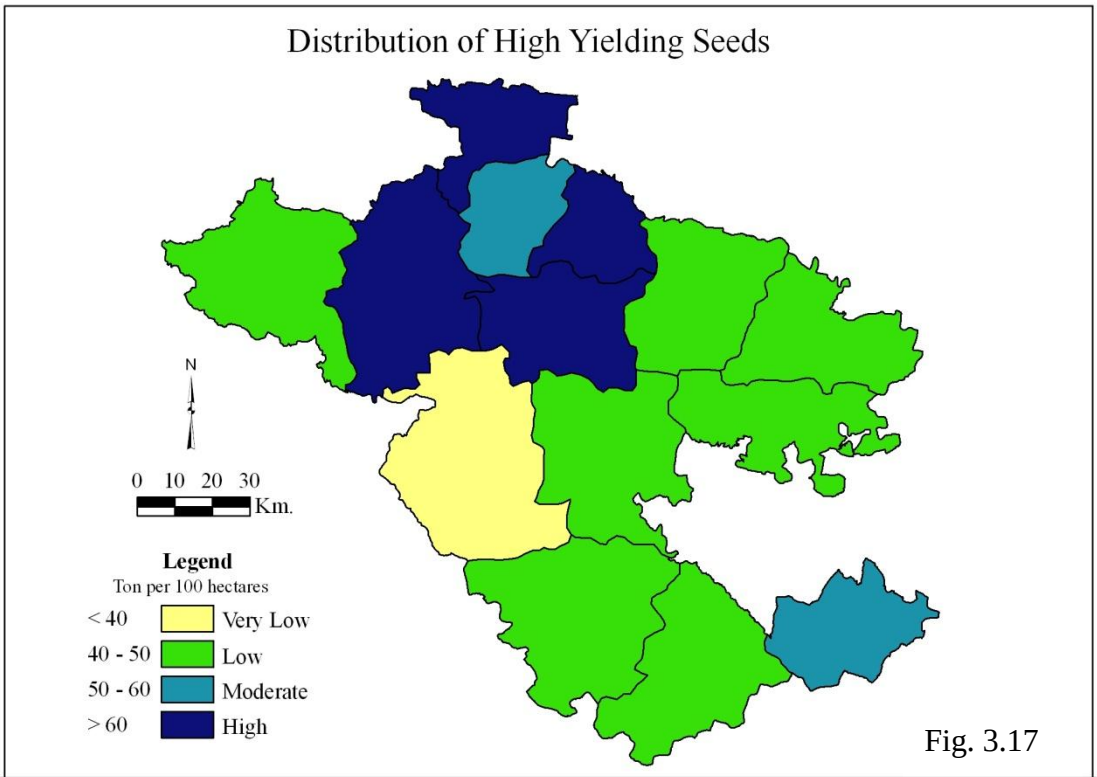


Fig. 3.17

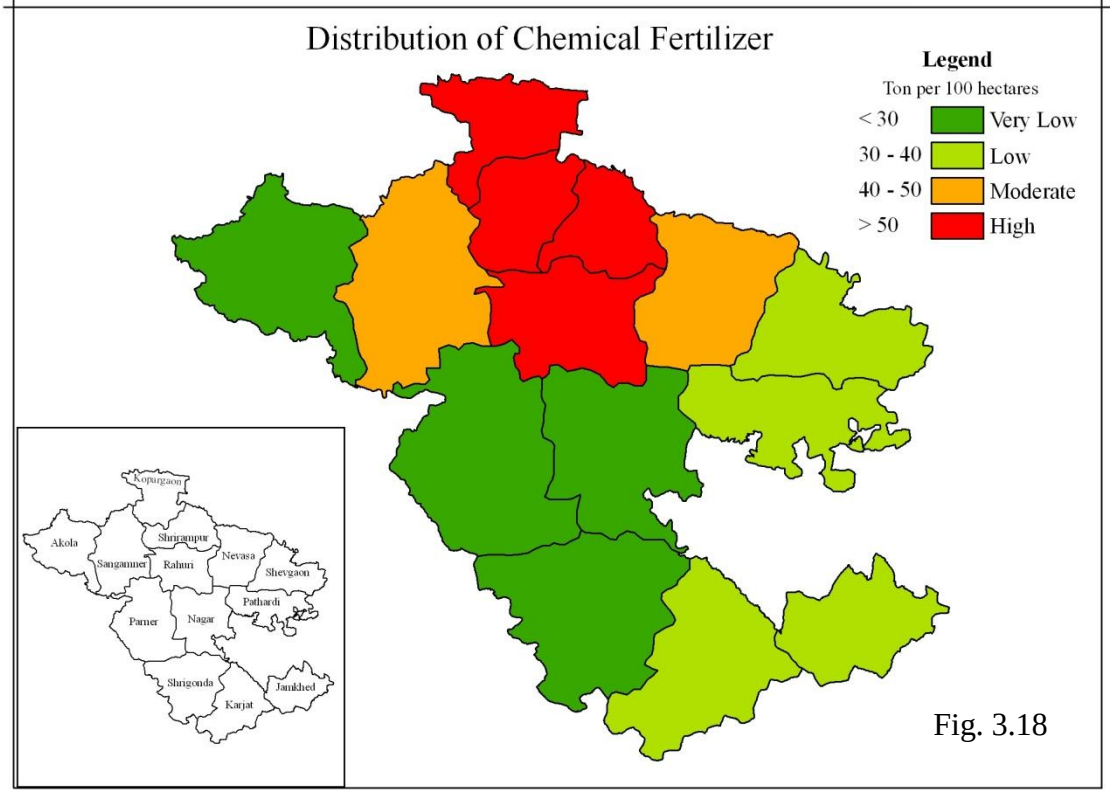


Fig. 3.18

Share of chemical fertilizer per hundred hectares of net sown area was worked out with the help of following formula (Chouhan, T. S. 1987).

$$\text{Share of Chemical Fertilizer} = \frac{\text{Total use of Chemical Fertilizer in } j^{th} \text{ tehsil}}{\text{Net sown area in } j^{th} \text{ tehsil}} \times 100 \text{ hectare}$$

The use of chemical fertilizers in district during the year 1990-91 data was not available so researcher interpreted only data of the year 2010-11. Total fertilizer consumption in district during this year was 424662 metric ton. Tehsil wise use of chemical fertilizer per hundred hectares to net sown area was work out (table 3.8) and divided into four different categories namely, very low, low, moderate and high having the range under 30, 30-14, 40-50 and above 50 respectively. Very low category was found in Akole, Parner, Nagar and Shrigonda tehsils while low category was marked in eastern parts of the district comprised tehsils of Shevgaon, Pathardi, Karjat and Jamkhed (fig. 3.18). Moderate to high category was registered in the northern part of district comprised tehsils of Sangamner, Nevasa, Kopargaon, Rahata, Shrirampur and Rahuri. North parts of district have irrigation facilities and maximum area under cash crops due to this their high use of chemical fertilizer.

3.8 Agricultural Credit

The agriculture needs to credit for a variety of purpose and for different period. Capital subscribes definite limitation to the selection of crops. All agricultural inputs like the livestock, irrigation, seed, fertilizer, insecticide, labour and various agricultural implements perches and repair require capital (Husain, M, 1996). District co-operative banks, Commercial banks and Nationalize banks provide credit to farmer for development of agriculture. They provide short and midterm loans for purchasing agricultural equipment. Beside this they provide long term loan for lift irrigation, digging and repairing of wells and for installing fruit processing units. Although farmer co-operative credit societies play vital role in the field of agricultural development by extending credit facilities on an extensive scale.

In the present study per hundred hectares loan distributed in each tehsil was worked out by dividing total loan distributed in each tehsil by net sown area multiplied by hundred hectares (Kashid, D. L. 2010) .

$$\text{Distribution of loan} = \frac{\text{Total loan distributed in } j^{th} \text{ tehsil}}{\text{Net sown area in } j^{th} \text{ tehsil}} \times 100 \text{ hectare}$$

In Ahmednagar district majority of the villages have farmer co-operative credit societies. During the years 1990-91 and 2010-11 district has 1091 and 1287 farmer's co-operative credit societies and these provided Rs. 641.59 and 494.28 thousand per hundred hectare of net sown area respectively.

Table 3.9 Framers Co-operative Credit Societies and Loan Distribution per Hundred Hectares of Net Sown Area (Note: Rs. in Thousands)

Tehsil	1990-91		2010-11		Volume of Change
	Number of Societies	Loan Advances	Number of Societies	Loan Advances	
Nagar	105	387.01	110	360.63	-26.38
Rahuri	89	1290.84	110	663.38	-627.46
Shrirampur	83	1013.17	69	585.71	-427.46
Nevasa	89	1451.15	134	556.41	-894.74
Shevgaon	68	626.3	74	520.3	-106
Pathardi	80	326.19	84	593.94	267.75
Jamkhed	43	109.02	48	559.96	450.94
Karjat	64	286.3	73	485.1	198.8
Shrigonda	75	629.44	106	384.93	-244.51
Parner	99	508.25	105	391.63	-116.62
Akole	45	343.22	48	404.21	60.99
Sangamner	126	635.6	134	476.17	-159.43
Kopargaon	125	929.54	117	584.98	-344.56
Rahata	-	-	75	717.54	--
District	**1091**	**641.59**	**1287**	**494.28**	**-147.31**

Source: (i) Socio economic abstract of Ahmednagar district (1990-91)

(ii) Dept. of agriculture of each tehsil (2010-11)

Agricultural credit per hundred hectares of net sown area was work out (table 3.9) for the years 1990-91 and 2010-11 and divided into four different categories namely, very low, low, moderate and high having the range below 400, 400-600, 600-800 and above 800 thousands Rs. per hundred hectares respectively.

During the year 1990-91, very low category was found in low irrigated tehsils namely, Nagar, Pathardi, Jamkhed, Karjat and Akole while low category was noticed in Parner tehsil. Moderate category was observed in tehsils of Shevgaon, Shrigonda and Sangamner while high category was recorded in tehsils of Rahuri, Shrirampur, Nevasa and Kopargaon (fig 3.19/A).

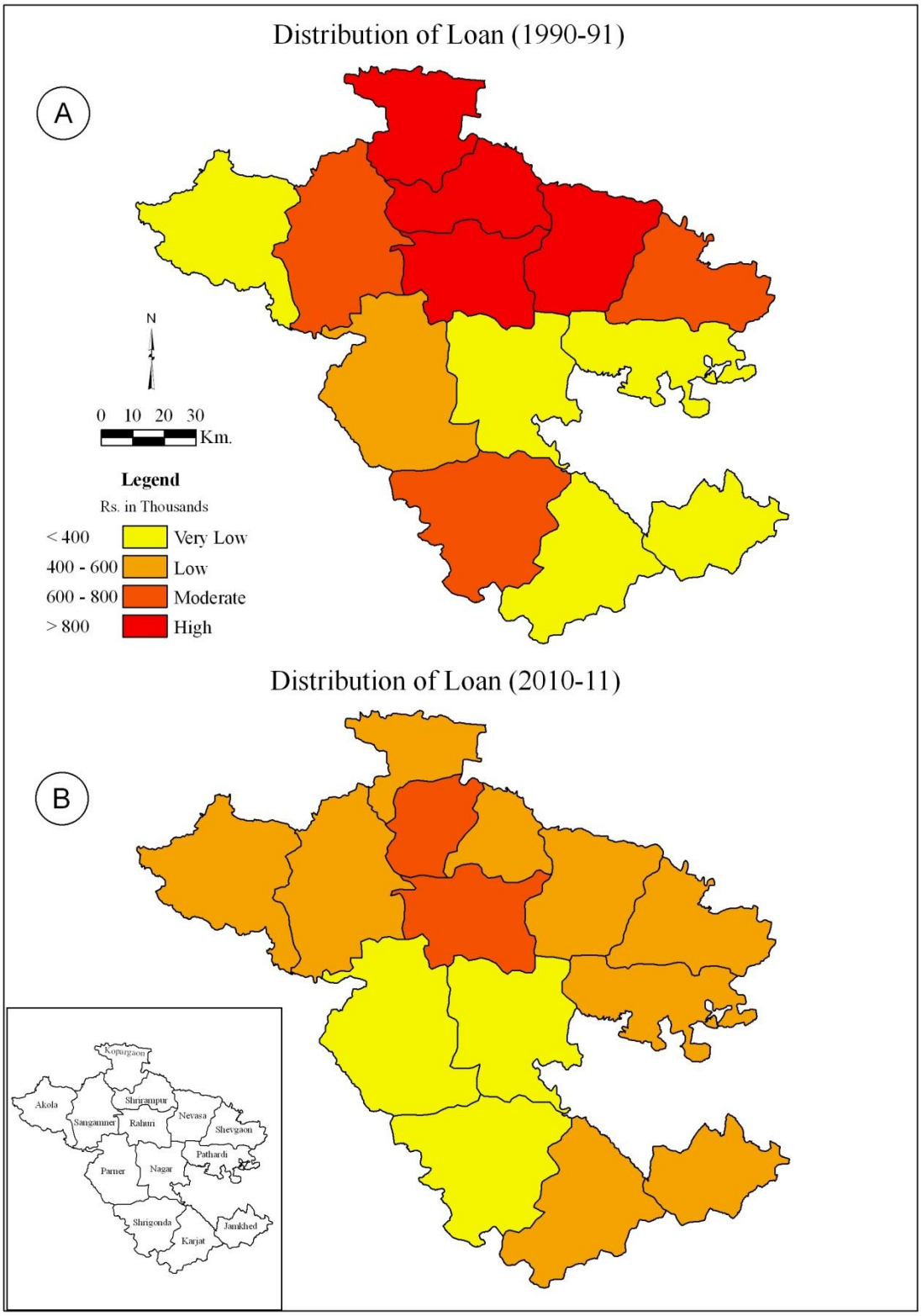

Distribution of Loan (1990-91)
A
N
0 10 20 30
Km.
Legend
Rs. in Thousands
< 400
Very Low
400 - 600
Low
600 - 800
Moderate
> 800
High
Distribution of Loan (2010-11)
B
Kopargaon
Akola
Shrirampur
Nevasa
Sangamner
Rahuri
Shevgaon
Pathardi
Parner
Nagar
Shrigonda
Jamkhed
Karjat

Fig: 3.19 A & B

During the year 2010-11, in district Rs. 5912071 thousands provided to farmers. It was very low in Parner, Nagar and Shrigonda tehsils whereas low loan distributed in Shrirampur, Nevasa, Shevgaon, Pathardi, Jamkhed, Karjat, Akole, Sangamner and Kopargaon tehsils (fig.3.19/B). Moderate loan provided to farmers in northern tehsils namely, Rahuri and Rahata where maximum area is under cash crops i.e. sugarcane while high category was not found during this year.

During the period of investigation in distribution of loan significant negative change was found in tehsils of Rahuri, Shrirampur, Nevasa, Shevgaon, Shrigonda, Parner, Sangamner and Kopargaon while significant positive change recorded in tehsils of Pathardi, Jamkhed and Karjat. Two tehsils namely, Nagar and Akole noticed insignificant change.

3.9 Market Facilities

Market can be defined as the performance of business activities that direct the flow of goods and services from the producer to the consumer. Market centers are the final step in agricultural activities. Distance from market centers have influence on cropping pattern so the accessibility to the market is a major consideration in the decision making of farmer. The intensity of agriculture and the production of crops decline as the location of cultivation get away from the marketing center (Singh, J. 2009). The development of market centers depends on physiography, population density, administrative importance, geographical area and better network of transport.

In development of agriculture rural markets plays an important role. It has not only facilitated economic transactions, but also brings about a flow of ideas. Purpose of rural markets is buying and selling of agricultural commodities. The Zilha Parishad Ahmednagar and Government of Maharashtra has established and regulated market centers in study region.

Fig. 3.20 revealed distribution of major and sub agricultural market centers in district. In study region there are 13 major, 24 sub and 157 weekly market centers during the year 1990-91. During the period of investigation all types market centers have increased. In year 2010-11, there are 14 major, 29 sub and 197 weekly market centers in district. Table 3.10 shows more number of weekly market centers in Nevasa and Kopargaon tansil, both are the agriculturally developed tehsils while tehsils Nagar Sangamner and Parner have more weekly market centers compared to remaining tehsils. On the basis of geographical area tehsil Pathardi and Jamkhed have less weekly market centers.

Table 3.10 Major, Sub and Weekly Agricultural Market Centers

Tehsils	Number of Major Market Center		Number of Sub Market Centers		Number of Weekly Market Centers	
	1990-91	2010-11	1990-91	2010-11	1990-91	2010-11
Nagar	1	1	0	0	16	20
Rahuri	1	1	1	3	5	7
Shrirampur	1	1	2	2	11	13
Nevasa	1	1	4	3	20	23
Shevgaon	1	1	2	3	11	14
Pathardi	1	1	4	4	7	9
Jamkhed	1	1	1	2	6	7
Karjat	1	1	2	2	11	12
Shrigonda	1	1	1	2	9	12
Parner	1	1	3	3	14	16
Akole	1	1	1	2	13	14
Sangamner	1	1	2	1	16	19
Kopargaon	1	1	1	0	18	23
Rahata	-	1	-	2	-	8
District	**13**	**14**	**24**	**29**	**157**	**197**

Source: Socio-economic abstract of Ahmednagar district, 1990-91 and 2010-11

3.10 Transport Facilities

Transport facilities also have a direct bearing on cropping pattern of a region. Better transport also makes it possible for farmers to put their less accessible land to more productive use. It contributes in the mobilization of resources and reduces the gap between rural and urban communities. In study region roads are lifelines and it plays an important role in agricultural development. They provide door to door service within short time. A network of roads, comprising trunk roads, link roads, approach roads and village roads provides proper access to markets for farmers.

Fig.3.20 shows the transportation network and table 3.11 revealed classifications of roads and their length in district. Total 12975.49 km. length roads are available for transportation. Out of this 35.23 percent are village road, national highway 0.47 percent, major state highway 0.15 percent, state highway 12.66 percent, major district roads 21.02 percent, other district roads are 25.78 percent and other road 3.59 percent.

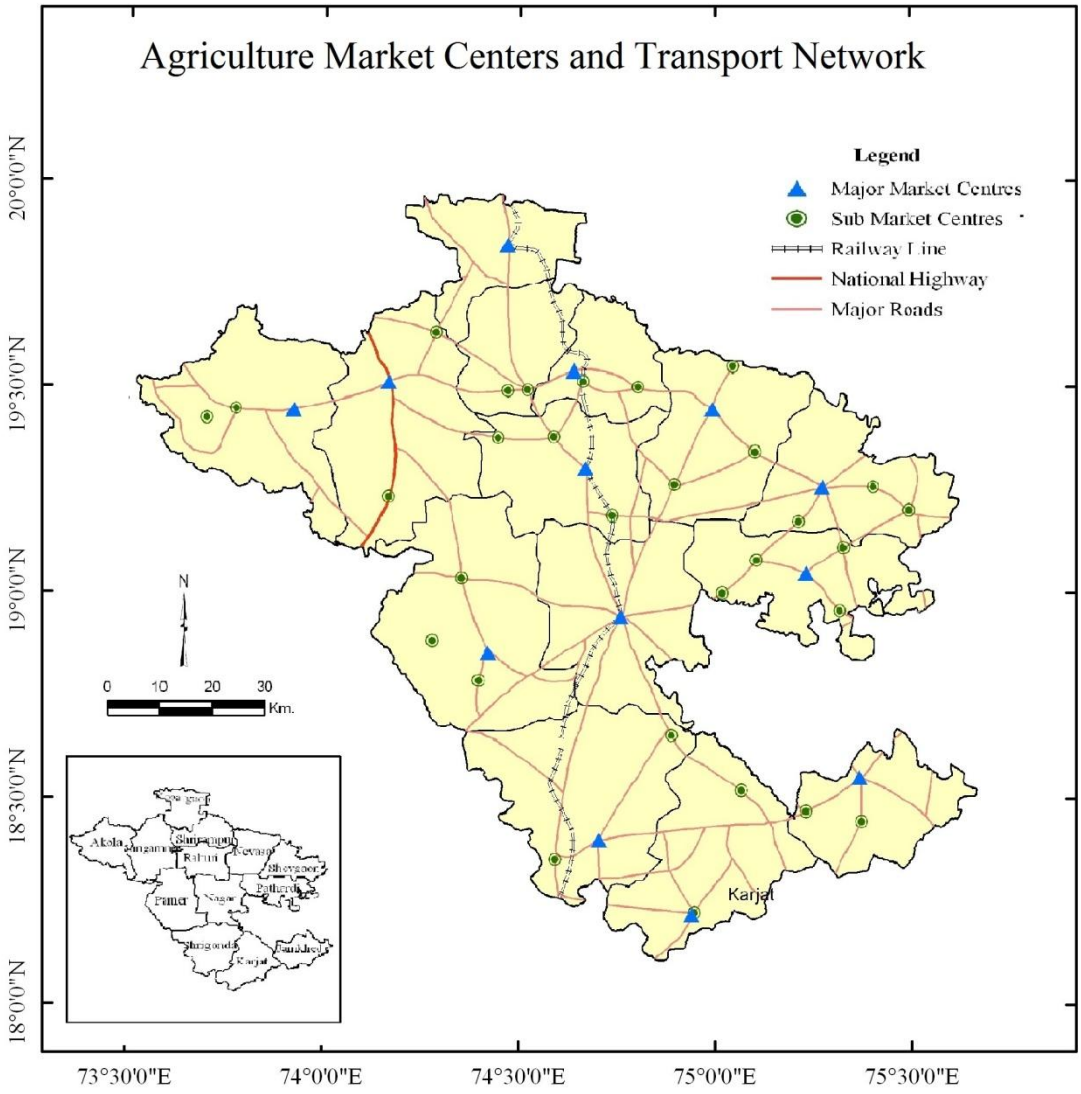

Agriculture Market Centers and Transport Network
Legend
Major Market Centres
Sub Market Centres
Railway Line
National Highway
Major Roads
N
0 10 20 30
Km.
Karjat
20°0'0"N
19°30'0"N
19°0'0"N
18°30'0"N
18°0'0"N
73°30'0"E
74°0'0"E
74°30'0"E
75°0'0"E
75°30'0"E

Fig: 3.20

Table 3.11 Road Transport in Ahmednagar District

Sr. No.	Type of road	Length in Km.	% to total district road
1	National Highway	61	0.47
2	Major State Highway	19.37	0.15
3	State Highway	1643.09	12.66
4	Major District Road	2727.59	21.02
5	Other District Road	3345.48	25.78
6	Village Road	4570.81	35.23
7	Other Road	466.15	3.59
	Total Road Length	**12975.49**	**100.00**

Source: Socio-economic abstract of Ahmednagar district, 2010-11

In study region limited facility is available by rail transport. Daund-Manmad line of the Central Railway is the only railway line passing through district. The total length of this line is 197 km in district. This route traverses through Shrigonda, Nagar, Rahuri, Shrirampur and Kopargaon tehsils. Thus it serves the transport need of the area having sugar factories in the district.

In study region availability of better transportation facilities farmers are able to supply his perishable goods like, fruits, vegetables and other commodities to the distant markets within a short time at a reasonable cost of transportation.

3.11 Role of Government

Pressure on agriculture is continuously increasing for food and fodder and raw material. To fulfill these needs boost agricultural production is the only way. For this, state and central government adopt new agricultural policies and support farmers for developing of their socio economic status. These policies are:

1. Providing short and long term credit at affordable rates of interest to support the resource requirements of the agriculture. This is useful for adopting modern technology and improved agricultural practices for increasing agricultural production and productivity.
2. Quality seed supply - promotion of newly released high yielding seed. Special steps to enhance the availability of quality cereals, pulses, oilseed and cotton seeds to every farmer.

3. Under the National Agricultural Insurance Scheme (NAIS) government provide insurance coverage and financial support to the framers in the event of failure crops result of natural calamities, pest and diseases.
4. To overcome the problem of labour scarcity, government sponsored to farmers under the various schemes like micro management of agriculture, dry land farming, technology mission for oilseed, pulses, national horticulture mission, national food security mission etc. for purchasing agricultural implements and machinery.
5. Government gives subsides for promotion of micro irrigation schemes such as drip and sprinkler irrigation, establishing farm pond, digging of well, plantation of horticulture crops and establishing of vermin composting unit.
6. State Agricultural University and Agricultural Engineering Colleges arrange training programmes for farmers to give training of new technology.
7. Technology dissemination through private extension and input supply by establishing agro clinics with soil testing facilities in rural area.
8. Under the plant protection scheme, government takes incentive steps for the pest control. In thrust areas integrated pest management program is conducted and ensuring availability of safe and efficient pesticides for keeping peat population under control.
9. For marketing of agricultural goods state government establish and regulate markets in rural area to facilitate marketing of agricultural products for the benefit of the farming community.
10. Promoting to farmers for establishing food processing unit to minimize wastage of agricultural products and to increase employment opportunities.
11. For empowerment of farm women establish women's self help group and involving them to take up entrepreneurial activities.
12. Gives loans to farmers for purchase livestock population and ensure them under livestock insurance scheme.
13. Government promotes to farmers for producing export quality of agricultural product and gives basic infrastructure facility and subsides to export these goods.

All above schemes are well implemented in Ahmednagar district, due to this cropping pattern as well as productivity of agriculture are also influenced in recent years.

Resume

Agricultural development of any region is governed by various non-physical determinants viz. irrigation, farm implements (traditional and modern), demographic factors, livestock, high yielding variety of seeds, use of chemical fertilizer, market facilities, agricultural credit and government policy. In study area for the purpose of irrigation many major, medium and minor projects are constructed viz. Bhandardara, Baragaon Nandur, Devthana, Mandohal, and Pargaon Ghatsheel. Canals, rivers, wells and tube wells are the major sources of irrigation in district. During the period of two decade net irrigated area increased by 5.05 percent of net sown area. During the period of investigation traditional farm implements such as wooden plough, iron plough, cart and oil engines density rapidly declined while modern farm implements such as tractors, electric pumps density increased in district.

In Ahmednagar district livestock plays a prominent role agricultural development. Goat and sheep combine occupied first rank while cattles occupy second rank out of total livestock population in district. During the period of investigation cattle and other livestock share was declined by 6.44 and 6.4 percent respectively while buffaloes and goat and sheep share increased by 4.63 and 8.2 percent respectively.

According to census 1991, 81.18 percent (2839454) population was receding in rural area while in the year 2011, 79.90 percent receding in rural area. Population density of district has 198 and 267 persons per square kilometer during the years 1991 and 2011 respectively. During the period of two decade density such as crude, physiological and agricultural increased in district. The use of high yielding variety of seeds and consumption of chemical fertilizers was higher in north parts of district compare to southern parts. During the year 2010-11 in *kharif* season 27212 thousand ton and in *rabi* season 58552 thousand ton high yielding variety of seeds used in the district. The total fertilizer consumption was 424662 metric ton in the year 2010-11. During the period of investigation major, sub and weekly market centers increased by 1, 5 and 40 respectively.

CHAPTER-IV

GENERAL LANDUSE PATTERN

4.1 General Introduction

Land use means surface utilization of all developed and vacant lands for a specific point at a give time and space (Foreman, T. 1968). In other word it denotes the availability of land for various purposes in view of its fertility and present status. General land use of any region mainly depends on various factors such as environmental i.e. topography, climate, soil, drainage and natural vegetation, socio-economic, demographic, technological and infrastructural.

In the second half of the 20th century world population rapidly increases. This growing population has increasing variety of demands which brings extra pressure on available land resources. For optimum use of these available land resources update information is required. From this point of view update information of land use has studied in present chapter. Such type of study is helpful for further planning for sustainable development.

This chapter attempts to study the spatial and temporal pattern of general land use of Ahmednagar district. In the present study general land use has been classified into five board categories i.e. forest land, land not available for cultivation, cultivable waste land, fallow land and net sown area. The temporal pattern of general land use and volume of change has been studied for the period of 20 years i.e. 1990-91 to 2010-11 while spatial pattern has been studied for the years 1990-91 and 2010-11. The data regarding land use of the year 1990-91 was obtained from socio economic abstract of Ahmednagar district while for the year 2010-11 was obtained from land record office, Ahmednagar. The obtained data was converted into percentage to the total geographical area. The pattern of general land use and volume of change has been represented by maps and table.

4.2 Classification of Landuse

According to Siddiqi, A. N. (1971) land classification means integrating land on the basis of their native characteristics, pre-existing use, production capacity and these classes are then assessed in relation to the suitability of various uses investigated in the plan. In 20th century several attempt have been made in different countries of world to classify land use from different point of views and different purposes using several methods. Stamp (1962) is pioneer in the field of land classification. In his work entitled ‘the land of Britain: it use and misuse’ he classified land of Britan into six different categories. In United State of America the widely use schemes of land use classification is based on land capability classes. On the basis of Zvorykin, K. V.

(1963) study Union of Soviet Socialist Republic (USSR) has categorized land into six major types. Phibrick, A.K. (1980) has classified land of China into seven different categories. In Japan, on the basis of land use maps land is classified into eleven major and many micro sub categories.

In India, Ministry of Agriculture has classified land use into six categories namely, (a) total geographical area, (b) area under forests, (c) area not available for cultivation, (d) current fallow land, (e) other uncultivated land and (f) net sown area.

In Maharashtra, according to season and crop report land use are noted in following five major categories.

(1) Area under forest

(2) Land not available for cultivation including
   - (i) Barren and uncultivable land
   - (ii) Land put to non agricultural uses

(3) Other pastures and grazing land including
   - (i) Cultivable waste land
   - (ii) Permanent pastures and grazing land
   - (iii) Land under miscellaneous tree crops and groves

(4) Fallow lands including
   - (i) Current fallows
   - (ii) Other fallows

(5) Cropped area including
   - (i) Net sown area
   - (ii) Area sown more than once
   - (iii) Gross cropped area

According to above classification in India several geographers have studied land use at regional, district and micro level to find the reliable solution of land use planning. Some eminent researchers carried research work on different aspects of land use such as, Singh, J. (1974), Date, V. S. (1984), Chouhan, T. S. (1987), Kumbhare, A. R. (1978), Lahiri, S. (1994), Bhattacharya, R. (1994), Vaidya, B. C. (2007), Madhuri, S. et al (2007), Kashid, D. L. (2010), Rahane, B. B. (2011), Shivaram, M. R. *et al* (2012), Adnaik, N. (2012), Chouhan, J. (2012), Patil, S. G. (2012), Raut, S. K. (2013) etc.

4.3 Temporal Variation in Landuse

The temporal variations of land use in the Ahmednagar district have been studied for a period of twenty years (1990-91 to 2010-11) to find out the trends of the variation in the general land use and to identify possible causes influencing on these changes. According to previous discussion following five major categories of land use is noted in the present study.

1. Forest covers
2. Area not available for cultivation
3. Cultivable waste land
4. Fallow land
5. Net Sown Area

Table 4.1 Temporal Variations in General Landuse (area in percentage)

Landuse Types	1990-91	1995-96	2000-01	2005-06	2010-11
Forest	10.09	9.84	8.70	7.89	8.64
Area not available for cultivation	8.57	7.43	7.66	11.78	7.26
Cultivable waste	4.0	4.98	5.14	1.17	4.7
Fallow land	7.54	14.67	7.94	7.5	9.13
Net sown area	69.79	62.61	69.75	71.1	70.28

Source: (i) Socio-economic abstract of Ahmednagar district (1990-91 to 2005-06)

(ii) Land record office, Ahmednagar (2010-11)

4.3.1 Forest Cover

Both from ecological and economic point of view, forest cover are the most significant land use type. It classified in three categories i.e. preserved, protected and village forest. In study region forest land occupied second position next to net sown area. The major forests, their types and species have been already described in second chapter. Table 4.1 and figure 4.1 revealed areas under forest was 10.09 percent and 8.64 percent of total geographical area during the years 1990-91and 2010-11 respectively. It is less than the average for Maharashtra (17.3 percent) as well as India (21.9 percent) (India, 2012). Area under forest is continuously declined up to 2005-06 after that slightly increased in next five year. During the period of investigation it has total decline by 1.46 percent. This fact suggests that forest land has been brought

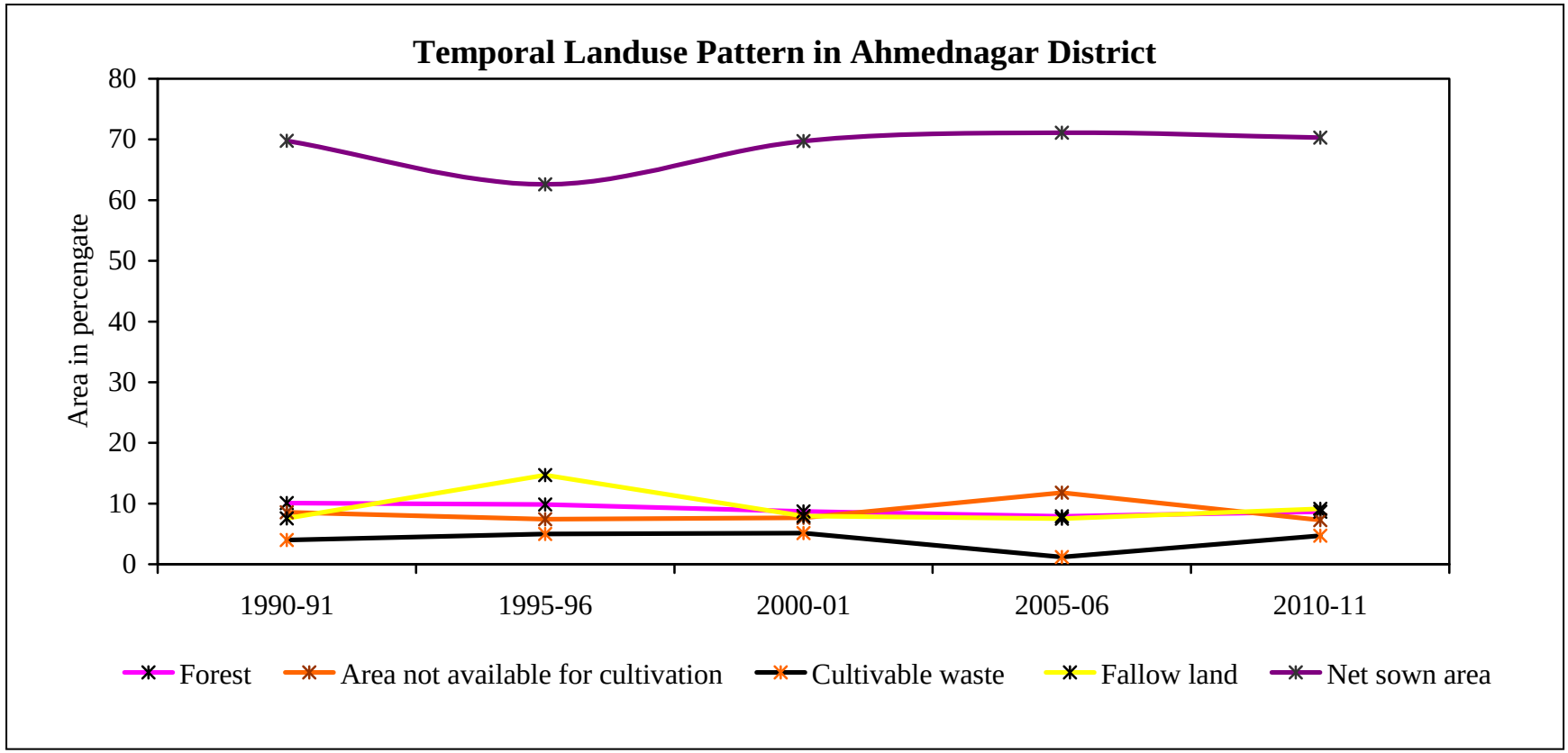

Temporal Landuse Pattern in Ahmednagar District
Area in percengate
80
70
60
50
40
30
20
10
0
1990-91
1995-96
2000-01
2005-06
2010-11
Forest
Area not available for cultivation
Cultivable waste
Fallow land
Net sown area

Fig. 4.1

under cultivation or other use. From the ecological point of view, this situation suggest red signal.

4.3.2 Area Not Available for Cultivation

The land is agriculturally unproductive or land not available for cultivation is may be described as non-cultivable land. It included two types of land namely, barren and uncultivable land i.e. land of rock exposure, small hillock, sand mountains etc. and area under non agricultural use i.e. land under settlement, roads, railway, streams, canals and rivers etc. Table 4.1 and fig. 4.1 reveals that area under this type of land was decreased by 0.91 percent up to 2000-01, during next five year it shift upward and again decrease by 4.52 percent during next five year. During the period of two decades it has notably decrease by 1.32 percent.

4.3.3 Cultivable Waste Land

Cultivable waste land includes (i) permanent pasture and other grazing land (ii) miscellaneous, trees crops and grooves not included in the net sown area (iii) culturable waste land. This category land is mainly meant for grazing purposes for livestock. Table 4.1 and fig. 4.1 shows this type of land use has fluctuation during period of investigation. This category of land accounted of 4 percent to the total geographical area of district during 1990-91 and 4.70 percent during 2010-11. It registered maximum (5.14 percent) share in the year 2000-01. During the period of two decades it has increase by 0.70 percent. Out of all major land use types this can be identified as an insignificant type of land use.

4.3.4 Fallow Land

Fallow lands are divided into two sub types, current fallow and other fallow which are virtually arable land. Current fallow are the lands which are kept fallow during the current years, for regenerating fertility of soil and other purposes during the agricultural year. Other fallow included all lands which were taken up for cultivation but are temporarily out of cultivation for period not less than one year and not more than five years. The amount of area under fallow varies with the variability in the amount of rainfall over that particular region. Fig. 4.1 shows except the year 1995-96 slight temporal variation in this type of land use. During the period of investigation it increases by 1.59 percent. The temporal variation in fallow land is mainly depends on erratic behavior of the monsoon.

4.3.5 Net Sown Area

Net sown area consists of net area sown with crops and orchards excluding the area sown more than once. Variation in net sown area depends on amount of rainfall received during the year as well as availability of irrigation facility. The study area has vast agricultural land resource but it suffers from instability due to vagaries of monsoon. According to area this type of land use has recorded first rank in study region. Table 4.1 and fig. 4.1 revealed slight temporal variation in net sown area. The net sown area in the district accounts 69.79 and 70.28 percent of the total geographical area during the years 1990-91 and 2010-11 respectively. During the period of investigation it has increased by only 0.48 percent. It means that farmers in the study region adopted cropping pattern which adjust to the climatic condition and availability of irrigation.

4.4 Spatial Variations in Landuse

The spatial pattern of land use of Ahmednagar district is the result of interaction between physical environment (rainfall, relief and soil), socio-economic environment and level of technological development. At the same time it influence by regional and local variables (Rahane, B. B. 2010). Table 4.2 shows the proportion of each category of land to total geographical area of each tehsils in Ahmednagar district.

4.4.1 Forest Cover

Spatial distribution pattern of forest largely depends on relief, rainfall distribution and agricultural development. Table 4.2 shows that the spatial distribution of forest is highly uneven. Percentage area under forest for each tehsil was worked out and divided into four different categories based on vegetation density i.e. area less than 5, 5 – 15, 15 – 25, and above 25 percent of the geographical area and were denoted as very low, low, moderate and high categories respectively.

During the year 1990-91 very low density of forest recorded in north and east pert of the district comprised tehsils of Kopargaon, Shrirampur, Nevasa, Shevgaon, Pathardi and Jamkhed (fig. 4.2/A). In this tehsils there is favorable condition for agriculture i.e. flat topography, fertile soil and availability of irrigation facility by canals of rivers Godavari, Paravara and Mula so density of forest is very low. Low density of forest was found in southern part of the district in Balaghat mountain range (sub range of Sahyadri) comprised tehsils of Parner, Karjat, Shrigonda and Nagar

Table 4.2 Spatial Variation in General Land Use (1990-91 and 2010-11) (Figures in percentage)

Tehsils	Forest Cover			Area Not Available for Cultivation			Cultivable Waste Land			Fallow Land			Net Sown area		
	1990-91	2010-11	Volume Change	1990-91	2010-11	Volume Change	1990-91	2010-11	Volume Change	1990-91	2010-11	Volume Change	1990-91	2010-11	Volume Change
Nagar	8.78	8.78	0	1.86	3.26	1.4	13.11	8.32	-4.79	5.52	3.53	-2	70.73	76.11	5.39
Rahuri	15.44	15.44	0	9.14	13.18	4.03	3.05	1.08	-1.97	8.06	11.21	3.15	64.31	59.1	-5.21
Shrirampur	0.00	0.00	0	0.61	1.98	1.37	0.12	3.56	3.44	23.6	12.25	-11.35	75.67	82.21	6.54
Nevasa	0.23	1.24	1.01	7.35	2.24	-5.1	4.64	0.39	-4.25	8.2	4.33	-3.86	79.58	91.8	12.21
Shevgaon	1.01	1.1	0.09	9.29	10.49	1.2	1.47	2.30	0.83	20.52	9.66	-10.86	67.71	76.45	8.74
Pathardi	1.00	5.34	4.34	2.00	9.01	7.01	0.00	3.42	3.42	15.1	5	-10.09	81.9	77.23	-4.67
Jamkhed	4.34	0.8	-3.54	5.02	1.94	-3.08	9.93	3.42	-6.51	1.6	32.42	30.82	79.11	61.42	-17.69
Karjat	14.75	8.71	-6.03	12.8	10.92	-1.88	2.88	10.92	8.04	2.95	9.85	6.9	66.62	59.58	-7.04
Shrigonda	10.09	9.47	-0.62	10.34	1.06	-9.28	3.8	5.61	1.81	1.18	14.77	13.58	74.58	69.1	-5.48
Parner	12.42	10.06	-2.36	19.16	10.92	-8.24	0.64	5.84	5.19	0.16	5.3	5.14	67.61	67.88	0.27
Akole	29.12	27.73	-1.4	5.92	3.79	-2.13	2.99	3.32	0.33	10.17	1.06	-9.11	51.8	64.1	12.30
Sangamner	18.01	11.59	-6.42	12.72	14.45	1.72	2.2	1.07	-1.13	6.96	8.5	1.55	60.11	64.39	4.28
Kopargaon	0.93	0	-0.93	4.76	6.52	1.76	8.49	5.67	-2.82	5.97	14.87	8.9	79.85	72.95	-6.9
Rahata	--	0	-	--	6.44	-	--	10.98	-	--	10.69	-	--	71.89	-
District	**10.09**	**8.64**	**-1.46**	**8.57**	**7.26**	**-1.32**	**4.0**	**4.7**	**0.7**	**7.54**	**9.13**	**1.59**	**69.79**	**70.28**	**0.48**

Source: (i) Socio economic abstract of Ahmednagar district (1990-91) (ii) Land record office, Ahmednagar (2010-11)

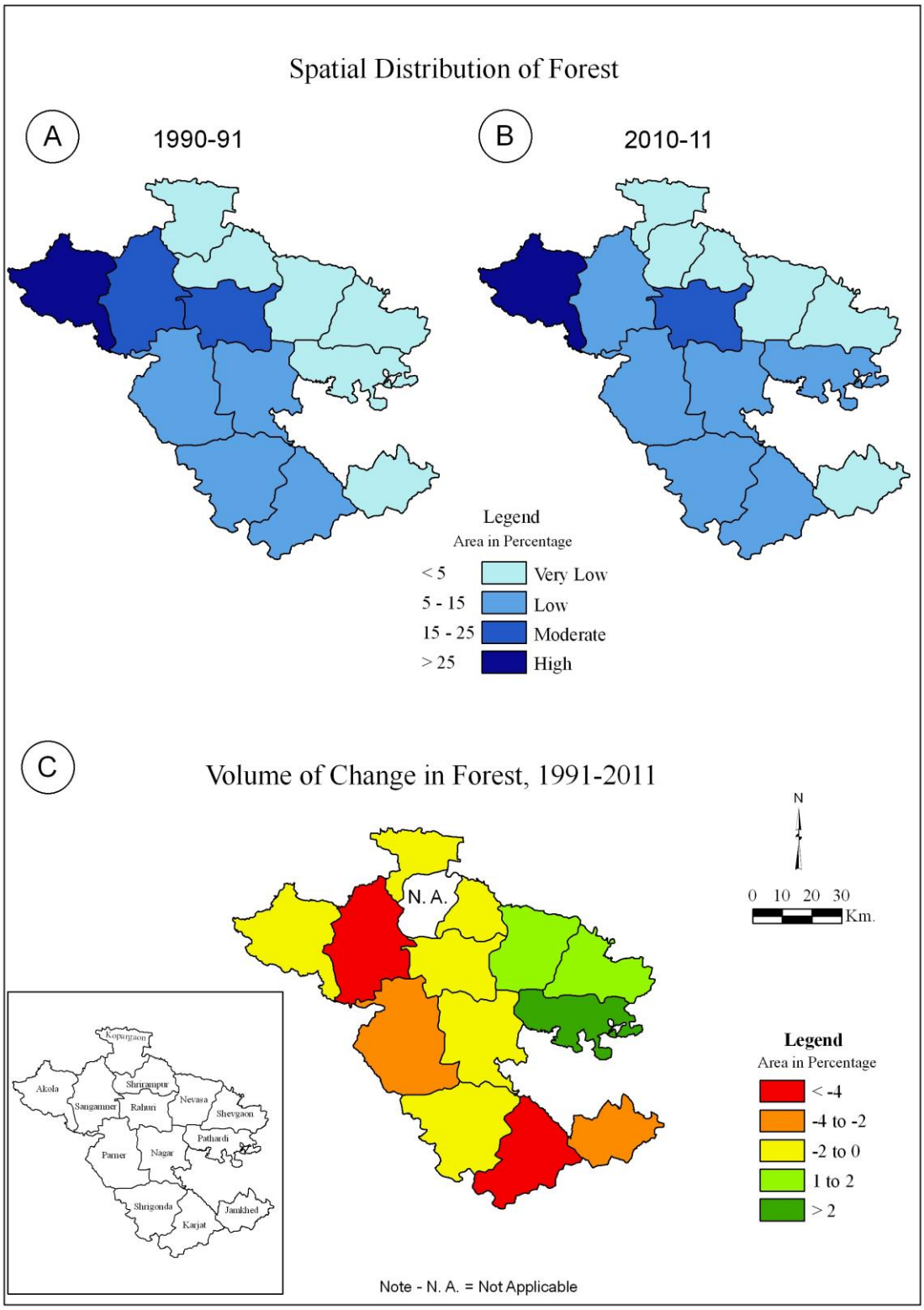

Spatial Distribution of Forest
A
1990-91
B
2010-11
Legend
Area in Percentage
< 5
Very Low
5 - 15
Low
15 - 25
Moderate
> 25
High
C
Volume of Change in Forest, 1991-2011
N. A.
N
0 10 20 30
Km.
Legend
Area in Percentage
< -4
-4 to -2
-2 to 0
1 to 2
> 2
Kopargaon
Akola
Shrirampur
Sangamner
Rahuri
Nevasa
Shevgaon
Pathardi
Parner
Nagar
Shrigonda
Jamkhed
Karjat
Note - N. A. = Not Applicable

Fig: 4.2 A, B & C

while moderate density was found in Sangamner and Rahuri tehsils where area under forest was 18.01and 15.44 percent to total geographical area respectively. High density of forest registered in west part of district in Sahyadri mountain range (tehsil Akole) where 29.12 percent area under forest of total geographical area.

Table 4.2 and fig. 4.2/B shows the spatial distribution of forest of the year 2010-11. North, north-east and south parts of district comprised tehsils of Kopargaon, Rahata, Shrirampur, Nevasa, Shevgaon and Jamkhed registered very low density of forest while tehsils of Sangamner, Parner, Nagar, Shrigonda and Karjat recorded low density of forest. Rahuri tehsil found moderate density while tehsil Akole recorded high density. The present proportion of the forest cover of Ahmednagar district is too short to fulfill the requirement of maintaining ecological balance. This situation shows urgent need of awareness regarding to forest among people.

Volume change in spatial distribution of forest is depicted in fig.4.2/C. During the study period positive change is observed in eastern part of the district comprised tehsils of Pathardi (4.34 percent), Nevasa (1.01 percent) and Shevgaon (0.90 percent) and rest of the tehsils recorded negative change. The maximum negative change recorded in Sangamner tehsil (6.42 percent) followed Karjat (6.03 percent) Jamkhed (3.54 percent) and 2.36 percent in Parner tehsil. Five tehsils namely, Jamkhed, Karjat, Parner, Akole and Sangamner noticed significant negative change while tehsil Pathardi recorded significant positive change. Rest of the tehils found insignificant change in area under forest.

4.4.2 Land Not Available for Cultivation

The percent contribution of land not available for cultivation was work out and divided into four different categories namely, very low, low, moderate and high having the range less than 4, 4-8, 8-12 and above 12 respectively. District was 8.57 and 7.26 percent land not available for cultivation to total geographical area during the years 1990-91 and 2010-11 respectively.

During the year 1990-91 spatial distribution pattern of this category of land use exhibited in table 4.2 and fig.4.3/A. The distribution of this land use varies within district. Very low category was found in Shrirampur, Pathardi and Nagar tehsils while low area put to not available for cultivation was found in Akole, Kopargaon, Nevasa, and Jamkhed tehsils. Moderate category was registered in Shrigonda, Shevgaon and Rahuri tehsils whereas high area put to non agricultural use was found in tehsil Parner lying western part of district followed by Karjat and Sangamner.

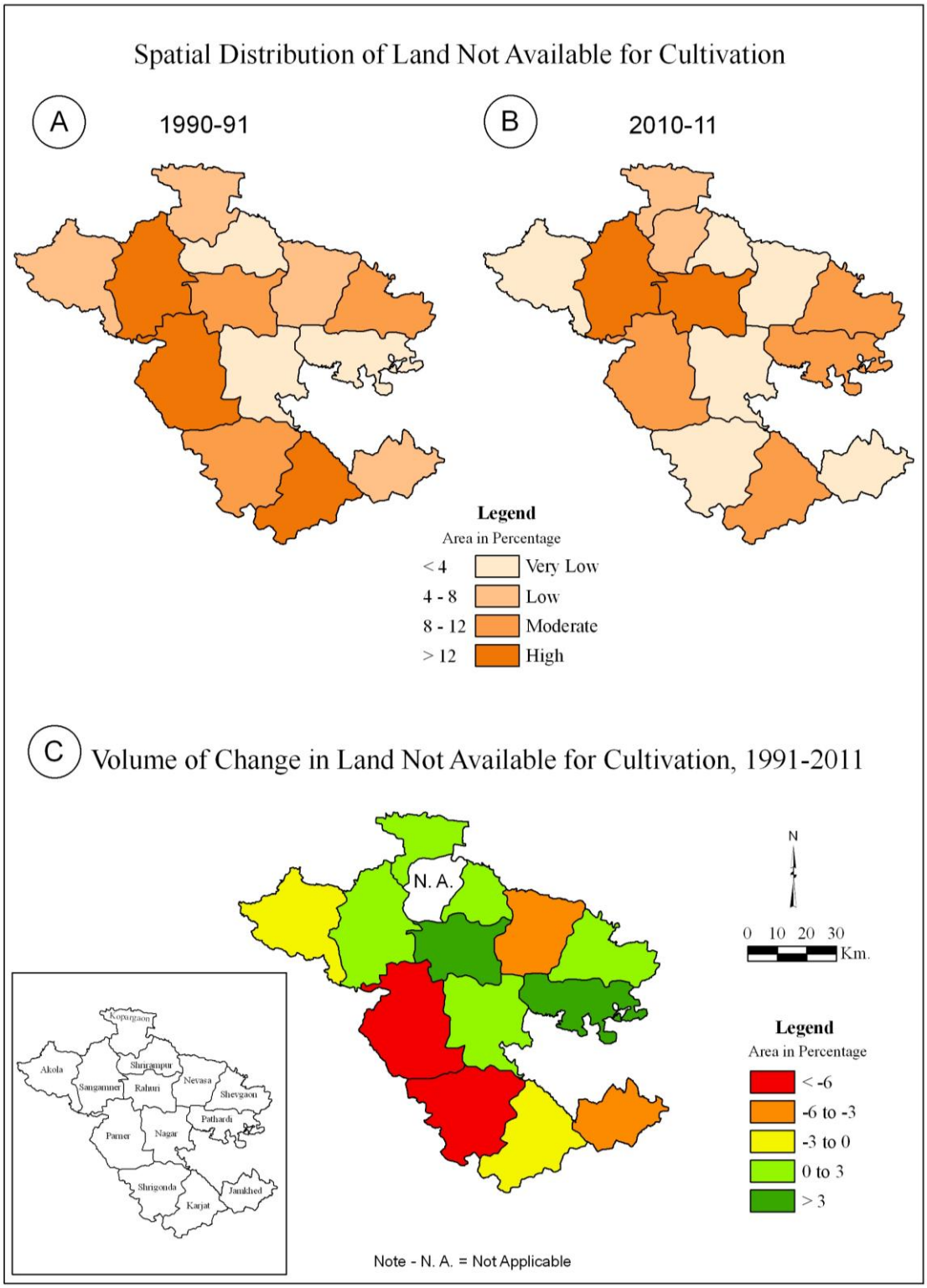

Spatial Distribution of Land Not Available for Cultivation
A
1990-91
B
2010-11
Legend
Area in Percentage
< 4
Very Low
4 - 8
Low
8 - 12
Moderate
> 12
High
C
Volume of Change in Land Not Available for Cultivation, 1991-2011
N. A.
N
0 10 20 30
Km.
Legend
Area in Percentage
< -6
-6 to -3
-3 to 0
0 to 3
> 3
Kopargaon
Akola
Shrirampur
Sangamner
Rahuri
Nevasa
Shevgaon
Pathardi
Parner
Nagar
Shrigonda
Jamkhed
Karjat
Note - N. A. = Not Applicable

Fig: 4.3 A, B & C

Table 4.2 and fig. 4.3/B revealed spatial distribution of land not available for cultivation of the year 2010-11. This land cover varies from 1.06 percent in Shrigonda to 14.45 percent in Sangamner. Very low category constituted in Akole, Nagar, Nevasa, Shrirampur, Shrigonda, Jamkhed tehsils while low category comprised in northern irrigated tehsils namely, Kopargon and Rahata. The tehsils Parner, Pathardi, Karjat and Shevgaon noticed moderate category whereas high area put to non agricultural use was found in Sangamner and Rahuri tehsils.

Volume of change in land not available for cultivation is shown in fig.4.3/C. During the period of investigation it has total declined by 1.32 percent (table 4.2). Highest proportion of positive change observed in tehsil Pathardi (7.01 percent) while highest negative change recorded in tehsil Shrigonda (9.28 percent). Six tehsils namely, Nevasa, Jamkhed, Karjat, Shrigonda, Parner and Akole found significant negative change while significant positive change noticed in Nagar, Rahuri, Shrirampur, Shevgaon, Pathardi, Sangamner and Kopargaon tehsils.

4.4.3 Cultivable Waste Land

The percent contribution of cultivable waste land was worked out and divided into three different categories namely, low, moderate and high having range less than 4, 4-8 and above 8 respectively. District had 4.0 and 4.7 percent cultivable waste land to total geographical area during the years 1990-91 and 2010-11 respectively.

Table 4.2 and fig. 4.4/A shows the uneven pattern of cultivable waste land during the year 1990-91. It varies from 0.00 percent in Pathardi to 13.11 percent in Nagar tehsil. Low category was registered in nine tehsils namely, Akole, Sangamner, Shrirampur, Rahuri, Shevgaon, Parner Karjat, Pathardi and Shrirampur while moderate category was found in Nevasa tehsil. High cultivable waste land recorded in Nagar, Jamkhed and Kopargaon tehsils.

During the year 2010-11, low category was registered in west, east and south parts of district comprised tehsils namely, Akole, Sangamner, Rahuri, Shrirampur, Nevasa, Shevgaon, Pathardi and Jamkhed while moderate category was found in Kopargaon, Parner and Shrigonda tehsils (fig.4.4/B). High category was recorded in Rahata, Karjat, and Nagar tehsils.

Volume of change in cultivable waste land is depicted in fig.4.4/C. In Ahmednagar district the area under cultivable waste was declined by 0.70 percent during study period. The highest decline recorded in Jamkhed while 3 to 6 percent negative change found in tehsils of Nagar and Nevasa while less than 3 percent

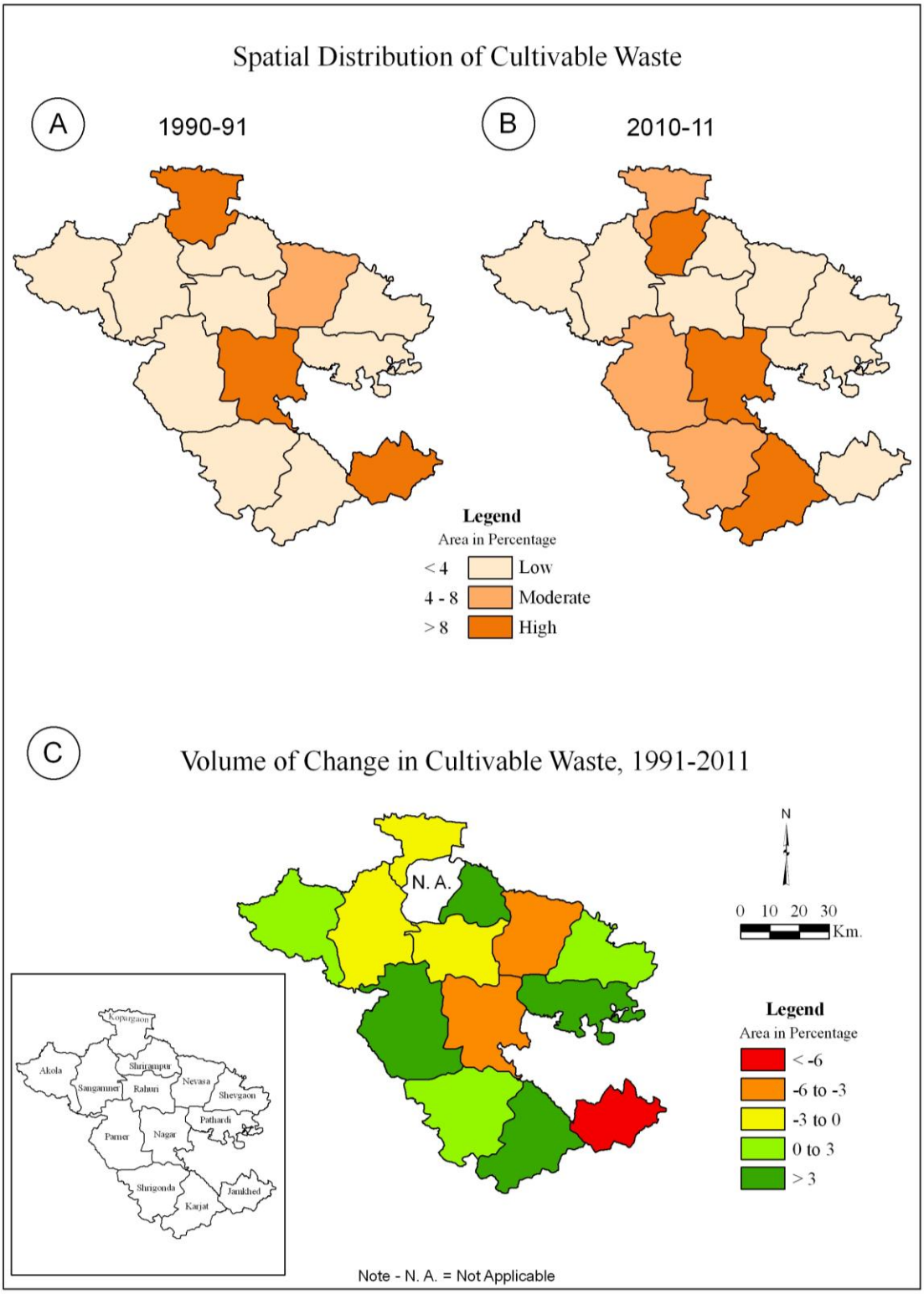

Spatial Distribution of Cultivable Waste
A
1990-91
B
2010-11
Legend
Area in Percentage
< 4 Low
4 - 8 Moderate
> 8 High
C
Volume of Change in Cultivable Waste, 1991-2011
N. A.
N
0 10 20 30
Km.
Legend
Area in Percentage
< -6
-6 to -3
-3 to 0
0 to 3
> 3
Kopargaon
Akola
Shrirampur
Nevasa
Sangamner
Rahuri
Shevgaon
Pathardi
Parner
Nagar
Shrigonda
Jamkhed
Karjat
Note - N. A. = Not Applicable

Fig: 4.4 A, B & C

negative change recorded in Kopargaon, Sangamner and Rahuri tehsils. Tehsils of Akole, Shevgaon and Shrigonda recorded below 3 percent positive change while Shrirampur, Pathardi, Parner and Karjat tehsils recorded above three percent positive change. All tehsils found significant change in cultivable waste land.

4.4.4 Fallow Land

The percent contribution of fallow land was worked out and divided into four different categories namely, very low , low moderate and high having range less than 5, 5-10, 10-15 and above 15 respectively.

Fig. 4.5/A revealed percent area under follow land varied from tehsil to tehsil during the year 1990-91. The variation of fallow land depends on several factors like rainfall, irrigation facilities, soil condition and also socio-economic condition of farmers. Southern parts of the district in tehsils of Parner, Shrigonda, Karjat and Jamkhed recorded very low percent of fallow land while low category was found in Nagar, Kopargaon, Nevasa, Sangamner and Rahuri tehsils. Akole tehsil found moderate category whereas high proportion of fallow land registered in north-east part of district comprised tehsils namely, Shrirampur, Shevgaon and Pathardi.

Fig. 4.5/B represents the spatial distribution of fallow land during the year 2010-11. Very low category was recorded in Pathardi, Nagar, Nevasa and Akole while low category was observed in Karjat, Sangamner, Shevgaon and Parner tehsils. Moderate contribution of fallow land found in five tehsils namely, Kopargaon, Shrigonda, Shrirampur, Rahuri and Rahata whereas high category was found in Jamkhed (32.42 percent of total geographical area).

Fig. 4.5/C revealed volume of change in fallow land during the period of investigation. Highest (above 20 percent) positive change noticed in tehsils of Jamkhed while 10 to 20 percent positive change found in Shrigonda tehsil. Tehsils of Kopargaon, Sangamner, Rahuri, Parner and Karjat marked below 10 percent positive change. Tehsil Akole, Nevasa and Nagar recorded below 10 percent negative change whereas Shrirampur, Pathardi and Shevgaon tehsils marked above 10 percent negative change. All tehsils found significant change in fallow land. Spatio-temporal variation in the proportion of fallow cover was the result of erratic behavior of monsoon and technological development.

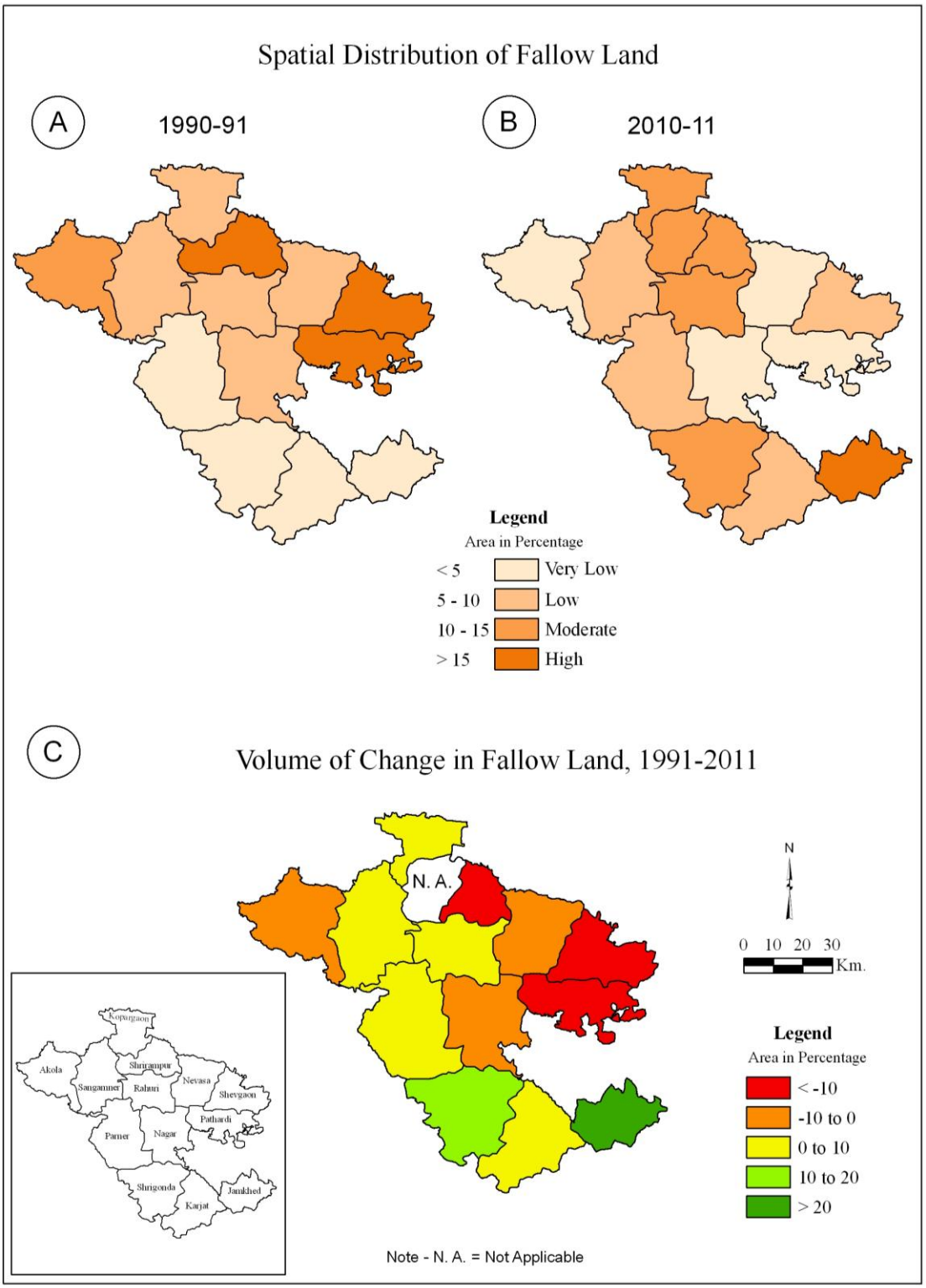

Spatial Distribution of Fallow Land
A
1990-91
B
2010-11
Legend
Area in Percentage
< 5
Very Low
5 - 10
Low
10 - 15
Moderate
> 15
High
C
Volume of Change in Fallow Land, 1991-2011
N. A.
N
0 10 20 30
Km.
Legend
Area in Percentage
< -10
-10 to 0
0 to 10
10 to 20
> 20
Kopargaon
Akola
Shrirampur
Sangamner
Rahuri
Nevasa
Shevgaon
Pathardi
Parner
Nagar
Shrigonda
Jamkhed
Karjat
Note - N. A. = Not Applicable

Fig: 4.5 A, B & C

4.4.5 Net Sown Area

Net sown area of any region is mainly depends on physiographic characteristics, distribution of rainfall and rainy days, availability of irrigation facilities, basic infrastructure of agricultural, availability of credits and attitude of farmers. The percent contribution of net sown area of total geographical area was work out and divided into four different categories namely, very low, low, moderate and high according to percent range i.e. below 60, 60-70, 70-80 and above 80 respectively.

During the year 1990-91 net area sown of the district varies between 51.80 percent in Akole tehsil to 81.90 percent in Pathardi (table 4.2). Very low percent net sown area (51.80 percent) recorded in tehsil Akole because of large portion of area cover by hilly topography, shallow soils and non availability of irrigation facility. Five tehsils namely Sangamner, Rahuri, Parner, Shevgaon and Karjat was found low category (fig.4.6/A). Moderate category was found in tehsils namely, Kopargaon Shrirampur and Nevasa where fertile plain of river Godavari, Pravara and Mula. Availability of irrigation from canals and better technological advancement is the reasons of moderate area under net sown. The central and southern parts of district tehsils namely, Nagar, Shrigonda and Jamkhed come under moderate category. The high proportion of net sown area noticed in Pathardi tehsil.

Table 4.2 and fig.4.6/B revealed the spatial distribution of net sown area during the year 2010-11. It was 70.28 percent of the total geographical area of the district. Highest net sown area was observe in Nevasa tehsil accounting 91.80 percent and lowest in Rahuri tehsil accounting 59.10 percent to total geographical area. Very low net sown area was recorded in Rahuri and Karjat tehsils while low category was found in Akole, Sangamner, Parner, Shrigonda and Jamkhed tehsils. Five tehsils namely, Pathardi, Shevgaon, Nagar, Kopargaon and Rahata recorded moderate net sown area whereas high percent area under this category was register in northern irrigated tehsils namely Nevasa and Shrirampur.

In the study area increase or decrease in the crop land use shall be in close association with the success or failure of monsoon. The net sown area in study region was increased by 0.48 percent during two decades. The highest (above 10 percent) positive change noticed in tehsils of Akole and Nevasa while 5 to 10 percent positive change recorded in three tehsils namely, Shrirampur, Nagar and Shevgaon (fig.5.6/C). Tehsils Sangamner and Parner found below five percent positive change. Tehsils of

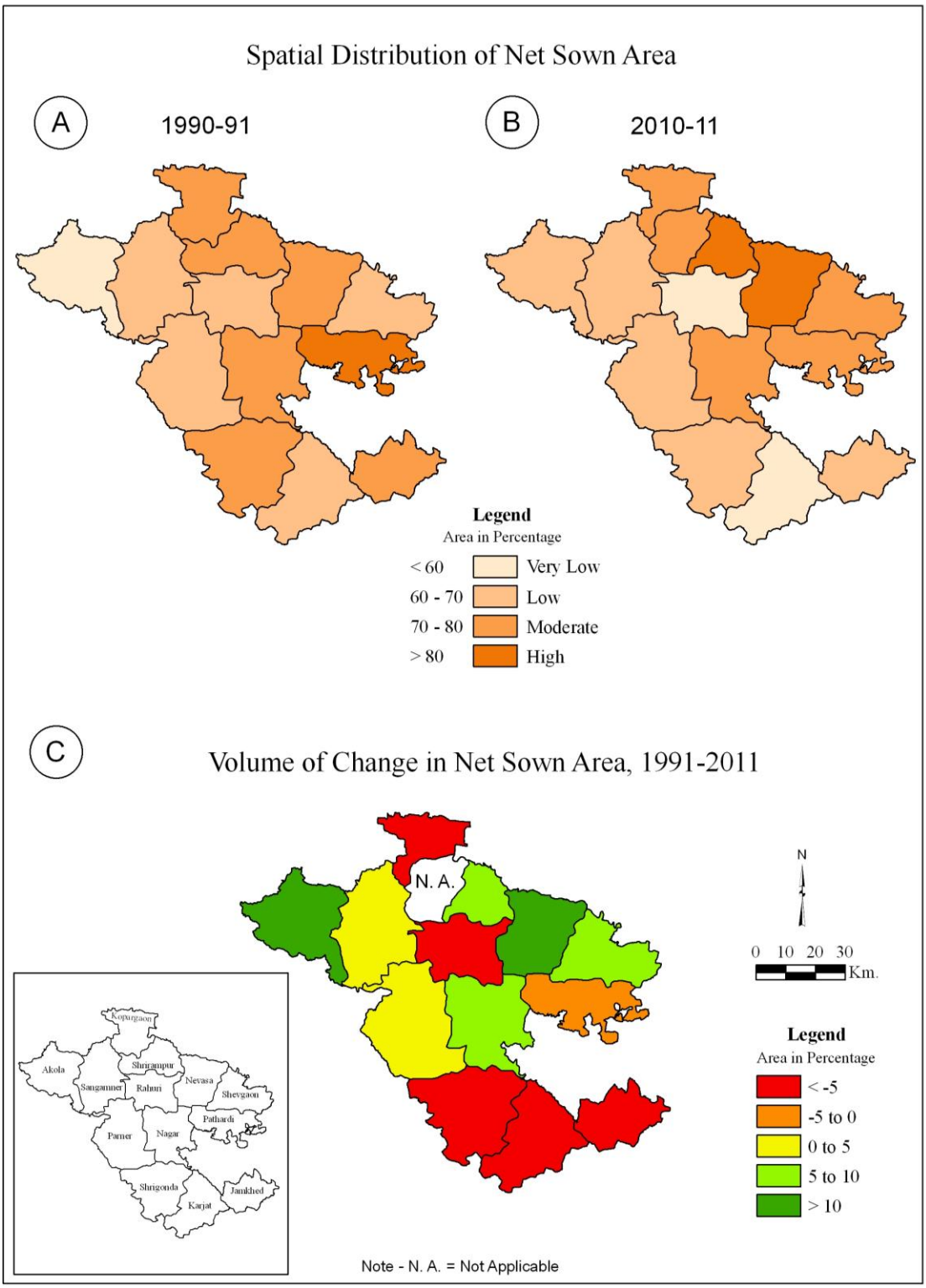

Spatial Distribution of Net Sown Area
A
1990-91
B
2010-11
Legend
Area in Percentage
< 60
Very Low
60 - 70
Low
70 - 80
Moderate
> 80
High
C
Volume of Change in Net Sown Area, 1991-2011
N. A.
N
0 10 20 30
Km.
Legend
Area in Percentage
< -5
-5 to 0
0 to 5
5 to 10
> 10
Kopargaon
Akola
Shrirampur
Nevasa
Sangamner
Rahuri
Shevgaon
Pathardi
Parner
Nagar
Shrigonda
Jamkhed
Karjat
Note - N. A. = Not Applicable

Fig: 4.6 A, B & C

Kopargaon, Rahuri, Shrigonda, Karjat and Jamkhed registered above five percent negative change while tehsil Pathardi was noticed below five percent negative change. All tehsils found significant change in net sown area.

Resume

This chapter is an attempt to study the spatio-temporal analysis of general land use of Ahmednagar district. The general land use has been classified as, forest cover, land not available for cultivation, cultivable waste land, fallow land and net sown area. In the study region net area sown is the most important type of land use and excels all the other land use categories. Proportion of such land is higher in both years i.e. 69.79 percent in 1990-91 and 70.28 percent in 2010-11. It was slightly increased by 0.48 percent during study period. The area under forest and land not available for cultivation was decline by 1.46 and1.32 percent respectively while area under cultivable waste land and fallow land was increased by 0.70 and 1.59 percent of total geographical area respectively. There are two separate belts in study region where highest distribution forest. One belt lies in western part of the district in sub ranges of Sahyadri consists tehsils of Akole, Sangamner, Rahuri and Parner whereas second belt lies in southern part of the district in Balaghat mountain range (sub range of Sahyadri) comprised tehsils of Karjat, Shrigonda. Spatial distribution of land not available for cultivation reveals uneven pattern. During the period of investigation it has positive change noticed in six tehsils while negative change recorded in eight tehsils. Highest proportion of positive change observed in tehsil Pathardi and highest negative change found in tehsil Shrigonda tehsil. Out of all major land use types cultivable waste land occupied lowest share of total geographical area in all the tehsils. Volume of change in cultivable waste reveals highest negative change has recorded in Jamkhed while highest positive change in Karjat tehsil. Both the years 1990-91 and 2010-11 spatial pattern of net sown area has recorded lowest in western tehsils namely, Akole and Sangamner because of large portion is occupied by hills, shallow soils and non availability of irrigation facility. The fertile track of river Godavari, Pravara and Mula has recorded more than 70 percent area under this category. The volume of change in net sown area was found upward change in northern tehsils while downward change noticed in southern parts of district.

CHAPTER - V

CROPPING PATTERN AND CROP COMBINATION REGION

5.1 General Introduction

Cropping pattern means the proportion of area under various crops at a point during the agricultural year. Agricultural land use pattern of any region depends on several factors i.e. relief, soil, climatic characteristics, socio-economic, technological, demographic, irrigation facilities and also farmers decision, methods of production, market price, previous experience and knowledge of farmer etc. (Vaidya, B.C. 2007). In developing countries like India where agriculture is the major source of economy and livelihood for more than two third of the working population, utilization of agricultural land resource plays the vital role in shaping the fabric of life and economy. It also establishes the pace of development and progress of the people and the country as a whole (Madhuri, S. *et al* 2007).

The present chapter is an attempt to study the spatial and temporal distribution of crops, changes therein and crop combination regions for the years 1990-91 and 2010-11. The possible causes responsible for present agricultural land use and changes therein are also studied. The area under different crops i.e. jowar, bajra, wheat, other cereals, pulses, oilseeds, cotton, sugarcane, fruits, vegetables, condiments and spices and fodder were considered. The data regarding area under various crops for the year 1990-91 have obtained from socio-economic abstract of Ahmednagar district and data for the year 2010-11 has been obtained from agricultural department of concerned tehsil. The cropping pattern and changes therein of each tehsil and district was work out by simple percent contribution and divided in different categories for showing spatial variation.

5.2 Agricultural Seasons and Crops

Ahmednagar district experiences two agricultural season viz. *kharif* and *rabi*. *Kharif* season starts from first week of June to ends of October. In this season bajra, soyabean, maize, cotton, groundnut, vegetables, pulses and fodders are major crops. *Rabi* season starts from October onwards and ends in February or March. The major crops in this season are jowar, wheat, gram, onion etc. while summer crops i.e. maize, groundnut, fruits and vegetables are grown in irrigated parts of the district. However, sugarcane is the perennial crop in canals command area.

5.3 Temporal Variation in Agricultural Land use

Table 5.1 and fig. 5.1 display temporal variations in area under various crops. During the year 1990-91, food crop, cash crops and fodder crops registered 78.46, 17.85 and 3.69 percent area to total cropped area respectively. During the year 2010-

11, food crops, commercial or cash crops and fodder crops occupied 66.88, 28.10 and 5.02 percent area to total cropped area respectively.

Table 5.1 Agricultural Landuse in Ahmednagar District (Values in percentage)

Sr. No	Name of Crops	Years		Volume of Change
		1990-91	2010-11	
1	Jowar	41.05	31.06	-9.99
2	Bajra	23.54	22.33	-1.21
3	Wheat	5.80	5.36	-0.44
4	Other cereals	1.41	2.45	1.03
5	Pulses	6.66	5.69	-0.97
6	Sugarcane	4.79	10.73	5.94
7	F, V, C, S *	1.97	5.63	3.66
8	Cotton	0.17	7.66	7.49
9	Oilseeds	10.92	4.09	-6.83
10	Fodders	3.69	5.02	1.33

Source: (i) Socio-economic abstract, Ahmednagar district (1990-91)

(ii) Department of Agriculture of each tehsil (2010-11)

* Fruits, vegetables, condiments and spices

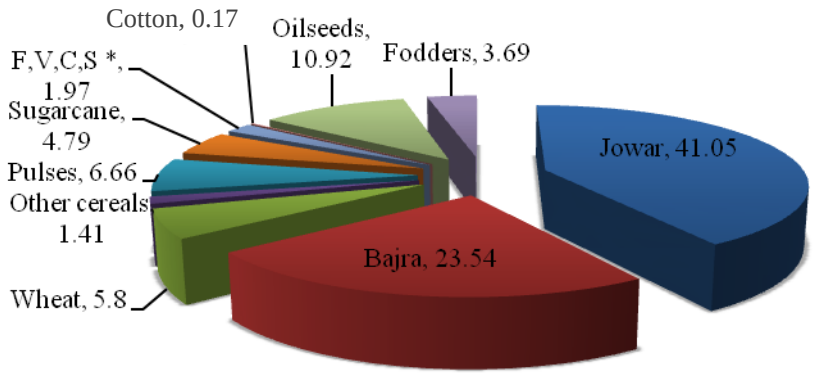
During the year 1990-91, jowar occupied 41.05 percent area to total cropped area. It is major cereal crop and mainly grown in *rabi* season in district. Bajra is the second ranking cereal crop is grown in *kharif* season in throughout the district. It occupied 23.54 percent area to total cropped area. Wheat occupied 5.80 percent area while cotton occupied 0.17 percent area to total cropped area. Oilseeds are the leading cash crops in study region and having a share of 10.92 percent. Sugarcane is cash crop having 4.79 percent area while fodder crops namely, maize, *kadwal* and green grass occupied 3.69 percent area to total cropped area.

During the year 2010-11 food crops namely, jowar, bajra and wheat occupied 31.06, 22.33 and 5.36 percent area to total cropped area respectively while cash crops namely, cotton, oilseed and sugarcane occupied 7.66, 4.09 and 10.73 percent area to total cropped area respectively. Fodder crops occupied 5.02 percent area to total cropped area of district.

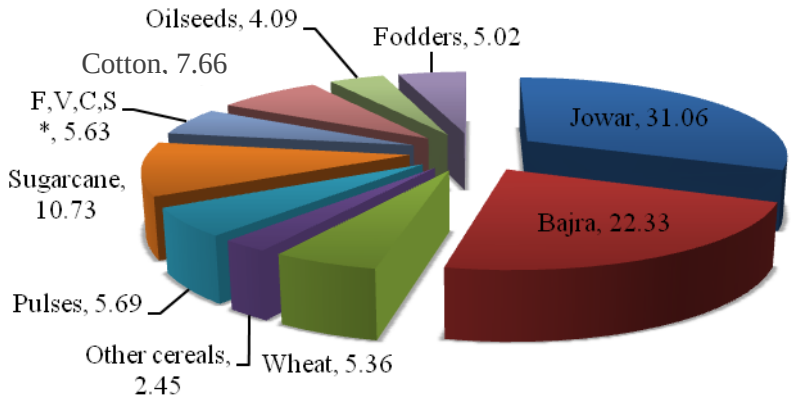
Table 5.1 revealed the changes in cropping pattern during study period. This change occurs due to various factors i.e. distribution and amount of rainfall,

Temporal Variation in Agricultural Landuse

1990-91



2010-11



Note: (i) Area in Percengate

(ii) F, V, C, S = Fruits, Vegetables, Condiments and Spices

Fig: 5.1

availability of irrigation facilities, farm credit, high yielding variety of seeds, market price of agricultural commodities, chemical and domestic fertilizer, labour coast and availability etc. The temporal pattern of volume change in area under crops registered significant positive change in sugarcane (5.94 percent), other cereals (1.03 percent), fruits, vegetables, condiments and spices (3.66 percent), cotton (7.49 percent) and fodders (1.33 percent) while significant negative change recorded in jowar (9.99 percent), bajra (1.21 percent), wheat (0.44 percent), pulses (0.97 percent) and oilseeds (6.83 percent). This change is indicating that the farmers have changed their attitude from food crops to cash crops. The change in cropping pattern in particular span of time clearly indicates the changes that have taken place in the agricultural development.

5.4 Spatial Variation of Agricultural Landuse

Ahmednagar district located in drought prone zone of Maharashtra but because of the availability of irrigation facilities farmers adopted new technique for agricultural practices. The areal variation of crops in Ahmednagar district is mainly depends on availability of irrigation, relief, soil types, distribution and amount of rainfall and farmer's attitude. Tehsil wise percentage share of each crops and volume of change was worked out for the years 1990-91 and 2010-11(Appendix-1) and interpreted in further text.

5.4. A Food Crops

Food crops play a vital role in the cropping of land under tillage, in study region 78.46 and 66.88 percent area to total cropped area under food crops during the years 1990-91and 2010-11 respectively.

5.4. A 1 Distribution of Jowar

Jowar is specially known as dry land crop. It is a major staple food grain and grown in *rabi* season generally in the field which have remained fallow in the previous *kharif* season. It is the most economical and productive accessory of food and fodder. It requires rainfall between 60 cm. to 100 cm. It grown in throughout the district because of favorable climatic condition and medium to deep black soils distributed in district.

Jowar occupied 41.05 and 31.06 percent area to total cropped area in district during the years 1990-91 and 2010-11 respectively. The percentage area under jowar was worked out (Appendix -I) and divided into five different categories namely, very

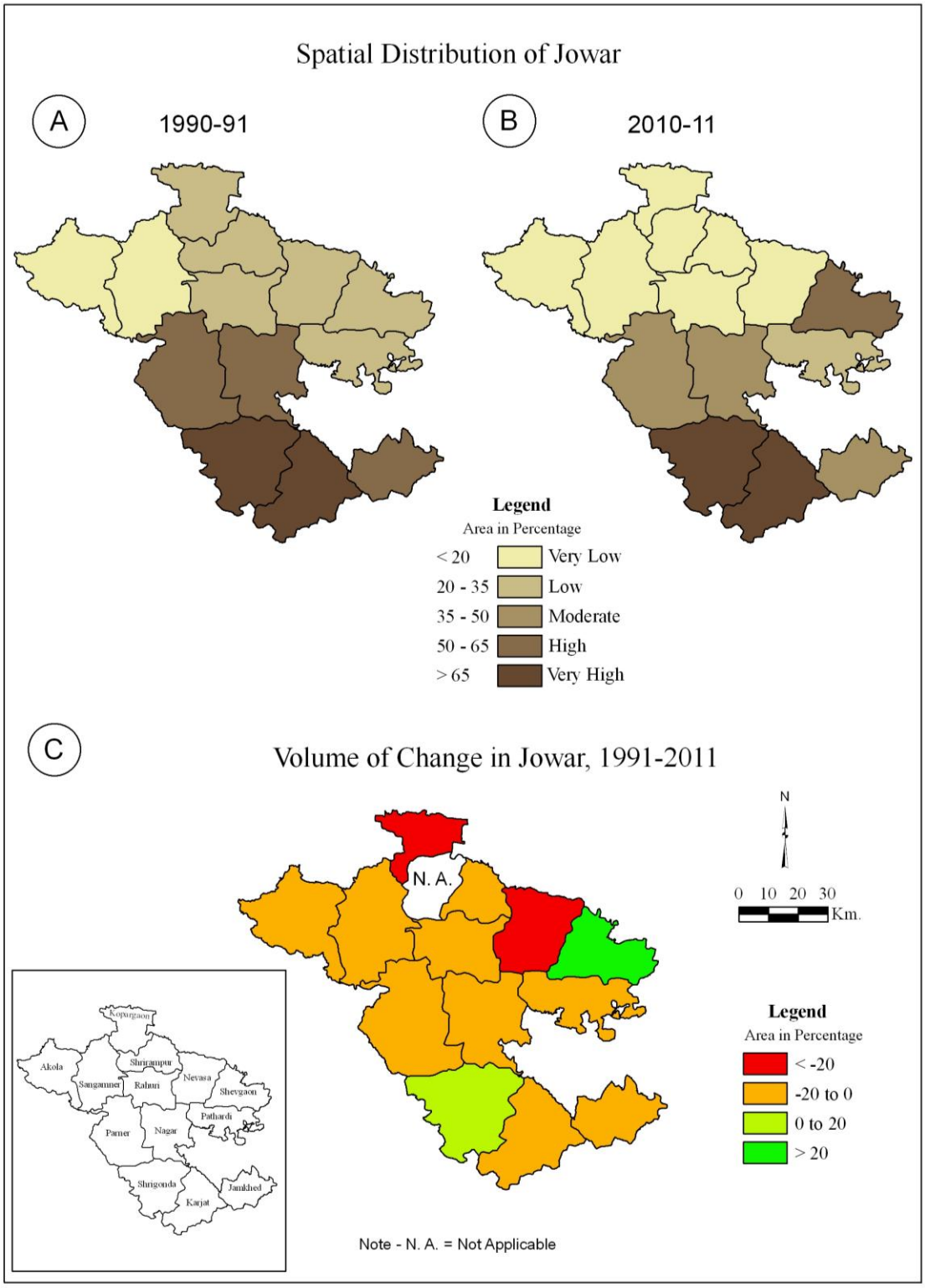

Spatial Distribution of Jowar
A
1990-91
B
2010-11
Legend
Area in Percentage
< 20 Very Low
20 - 35 Low
35 - 50 Moderate
50 - 65 High
> 65 Very High
C
Volume of Change in Jowar, 1991-2011
N. A.
N
0 10 20 30
Km.
Legend
Area in Percentage
< -20
-20 to 0
0 to 20
> 20
Kopargaon
Akola
Shrirampur
Sangamner
Rahuri
Nevasa
Shevgaon
Pathardi
Parner
Nagar
Shrigonda
Jamkhed
Karjat
Note - N. A. = Not Applicable

Fig: 5.2 A, B & C

low, low, moderate, high and very high having the range below 20, 20 - 35, 35 – 50, 50 – 65 and above 65 percent respectively (fig. 5.2 A & B).

During the year 1990-91, very low area under jowar was found in the tehsils namely, Akole and Sangamner because of unfavorable climatic condition and shallow soil (fig. 5.2/A). Low category was found in north and north-east parts of district confined tehsils of Kopargaon, Rahuri, Shrirampur, Nevasa, Shevgaon and Pathardi while moderate category was not found in any tehsil. High category was found in Parner, Nagar and Jamkhed tehsils whereas very high area under jowar was found in south part of district comprised tehsils of Shrigonda and Karjat (Appendix- 1).

Spatial distribution of jowar during the year 2010-11 has exhibited in fig.5.2/B. Very low area under jowar was found in northern and western parts of district comprised tehsils Kopargaon, Rahata, Shrirampur, Rahuri, Nevasa, Sangamner and Akole. In these tehsils due to availability of irrigation facilities area under cash crops are higher. Low category was found in Pathardi tehsil while moderate area recorded in three tehsils namely, Nagar, Parner and Jamkhed. High category was recorded in Shevgaon tehsil whereas very high category was found south parts of district confined the tehsils namely, Shrigonda and Karjat.

Fig. 5.2/C and Appendix-I revealed during the study period the area under jowar was decline because of change in the attitude of farmers from traditional crops to cash crops. High (above 20 percent) percentage area declined in Nevasa and Kopargaon tehsil while tehsils of Jamkhed, Shrirampur, Pathardi, Rahuri, Nagar, Akole, Sangamner, Karjat and Parner declined by below 20 percent. Positive change recorded in two tehsils namely, Shevgaon (32.30 percent) and Shrigonda (2.14 percent).

Tehsils of Nagar, Rahuri, Shrirampur, Nevasa, Pathardi, Jamkhed and Kopargaon found significant negative change in area of jowar while significant positive change found in Shevgaon tehsil. Rest of the tehsils marked insignificant change.

5.4. A 2 Distribution of Bajra

Bajra is the second ranking crop in the study region. It is drought resistant crop cultivated in *kharif* season. It requires less amount of water during the growing period and suffers less from biological hazards than other food grains. During mature stage heavy rains are disastrous to bajra. The distribution of bajra is mainly influenced by soil types, relief and amount of rainfall and rainy days. The percentage area under

bajra was work out and grouped into five different categories namely, very low, low, moderate, high and very high having the range below 10, 10-20, 20-30, 30-40 and above 40 percent.

Appendix-I and fig. 5.3/A revealed spatial pattern of bajra cultivation during the year 1990-91. It revealed that very low concentration was found in south parts of district constituted in tehsils namely, Jamkhed, Karjat and Shrigonda while low category was recorded in Nagar and Shrirampur tehsils. Moderate category was registered in Akole, Parner, Nevasa and Rahuri tehsils whereas high category was found in Kopargaon and Shevgaon tehsils. Very high concentration was found in two tehsils namely, Sangamner and Pathardi.

Appendix-I and fig. 5.3/B revealed spatial distribution of bajra during the year 2010-11. Very low area occupied by bajra in tehsils of Nevasa, Shevgaon, Jamkhed and Shrigonda while low category was found in three tehsils namely, Shrirampur, Karjat and Kopargaon. Three tehsil namely, Rahuri, Akole and Rahata noticed moderate category whereas high to very high concentration of bajra recorded in Nagar, Parner, Pathardi and Sangamner tehsils.

Appendix-I and fig. 5.3/C revealed volume of change in area of bajra. It shows that above 20 percent negative change recorded in north-east part of district comprised tehsils of Shevgaon and Nevasa while below 20 percent negative change was recorded in tehsils of Kopargaon, Pathardi, Akole and Sangamner. In these tehsils due to availability of individual and institutional irrigation facility farmers cultivate cash crops instead of bajra. Tehsil Nagar recorded above 20 percent positive change whereas rest of tehsils recorded below 20 percent positive change.

Four tehsils namely, Nagar, Rahuri, Karjat and Parner recorded significant positive change while tehsil of Nevasa, Shevgaon, Pathardi, Akole, Sangamner and Kopargaon noticed significant negative change. Three tehsils namely, Shrirampur, Jamkhed and Shrigonda found insignificant change.

5.4. A 3 Distribution of Wheat

Wheat is the chief rabbi cereal grown for human food, it require dry and mild climate for growth. It grown under a variety of temperature conditions, ranging from extremely low to rather high. A mean temperature of 15^0 to 20^0 C, 50 to 75 cm rainfall and also moderate irrigation is the optimum for growth and development of wheat. It mature period is three to four months. It is generally sown in the first or second week of November and harvested up to last week of March. Black fertile soil with fine

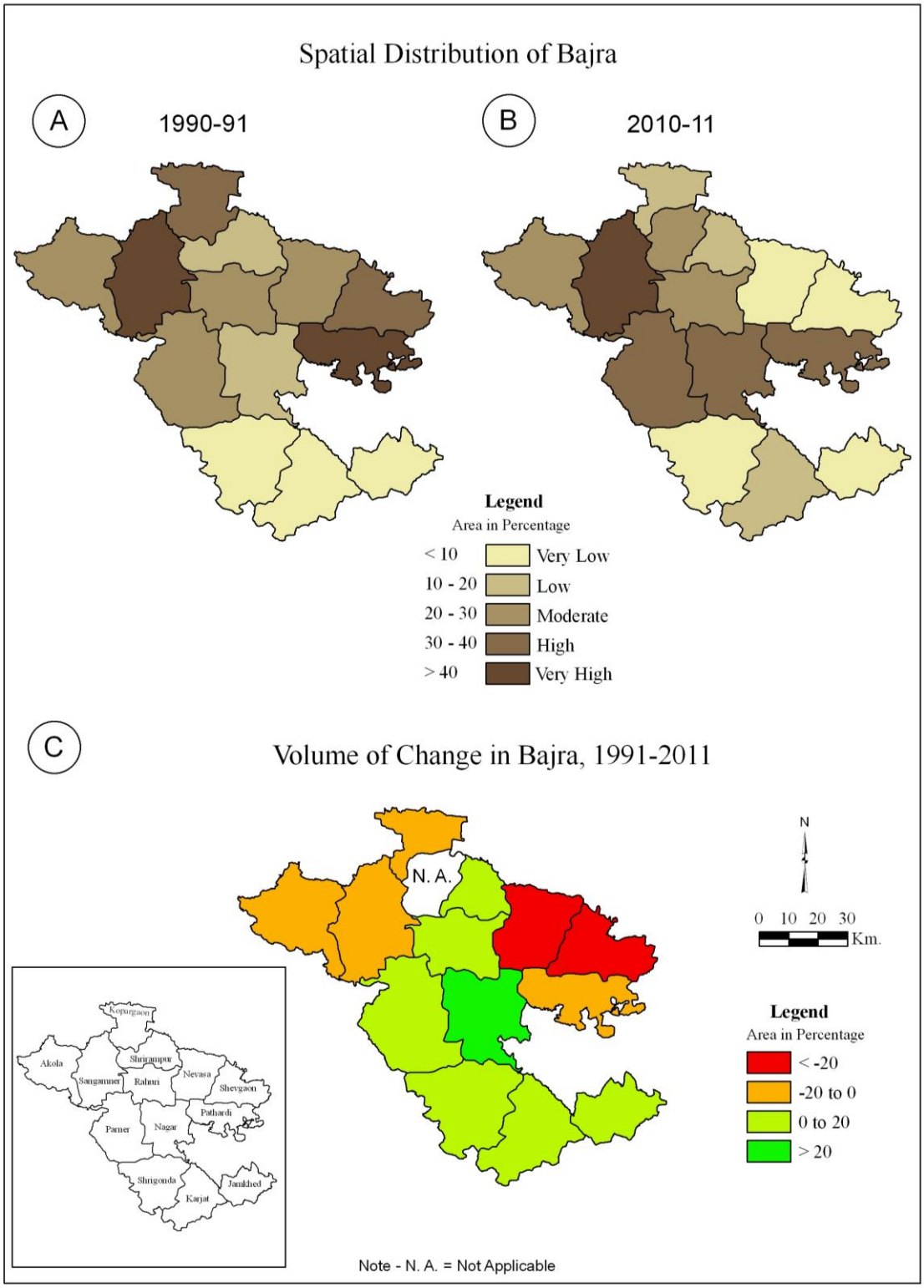

Spatial Distribution of Bajra
A
1990-91
B
2010-11
Legend
Area in Percentage
< 10
Very Low
10 - 20
Low
20 - 30
Moderate
30 - 40
High
> 40
Very High
C
Volume of Change in Bajra, 1991-2011
N. A.
N
0 10 20 30
Km.
Legend
Area in Percentage
< -20
-20 to 0
0 to 20
> 20
Kopargaon
Akola
Shrirampur
Nevasa
Sangamner
Rahuri
Shevgaon
Pathardi
Parner
Nagar
Shrigonda
Jamkhed
Karjat
Note - N. A. = Not Applicable

Fig: 5.3 A, B & C

loamy clay texture is suitable for high yield. It requires three to four rotation of irrigation according to soil type.

Percentage area under wheat to total cropped area was worked out for the years 1990-91 and 2010-11 and divided into four different categories namely, very low, low, moderate and high having the range below 4, 4-8, 8-12, and above 12 respectively.

The spatial distribution of wheat during the year 1990-91 is shown in Appendix-I and fig.5.4/A. It revealed very low category was found in five tehsils namely, Shevgaon, Parner Jamkhed, Karjat and Akole while low category was recorded in Sangamner, Kopargaon, Shrigonda Nagar and Pathardi tehsils. Nevasa and Rahuri tehsils noticed moderate category while high category was found in tehsil Shrirampur. Wheat cultivation belt was found in north part of study region, where canal irrigation is dominant.

Fig. 5.4/B revealed area under wheat during the year 2010-11. It revealed very low category was found in south, west and east parts of district confined tehsils Jamkhed, Karjat, Akole, Parner, Nevasa, Shevgaon and Pathardi whereas low category was registered in tehsils namely, Sangamner and Nagar. Two tehsils Rahata and Shrigonda noticed moderate category while high concentration registered in north part of study region consisting tehsils Rahuri, Shrirampur and Kopargaon.

An analysis of an area under wheat revealed downward trend in its land occupancy. In canal command area of northern part in district has observed significant positive change. Above six percent positive change recorded in tehsils of Rahuri and Kopargaon followed by Shrigonda while below 3 percent positive change found in Akole and Shrirampur tehsils (fig. 5.4/C). The significant negative change found in the tehsil of Nevasa tehsil (8.61 percent), Pathardi (4.59 percent) whereas Shevgaon, Jamkhed, Nagar, Karjat Parner and Sangamner tehsils recorded below 3 percent negative change, it was also significant(Appendix-I).

5.4. A 4 Distribution of Other Cereals

The crops such as Maize, *Kutki*, *Ragi* (local name *Nagli* or *Nachni*), *Vari* and *Kodra* etc. are included in this category. Rice occupied very small area and grown in only western ghat track of Akole tehsil due to this it included in other cereals. In term of area maize is the only important crop. The percentage area under other cereals was worked out (Appendix - I) and divided into three different categories namely, low, moderate and high having the range below 0.5, 0.5-1.0 and above 1.0 respectively.

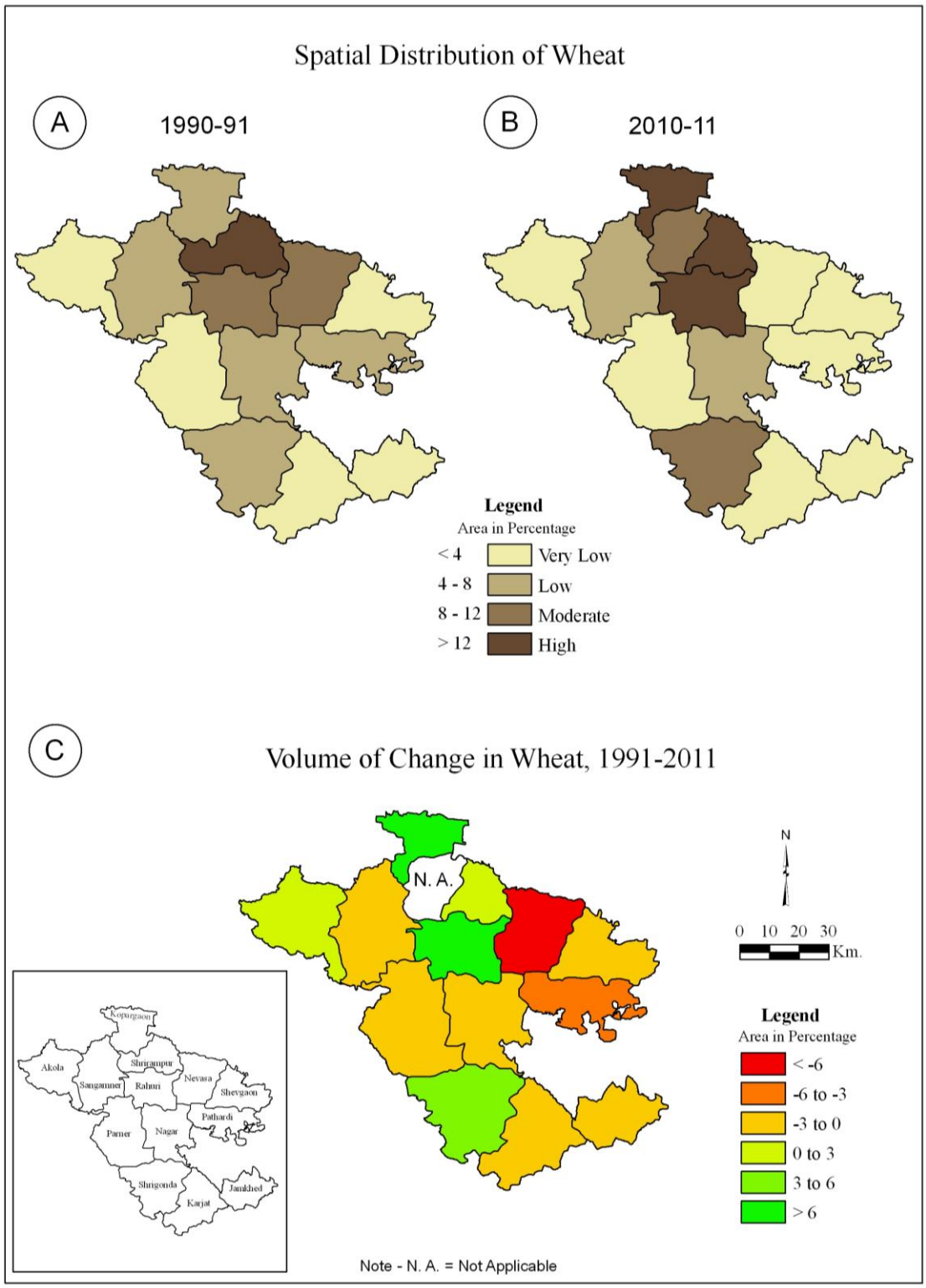

Spatial Distribution of Wheat
A
1990-91
B
2010-11
Legend
Area in Percentage
< 4 Very Low
4 - 8 Low
8 - 12 Moderate
> 12 High
C
Volume of Change in Wheat, 1991-2011
N. A.
N
0 10 20 30
Km.
Legend
Area in Percentage
< -6
-6 to -3
-3 to 0
0 to 3
3 to 6
> 6
Kopargaon
Akola
Shrirampur
Sangamner
Rahuri
Nevasa
Shevgaon
Pathardi
Parner
Nagar
Shrigonda
Karjat
Jamkhed
Note - N. A. = Not Applicable

Fig: 5.4 A, B & C

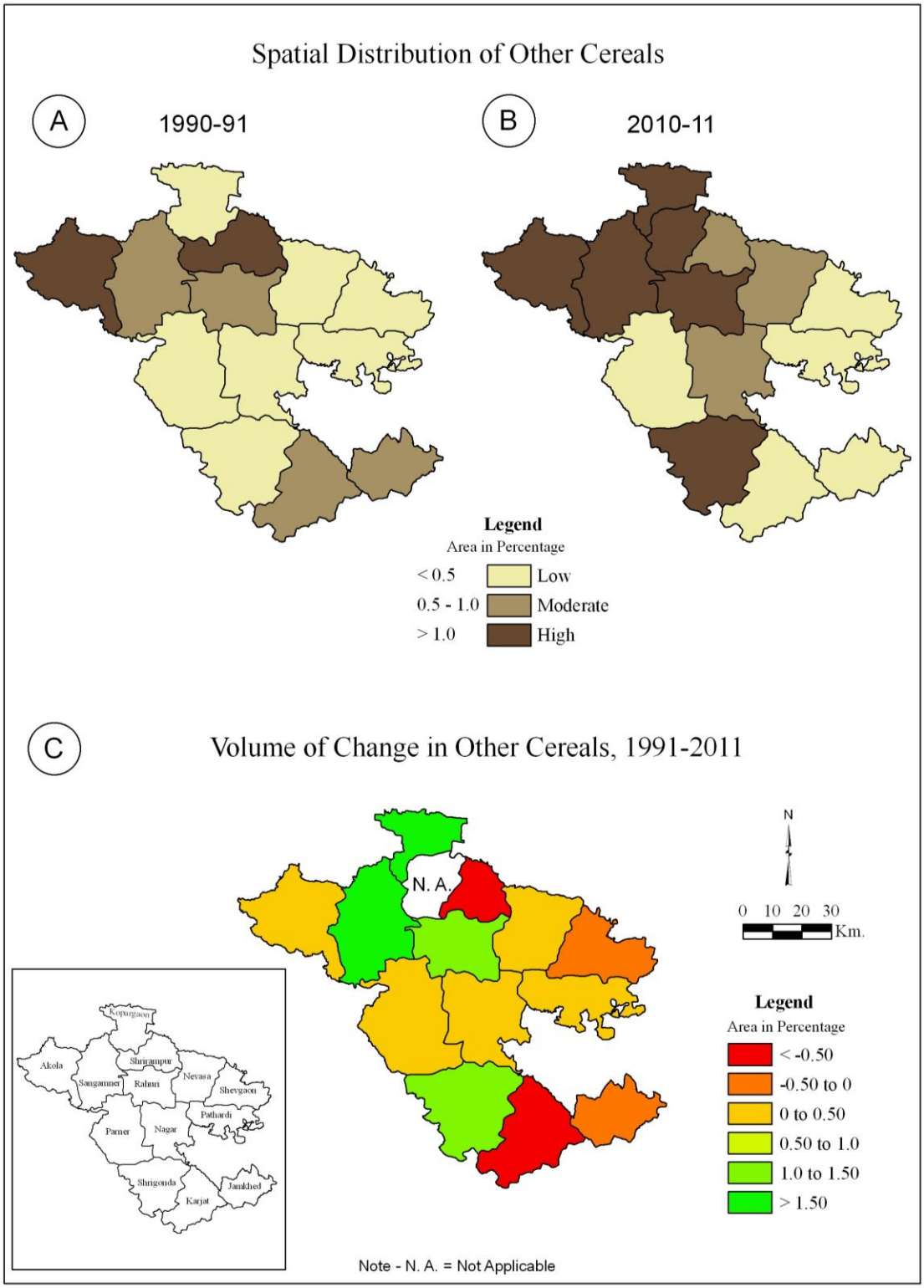

Spatial Distribution of Other Cereals
A
1990-91
B
2010-11
Legend
Area in Percentage
< 0.5
Low
0.5 - 1.0
Moderate
> 1.0
High
C
Volume of Change in Other Cereals, 1991-2011
N. A.
N
0 10 20 30
Km.
Legend
Area in Percentage
< -0.50
-0.50 to 0
0 to 0.50
0.50 to 1.0
1.0 to 1.50
> 1.50
Kopargaon
Akola
Shrirampur
Sangamner
Rahuri
Nevasa
Shevgaon
Pathardi
Parner
Nagar
Shrigonda
Jamkhed
Karjat
Note - N. A. = Not Applicable

Fig: 5.5 A, B & C

Appendix-I and fig. 5.5/A revealed percentage area under other cereals to total cropped area during the year 1990-91. Low concentration was observed in tehsil Kopargaon, Nevasa, Shevgaon, Pathardi, Nagar, Parner and Shrigonda while moderate category was recorded in four tehsils namely, Sangamner, Karjat, Jamkhed and Rahuri. High concentration of other cereals observed in Akole and Shrirampur tehsils.

Fig. 5.5/B and appendix-I revealed spatial distribution of other cereals during the year 2010-11. It revealed that low concentration noticed in tehsils of Shevgaon, Pathardi, Parner, Karjat and Jamkhed while moderate concentration was recorded in central and north-east parts of district confined tehsil of Nagar, Shrirampur and Nevasa. High category was found in north and north-west parts of district confined tehsils of Akole, Sangamner, Kopargaon, Rahata and Rahuri tehsils whereas Shrigonda tehsil also found high category.

During the period of investigation area under other cereal was slightly increased by 1.03 percent. Appendix-I and fig. 5.5/C revealed that highest (above 1.50 percent) positive change found in northern part of district consisting tehsils of Kopargaon and Sangamner while 1.0 to 1.50 percent positive change found in Rahuri and Shrigonda tehsils. Five tehsils namely, Akole, Parner, Nagar Nevasa and Pathardi registered below 0.50 percent positive changes. Negative change was found in four tehsils namely, Shrirampur (0.92 percent) followed by Karjat, Shevgaon and Jamkhed.

During the period of two decades significant positive change recorded in tehsil of Rahuri, Shrigonda, Sangamner and Kopargaon whereas significant negative change noticed in tehsil Shrirampur and rest of tehsils found insignificant change in area of other cereals.

5.4. A 5 Distribution of Pulses

Pulses are an important source of protein supply in the daily diet of people and also furnish useful leguminous rotation for increasing soil fertility. In the present study the crops such as Gram, *Arhar* (tur), *Moong (*green gram*), Urd* (black gram), *Moth* (brown gram*),* and *Kulthi* have considered. These are grown in both *kharif* and *rabi* (Gram) season. These crops are not grown on a large scale in study area. The spatial pattern of pulses cultivation is influenced by the condition like low rainfall, terrain characteristics and physical and chemical properties of the soils. The

percentage area under pulses was work out and divided into three different categories i.e. low, moderate and high having range below 5, 5-10 and above 10 respectively.

Appendix-I revealed the pulses as a group account 6.66 percent area to total cropped area in 1990-91. Fig. 5.6/A shows spatial distribution of pulses. It revealed low area under pulses registered in tehsils of Pathardi and Shrigonda while moderate area was registered in tehsils Kopargaon, Shrirampur, Akole, Sangamner, Rahuri, Nevasa, Parner, Nagar, Jamkhed and Karjat. High category was noticed in Shvegaon tehsil.

The spatial distribution of pulses during 2010-11 is shown in appendix-I and fig. 5.6/B. Eight tehils namely, Akole, Nevasa, Shevgaon, Rahuri, Pathardi, Nagar, Shrigonda, Karjat recorded low category while moderate category observed in tehsil of Shirampur, Parner, Kopargaon, Rahata and Sangamner. High area under pulses recorded in Jamkhed tehsil.

Appendix-I revealed that area under pulses slight declined during the period of investigation. Highest declined found in Shevgaon tehsil (9.51 percent) and Nagar (6.04 percent). Three tehsils namely, Akole, Rahuri and Nevasa have recorded by 3 to 6 percent declined while below 3 percent declined in tehsils Kopargaon, Sangamner, Shrigonda and Karjat. Highest area increased in Jamkhed tehsil (17.57 percent) while below 3 percent positive change found in two tehsils namely Parner and Shrirampur (fig. 5.6/C).

Tehsil namely, Nagar, Rahuri, Nevasa, Shevgaon, Pathardi, Akole and Kopargaon found significant negative change while significant positive change recorded in Jamkhed and Parner tehsils. Four tehsil namely, Shrirampur, Karjat, Shrigonda and Sangamner marked insignificant change in area under pulses.

5.4. B Cash Crops

Crops such as sugarcane, fruits, vegetables, condiments and spices, cotton and oil seeds are included in this category.

5.4. B 1 Distribution of Sugarcane

Sugarcane is tropical and sub-tropical crop. It has been grown in India since the ancient times. For better growth and high yield it require black to deep black soil, monthly mean temperature range from 21^0 C to 27^0 C throughout the year, absence of frost, 125 cm to 150 cm annual water, high intensity of irrigation, chemical fertilizers. Sugar industries, market price and availability of cheap labour are also effect on sugarcane cultivation. The growing period of sugarcane varies from 9 months for

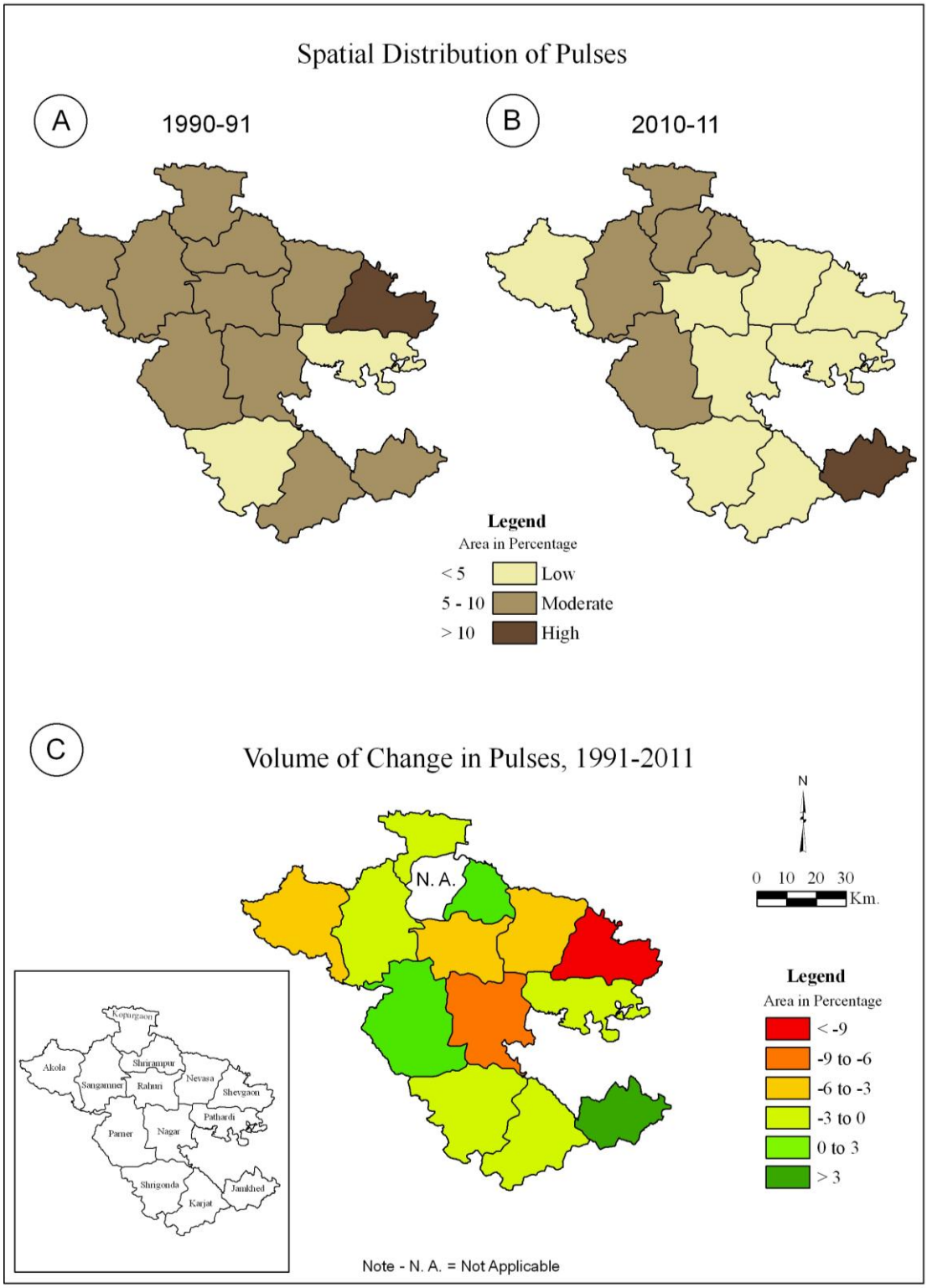

Spatial Distribution of Pulses
A
1990-91
B
2010-11
Legend
Area in Percentage
< 5
Low
5 - 10
Moderate
> 10
High
C
Volume of Change in Pulses, 1991-2011
N. A.
N
0 10 20 30
Km.
Legend
Area in Percentage
< -9
-9 to -6
-6 to -3
-3 to 0
0 to 3
> 3
Kopargaon
Akola
Shrirampur
Nevasa
Sangamner
Rahuri
Shevgaon
Pathardi
Parner
Nagar
Shrigonda
Jamkhed
Karjat
Note - N. A. = Not Applicable

Fig: 5.6 A, B & C

early maturing varieties to 12 months in late maturing varieties. During the growing period it requires frequent watering. All factors which are require for better growth and production of sugarcane are available in Ahmednagar district so it becomes most important cash crop and grown throughout the district.

The percentage area under sugarcane was work out and divided into four categories namely, very low, low, moderate and high having range under 5, 5-10, 10-15 and above 15 respectively. Sugarcane occupied 4.79 and 10.73 percent area to total cropped area during the years 1990-91 and 2010-11 respectively.

Fig. 5.7/A shows spatial distribution of sugarcane during the year 1990-91. It is revealed that tehsils namely, Shrigonda, Akole, Pathardi Nagar, Karjat, Jamkhed and Parner found very low area under sugarcane whereas low area under sugarcane recorded in tehsils of Sangamner, Kopargaon and Shevgaon. Shrirampur and Nevasa tehsils was found moderate category while high category was noticed in Rahuri tehsil. Here concentration of sugarcane is supported by black soils, canal irrigation and good transportation facility.

Fig. 5.7/B and Appendix-I revealed the spatial distribution of sugarcane during the year 2010-11. Very low concentration found in tehsils of Akole, Parner, Nagar, Pathardi, Karjat and Jamkhed while four tehsils namely, Shevgaon, Sangamner, Kopargaon and Shrigonda noticed low category. Shrirampur and Rahata tehsils recorded moderate category whereas high concentration recorded in Nevasa and Rahuri tehsil.

Appendix-I and fig. 5.7/C revealed volume of change in area of sugarcane. It shows that high positive change found in Nevasa (44.46 percent) followed by Rahuri (13.14 percent) while below 10 percent positive change recorded in tehsils of Shrigonda, Shevgaon, Shrirampur, Pathardi, Jamkhed, Sangamner, Kopargaon, Parner and Karjat. Two tehsils namely, Akole and Nagar notice negative change by 1.72 and 1.13 percent respectively.

Only two tehsils namely, Rahuri and Nevasa recorded significant positive change while rest of tehsils noticed insignificant change in area of sugarcane.

5.4. B 2 Distribution of Fruits, Vegetables, Condiments and Spices

Fruits include grapes, guava, *chiku*, orange and mango while vegetables include brinjal, *bhendi* (lady's finger), raddish, cabbage, cauliflower, spinach, onion, chilly, peas, tomato, cucumber, fenugreek etc. are the major fruits and vegetables grown in study area. The percentage area under fruits vegetables, condiments and

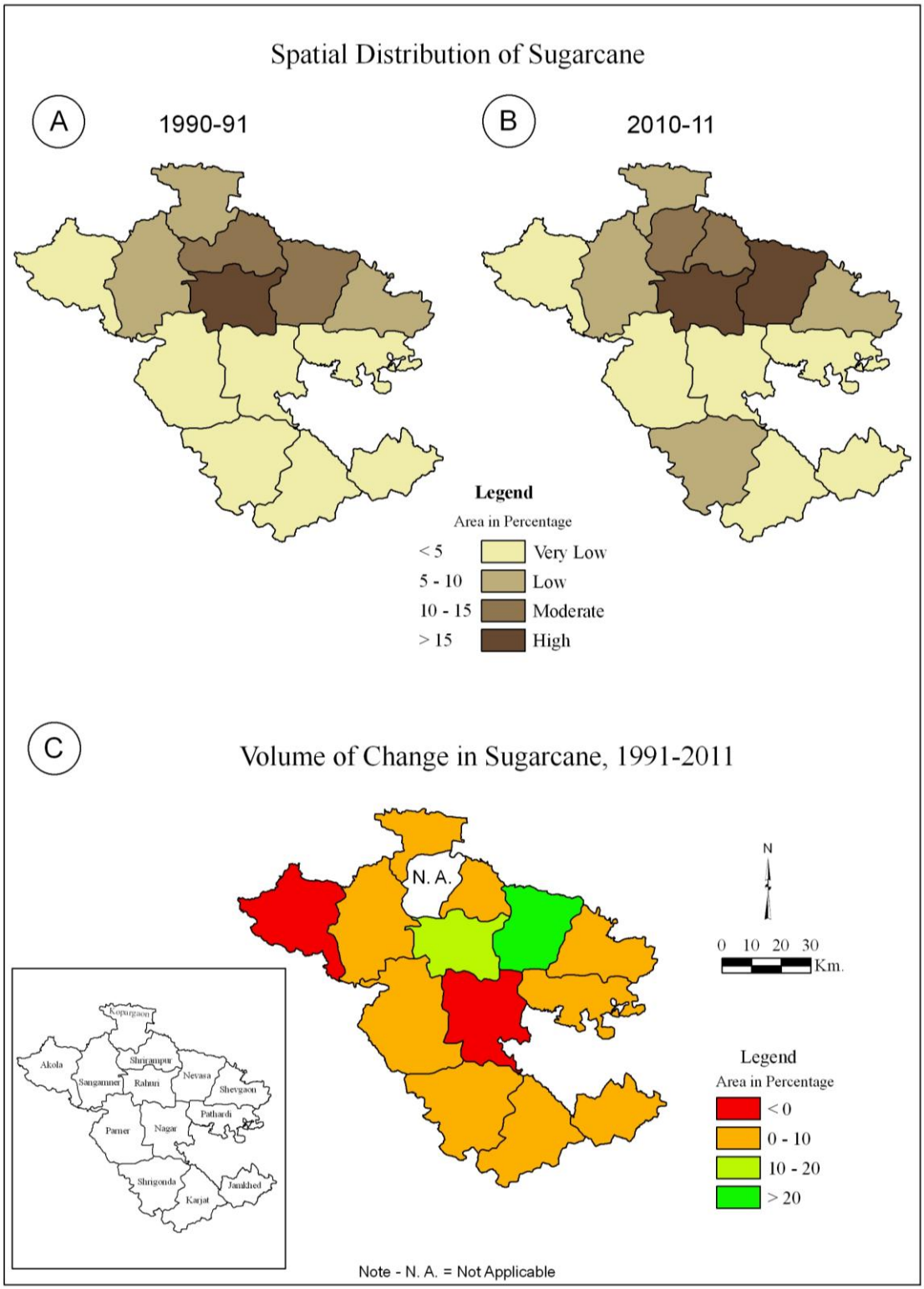

Spatial Distribution of Sugarcane
A
1990-91
B
2010-11
Legend
Area in Percentage
< 5
Very Low
5 - 10
Low
10 - 15
Moderate
> 15
High
C
Volume of Change in Sugarcane, 1991-2011
N. A.
N
0 10 20 30
Km.
Legend
Area in Percentage
< 0
0 - 10
10 - 20
> 20
Kopargaon
Akola
Shrirampur
Sangamner
Rahuri
Nevasa
Shevgaon
Pathardi
Parner
Nagar
Shrigonda
Jamkhed
Karjat
Note - N. A. = Not Applicable

Fig: 5.7 A, B & C

spices was worked out and divided into five different categories i.e. very low, low, moderate, high and very high having range below 2, 2-4, 4-6, 6-8 and above 8 respectively.

The distribution of fruits and vegetables are influenced by transport, market centers and irrigation. Appendix-I and fig. 5.8/A revealed percentage area under fruits, vegetables, condiments and spices during the year 1990-91. Very low percent area recorded in Rahuri, Nevasa, Shevgaon, Pathardi, Jamkhed, Karjat, Shrigonda and Akole tehsils while low area was found in four tehsils namely, Nagar, Shrirampur, Parner and Kopargaon. Moderate category was recorded in Sangamner teshsil while very high and high category was not found during this year.

Appendix-I and fig. 5.8/B revealed spatial distribution of fruits, vegetables, condiments and spices during 2010-11. It revealed that very low category confined in Nagar and Shevgaon tehsils whereas three tehsils namely, Jamkhed, Pathardi and Karjat recorded low concentration. Four tehsils namely, Rahuri, Shrigonda, Parner and Akole recorded moderate category while high category recorded in Shrirampur and Rahata tehsils. Very high concentration found in Nevasa, Sangamner and Kopargaon tehsils.

Fig. 5.8/C revealed volume of change in area of fruits, vegetables, condiments and spices. It shows that except Nagar tehsil rest of the tehsils recorded upward trend. Tehsils of Shevgaon, Pathardi, Shrirampur, Rahuri, Parner, Karjat, Shrigonda and Jamkhed recorded below 4 percent positive change while 4 to 8 percent positive change found in Akole and Sangamner tehsils. Tehsils of Kopargaon and Nevasa registered above 8 percent positive change.

Tehsils of Nevasa, Kopargaon, Akole and Sangamner recorded significant positive change whereas rest of the tehsils found positive change but it was not significant.

5.4. B 3 Distribution of Cotton

Cotton is the leading cash crop cultivated mostly in the north eastern parts of district. The distribution pattern of cotton was worked out and divided into four different categories namely, very low, low, moderate and high having range below 5, 5-10, 10-15 and above 15 respectively. District has 0.17 and 7.66 percent area to total cultivated area under cotton in the years 1990-91 and 2010-11 respectively.

Appendix- 1 and fig. 5.9/A pointed out that vary low category was observed in all tehsils while low, moderate and high category not recorded during this year.

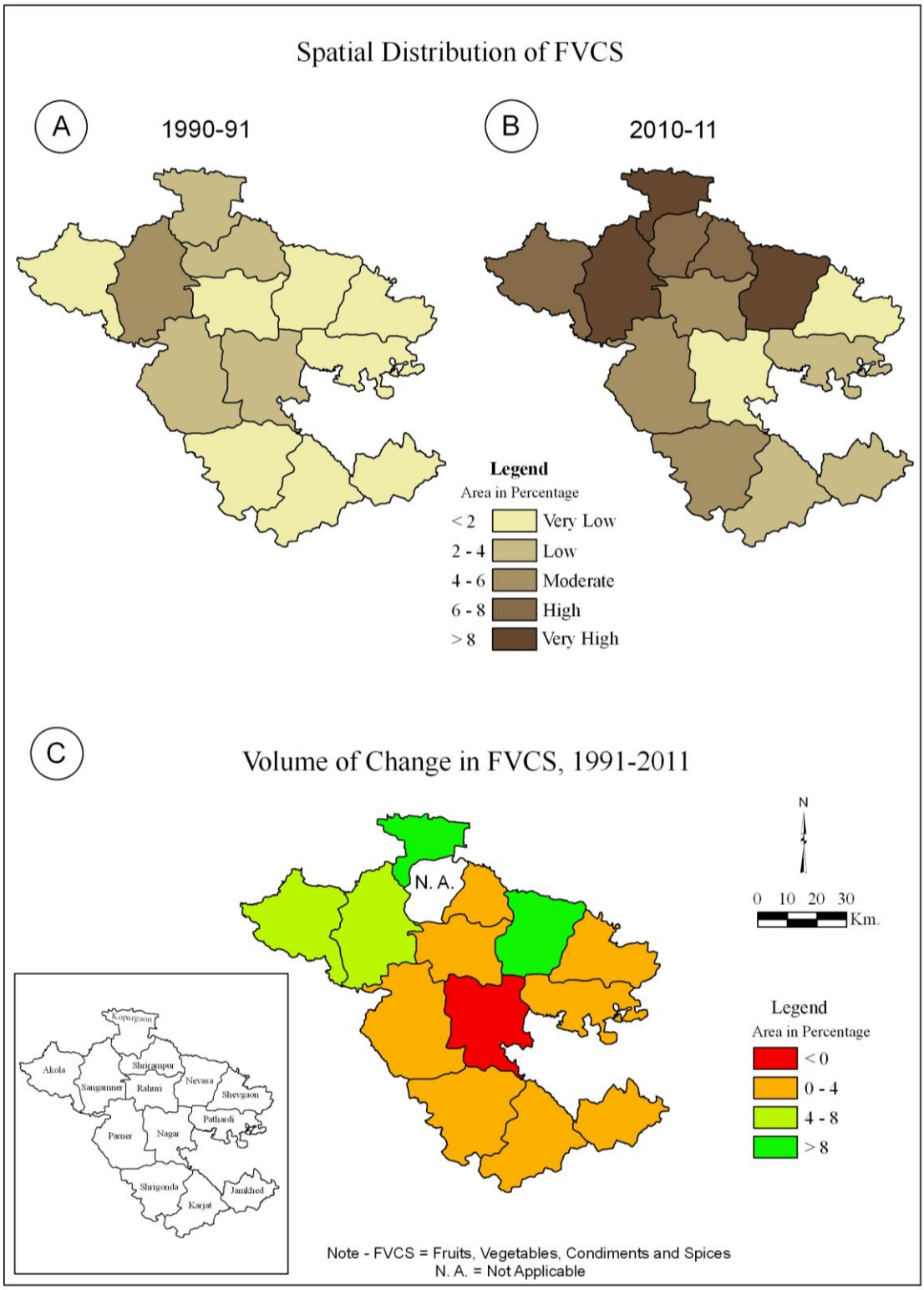

Spatial Distribution of FVCS
A
1990-91
B
2010-11
Legend
Area in Percentage
< 2 Very Low
2 - 4 Low
4 - 6 Moderate
6 - 8 High
> 8 Very High
C
Volume of Change in FVCS, 1991-2011
N. A.
N
0 10 20 30
Km.
Legend
Area in Percentage
< 0
0 - 4
4 - 8
> 8
Kopargaon
Akola
Shirampur
Sangamner
Rahuri
Nevasa
Shevgaon
Pathardi
Parner
Nagar
Shrigonda
Jamkhed
Karjat
Note - FVCS = Fruits, Vegetables, Condiments and Spices
N. A. = Not Applicable

Fig: 5.8 A, B & C

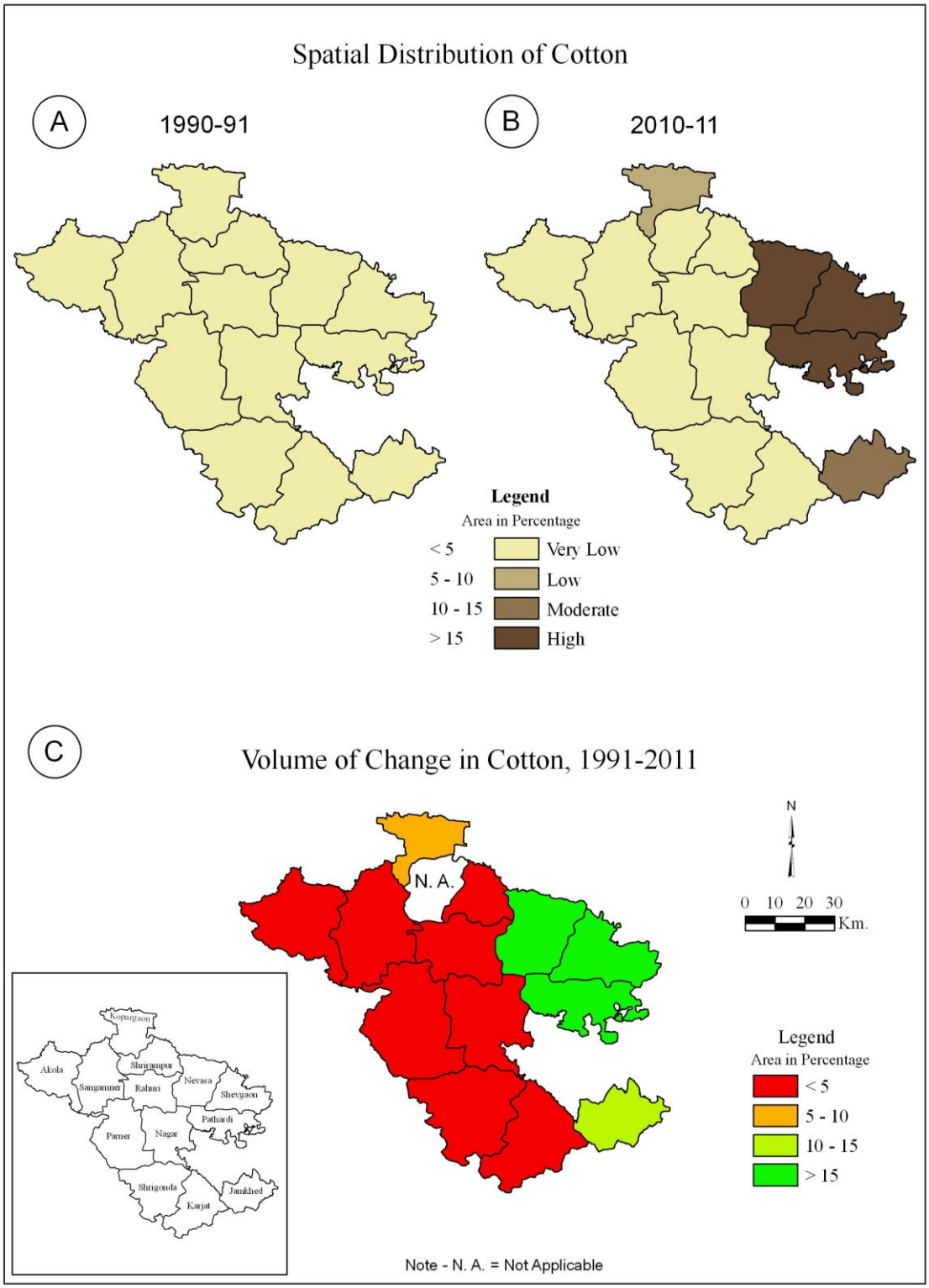

Spatial Distribution of Cotton
A
1990-91
B
2010-11
Legend
Area in Percentage
< 5
Very Low
5 - 10
Low
10 - 15
Moderate
> 15
High
C
Volume of Change in Cotton, 1991-2011
N. A.
N
0 10 20 30
Km.
Legend
Area in Percentage
< 5
5 - 10
10 - 15
> 15
Kopargaon
Akola
Shrirampur
Sangamner
Rahuri
Nevasa
Shevgaon
Pathardi
Parner
Nagar
Shrigonda
Jamkhed
Karjat
Note - N. A. = Not Applicable

Fig: 5.9 A, B & C

Appendix-I and fig. 5.9/B revealed the spatial distribution of cotton during the year 2010-11. It revealed very low area under cotton found in tehsils of Nagar, Rahuri, Shrirampur, Karjat, Shrigonda, Parner, Akole, Sangamner and Rahata while Kopargaon noticed low category. Moderate concentration was found in Jamkhed tehsils whereas high category observed in Pathardi, Nevasa and Shevgaon tehsils.

Fig. 5.9/C and appendix-I revealed volume of change in area of cotton. It shows that below 5 percent positive change recorded in Akole, Shrirampur, Rahuri, Parner, Nagar, Shrigonda and Karjat tehsils whereas tehsils Kopargaon and Jamkhed was recorded positive change by 8.44 and 13.70 percent respectively. Western parts of district confined tehsils of Nevasa, Shevgaon and Pathardi recorded above 15 percent positive change in area of Cotton.

Tehsils namely, Nevasa, Shevgaon, Pathardi, Jamkhed and Kopargaon found significant positive change while rest of the tehsils recorded insignificant change in area of cotton.

5.4. B 4 Distribution of Oil Seeds

The term 'oilseeds' refers to the seeds of such plants from which various kinds of oils are recovered i.e. food oils and non food oils. In study region groundnut, soyabean, sunflower are major and *til*, linseed, castor are minor crops in term of area. Groundnut and sunflower is grown in both *kharif* and *rabbi* season and rest of the crops grown in *kharif* season. The distribution pattern of oilseeds is largely influenced by soil, amount of rainfall and temperature during specific stages of crop growth.

The percentage concentration of oil seed crops to total cultivated area was worked out (Appendix - I) and divided into three different categories namely, low, moderate and high having the range of under 10, 10-20 and above 20 respectively (fig. 5.10 A & B). District has 10.92 and 4. 09 percent area of total cropped area during the years 1990-91 and 2010-11 respectively.

Fig.5.10/A revealed spatial distribution pattern of oilseeds during the year 1990-91. Very low category registered in Kopargaon, Akole, Sangamner, Rahuri, Parner and Shevgaon tehsils whereas moderate category was found in Karjat, Pathardi, Shrirampur, Nevasa and Nagar tehsils. High concentration registered in south parts of district comprised tehsils Jamkhed and Shrigonda.

Fig. 5.10/B revealed moderate and high categories were recorded in Kopargaon, Shrirampur and Rahata tehsils respectively while rest of the tehsils recorded low category.

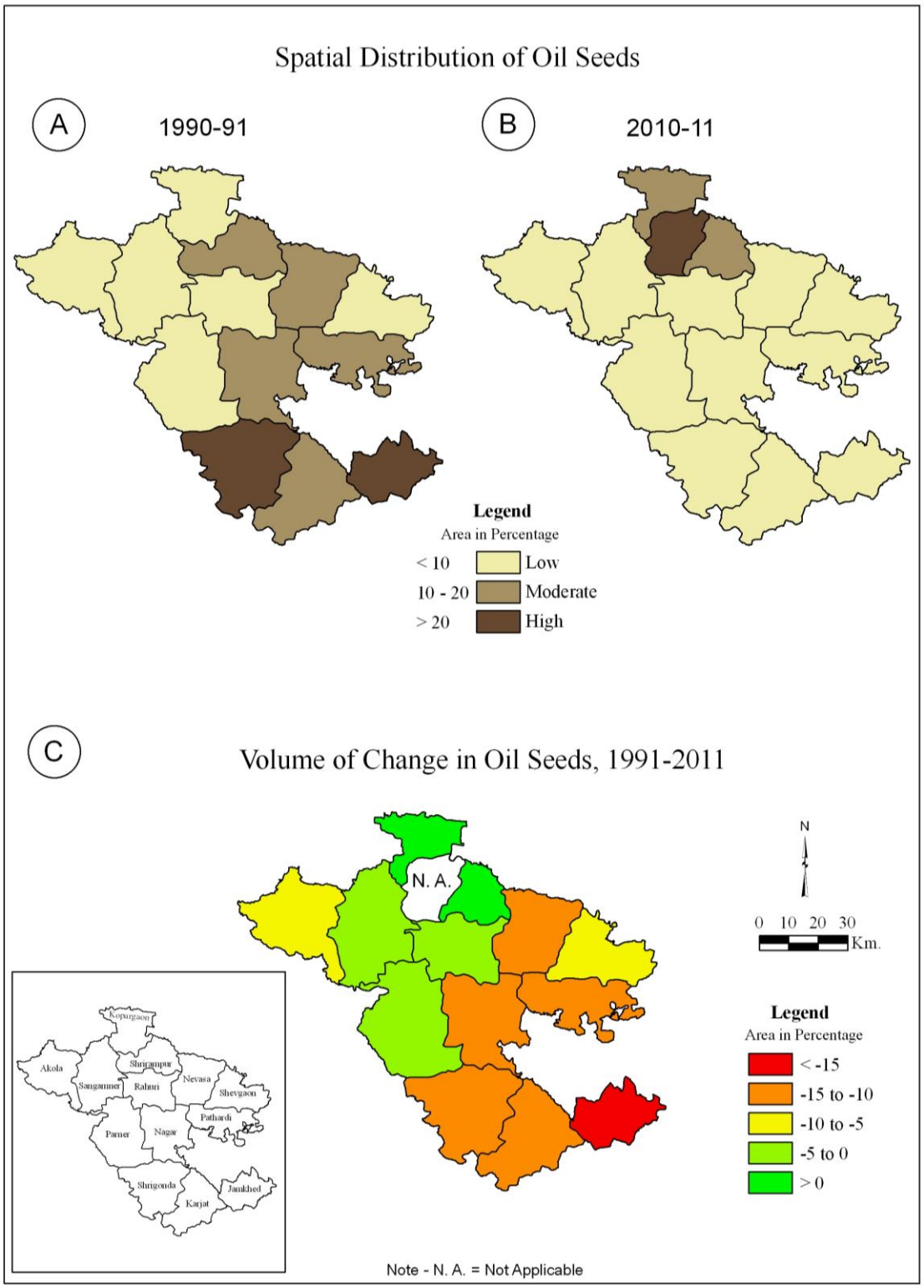

Spatial Distribution of Oil Seeds
A
1990-91
B
2010-11
Legend
Area in Percentage
< 10
Low
10 - 20
Moderate
> 20
High
C
Volume of Change in Oil Seeds, 1991-2011
N. A.
N
0 10 20 30
Km.
Legend
Area in Percentage
< -15
-15 to -10
-10 to -5
-5 to 0
> 0
Kopargaon
Akola
Shrirampur
Sangamner
Rahuri
Nevasa
Shevgaon
Pathardi
Parner
Nagar
Shrigonda
Karjat
Jamkhed
Note - N. A. = Not Applicable

Fig: 5.10 A, B & C

Appendix-I reveals that the area under oilseed cultivation decreased by 6.83 percent during the study period. Area under oilseeds has increased in two tehsils and decreased in 11 tehsils (fig. 5.10/C). Significant negative change recorded in Jamkhed (above 15 percent), Nagar, Nevasa, Pathardi, Karjat, Shrigonda (10-15 percent) and Shevgaon (9.56) tehsils. Four tehsils namely, Akole (5 percent), Rahuri (4.91 percent), Parner (3.77 percent), and Sangamner (1.66 percent) recorded insignificant negative change. Only in Kopargaon tehsil (12.89 percent) recorded significant positive change.

5.4. C Distribution of Fodder Crops

In Ahmednagar district elephant grass, green grass, *kadwal*, maize etc. are the major fodder crops. It is widely cultivated throughout the district. These crops are grown in both *kharif* and *rabi* season. The percentage area under fodder crops to total cropped area was worked out and divided into three different categories namely, low, moderate and high having values of below 10, 10-20 and above 20 respectively. District has 3.69 and 5.02 percent area under fodder crops to total cultivated area during 1990-91 and 2010-11 respectively.

Fig. 5.11/A and appendix-I revealed spatial distribution of fodder crops during the year 1990-91. Moderate and high categories were registered Rahuri and Akole tehsils respectively while rest of the tehsils recorded low category.

Fig.5.11/B and appendix- I revealed the spatial distribution pattern of fodder crops during the year 2010-11. High category registered in Akole tehsil while rest of the tehsils recorded low category. None of the tehsils found Moderate category.

Fig.5.11/C revealed volume of change in percentage area under fodder crops. It shows that tehsils of Akole (12.71), Shrirampur (4.52), Sangamner (4.33) and Kopargaon (2.89) found significant positive change while Nevasa, Shevgaon, Pathardi, Jamkhed, Karjat found insignificant positive change. Significant negative change found in Rahuri (9.65) and Parner (2.19) tehsils whereas tehsils Shrigonda and Nagar recorded insignificant negative change.

5.5 Crop Combination Regions

Crop combination analysis is defined as the geographical investigation of agriculture, which has the purpose to select various crops to be studied collectively in an area (Pandey, D. C. 1992). The study of crop combination regions constitutes an important aspect of agricultural geography as it provides good basis for agricultural

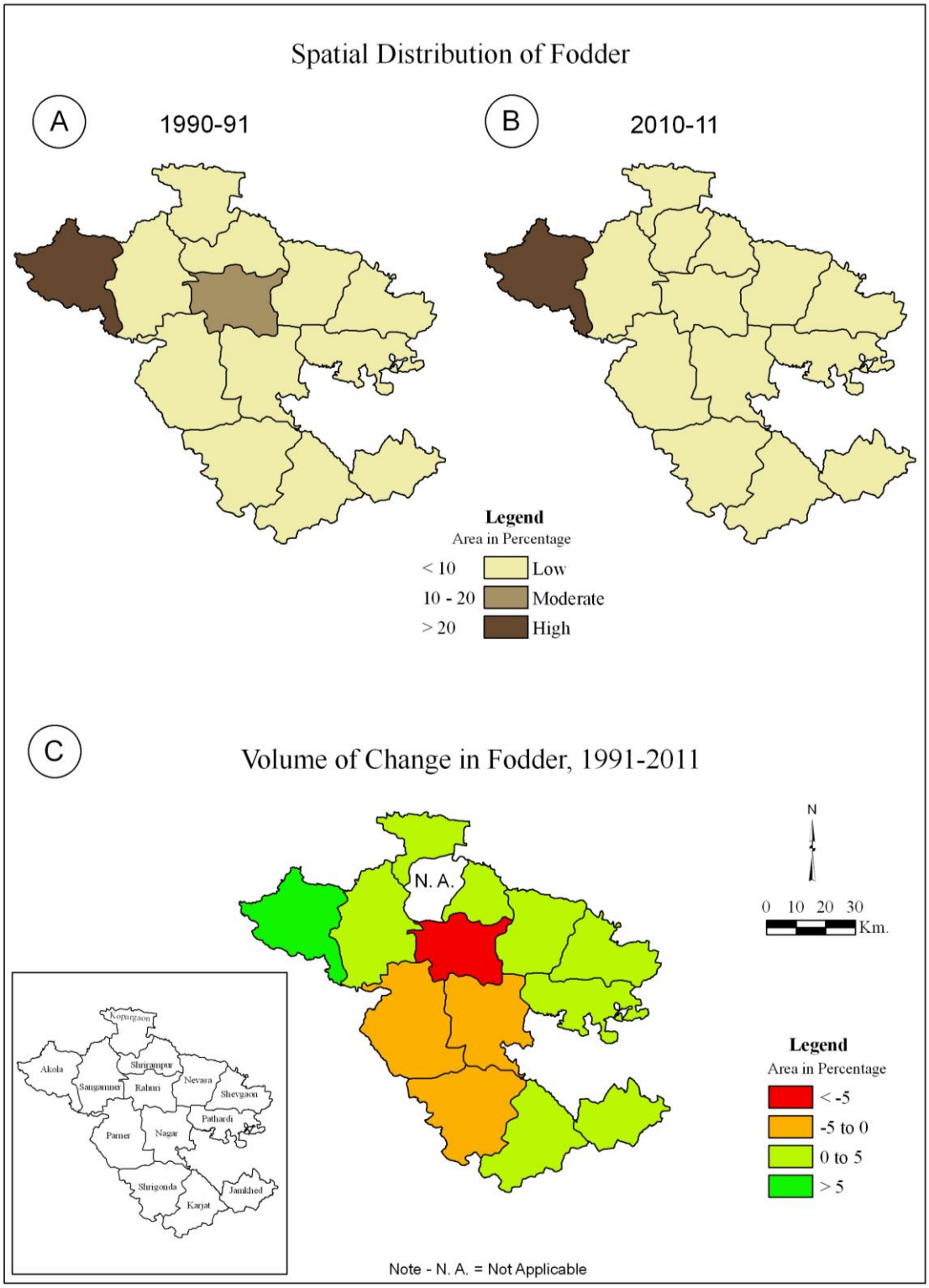

Spatial Distribution of Fodder
A
1990-91
B
2010-11
Legend
Area in Percentage
< 10
Low
10 - 20
Moderate
> 20
High
C
Volume of Change in Fodder, 1991-2011
N. A.
N
0 10 20 30
Km.
Legend
Area in Percentage
< -5
-5 to 0
0 to 5
> 5
Kopargaon
Akola
Shrirampur
Nevasa
Sangamner
Rahuri
Shevgaon
Pathardi
Parner
Nagar
Shrigonda
Jamkhed
Karjat
Note - N. A. = Not Applicable

Fig: 5.11 A, B & C

regionalization. This type of study is useful for regional agricultural planning for sustainable development.

To demarcate crop combination regions two techniques viz. qualitative and quantitative has been used by different scholars. Compared to qualitative technique statistical technique is more accurate, scientific and popular for establishing crops combination. Thus, number of scholars in the field of geography and economics has used various statistical techniques to demarcate crop combination regions in India and abroad. In the field of agricultural geography, Weaver, J. C. (1954) was the first to use statistical technique to establish the crop combination regions of Middle West in United States. Later on in the field of agricultural geography many scholars modified Weaver's technique and these modified techniques are used by several scholars at national, regional and micro level.

In the present study Doi's (1959) crop combination technique has been used. According to this technique crop combination is established by consulting one sheet table (Appendix- II) which presents critical values for various elements at different rank against cumulative percentage of elements at higher ranks. The use of one sheet table requires only the summing up of actual percentage under different crops instead of findings the difference between actual percentage and theoretical distributions. If the critical value is higher than the actual percentage the crop is not included in the combination but if the values is lower than the crop percentage the crop is included in the combination. All those crops included in the combinations whose cumulative percentage is less than 50, or the critical value for all the elements at different ranks against 50 is zero. Therefore, the cumulative percentage start from above 50 percent, which is contributed by higher ranks, may be first one, two, or three crops or so on.

In the present study ten crops i.e. jowar, bajra, wheat, other cereals, sugarcane, pulses, cotton, oilseeds, fruits and vegetables and fodders have considered for worked out crop combination regions. Figure 5.12/A&B and table 5.2 revealed that the monoculture, two, three, four, five and six crop combinations have been found in Ahmednagar district during the years 1990-91 and 2010-11.

A. Monoculture

During the year 1990-91 monoculture is found in southern part of the district comprised tehsils of Karjat and Shrigonda, where jowar is the major crop and occupied 70.80 percent, 66.74 percent area to total cultivated area respectively (fig. 5.12/ A). It is the result of low intensity of irrigation, amount of rainfall and black

fertile soils. During the year 2010-11, monoculture is found in three tehsils namely, Shevgaon, Karjat and Shrigonda, where jowar is the major crop (fig. 5.12/B) and it occupied 62.79, 67.42 and 68.88 percent area respectively.

Table 5. 2 Crop Combination Regions

Crop Combination Regions	1990-91		2010-11	
	Crops in Combination	Number of Tehsils	Crops in Combination	Number of Tehsils
Monoculture	J	2	J	3
Two Crop	B/J	4	J/B	2
	J/B	1	S/C	1
	J/Oi	2	B/Fv	1
Three Crop	Fo/B/Oc	1	C/B/J	1
			J/P/Fi	1
			Fo/B/Oc	1
Four Crop	-	-	S/B/W/J	1
			Oi/B/S/W	1
Five Crop	J/B/W/Oi/S	1	B/Oi/S/W/J	1
Six Crop	B/J/S/Fo/W/P	1	Oi/B/W/Fv/C/Oi	1

Source: Compiled by researcher

Note: J = Jowar, B = Bajra, W = Wheat, Fo = Fodder Crops, S = Sugarcane, C = Cotton, Oi = Oilseeds, P = Pulses, Oc = Other cereals, Fv = Fruits, Vegetables, Condiments and Spices

B. Two Crop Combinations

Fig. 5.12/A and table 5.2 reveals two crop combination regions in study region during 1990-91. Three crops viz. jowar, bajra, and oilseed have entered in this combination in seven tehsils. Four tehsils namely, Shevgaon, Pathardi, Sangamner and Kopargaon have bajra and jowar combination while Parner tehsil have jowar and bajra combination. However, jowar and oilseed combination found in Jamkhed and Nagar tehsils.

During the year 2010-11 two crop combination found in four tehsils namely, Nagar, Nevasa, Parner and Sangamner. Five crops, namely, jowar, bajra, sugarcane, cotton and fruit and vegetable have included in combination. In tehsils of Nagar and Parner have jowar is combined with bajra while in Nevasa tehsil sugarcane is combined with cotton, whereas Sangamner has bajra, fruit and vegetables.

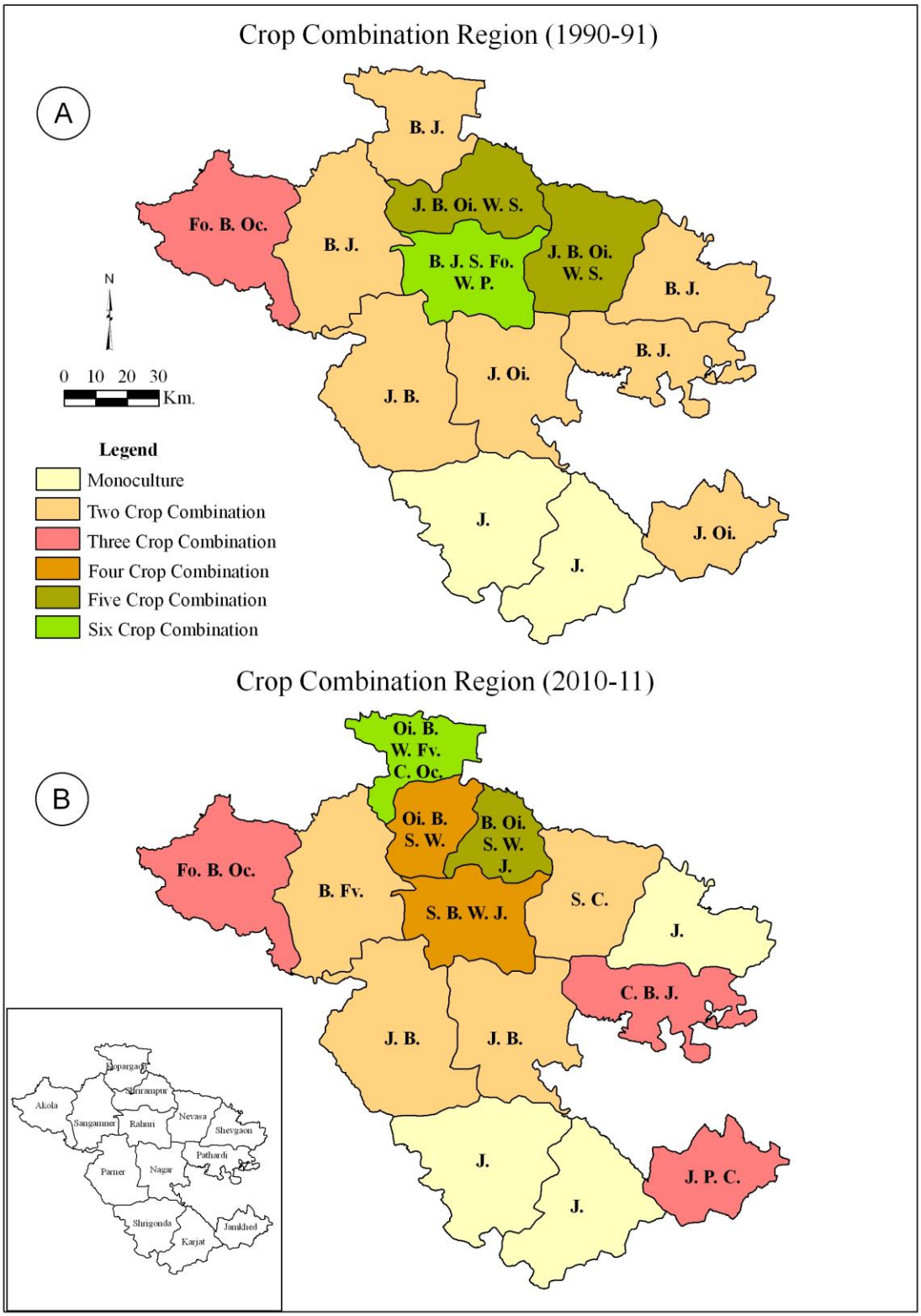


Fig: 5.12 A & B

Note: J = Jowar, B = Bajra, W = Wheat, Fo = Fodder Crops, S = Sugarcane, C = Cotton, Oi = Oilseed crops, P = Pulses, Oc = Other cereals, Fv = Fruits, Vegetables, Condiments and Spices

C. Three Crop Combinations

Three crop combinations have found in Akole tehsil during the year 1990-91(fig.5.12/A). Fodder, bajra and other cereal crops have entered in this combination. In these tehsil more area covered by hills and high intensity of rainfall due to this maximum area is under fodder crops.

Three crop combination found in three tehsils during the year 2010-11 (fig. 5.12/B). Six crops enter in this combination namely, bajra, jowar, cotton, fodder, pulses and other cereal. These crops combination appears in the western, eastern and southern parts of the district. In Pathardi tehsil three crops combination are found where cotton combined with bajra and jowar. The soil of Pathardi tehsil is suitable for cotton cultivation. In Jamkhed tehsil jowar is the main crop followed by cotton and pulses. Fodders combined with bajra and other cereals in Akole tehsil in west part of study region.

D. Four Crop Combinations

During the year 1990-91 four crop combinations was not found in Ahemadnagar district.

During the year 2010-11 four crop combinations have found in two tehsils namely, Rahuri and Rahata (fig.5.12/B). Five crops entered in this combination namely, sugarcane, bajra, wheat, oilseed and jowar. The region of four crop combination has located in the northern parts of the district where high intensity of irrigation and fertile soils. Due to this sugarcane is the prominent crop in both the tehsils. In Rahuri tehsil sugarcane is combined with bajra, wheat and jowar, while in Rahata oilseeds is combined with bajra, sugarcane and wheat.

E. Five Crop Combinations

Fig.5.12/A revealed five crop combinations in Ahmednagar district during 1990-91. Jowar, bajra, wheat, oilseed and sugarcane have entered in this combination. Five crop combinations are found in the north-east parts of study region included tehsils Shrirampur and Nevasa. Jowar is the dominant crop in both tehsil followed by bajra, oilseed, wheat and sugarcane.

During the year 2010-11 tehsil Shrirampue found five crop combinations (fig. 5.12/B). These crops are bajra, oilseeds, sugarcane, wheat and jowar which occupied 19.4, 15.23, 14.79, 13.41 and 13.11 percent area respectively.

F. Six Crop Combinations

Bajra, jowar, sugarcane, fodder, wheat and pulses is identified as six crops combination in Ahmednagar district during 1990-91. It found in tehsil Rahuri located in central part of the study region where moderate rainfall, fertile soil and high intensity of irrigation by river Mula and it left and right bank canals (fig.5.12/A).

During the year 2010-11 six crop combination found in Kopargaon tehsil laying in northern part of study area (fig.5.12/B). Oilseeds, bajra, wheat, fruit and vegetables, cotton and other cereals are entered in this combination where fertile soil and availability of irrigation facility by river Godavari and it left and right bank canals.

Above result of crop combinations shows that high intensity of irrigation means high number of crops in combination. Number of crops in combination is increased southward to north.

Resume

The spatio-temporal pattern of agricultural landuse and changes therein has studied in present chapter. Soil types, irrigation, rainfall distribution, transport and proximity of market centers are major controlling factors for changing the spatio-temporal agricultural landuse. In study region various crops are grown viz. wheat, jowar, bajra, sugarcane, pulses, fruits, vegetables, condiment, spices, various oilseeds and fodder. Temporal pattern of agricultural landuse shows positive trend in the crops such as other cereals, sugarcane, fruit vegetables and condiment, cotton and fodder crops while declined trend found in food crops such as wheat, jowar, bajra, pulses and oilseed. During the period of two decade area under jowar was decline by 9.99 percent to total cropped area. The north parts of district have river and canal irrigation facility so farmers move from food crops to cash crops i.e. sugarcane, fruit and vegetables. Recently dairy farming is increasing in north tehsils so increase area under fodder crops.

Spatial pattern of agricultural land use shows the area under jowar was increase in two tehsils namely, Shevgaon and Shrigonda while rest of the tehsils found declined trend because of change in the attitude of farmers from traditional crops to cash crops. Area under bajra was decline in north part of district while it was minor increase in south parts of district. Area under wheat was increased in canals command area of district. Pulses are not cultivated on large scale in district. Area under pulses was slightly decreased in major portion of district while it was increase

in Jamkhed, Parner and Shrirampur tehsils. Sugarcane is the major cash crop of district and mainly cultivated in canals command area. Area under sugarcane decreased in Akole and Nagar tehsils while rest of tehsils found increased area under sugarcane. Cotton is grown in eastern part of district comprised tehsils of Pathardi, Nevasa and Shevgaon while rest of the tehsils occupied negligible area. Oilseeds are the major cash crops cultivated in throughout the district. In study region dairy farming plays an important role in increased area under fodder crops.

On the basis of Doi's crop combination technique, during the period of investigation monoculture, two, three, four, five and six crop combinations found in study region. Monoculture is found in the south part of the district where jowar is the major crop. The number of crops has increased in combination from southward to north. Crop combination result shows that increase intensity of irrigation increase the number of crops in combination.

CHAPTER - VI

MEASUREMENT OF AGRICULTURAL PRODUCTIVITY

6.1 General Introduction

Agricultural productivity has been defined by several scholars with reference to their own views and disciplines. Geographers, agronomists, agriculturalists and economists have interpreted it in different ways according to objectives. Agricultural productivity is defined in agricultural geography as "output per unit of input" or "output per unit of land area". According to Mohammad, N. (1992) agricultural productivity means 'the ratio of output to input in relation to land, capital and overall resources employed in agriculture'. It is a dynamic concept, which includes effective management of available natural and human resources, technological advancement and organizational set-up for the agricultural production.

Agricultural productivity is the function of a number of variables such as physical i.e. relief, altitude, climate and soil, socio-economic i.e. size of holding, tenancy system, occupational structure of population, literacy level and technical variables i.e. irrigation, chemical fertilizers, high yielding variety of seeds and mechanization. All above factors are highly varied and dynamic both in space and time, due to this spatio-temporal variation in agricultural productivity (Mohammad, N. and Majeed, A. 1992).

The pressure of population on cultivable land is rapidly increasing so demand of agricultural product is increasing. A proper way to solve the food problem is, to increase the production per unit area and per unit of time.

Agricultural productivity is taken as the most important indicator to show the spatial pattern of agricultural development. It helps in knowing the areas that are performing rather less or higher efficiency in comparison with the nearby areas. It also provides an opportunity to ascertain the actual situation, the real cause of agricultural backwardness of an area. It will be of immense help in appropriate planning for the sustainable development of each region according to its physio-socio-economic condition.

In present chapter an attempt is made to study the spatio-temporal changes in agricultural productivity in Ahmednagar district for the years 1990-91 and 2010-11. Rahata tehsil has been created in 1997 so it not included in calculation of 1990-91. To measurement of agricultural productivity different seven indices have been applied. In each of the seven indices the aim is to measure the agricultural productivity from different angles by using different approaches. Major crops viz. wheat, jowar, bajra, other cereals, pulses, sugarcane, cotton, fruit and vegetables, oilseeds and fodders

grown in the district were considered for the productivity analysis. In some method cotton, some pulses, some cereals and some oilseed crops are omitted. According to seven parameters agricultural productivity was worked out and index values divided into three different categories namely, high, moderate and low based on statistical technique i.e. range (Hifzur, H. *et al.* 2008) for the years 1990-91 and 2010-11 separately.

These seven methods have given below:

i. Kendall's Ranking Coefficient Index
ii. Bhatia's Productivity Index
iii. Standard Nutrition Unit's Index
iv. Enyedi's Productivity Index
v. Shafi's Modified Coefficient Index
vi. Calories per Capita Index
vii. Sapre and Deshpande's Productivity Index

The composite productivity regions were worked out. For this, all these productivity indices maps are combined together with the help of GIS software i.e. Arc GIS. Its output generates a map which shows composite productivity regions i.e. high, moderate and low. It was done for the years 1990-91 and 2010-11 separately.

6.2 Kendall's Ranking Coefficient Index

Kendall, M.G. (1939) ranking coefficient method is more reliable and easy to apply for measure of agricultural productivity of an area. In this technique, ranks are given according to yield per unit of area or each crop and later on average rank is worked out which is called ranking coefficient.

The formula for ranking coefficient index is as follows:

$$\text{Ranking Coefficient Index} = \frac{r_1 + r_2 + r_3 + \ldots\ldots\ldots + r_n}{n}$$

Where,

r = Ranking of yield of individual crop

n = Number of crops.

According to this index the component areal unit with relatively high yield will have low ranking coefficient, indicating high agricultural productivity. In other word, if a component areal unit was at the top of every list of crops it would have a ranking of one and thus having the highest productivity. However, the areal unit was

at the bottom of every list it would have ranking coefficient equal to number of units considered, showing the lowest agricultural productivity among the constituent units.

This method has some drawbacks, first is the hectareage and production of each crop does not get the weightage. Second is the difference between the two tehsils yields is very little it would still get the difference of one rank. Third is one tehsil has a very high yield and the other tehsils next in rank has a comparatively, low yield, it would invariably get the next rank showing a difference of one only. However, this method gives productivity level from a particular angle i.e. ranks only. Thus it is a rather intensive measure of agricultural productivity.

In present study ranks are given in descending order for each crop separately. Then all the ranks of each tehsil are summed up and divided by the number of crop considered. This is done for each of the years 1990-91 and 2010-11 separately. The index values are divided into three groups according to range to ascertain the high, moderate and low level of agricultural productivity.

6.2.1 Productivity Regions Based on Kendall's Ranking Coefficient Index (1990-91)

Regional pattern of agricultural productivity on the basis of Kendall's index shows a wide range of variation. It varies from a minimum 5.63 in Shrirampur and Nevasa to maximum of 8.25 in Parner tehsil (Appendix - III). It categorized in table 6.1 and shown in fig.6.1/A.

Table 6.1 Agricultural Productivity Regions Based on Kendall's Ranking Coefficient

Sr. No.	Ranking Coefficient	Productivity grade	Number of tehsils	% of total number of tehsils in district
1.	Below 6.59	High	5	38.46
2.	6.60 to 7.55	Moderate	3	23.07
3.	Above 7.56	Low	5	38.46

Source: Compiled by the researcher.

1. High Productivity Region

Regional pattern shows that high agricultural productivity grade is found in northern and southern part of the district it has been shown in fig.6.1/A. In northern part of district one continues belt running west-east direction comprises the tehsils Sangamner, Rahuri, Shrirampur and Nevasa. Sugarcane and cereal crops have major crops having high yield in these tehsils. In southern part of district one isolated patch found high productivity it comprised tehsil Karjat having index value 6.50. It has

predominant for jowar cultivation having high yield. High Productivity region occupied 38.46 percent tehsils and 25.32 percent net sown area in district.

2. Moderate Productivity Region

The regional pattern of the moderate agricultural productivity shows that there are three tehsils, which have moderate agricultural productivity. These tehsils are Shrigonda, Kopargaon and Pathardi having index value 6.75, 6.94 and 7.19 respectively. These tehsils are scattered in southern, northern and eastern part of district. Moderate grade agricultural productivity region cover an area of 305504 hectares, which is 25.54 percent of net sown area of the district. Some part of tehsil Shrigonda, Kopargaon and Pathardi are irrigated by canals of river, Kukadi, Godavari and Mula respectively while most of the parts are rainfed so yield of crops is comparatively low.

3. Low Productivity Region

Low productivity is designated with the index value above 7.56. Low productivity found in the central, south, east and western part of the district. Five tehsils namely, Parner, Shevgaon, Nagar, Jamkhed and Akole (fig. 6.1/A) comes under low productivity region. It covers 38.46 percent tehsils of district. The productivity of these tehsils is low because of largest part cover by shallow soil, low intensity of irrigation, relatively low rate of fertilizer consumption and socio-economic condition of farmers while largest area of these tehsils has occupied by cereal crops having low yield.

6.2.2 Productivity Regions Based on Kendall's Ranking Coefficient Index (2010-11)

Ranking coefficient values (Appendix-VI) of high, moderate and low productivity have been given in table 6.2, while the resultant pattern of productivity has been plotted in fig. 6.1/B.

Table 6.2 Agricultural Productivity Regions Based on Kendall's Ranking Coefficient

Sr. No.	Ranking Coefficient	Productivity grade	Number of tehsils	% of total number of tehsils in district
1.	Below 6.25	High	3	21.43
2.	6.26 to 8.75	Moderate	8	57.14
3.	Above 8.76	Low	3	21.43

Source: Compiled by the researcher.

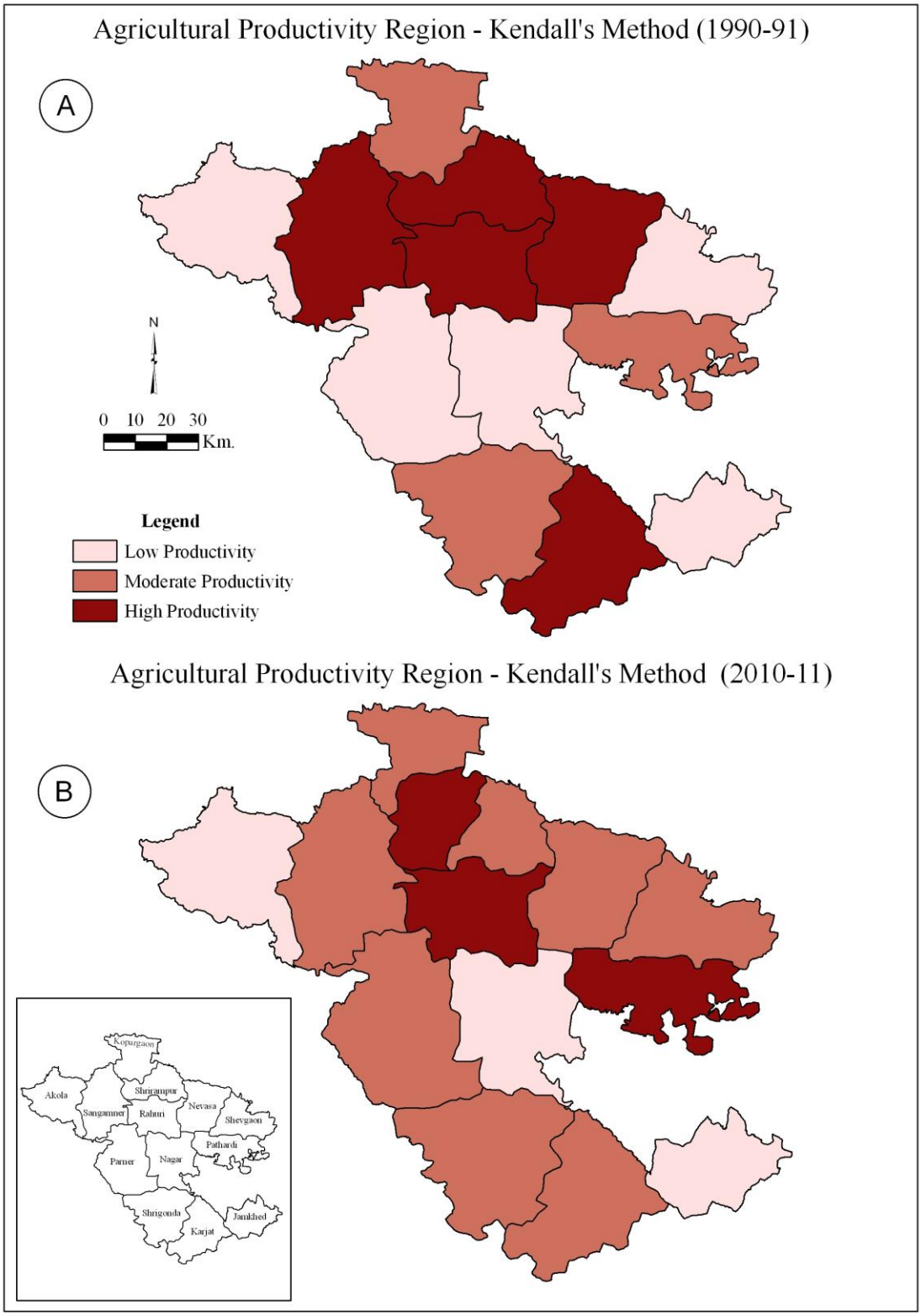

Agricultural Productivity Region - Kendall's Method (1990-91)
A
N
0 10 20 30
Km.
Legend
Low Productivity
Moderate Productivity
High Productivity
Agricultural Productivity Region - Kendall's Method (2010-11)
B
Kopargaon
Akola
Shrirampur
Nevasa
Sangamner
Rahuri
Shevgaon
Pathardi
Parner
Nagar
Shrigonda
Jamkhed
Karjat

Fig: 6.1 A & B

1. High Productivity Region

High productivity region are designated with the index values below 6.25. There are two pockets of high productivity (fig. 6.1/B) lies in northern and north-eastern parts of district. Tehsils namely, Rahata, Rahuri and Pathardi comes under this category. The high agricultural productivity covers an area of 139536 hectares, which is 17 percent net sown area of district. It is interesting to note that in these tehsil irrigated area has 95, 73 and 13.87 percent respectively. In Pathardi tehsils net irrigated has comparatively low but soils are fertile due to this it comes in high productivity region. Farmers of this tehsils are highly receptive to new agricultural innovations.

2. Moderate Productivity Region

Moderate productivity region are designated with the index values ranging from 6.26 to 8.75. These tehsils are scattered especially in the black and shallow soils areas of district. There are two continues belts having moderate productivity. One belt running north-south direction confined tehsils of Kopargaon, Sangamner, Parner, Shrigonda and Karjat while second belt lies in northern part of district running east-west direction confined tehsils of Shrirampur, Nevasa and Shevgaon. The agriculture of the these tehsils is highly diversified and the farmers are growing assorted crops, ranging from high water requiring (sugarcane, wheat and oilseeds) to less water requiring (bajra, jowar and other cereals) crops.

3. Low Productivity Region

Three tehsils which possesses low productivity are namely, Jamkhed, Akole and Nagar having the index value 9.38, 10.13 and 11.13 respectively. It covers 22.29 percent net sown area of district. The agriculture of these tehsils is still subsistent and traditional bound. Non availability of irrigation is the major barrier in the intensification and development of agriculture. Jamkhed and Nagar tehsils dominating of jowar and oilseeds crops while tehsil Akole has other cereals as the predominant crops having low yield.

On the basis of this index during the period of two decades seven tehsils noticed change in their productivity level. Four tehsils namely, Shrirampur, Nevasa, Karjat and Sangamner recorded negative change. These are shifted high to moderate productivity grade. Two tehsils namely, Parner and Shevgaon shifted low to moderate productivity category while tehsil Pathardi shifted moderate to high productivity region.

6.3 Bhatia's Productivity Index

According to Bhatia, S. S. (1967) hectare yields express all the physical and human factors which join in to produce the agricultural outputs. At the same time the contribution of each crop to agricultural efficiency would be relative to its percentage of cropland also. It further, partly shows the efficiency of the sub unit in relation to entire region. This method deals with the yield and the magnitude of the area under various crops. Only yield per hectare not give a correct picture of the importance of a particular crops. It may have high yields, but insignificant hectareage, it bring out the productivity in the true sense.

According to this index the yields of the eight principal crops (wheat, jowar, bajra, other cereals, pulses, sugarcane, cotton and oil seeds) for each tehsil are calculated as a percentage of district yields of the respective crops this percentage are then weighted by the percentage of land under those crops. Bhatia has expressed this method with the following formulae.

$$IYA = \frac{Yc}{Yr} \times 100$$

Where,

IYA = Yield index of crop "a"

YC = Hectare yield of crop "a" in the tehsil.

Yr = Average yield of crop "a" in the study region.

$$API = \frac{IYA \times Ca + IYB \times Cb + IYC \times Cc.... IYN \times Cn}{Ca + Cb + Cc \ldots Cn}$$

Where,

API = Composite agricultural productivity index.

IYA, IYB … IYN = Yields indices (Per hectare) of crops a, b… n.

Ca, Cb ... Cn = Percentage area under crop a, b … n.

The 'API' for each tehsils was worked out for the years 1990-91 and 2010-11 (Appendix- III and IV) separately and index values divided into three different categories i.e. high, moderate and low.

6.3.1 Productivity Regions Based on Bhatia's Index (1990-91)

Table 6.3 reveals the variation in productivity levels and fig. 6.2/A shows the general pattern of regional imbalances in the levels of agricultural productivity.

Table 6.3 Agricultural Productivity Regions Based on Bhatia's Productivity Index

Sr. No.	Index Value	Productivity grade	Number of tehsils	% of total number of tehsils in district
1.	Above 106.01	High	6	46.15
2.	90.01 to 106.00	Moderate	4	30.76
3.	below 90.00	Low	3	23.07

Source: Compiled by the researcher.

1. High Productivity Region

The productivity index of this region is 106.01 and above. This region has covered 46.15 percent tehsils in district. There are two separate belts of high productivity. One is located in north-eastern part of the district consisting tehsils of Shrirampur, Rahuri and Nevasa. The high productivity of these tehsils is owing to several favorable factors such as deep black to medium black soil, adequate irrigation facility by canals and well, high use of chemical as well as farm manure, use of high yielding verity seeds, availability of credit facility by sugar factories and farmers cooperative societies. The second belt is running east-west direction lies in south part of district. It includes the tehsils Jamkhed, Karjat and Shrigonda which have productivity index 123.13, 115.26 and 106.37 respectively. These tehsils have shallow to black soils and satisfactory rainfall according to crop need. It has jowar, bajra, pulses and oilseed dominant region and per hectare yield of these crops have high during this year.

2. Moderate Productivity Region

The tehsils having recorded a productivity index varies from 90.01 to 106.0 have been categorized under this region. There are two distinct belts of the moderate productivity region. One belt lies in central-eastern part of the district which covers tehsils of Pathardi, Shevgaon and Nagar having 101.56, 93.04 and 92.66 as their productivity index respectively. Second, isolated patch found in the northern part of the district. It included tehsil Kopargaon where sizable area under irrigation, black soils and availability of non-physical determinants are resultant of this moderate productivity.

3. Low productivity Region

The productivity index of this region is below 90.00. There is a single continuous belt of low productivity lies the north- western part of the district consisting tehsils Akole, Parner and Sangamner which have a productivity index 89.23, 77.69 and 73.91 respectively. Low productivity in these tehsils has several reasons i.e. uneven topography, large area covered by shallow soils, weather abnormality, low level of modernization in agriculture, lesser number of non physical determinants i.e. tractor, rural electrification, chemical fertilizers, high yielding variety of seeds, low rural literacy etc.

6.3.2 Productivity Regions Based on Bhatia's Index (2010-11)

The table 6.4 and fig. 6.2/B reveal the general pattern of regional imbalances in the levels of agricultural productivity.

Table 6.4 Agricultural Productivity Regions Based on Bhatia's Productivity Index

Sr. No.	Index Value	Productivity grade	Total number of tehsils	% of total number of tehsils in district
1.	Above 117.01	High	4	28.57
2.	103.26 to 117.0	Moderate	3	21.42
3.	Below 103.25	Low	7	50.00

Source: Compiled by the researcher.

1. High Productivity Region

High productivity region are designated with the index values above 117.01. It covers 24.56 percent net sown area and 28.57 percent of the total number of tehsils in district. There are two pockets have high productivity (fig. 6.2 /B) lies in northern and north-eastern parts of district. Northern part consisting tehsils of Sangamner, Rahata and Rahuri which has index values 123.59, 119.58 and 128.02 respectively. In north-eastern part one tehsil namely, Shevgaon with an index value 130.77 comes under this productivity region.

2. Moderate Productivity Region

Moderate productivity region are designated with the index values ranging between 103.26 and 117.0. It covers 19.81 net sown area and 21.42 percent tehsils of district. Three tehsils are characterized with moderate productivity in the district. They form one continuous regions and one isolated patch, continues belt lies in the southern part of the district which included the tehsils of Karjat and Jamkhed which have index value 107.01 and 109.44 respectively. The isolated patch lies in eastern

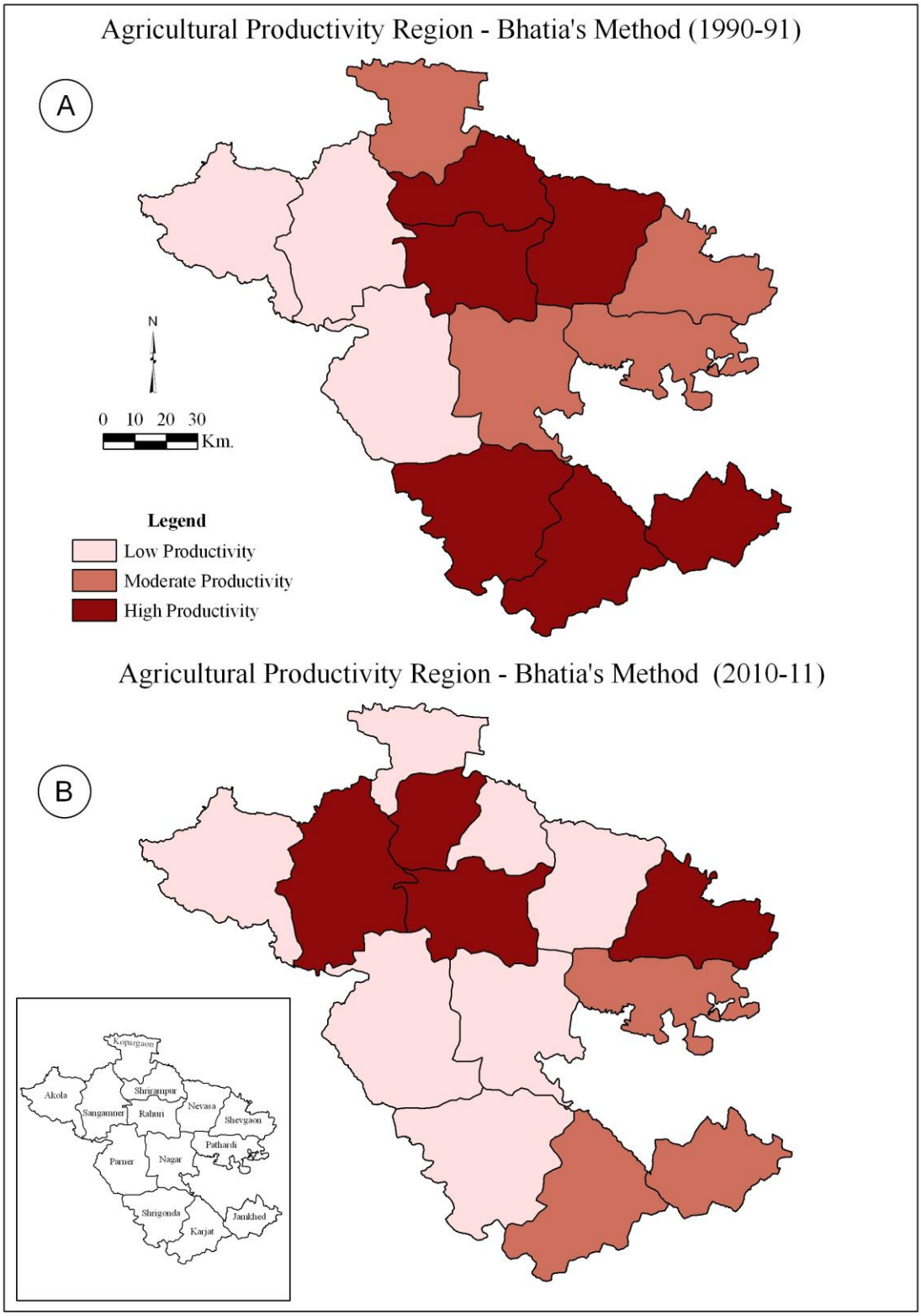

Agricultural Productivity Region - Bhatia's Method (1990-91)
A
N
0 10 20 30
Km.
Legend
Low Productivity
Moderate Productivity
High Productivity
Agricultural Productivity Region - Bhatia's Method (2010-11)
B
Kopargaon
Akola
Shrirampur
Sangamner
Rahuri
Nevasa
Shevgaon
Pathardi
Parner
Nagar
Shrigonda
Jamkhed
Karjat

Fig: 6.2 A & B

part of district comprise tehsil Pathardi having index value 113.44.

3. Low Productivity Region

There are seven tehsils come under low grade of agricultural productivity. They form two continuous belt and two isolated patches. One continuous belt lies in the south part of the district which includes the tehsils of Parner, Nagar and Shrigonda while second continuous belt found in north-eastern part of district consisting tehsils of Shrirampur and Nevasa. One isolated patch lies in northern part of district included tehsil Kopargaon while second isolated patch lies in north-western part of district comprised tehsil Akole.

On the basis of Bhatia's productivity index during the period of two decades nine tehsils recorded changes in their productivity level. Out of these seven tehsils registered negative change while two tehsil noticed positive change. Two tehsils namely, Jamkhed and Karjat shifted high to moderate grade while three tehsils namely, Shrigonda, Shrirampur and Nevasa shifted high to low category. Two tehsils Kopargaon and Nagar shifted moderate to low productivity region. Tehsil Shevgaon shifted moderate to high while tehsil Sangamner shifted low to high productivity region.

6.4 Standard Nutrition Units (SNU) Per Hectare Index

The measure of the carrying capacity of land (in term of population) is one of the most helpful methods for judging agricultural productivity. It is an effective measure of farm efficiency. This approach was suggested by Prof. Stamp in his presidential address at the International Geographical Congress at Rio de Janerio in 1956. Shafi, M. (1983) used the Standard Nutrition Units as an approach to measure agricultural productivity in Uttar Pradesh.

In the present study total outturns of each major food crop is converted into calories and then divided by the sum of area under those crops. This has given the number of calories available per hectare. This figure is then divided by Standard Nutrition Unit i.e. 8, 00,000 Calories. Shafi considered 8, 00,000 calories as the Standard Nutrition Unit (SNU) for Indian population. The same number is taken in the present study.

The formula for this is as follows:

$$\text{SNU's per hectare} = \frac{\dfrac{(\text{OTC a x cal}) + (\text{OTC b x cal}) + \ldots + (\text{OTC n x cal})}{\text{AUC a} + \text{AUC b} + \ldots + \text{AUC n}}}{8,\,00{,}000}$$

Where,

OTC - is outturn of crop

AUC - is area under crop

This index reveals that the available number of SNUs per hectare. Such computations were done for each tehsils of the years 1990-91 and 2010-11 (Appendix- III and IV). Some 8 major crops (wheat, jowar, bajra, maiz, tur, gram, sugarcane and groundnut) grown in the district were considered for the productivity analysis. The calorie value per kilogram of each crop was taken from following table.

Table 6.5 Calorie Value of Food Crops

Sr. No.	Crops	Calories/Kg.
1.	Wheat (whole)	3460
2.	Jowar	3490
3.	Bajra	3610
4.	Maiz	3420
5.	Tur	3350
6.	Gram	3600
7.	Sugarcane (Jaggery)	3830
8	Groundnut	5670

Source: Gopalan, C., Ramasastri, B.V., Balasubramaniam, S.C. (2004), "Nutritive Value of Indian Foods", National Institute of Nutrition, Indian Council of Medical Research, Hyderabad, India.

6.4.1 Productivity Regions Based on SNU's Index (1990-91)

With the help of above formula the productivity index of each tehsil have been worked out and divided into three different categories to distinguish high, moderate and low level of productivity. These categories has shown in table 6.6 and mapped in fig. 6.3/A.

Table 6.6 Agricultural Productivity Regions Based on SNU's per Hectare Index

Sr. No.	Index value	Productivity grade	Number. of tehsils	% of total number of tehsils in district
1.	Above 3.75	High	5	38.46
2.	2.95 to 3.74	Moderate	5	38.46
3.	Below 2.94	Low	3	23.08

Source: Compiled by the researcher.

1. High Productivity Region

The productivity index of this region is above 3.75. This category covers 33.20 percent net sown area and 38.46 percent of the total number of tehsils in district. High productivity region scattered western, southern and northern parts of district. In western part tehsil Akole comes under this category which has index value 4.53 while tehsils Jamkhed and Shrigonda comes under this category which has index value 3.94 and 3.93 respectively. Two tehsils namely, Rahuri and Shrirampur of northern part of district comes under this category having index values 3.82 and 4.24 respectively.

2. Moderate Productivity Region

The productivity index of this region varies from 2.95 to 3.74. There are three separate belts spread in the district having moderate productivity. One belt located in eastern part of district in fertile track of river Dhora and Pravara. It includes the tehsils of Pathardi and Nevasa. Second isolated patch located in Godavari basin consisting tehsil Kopargaon. The third belt lies in the south part of the district included the tehsils of Nagar and Karjat having productivity index of 3.09 and 3.62 respectively. This region predominant for cereal crops i.e. jowar and bajra having moderate yield.

3. Low Productivity Region

Tehsils having productivity index less than 2.94 has been categorized under this region. This region covers 25.33 percent net sown area and 23.08 percent tehsils of district. There are two distinct belts found low productivity which is located in north-west and north-east part of the district covers the tehsils of Sangamner, Parner and Shevgaon which have 2.68, 2.14 and 2.70 as their productivity index respectively. The basic causes of low productivity of these tehsils are most of the sown area depends on monsoon rainfall also low level of technological and institutional advancement.

6.4.2 Productivity Regions Based on SNU's Index (2010-11)

SNU's per hectare was worked out for the year 2010-11 (Appendix- IV) and plotted in figure 6.3/B to obtained visual picture of spatial variation in productivity. Productivity regions has been demarcated (table 6.7) on the basis of previous discussed method.

Table 6.7Agricultural Productivity Regions Based on SNU's per Hectare Index

Sr. No.	SNU's Values	Productivity Grade	Number of tehsils	% of total number of tehsils in district
1.	Above 5.81	High	3	21.42
2.	4.79 to 5.80	Moderate	3	21.42
3.	Below 4.78	Low	8	57.14

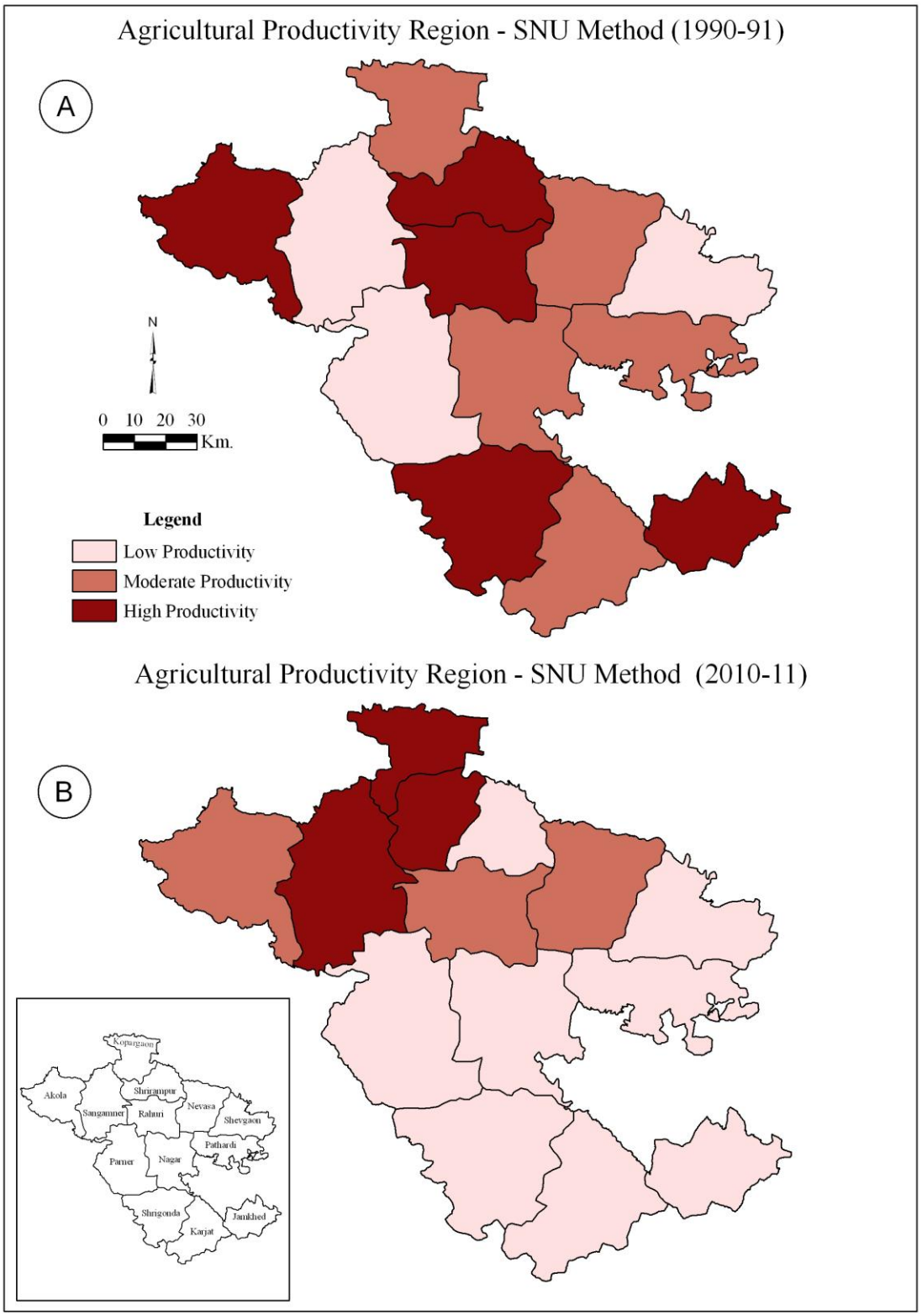
Source: Compiled by the researcher.

1. High Productivity Region

High productivity region are designated with the index value above 5.81. There are three tehsils which comes under high grade of agricultural productivity. It covers 16.83 percent net sown area and 21.42 percent tehsils of district. There are single continues belt of high agricultural productivity lies in north part of the district consisting the tehsils of Rahata, Kopargaon and Sangamner which have index value 6.72, 6.82 and 6.49 respectively. The high productivity of these tehsils is the result of left and right bank canals of river Godavari and Pravara irrigates wide area of these tehsils. However, fertile soils of Godavari and Pravara valleys contribute significantly to the high productivity while use of high yielding varieties of seeds, fertilizers, good transport network and farmer's co-operative societies provide credit to develop basic agricultural infrastructure.

2. Moderate Productivity Region

Moderate productivity region are designated with the index values from 4.79 to 5.80. It covers 20.72 net sown area of district. There were two separate pockets having moderate productivity, one belt running east-west direction lies in fertile track of river Mula and Pravara which consist tehsils Rahuri and Nevasa having index value 5.45 and 4.85 respectively. Second pocket lies in the western part of district in Pravara basin (tehsil Akole). This tehsil receives high amount of precipitation which makes the land moist and fertile and consequently increases the productivity of crops. Other cereals and sugarcane are the predominant crops in this tehsil.


Agricultural Productivity Region - SNU Method (1990-91)
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Km.
Legend
Low Productivity
Moderate Productivity
High Productivity
Agricultural Productivity Region - SNU Method (2010-11)
B
Kopargaon
Akola
Shrirampur
Sangamner
Rahuri
Nevasa
Shevgaon
Pathardi
Parner
Nagar
Shrigonda
Jamkhed
Karjat

Fig: 6.3 A & B

3. Low Productivity Region

As per the principle of grading system, this category includes the tehsils having less than 4.78 index values of agricultural productivity. There are eight tehsils comes under this category, they all put together cover 55.29 percent net sown area and 57.14 percent total number of tehsils in district. This region occupied the central, south and eastern part of the district. Tehsils namely, Nagar, Jamkhed, Karjat, Shrigonda, Parner, Shrirampur and Shevgaon included in this category.

On the basis of Standard Nutrition Unit's index ten tehsils indicated a change in level of productivity. Two tehsils namely, Akole and Rahuri shifted high to moderate category while three tehsils namely, Shrirampur, Shrigonda and Jamkhed shift high to low productivity grade. Tehsils Karjat, Nagar and Pathardi shifted moderate to low productivity. Kopargaon tehsil shifted moderate to high category whereas tehsil Sangamner shifted low to high category.

6.5 Enyedi's Productivity Index

Enyedi, G. Y. (1964) devised a technique for determining an index of productivity coefficient. Shafi (1972 and 1974) also adopted this approach to determine the productivity indices in respect of twelve food crops in India. His formula for productivity index is:

$$\text{Productivity index} = \frac{Y}{Yn} \div \frac{T}{Tn}$$

Where,

Y = Total production of the selected crop in unit area i.e. tehsil

Yn = Total production of the same crop at regional level (entire study region)

T = Total cropped area of the unit area (tehsil level)

Tn = Total cropped area on national scale (entire study region)

Enyedi's technique is appreciable in the sense that it determines the productivity index of an area with reference to national level.

With the help of above formula the productivity index of each tehsil was worked out for the years 1990-91 and 2010-11 (Appendix- III and IV). The productivity indices of all the tehsils were then divided into three different categories to demarcate the productivity regions as high, moderate and low.

6.5.1 Productivity Regions Based on Enyedi's Productivity Index (1990-91)

Table 6.8 reveals the variation in productivity levels and fig. 6.4/A revealed the spatial pattern of regional imbalances in agricultural productivity.

Table 6.8 Agricultural Productivity Regions Based on Enyedi's Productivity Index

Sr. No.	Index Value	Productivity grade	Total number of tehsils	% of total number of tehsils in district
1.	Above 111.13	High	6	46.15
2.	93.12 to 111.12	Moderate	3	23.07
3.	Below 93.11	Low	4	30.76

Source: Compiled by the researcher.

1. High Productivity Region

High productivity region is confined to six tehsils while cover 39.93 percent net sown area and 46.15 percent total number of tehsils of district with an index value of above 111.13. There are two separate belts having high productivity, one belt lies in north part of the district which included tehsils Rahuri, Nevasa and Shrirampur. This region has high productivity because of adequate irrigation facilities, modern farm implements, high doses of fertilizer, use of high yielding verities of seeds, farmers credit societies, better transport network, market facilities and availability of cheep labour. However, co-operative sugar factories provide various facilities to farmer for agricultural development. Second belt occupied south part of the district which included tehsils Jamkhed, Karjat and Shrigonda have a productivity index of 119.91, 112.98 and 111.14 respectively where jowar is major drought resistant crop.

2. Moderate Productivity Region

The moderate productivity region is a transitional zone between the high and low agricultural productivity regions. Moderate productivity is designated with the index value ranging from 93.12 to 111.12. This region occupied 24.42 percent net sown area and 23.07 percent total number of tehsils of district. This category covers three tehsils lies in northern, eastern and central parts of district. It included the tehsils Kopargaon, Pathardi and Nagar which have index value 98.50, 94.11 and 93.72 respectively.

3. Low Productivity Region

The range of the productivity index for this region is from 93.11 and below. There are four tehsils in district have low productivity which covers 23.07 percent of the total tehsil and 29.53 percent net sown area in district. There are two separate belts

in district found low productivity, one belt lies in western part of the district which included tehsils Parner, Sangamner and Akole which have index value 75.10, 78.07 and 93.07 respectively. Second isolated patch lies in eastern part of the district which included tehsil Shevgaon where intensity of irrigation has low and non physical determinants are also low, where jowar is the predominant crop having low yield.

6.5.2 Productivity Regions Based on Enyedi's Productivity Index (2010-11)

Enyedi's productivity index values were calculated for each tehsil of Ahmednagar district for the year 2010-11 (Appendix-IV) and the productivity regions was demarcate (table 6.9) and mapped in fig. 6.4/B.

Table 6.9 Agricultural Productivity Regions Based on Enyedi's Productivity Index

Sr. No.	Index Value	Productivity grade	Total number of tehsils	% of total number of tehsils in district
1.	Above 124.50	High	5	35.71
2.	89.56 to 124.49	Moderate	4	28.57
3.	Below 89.55	Low	5	35.71

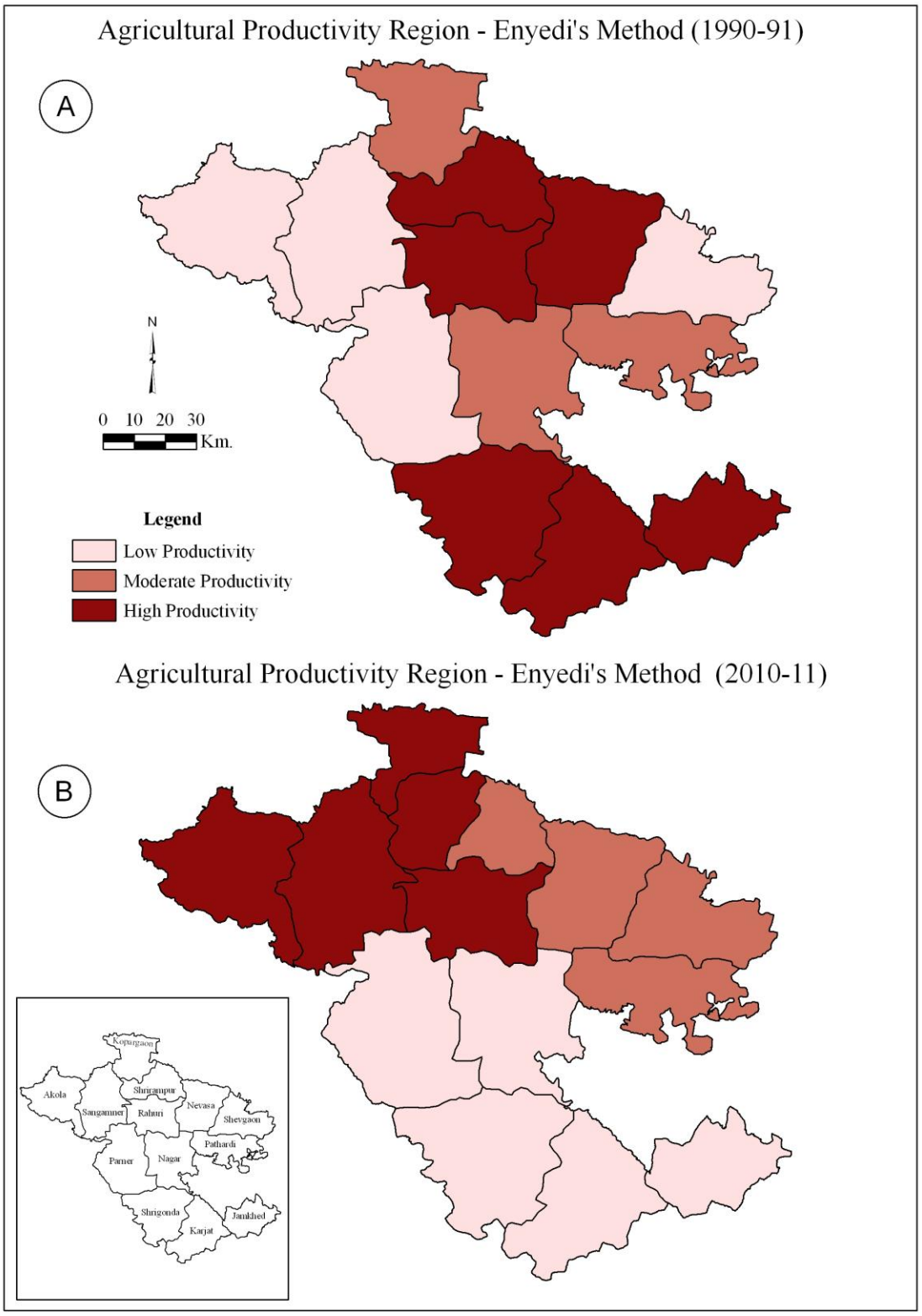
Source: Compiled by the researcher.

1. High Productivity Region

High productivity region are designated with the index value above 124.50. Five tehsils have characterized with high productivity in the district which covers 30.02 percent net sown area and 35.71 percent total number of tehsils in district. There is a single continuous belt of high agricultural productivity it lies northern parts of the district consisting tehsils of Akole, Sangamner, Rahuri, Rahata and Kopargaon. This is the sugarcane cultivation belt of district due to this cooperative sugar factories are located in this region. These sugar factories provide basic infrastructure for agricultural development such as fertilizer, high yielding variety seeds, credit, lift irrigation, transport, market etc. Due to this productivity of these tehsils is high.

2. Moderate Productivity Region

The productivity index of this region varies from 89.56 to 124.49. It covers 28.29 percent net sown area and 28.57 percent total number of tehsils in district. There are one continues belt lies in north- eastern part of the district which included the tehsils Shrirampur, Nevasa, Shevgaon and Pathardi which have a productivity index 110.59, 94.66, 97.11 and 108.09 respectively.


Agricultural Productivity Region - Enyedi's Method (1990-91)
A
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Km.
Legend
Low Productivity
Moderate Productivity
High Productivity
Agricultural Productivity Region - Enyedi's Method (2010-11)
B
Kopargaon
Akola
Shrirampur
Sangamner
Rahuri
Nevasa
Shevgaon
Pathardi
Parner
Nagar
Shrigonda
Jamkhed
Karjat

Fig: 6.4 A & B

3. Low Productivity Region

There is a single continuous belt lies in south part of the district. It covered 41.68 percent net sown area of district. It included tehsils Nagar, Parner, Shrigonda, Karjat and Jamkhed which index values of productivity are below 89.55. This region has low intensity of irrigation, shallow to moderate black soils, less availability of transport facility and use of traditional farm implements are the causes of low productivity. It is the jowar and bajra cultivation belt of district.

On the basis of this productivity index ten tehsils recorded change in productivity level. Out of these four tehsils recorded positive change. Tehsil Kopargaon shifted moderate to high category while Akole and Sangamner shifted low to high grade. Tehsil Shevgaon shifted low to moderate productivity. Tehsils namely, Nevasa and Shrirampur shifted high to moderate category while tehsils Shrigonda, Karjat and Jamkhed shifted high to low productivity region. Nagar tehsil shifted moderate to low productivity region.

6.6 Shafi's Modified Productivity Coefficient Index

In this index the calories values relating to each crop have been incorporated in the total outturns of each crop. This is then divided by the total hectarege under the crops considered. These calculations for each tehsil are kept as ratios in relation to the same calculations for the district as a whole.

The formula runs as follows:

$$PCI = \frac{\dfrac{(Ti \times Calories) + (Tii \times Calories) + \ldots\ldots + (Tn \times calories)}{Ci + Cii + \ldots\ldots Cn}}{\dfrac{(Si \times Calories) + (Sii \times Calories) + \ldots\ldots (Sn \times Calories)}{Ai + Aii + \ldots\ldots An}}$$

Where,

PCI = Productivity Coefficient Index

Ti….Tn = Total outturns of crop i ……Crop n in a tehsils

Ci….Cn = Total area of crop i…….. Crop n in a tehsils

Si…...Sn = Outturns of crop i ……. Crop n in the study region

Ai…...An = Total area of crop i…… Crop n in the study region

In this index the major crops considered are the same as in the SNU's index, namely, wheat, jowar, bajra, maize, gram, tur, sugarcane and groundnut. For the

present analysis calorie value per kilogram of major crop is taken from table 6.5. According to this method the ratio between the total number of calories available per hectare at the tehsil level and calories available per hectare for entire study region has been worked out. Such calculations are done for the years 1990-91 and 2010-11 separately (Appendix- III and IV). This method is useful for understand the regional variation in relation to the study region as a whole. The surplus and the deficit regions are brought out more effectively.

6.6.1 Productivity Regions Based on Shafi's Modified Index (1990-91)

Table 6.10 and fig. 6.5/A reveals the general pattern of regional imbalances in the levels of agricultural productivity of Ahmednagar district.

Table 6.10 Agricultural Productivity Regions Based on Shafi's Modified Index

Sr. No.	Index Value	Productivity grade	Total number of tehsils	% of total number of tehsils in district
1.	Above 1.24	High	5	38.46
2.	0.97 to 1.23	Moderate	5	38.46
3.	Below .96	Low	3	23.07

Source: Compiled by the researcher.

1. High Productivity Region

There are different pockets of high productivity (fig. 6.5/A) lies in northern, western and southern parts of district with the index values above1.24. It covers five tehsils and 33.20 percent net sown area in district. There are four separate pockets of high agricultural productivity. The one pocket lies in northern part of district which includes tehsils of Rahuri and Shrirampur. This region has dominance of high calories crops such as sugarcane and wheat. In southern part of the district comprise tehils of Shrigonda and Jamkhed which have a productivity index of 1.29 and 1.30 respectively. One pocket lies in western part of district it comprise tehsil Akole having index value 1.49.

2. Moderate Productivity Region

There are three different pockets of moderate productivity (fig. 6.5/A) lies in northern, eastern and southern parts of district with the index values ranging from 0.97 to 1.23. It covers five tehsils in district. Eastern parts of district comprised tehsils Nevasa, Pathardi and Nagar comes under this category which has index value 1.22, 1.04 and 1.01 respectively. Tehsils Kopargaon and Karjat come under this category.

3. Low Productivity Region

The regional pattern of low agricultural productivity shows that there are three tehsils, which have low agricultural productivity. It forms one continues belt in the western part and one isolated pocket lies in north- eastern part of district. It includes the tehsils of Sangamner, Parner and Pathardi which has productivity index 0.88, 0.70 and 1.04 respectively. It covers 27.40 percent net sown area of district. In this tehsils large cultivated area under low calories crops i.e. cereals and pulses, which mostly depends on monsoon due to low agriculture productivity.

6.6.2 Productivity Regions Based on Shafi's Modified Index (2010-11)

Regional pattern of agricultural productivity on the basis of Shafi's productivity index shows a wide range of variation. It varies from a minimum of 1.23 in Shrigonda to the maximum of 2.34 in Rahuri as shown in appendix -IV and fig.6.5/B.

Table 6.11 Agricultural Productivity Regions Based on Shafi's Modified Index

Sr. No.	Index Value	Productivity grade	Total number of tehsils	% of total number of tehsils in district
1.	Above 1.76	High	5	35.71
2.	1.46 to 1.75	Moderate	4	28.57
3.	Below 1.45	Low	5	35.71

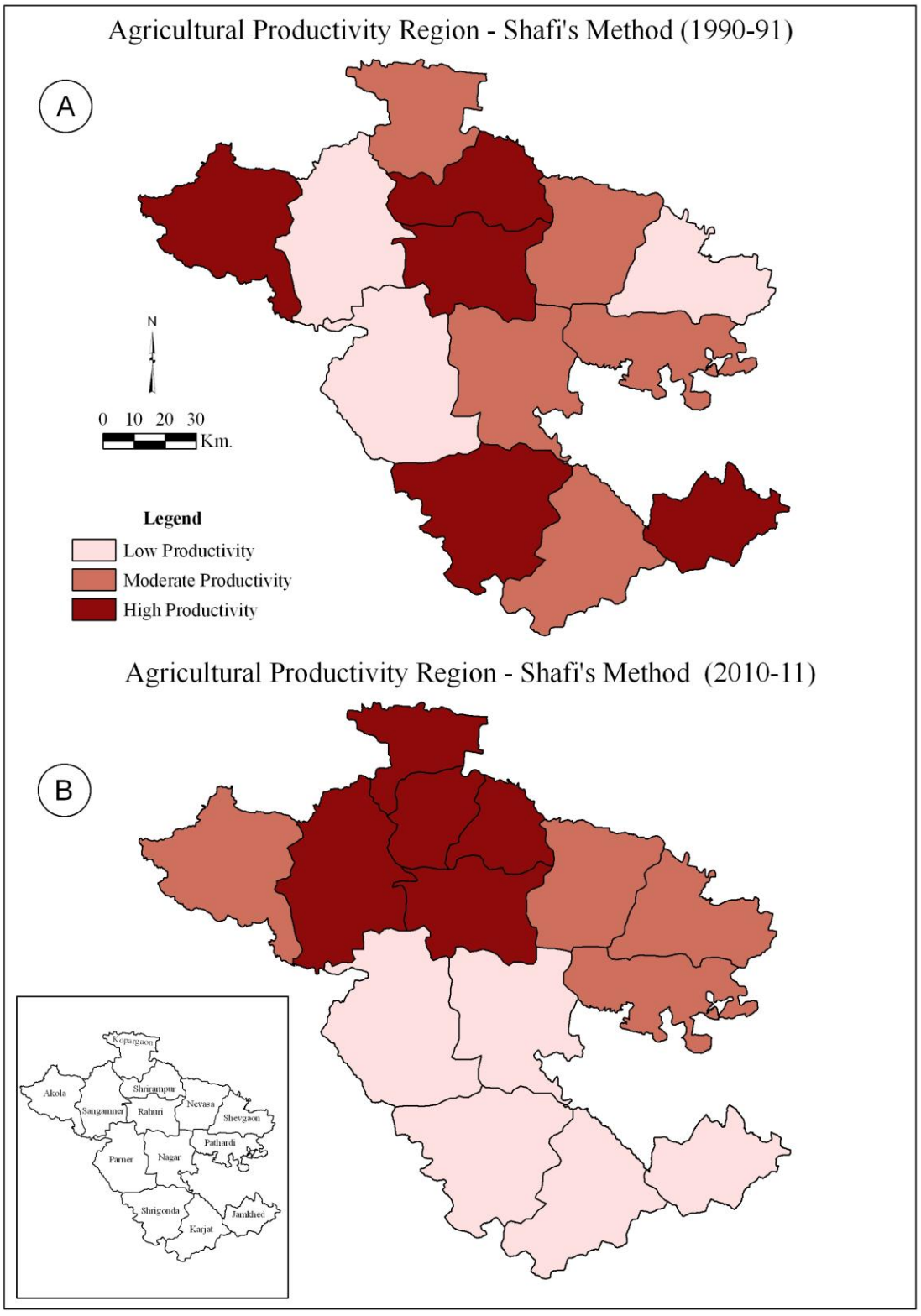
Source: Compiled by the researcher

1. High Productivity Region

There is continuous belt running south-north direction in north part of the district located in river Godavari and Pravara basin with the index value above 1.76. High productivity is noticed in five tehsils and it covers 25.40 percent net sown area of district. Tehsils namely, Rahuri, Rahata, Shrirampur, Sangamner and Kopargaon was included in this region. These tehsil have better irrigation facility by river, canals and wells apart from this better use of fertilizer, high yielding varieties of seed, modern farm implement and fertile black to deep black soils are the reason of high productivity. This region cultivated high calorie value crops such as wheat, bajra, oilseed and sugarcane having per hectare high yield.

2. Moderate Productivity Region

Moderate productivity is confined in four tehsils with an index value from 1.46 to 1.75. There are two separate belts in district found moderate productivity. One is located in eastern part of the district included tehsils of Nevasa, Shevgaon and


Agricultural Productivity Region - Shafi's Method (1990-91)
A
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Km.
Legend
Low Productivity
Moderate Productivity
High Productivity
Agricultural Productivity Region - Shafi's Method (2010-11)
B
Kopargaon
Akola
Shrirampur
Sangamner
Rahuri
Nevasa
Shevgaon
Pathardi
Parner
Nagar
Shrigonda
Jamkhed
Karjat

Fig: 6.5 A & B

Pathardi which have index value 1.61, 1.51 and 1.51 respectively. Second isolated patch lies in western part of the district. It comprised tehsil Akole haveing index value 1.62.

3. Low Productivity Region

The productivity index of this region is less than 1.45. It covers 41.68 percent net sown area of district. There are single continuous belt of low agricultural productivity lies in southern part of district consisting tehsils of Parner, Nagar, Karjat, Shrigonda and Jamkhed. The basic causes of low productivity are erratic behavior of monsoon, low level of institutional and modern advancement.

On the basis of this productivity index during the period of investigation eight tehsils noticed change in productivity level. Tehsil Akole shifted high to moderate productivity region while tehsils Shrigonda and Jamkhed shifted high to low category. Tehsil Kopargaon shifted moderate to high grade while tehsil Nagar and Karjat shifted moderate to low category. Tehiils Sangamner and Shevgaon shifted low to high and moderate productivity region respectively.

6.7 Calories per Capita Index

Shafi (1983) use this method for the study of agricultural productivity of Uttar Pradesh. According to this method, in the present study total outturns of crops are converted into calories and the sum of all the calories is divided by the total population of each tehsil. It gives the available number of calories per head of population for per year. For measurement of productivity index tehsil wise population data have been taken from census 1991 and 2011. The calories per capita are calculated with the help of following formula.

$$\text{Calories Per Capita} = \frac{\text{OTCa x Cal + OTCb x Cal …OTCn x Cal}}{\text{Total population}}$$

Where,

OTC = Outturn of crop

Cal = Calories

With the help of above formula the calories per capita productivity index of each tehsil was worked out for the years 1990-91 and 2010-11 separately (Appendix III and IV).

6.7.1 Productivity Regions based on Calories per Capita Index (1990-91)

Calories per capita values worked out for each tehsil and regions were demarcated (table 6.12) and spatial pattern of the agricultural productivity has plotted in fig 6.6/A.

Table6.12 Agricultural Productivity Regions Based on Calories per Capita Index

Sr. No.	Index Value	Productivity grade	Total number of tehsils	% of total number of tehsils in district
1.	Above 1470000.01	High	3	23.07
2.	990000.01 to 1470000.0	Moderate	3	23.07
3.	below 990000.0	Low	7	53.84

Source: Compiled by the researcher.

1. High Productivity Region

High productivity region are designated with the index values above 1470000.01. It included three tehsils and 24.18 percent net sown area of district. Tehsils of Patardi, Shrigonda and Jamkhed are included in this region. These tehsil have low level of technological, institutional advancement and lack of irrigation. Though, agricultural productivity is high because of low population density. Population density of Pathardi, Shrigonda and Jamkhed has 155, 147 and 136 persons per sq. km. respectively.

2. Moderate Productivity Region

There are three different pockets of moderate productivity (fig. 6.6/A) lies in north-eastern, central and southern parts of district it covers 27.66 percent net sown area of district with the index values ranging from 990000.01 to 1470000.0. It included tehsils Karjat, Parner and Nevasa which have index values 1462837.96, 1201538.29 and 1077635.46 respectively.

3. Low Productivity Region

This category included the tehsils having less than 990000.0 per capita calories. There is one continuous belt spread south-north direction located in the Mula, Pravara and Godavari basin. Except Nagar tehsil remaining six tehsils have adequate irrigation facility, fertile soils, high doses of fertilizer, use of high yielding verity seeds and modern farm implements, due to this agricultural productivity is high. Though, population density is quite high so less calories available per person due to this these tehsils come under low productivity region. In Nagar tehsil

Ahmednagar city is district headquarter and industrial cluster so high density population (322 persons per square km.) due to this less availability of per capita calories.

6.7.2 Productivity Region Based on Calories per Capita Index (2010-11)

Spatial pattern of agricultural productivity on the basis of Calories per Capita index shows a wide range of variation. Table 6.13 shows the principal of grading system and fig. 6.6/B revels regional variation in agricultural productivity.

Table 6.13 Agricultural Productivity Regions Based on Calories Per Capita Index

Sr. No.	Calories Per Capita	Productivity grade	Total number of tehsils	% of total number of tehsils in district
1.	Above 1100000.01	High	2	14.28
2.	740000.01 to 1100000.0	Moderate	7	50.00
3.	Below 740000.0	Low	5	35.71

Source: Compiled by the researcher

1. High Productivity Region

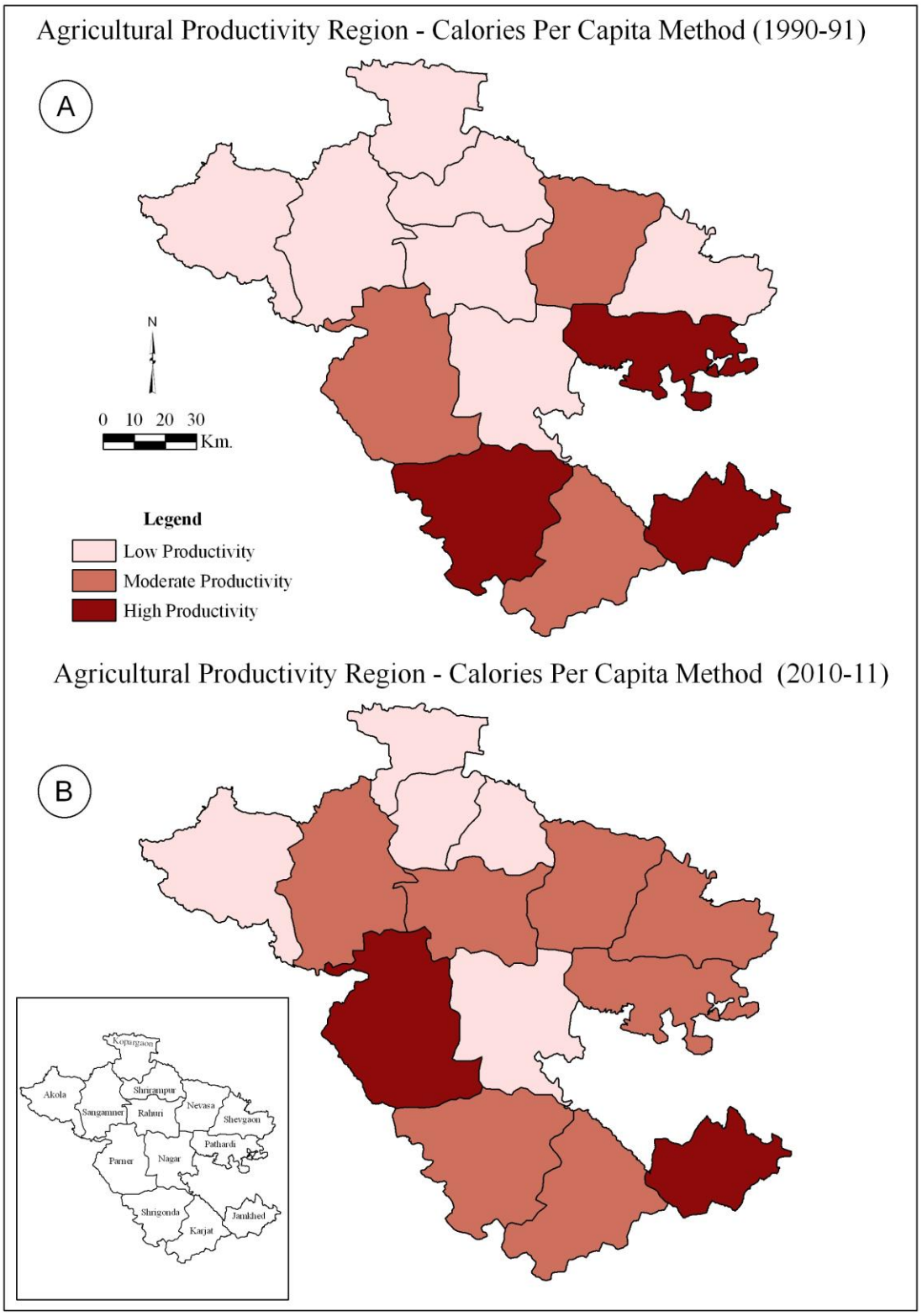
Two tehsils namely, Jamkhed and Parner appear in this category. It covers 15.51 percent net sown area in district. These tehsils located in less irrigated zone of district, farmers of these tehsils cultivate food /cash crops which require less amount of water. Besides this, low population density is the basic cause of high productivity.

2. Moderate Productivity Region

Moderate productivity is confined seven tehsils and cover 55.04 percent net sown area in district. The calorie value per person of this region is varies from 740000.01 to 1100000.0. There are two separate belts in district have moderate productivity. One belt spread west- east direction in north part of the district comprised tehsils of Sangamner, Rahuri, Nevasa, Shevgaon and Pathardi. Second belt running east-west direction in southern part of district consist tehsils of Shrigonda and Karjat.

3. Low Productivity Region

The calorie per person of this region is less than 740000.0 have been categorized under this region. It covers 35.71 percent tehsils of district. There are three different pockets which registered low productivity. One belt started from river Pravara and spread up to river Godavari, it included the tehsils of Rahata, Shrirampur and Kopargaon. Second isolated patch lies in western part of district, it included tehsil Akole and third pocket lies in central part of the district comprised tehsil Nagar.


Agricultural Productivity Region - Calories Per Capita Method (1990-91)
A
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0 10 20 30
Km.
Legend
Low Productivity
Moderate Productivity
High Productivity
Agricultural Productivity Region - Calories Per Capita Method (2010-11)
B
Kopargaon
Akola
Shrirampur
Sangamner
Rahuri
Nevasa
Shevgaon
Pathardi
Parner
Nagar
Shrigonda
Jamkhed
Karjat

Fig: 6.6 A & B

High population density is the basic cause of low productivity.

On the basis of this productivity index six tehsils have change in their productivity level. Three tehsils namely, Sangamner, Rahuri, Shevgaon shifted low to moderate region while Parner tehsil shifted moderate to high productivity region. Tehsils of Shrigonda and Pathardi recorded negative change, these are shifted high to moderated productivity region.

6.8 Sapre and Deshpande's Index

Sapre, S. G. and Deshpande, V. D. (1964) suggested a slight modification in Kendall's 'ranking coefficient' technique. They have used the 'weighted average ranks' instead of the 'simple average of ranks'. The weighted ranks of various crops are proportionate to the percentage of cropland under each crop. Formula for assessing productivity index would be read thus:

$$\text{Agricultural Productivity Index} = \frac{(r_1 x\ c_1) + (r_2 x\ c_2) + \ldots (r_n x\ c_n)}{c_1 + c_2 + c_3 + \ldots\ldots c_n}$$

Where,

r = Ranking of yield of individual crop

c = Crop land share in percentage.

According to this method low index value means high productivity and vice-versa. To measurement of agricultural productivity wheat, jowar, bajra, other cereals, pulses, sugarcane, cotton and oilseed crops have been considered. Productivity index of each tehsil was worked out for the years 1990-91 and 2010-11 separately (Appendix- III and IV).

6.8.1 Productivity Regions Based on Sapre and Deshpande's Index (1990-91)

Spatial pattern of agricultural productivity on the basis of Sapre and Deshpande's index shows a wide range of variation. The index values groups shows in table 6.14 and regional variation shows in fig. 6.7/ A.

Table 6.14 Agricultural Productivity Regions Based on Sapre and Deshpande's Index

Sr. No.	Index Value	Productivity grade	Total number of tehsils	% of total number of tehsils in district
1.	Below 5.51	High	6	46.15
2.	5.52 to 7.67	Moderate	2	15.38
3.	Above 7.68	Low	5	38.46

Source: Compiled by the researcher

1. High Productivity Region

High productivity is designated with the index value below 5.51 and it occupied 33.60 percent net sown area of district. There are two separate belts have high agricultural productivity. One belt lies in northern part of the district comprised tehsils Rahuri, Shrirampur and Nevasa. These tehsils have adequate irrigation facility by canals and wells due to this these tehsils maximum area is under cash crops and per hectare high yield of all major crops. Second belt running west-east direction lies in south part of the district. It confined tehsils Jamkhed and Karjat which have index value 3.36 and 3.75 respectively.

2. Moderate Productivity Region

The tehsils having productivity index from 5.52 to 7.67 have been comes under moderated productivity region which cover 25.55 percent net sown area of district. The regional pattern of the distribution of shows that there are three tehsils, which have moderate agricultural productivity. These tehsils are Kopargaon, Pathardi and Shrigonda which have index value 6.92, 6.80 and 5.51 respectively.

3. Low Productivity Region

Low productivity forms a one continuous belt in central to north-western part and one isolated patch in eastern part of district. The tehsils those are having the index value above 7.68 are classed as the region of low productivity. These cover 40.84 percent net sown area of district. Five tehsils namely, Nagar, Akole, Shevgaon, Parner and Sangamner come under this category. In Akole, Sangamner and Parner tehsils most of the area is covered by sub ranges of Sahyadri due to this soil is shallow, thin and unproductive and lack of irrigation facility causes low productivity. In central part tehsil Nagar is more urbanized due to this cultivable waste land is increased because of this agricultural productivity is reduced. In Shevgaon tehsil largest area is covered by one crop i.e. jowar which is depends on erratic monsoon which is the basic cause of low productivity.

6.8.2 Productivity Regions Based on Sapre and Deshpande's Index (2010-11)

Appendix- IV and fig. 6.7/B reveal the spatial variation in agricultural productivity based on Sapre and Deshpande's index.

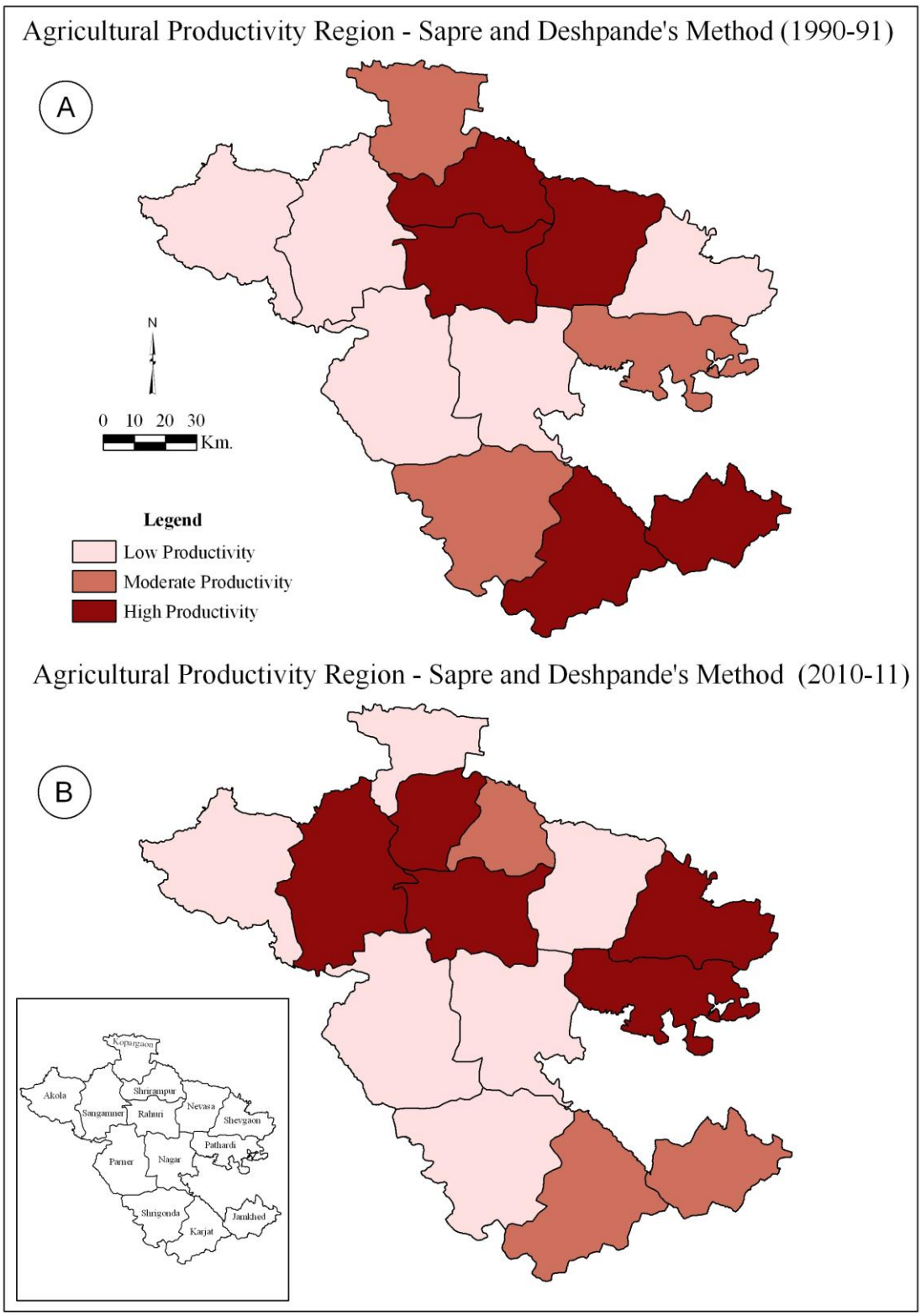

Agricultural Productivity Region - Sapre and Deshpande's Method (1990-91)
A
N
0 10 20 30
Km.
Legend
Low Productivity
Moderate Productivity
High Productivity
Agricultural Productivity Region - Sapre and Deshpande's Method (2010-11)
B
Kopargaon
Akola
Shrirampur
Nevasa
Sangamner
Rahuri
Shevgaon
Pathardi
Parner
Nagar
Shrigonda
Jamkhed
Karjat

Fig: 6.7 A & B

Table 6.15 Agricultural Productivity Regions Based on Sapre and Deshpande's Index

Sr. No.	Index Value	Productivity grade	Total number of tehsils	% of total number of tehsils in district
1.	Below 4.85	High	5	35.71
2.	4.86 to 7.38	Moderate	3	21.42
3.	Above 7.39	Low	6	42.85

Source: Compiled by researcher.

1. High Productivity Region

The tehsils with the index value below 4.85 are classed as having high productivity. High productivity region spread in northern and eastern part of the district. Northern three tehsils Sangamner, Rataha and Rahuri comes under this region which has index value 3.75, 3.43 and 2.31 respectively. In eastern part of district confined tehsils of Shevgaon and Pathardi recorded high productivity which has index value 4.70 and 4.31 respectively.

2. Moderate Productivity Region

The productivity index of this region varies from 4.86 to 7.38. There are two separate belts in district recorded moderate productivity. The one belt is running east-west direction lies southern part of the district comprises tehsils Karjat and Jamkhed which have productivity index of 6.70 and 7.14 respectively. Jowar is the dominant crop of this belt. The second isolated patch lies in fertile track of Pravara basin. It included tehsil Shrirampur having productivity index 6.93.

3. Low Productivity Region

The tehsils with the index value above 7.39 are classed as having low productivity. This region covers 52.19 percent net sown area of district. Low agricultural productivity region form one continuous belt and two isolated pockets in district. The continuous belt running south to north-east direction, it included tehsils Shrigonda, Parner, Nagar and Nevasa. One isolated patch lies in western part of district (tehsil Akole) and second isolated patch lies in northern part of district (tehsil Kopargaon) have index value 8.52.

On the basis of this productivity index nine tehsils recorded change in their level of productivity. Two tehsils namely Sangamner and Shevgaon recorded upward change they shifted low to high category while Shrigonda and Kopargaon tehsils shifted moderate to low region. Tehsils namely, Jamkhed, Karjat and Shrirampur

noticed negative change they shift high to moderate grade. Nevasa tehsil shifted high to low category while tehsil Pathardi recorded upward change.

6.9 Composite Productivity Regions

Spatial pattern of agricultural productivity in Ahmednagar district have been examined by applying different seven indices of agricultural productivity. These indices shows more or less similar pattern of agricultural productivity in the study region. So far as agricultural productivity is concerned there is not a single universally accepted method of measuring agricultural productivity. Therefore, it is decided to examine composite productivity regions. For this, all these productivity indices maps are combined together with the help of GIS software i.e. Arc GIS. It output generate a map which shows composite productivity regions i.e. high, moderate and low. It was done for the years 1990-91 and 2010-11 separately.

6.9.1 Composite Productivity Regions (1990-91)

Fig. 6.8/A revealed there are two contiguous belts of high productivity. The first belt is running in west-east direction in the fertile track of the Godavari, Pravara and Mula basin. It comprises tehsils of Shrirampur, Rahuri and Nevasa. The second belt stretches in west-east direction in the south part of district including tehsils of Shrigonda, Karjat and Jamkhed. This is a region of high and moderate productivity on all seven indices separately.

The tehsils of moderate productivity level are mainly concentrated in the northern, central and eastern part of the district. It comprises three tehsils namely, Kopargaon, Nagar and Pathardi. Out of seven productivity indices Kopargaon and Patherdi tehsils noticed moderate productivity in six productivity indices while Nagar tehsil registered moderate productivity in four productivity indices.

Low productivity regions found in the western and eastern part of district comprises tehsils of Akole, Sangamner, Parner and Shevgaon. The basic causes of low productivity of in these tehsils are low level of technological and institutional advancement i.e. lack of irrigation facilities, low quality of seeds, less use of chemical fertilizer, use of traditional farm implements etc.

6.9.2 Composite Productivity Regions (2010-11)

Fig. 6.8/B revealed that there is a single contiguous belt of high productivity lies in the northern part of district consisting tehsils of Sangamner, Kopargaon, Rahata and Rahuri. On all seven indices these tehsils noticed high to moderate productivity separately.

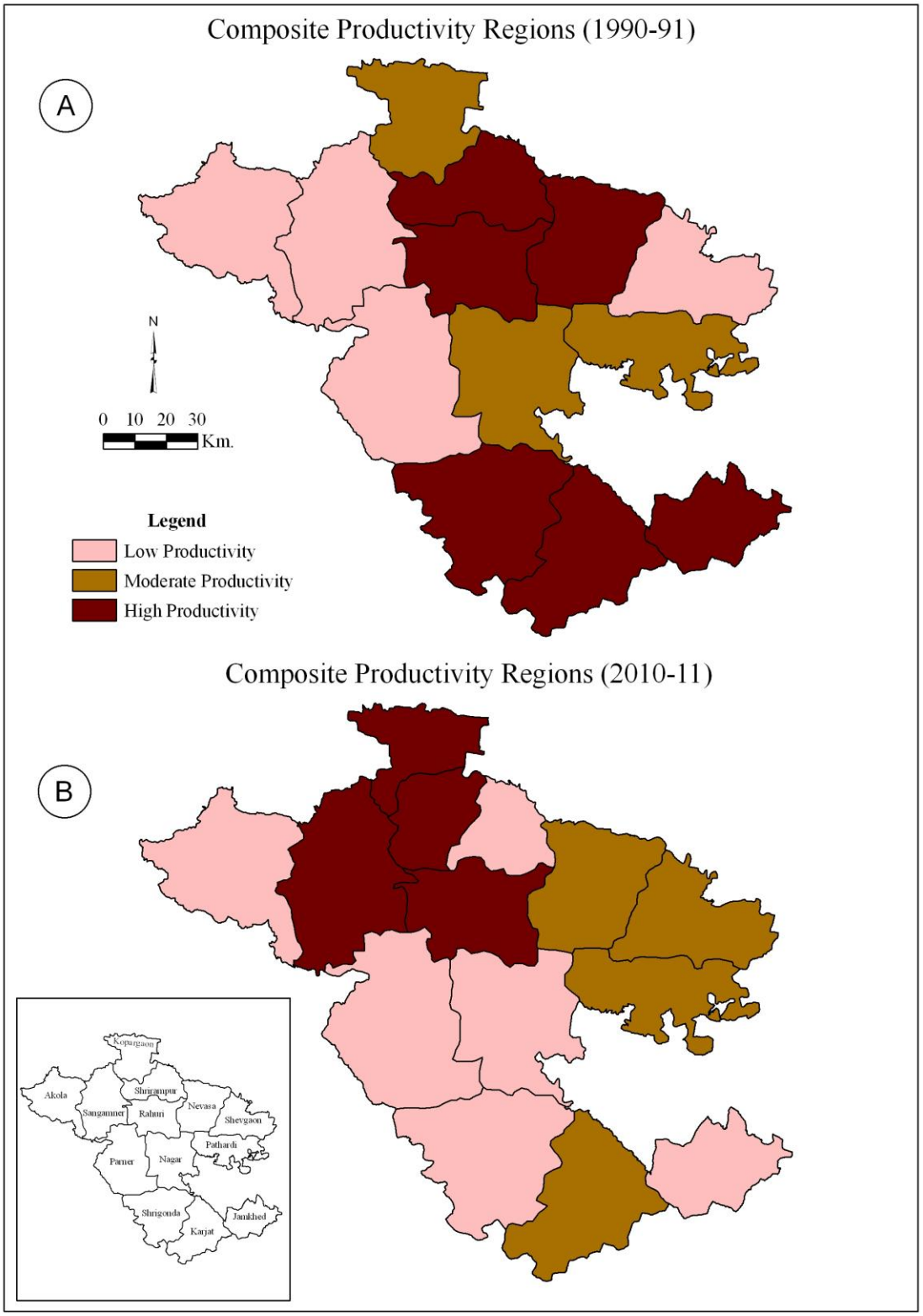

Composite Productivity Regions (1990-91)
A
N
0 10 20 30
Km.
Legend
Low Productivity
Moderate Productivity
High Productivity
Composite Productivity Regions (2010-11)
B
Kopargaon
Akola
Shrirampur
Sangamner
Rahuri
Nevasa
Shevgaon
Pathardi
Parner
Nagar
Shrigonda
Jamkhed
Karjat

Fig: 6.8 A& B

There is one contiguous belt and one isolated patch of moderate productivity. The contiguous belt lies in north eastern parts of district comprise tehsils of Nevasa, Shevgaon and Pathardi while the isolated patch lies in the south part of district comprise thesil Karjat.

Low productivity region spared in north, western, central and southern parts of district comprise tehsils of Shrirampur, Akole, Parner, Nagar, Shrigonda and Jamkhed.

Spatio temporal changing pattern of composite productivity regions shows that negative change noticed in four tehsils namely, Nagar, Shrirampur, Nevasa and Karjat. Tehsil of Nagar and Shrirampur shifted moderate and high to low productivity region respectively while tehsil Nevasa and Karjat shifted high to moderate region. Positive change noticed in three tehsils namely, Shevgaon, Sangamner and Kopargaon. Tehsil Shevgaon shifted low to moderate region while tehsil of Sangamner and Kopargaon shifted low and moderate to high region respectively. Rest of the six tehsils namely, Rahuri, Pathardi, Jamkhed, Shrigonda, Parner and Akole noticed no change in their productivity region.

6.10 Quantitative Evaluation of Agricultural Productivity

In previous part of this chapter researcher studied spatio-temporal variation in agricultural productivity in Ahmednagar district by using seven different indices. It displays considerable spatial and temporal variation in productivity in each index. The present section deals with the quantitative evaluation of agricultural productivity with the objective to find out the correlation between agricultural productivity and physical and non-physical variables. For this, correlation coefficient technique has been applied for the year 2010-11.

6.11 Correlation Analysis

In correlation coefficient analysis the Kendall's ranking coefficient index and Sapre and Deshpande index is not included because it deals with ranks, which mean higher the ranks lower is the level of productivity. It goes against the grain of the other indices used, where higher the rating higher is the productivity. Thus, only five indices are used in this analysis. For establish correlation twenty two variables were carefully chosen. These variables represent the physio-socio-economic environmental conditions made up by some climatic elements, level of inputs and technology and demographic characteristics. The chosen variables are as below:

X 1 – Bhatia's productivity index

X 2 – Standard Nutrition Unit per hectare

X 3 - Enyedi's productivity index

X 4 – Shafi's modified productivity index

X 5 – Calories per head of total population index

X 6 – Total annual rainfall in mm

X 7 – Net irrigated area as a percentage of net sown area

X 8 – Number of wooden ploughs per hundred hectares of net sown area

X 9 – Number of iron ploughs per hundred hectares of net sown area

X 10 - Number of animal drawn carts per hundred hectares of net sown area

X 11 - Number of oil engines per hundred hectares of net sown area

X 12 - Number of electric pumps per hundred hectares of net sown area

X 13 - Number of tractors per hundred hectares of net sown area

X 14 - Number of livestock population per hundred hectares of net sown area

X 15 – Rural literacy as a percentage of total rural population

X 16 – Crude density of population

X 17 - Physiological density of population

X 18 – Agricultural density of population

X 19 - High yielding variety seeds per hundred hectare of total cultivated area (excluding sugarcane and fodder crops)

X 20 – Chemical fertilizer per hundred hectares of net sown area

X 21 - Number of agriculture market centers per hundred hectares of net sown area

X 22 - Agricultural credits per hundred hectares of net sown area

The reason for selection of above variables is strengthening the result of hypothesis that the productivity is related to some physio-socio-economic variables. The selecting the total annual rainfall is that it represents an essential elements of the physical environment as it affects the curtail factor of soil moisture and soil productivity. Therefore positive correlation is expected between rainfall and agricultural productivity. The variable X 7 i.e. net irrigated area, it ensures the benefits to farmers by reducing the risk of crop failure, increasing the average yields and permitting multiple cropping. Thus, it leads to more productivity. Therefore, a positive correlation is expected between this variable and productivity. The variables X8 to X13 indicate the economical and technological aspects of environment. It includes some traditional and some modern implements, it has basic controlling

factors of agricultural productivity in modern era. These variables are expected to have a positive correlation with productivity.

Variable X 14 i.e. number of livestock population per hundred hectares of net sown area. Livestock plays a prominent role in agricultural development. They are the chief source of power and manure. The highest number of livestock population means highest productivity. Therefore, positive correlation is expected between livestock population and productivity.

Variables X15 to X18 are the demographic and socio-cultural aspects of environment. Literacy indicates the quality of manpower. Education helps human being in many ways to develop various skills, so literacy is a necessity for all those who wish to practice the agricultural occupation on modern lines. Rural literate population adopt new agricultural technology it positive effects on agricultural productivity. Therefore, positive correlation is expected between rural literacy (X15) and agricultural productivity. In India agricultural operations mainly based on labour intensive because of small size of holding, lack of mechanizations and physiogaphy. Therefore, positive correlation is expected between (X16, X17 and X18) population density and agricultural productivity. The Calories per capita index was worked out by total calories divided by total population. It means that higher the population lowers the productivity. Therefore, negative correlation expected between the variables X5 with X16, X17 and X18.

Variable X19 and X 20 i.e. use of high yielding variety of seeds and chemical fertilizer. After green revolution there is drastic change in agricultural productivity because use of these variables. High intensity in use of these variables means higher is the productivity, so positive correlation is expected between these variables and agricultural productivity.

Variable X 21 i.e. number of agriculture market centers per hundred hectares of net sown area. Distance from market centers makes an influence on cropping pattern so the accessibility to the market is a major consideration in the decision making of farmer. The intensity of agriculture and the production of crops decline as the location of cultivation get away from the marketing center. But in recent day development in transport facility local market does not make an influence on cropping pattern, therefore, not high positive correlation expected between variable X21 and agricultural productivity. All agricultural inputs like the livestock, irrigation, seed, fertilizer, insecticide, labour and various agricultural implements purchase and repair

require capital. The higher the use of capital in agricultural operation means higher the degree of commercialization. It lead to high productivity, therefore, positive correlation is expected between variable X22 and productivity.

6.12 Result of Correlation Analysis

On the basis of 14 x 22 data matrix Pearson's product moment coefficient of correlation was worked out. Later on Student's 't' test has applied to determine significance 'r' values at 0.05 and 0.01 percent level of significance. The results obtained (table 6.16) show certain significant associations among the various selected variables which are described as follows:

X1 Bhatia's Productivity Index

Table 6.16 shows that except wooden plough and market centers remaining variables shows the positive correlation with Bhatia's productivity index. This index is positively significant correlation to number electric pump (r = 0.585), number of tractor (r = 0.533), use of chemical fertilizer (r = 0.638) and agricultural credit (r = 0.619) per hundred hectare to net sown area at 0.05 % level of significant. Positive but not significant correlation found with animal drawn cart (r = 0.528) and livestock population (r = 0.518), agricultural density of population (r = 0.361) and high yielding varieties of seeds (r = 0.492).

X 2 Standard Nutrition Units per Hectare

This index very significant correlation with number of electric pump (r = 0.681), number of tractor (r = 0.832), agricultural density of population (r = 0.800) and use of chemical fertilizer (r = 0.712) per hundred hectare to net sown area at 0.01% level of significant. Even for this productivity index positive correlation with irrigation (r = 0.553), physiological density of population (r = 0.538), use of high yielding variety of seeds (r = 0.636) and agricultural credit (r = 0.538) at 0.05 % level of significant.

X3 Enyedi's Productivity Index

This agricultural productivity index highly positive correlated with agricultural density of population (r = 0.743) at 0.01 % level of significant. While positive correlation with irrigation (r = 0.546), high yielding variety of seeds (r = 0.563) and use of chemical fertilizer (r = 0.610) per hundred hector to net sown area at 5 % level of significant. However, high positive but not significant correlated with number electric pump (r = 0.504), number of tractor (r = 0.521) and agricultural credit (r = 0.519).

Table 6.16 Correlation Matrix

Variables	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16	X17	X18	X19	X20	X21	X22
X1	1																					
X2	0.407	1																				
X3	0.340	0.828	1																			
X4	0.494	0.920	0.881	1																		
X5	0.229	-0.386	-0.544	-0.364	1																	
X6	0.153	-0.169	0.131	-0.012	-0.397	1																
X7	0.332	0.553	0.546	0.721	-0.374	0.267	1															
X8	-0.130	-0.156	0.177	-0.176	0.085	0.042	-0.320	1														
X9	0.150	-0.228	-0.077	-0.281	0.373	0.135	-0.286	0.8239	1													
X10	0.528	-0.032	-0.078	-0.096	0.385	0.061	-0.201	0.4729	0.788	1												
X11	0.187	-0.302	-0.336	-0.394	0.648	-0.155	-0.521	0.5855	0.811	0.788	1											
X12	0.585	0.681	0.504	0.622	-0.082	0.057	0.647	0.0181	0.278	0.415	0.070	1										
X13	0.533	0.832	0.521	0.694	-0.214	-0.394	0.313	-0.2220	-0.196	0.007	-0.164	0.534	1									
X14	0.518	0.202	0.256	0.354	0.273	0.025	0.022	0.0759	0.029	0.308	0.308	-0.006	0.006	1								
X15	0.156	0.105	0.120	0.030	0.408	-0.078	-0.013	0.4536	0.587	0.417	0.425	0.346	0.052	0.074	1							
X16	0.008	0.444	0.358	0.525	-0.669	0.169	0.719	-0.4341	-0.505	-0.320	-0.591	0.328	0.421	-0.127	-0.555	1						
X17	0.119	0.538	0.479	0.647	-0.635	0.093	0.747	-0.4423	-0.552	-0.366	-0.645	0.361	0.460	-0.069	-0.586	0.962	1					
X18	0.361	0.800	0.743	0.879	-0.487	0.067	0.895	-0.2736	-0.300	-0.148	-0.497	0.708	0.643	0.018	-0.018	0.742	0.798	1				
X19	0.492	0.636	0.563	0.766	-0.408	0.080	0.664	-0.5497	-0.582	-0.194	-0.563	0.343	0.492	0.261	-0.318	0.656	0.733	0.775	1			
X20	0.638	0.712	0.610	0.850	-0.189	0.208	0.782	-0.4443	-0.319	-0.038	-0.360	0.609	0.551	0.342	0.027	0.518	0.584	0.825	0.852	1		
X21	-0.080	0.494	0.347	0.499	-0.397	-0.093	0.445	-0.2560	-0.268	-0.157	-0.305	0.296	0.755	-0.159	-0.154	0.681	0.622	0.659	0.555	0.523	1	
X22	0.619	0.583	0.519	0.686	-0.161	0.429	0.739	-0.3560	-0.124	0.010	-0.242	0.681	0.398	0.173	0.111	0.401	0.445	0.716	0.626	0.904	0.376	1

Source: Compiled by researcher

X4 Shafi's Modified Productivity Index

This index brings out the ratio of land productivity of tehsils in relation to the land productivity of the district as a unit. This agricultural productivity index highly positively correlated with net irrigated area (r = 0.721), number of tractor (r = 0.694), agricultural density of population (r = 0.766), use of high yielding variety of seeds (r = 0.766), use of chemical fertilizer (r = 0.850) and agricultural credit (r = 0.686) at 1 % level of significant. This index positive correlated with number of electric pump (r = 0.622), crude density of population (r = 0.525) and physiological density of population (r = 0.647) at 5 % level of significant.

X5 Calories per Capita Index

This index brings out the agricultural productivity combined with the population pressure on the cultivated land due to this physico-socio-economic, technological, demographic and cultural factors not positive correlated with this index at any level of significant. This index is high negative correlated with population density (r = -0.669) at 0.01 % level of significant, while negative correlated with physiological density of population (r = -0.635) at 0.05 % level of significant. This index is high positive correlated with number of wooden plough (r = 0.721) per hundred hectare to net sown area at 0.01 % level of significant.

The conclusion after the study of correlation, there is a significant positive correlation of agricultural productivity with various agricultural inputs such as tractor, electric pumps, irrigation facilities, rural literacy, crude density of population, physiological density of population, agricultural density of population, chemical fertilizer, high yielding variety of seeds and agricultural credits.

Resume

The present chapter deals with spatio temporal changes in agricultural productivity which is measured by seven different indices. These show the existing patterns of productivity levels and demarcate regional variation in agricultural productivity. The composite productivity regions show the real picture of spatial variation in agricultural productivity of district. The correlation coefficient technique prove hypothesis that saptio temporal changes in agricultural productivity is the causing of various physical and non physical determinants. The result of correlation shows that positive correlation between agricultural productivity and irrigation, number of electric pump, number of tractor, crude density of population, physiological density of population, agricultural density of population, high yielding

varieties of seed, chemical fertilizer and agricultural credit. The variables like rainfall, number of livestock, rural literate, number of market centers and traditional farm implements such as wooden plough, iron plough, animal drawn cart and oil engines have insignificant correlation with agricultural productivity.

CHAPTER-VII

CASE STUDIES OF SAMPLE VILLAGES

7.1 General Introduction

7.2 Basis of Sampling

7.3 Nandurkhi (Kh) Village

7.4 Belpandhari Village

7.5 Jakhangaon Village

7.6 Comparative Study of Sample Villages

7.1 General Introduction

Village wise study of agricultural productivity is most useful to evaluate agricultural resources properly for further agricultural planning and development. Keeping this view for in depth study of the agricultural resources, micro level study has been carried out of selected villages which are representative to district specific issue of agricultural productivity. As in depth study survey of each and every village is practically not possible because it is time consuming job. To overcome this drawback many researchers in the field of agricultural geography suggested sample survey to study the various aspects of agricultural resources (Gupta, G. M. 1992). It is more reliable in order to save time, money and man power.

The objective of present chapter is to assess the present status of demography, soil types, irrigation facilities, general land use pattern, cropping pattern, production of various crops, livestock and problems being faced by people related to agriculture of selected villages which is the representative of high, moderate and low productivity region.

Before proceeding to villages for survey, secondary data was collect from various government offices of selected village tehsil such as agriculture department, irrigation department, animal husbandry department and also the Talathi, Gramsevak and Sarpanch of selected villages. The data regarding population is obtained from census of 2011.

After proceeding to villages, preliminary discussions were held with villagers about the issues related to agriculture. To generate primary data two separate questionnaire were prepared, one for Talathi and Gramshvak and second for cultivators (Appendix- VI and VII). The questions included in questionnaire related to land use, season wise cropping pattern, agricultural production, source of irrigation, use of HYV seeds, chemical fertilizer, farm implements, market facilities, livestock and various problems of agriculture. Beside this continues visits of the villages to obtained relevant information and personal observations.

7.2 Basis of Sampling

Following method has been adopted for selection of sample villages. In the present study seven productivity indices have been used to identify level of productivity regions i.e. high, moderate and low. According to these productivity indices (2010-11) frequency table is worked out (Appendix-V) and from each region one tehsil is selected which frequency has maximum. From this tehsil one village is

selected for case study by purposive systematic sampling method. Productivity region wise selected villages are shown in table 7.1 and locations are shown in fig. 7.1.

Table 7.1 Agricultural Regions and Sample Villages

Sr. No.	Agricultural Productivity Regions	Tehsils	Villages	Area (Hectares)
1	High productivity	Rahata	Nandurhi (Kh)	227.36
2	Moderate Productivity	Nevasa	Belpandhri	988.34
3	Low Productivity	Nagar	Jakhangaon	1034.32

Source: Compiled by researcher and Talathi office of villages

7.3. Nandurkhi (Kh) Village

The village Nandurhki (Kh) lies almost exactly crossing of 19° 44´ 51´´ north latitude and 74° 26´ 42´´ east longitude. The village is about 5 km. west of the tehsil place Rahata. It is well connected by roads with its neighboring villages like Kankuri in the north, Dorhale in the west, Korhale in south and Nandurhi (Bk) in east (fig.7.2). It is just 6 km south-west of holy place Shirdi. Total area of the village is 227.36 hectare having population of 1259 in 2011.

7.3.1 Physiography, Climate and Soil

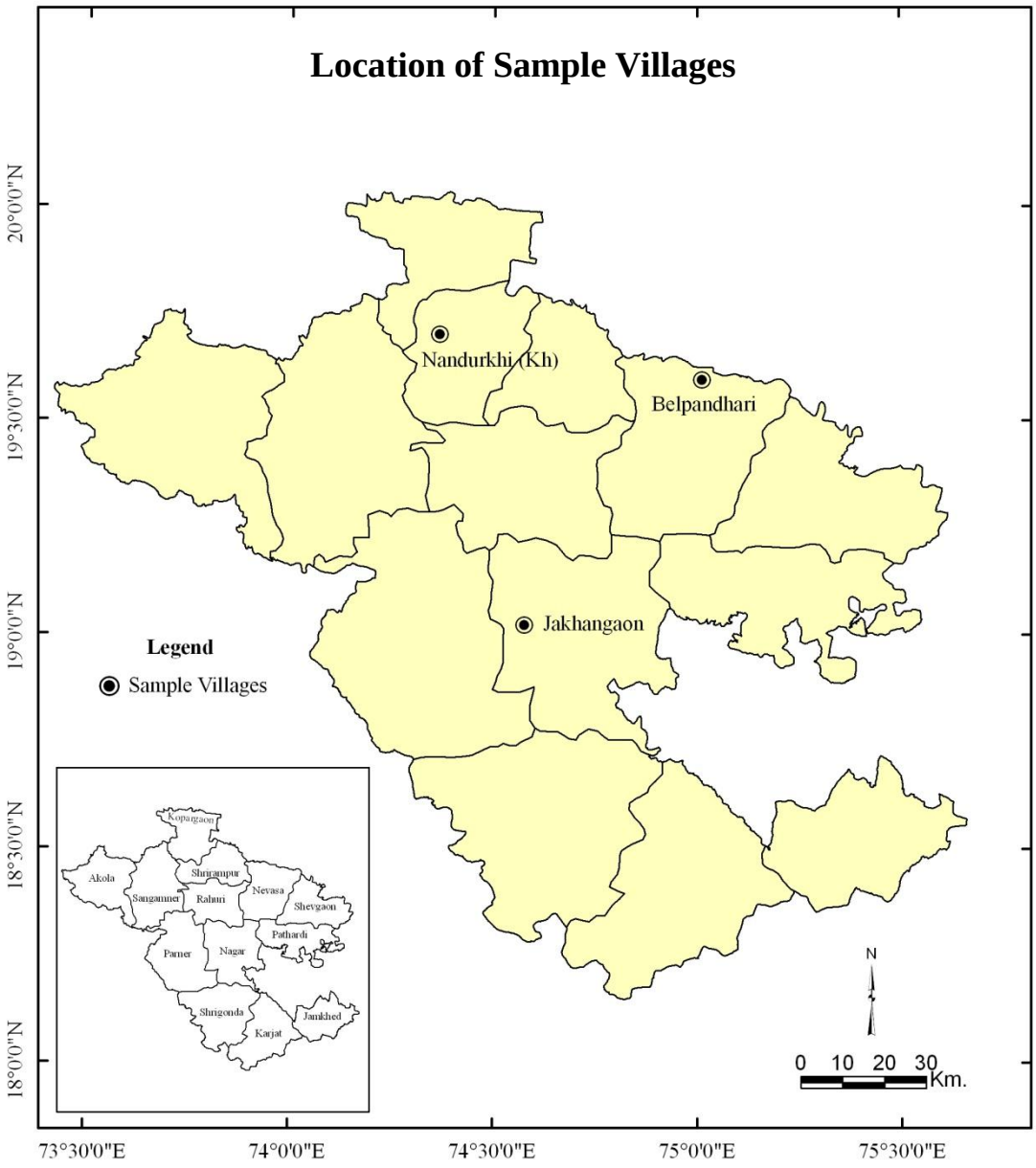
The average height of village is 520 meters above mean sea level. The general slope is from south to north with an elevated portion at the south-west part. The entire northern portion of village presents almost a flat level plain remarkably homogeneous in character.

In this village, the climate is identical to that of the district- that is hot summer and distributed rain during the south-west monsoon. Temperature rises from early March steadily till May, which is the hottest month of the year. The mean maximum temperature of May is 38^0C. The onset of monsoon is from first week of June, and lasts up to September. Average annual rainfall of this area is about 546.17 mm. About 89.61 percent of the total annual rainfall is received during the monsoon (June to October) (table 7.2). From November, the day temperature also begins to drop rapidly. December and January are usually the coldest month of the year.

Table 7.2 Average Rainfall

Station	Annual Rainfall	June - Oct.		Nov.- Feb.		March - May	
		mm	%	mm	%	mm	%
Rahata	546.17 mm	489.44	89.61	25.28	4.63	31.45	5.76

Source: Department of irrigation, Rahata (2012-13)


Location of Sample Villages
Nandurkhi (Kh)
Belpandhari
Jakhangaon
Legend
Sample Villages
Kopargaon
Akola
Shrirampur
Sangamner
Rahuri
Nevasa
Shevgaon
Pathardi
Parner
Nagar
Shrigonda
Jamkhed
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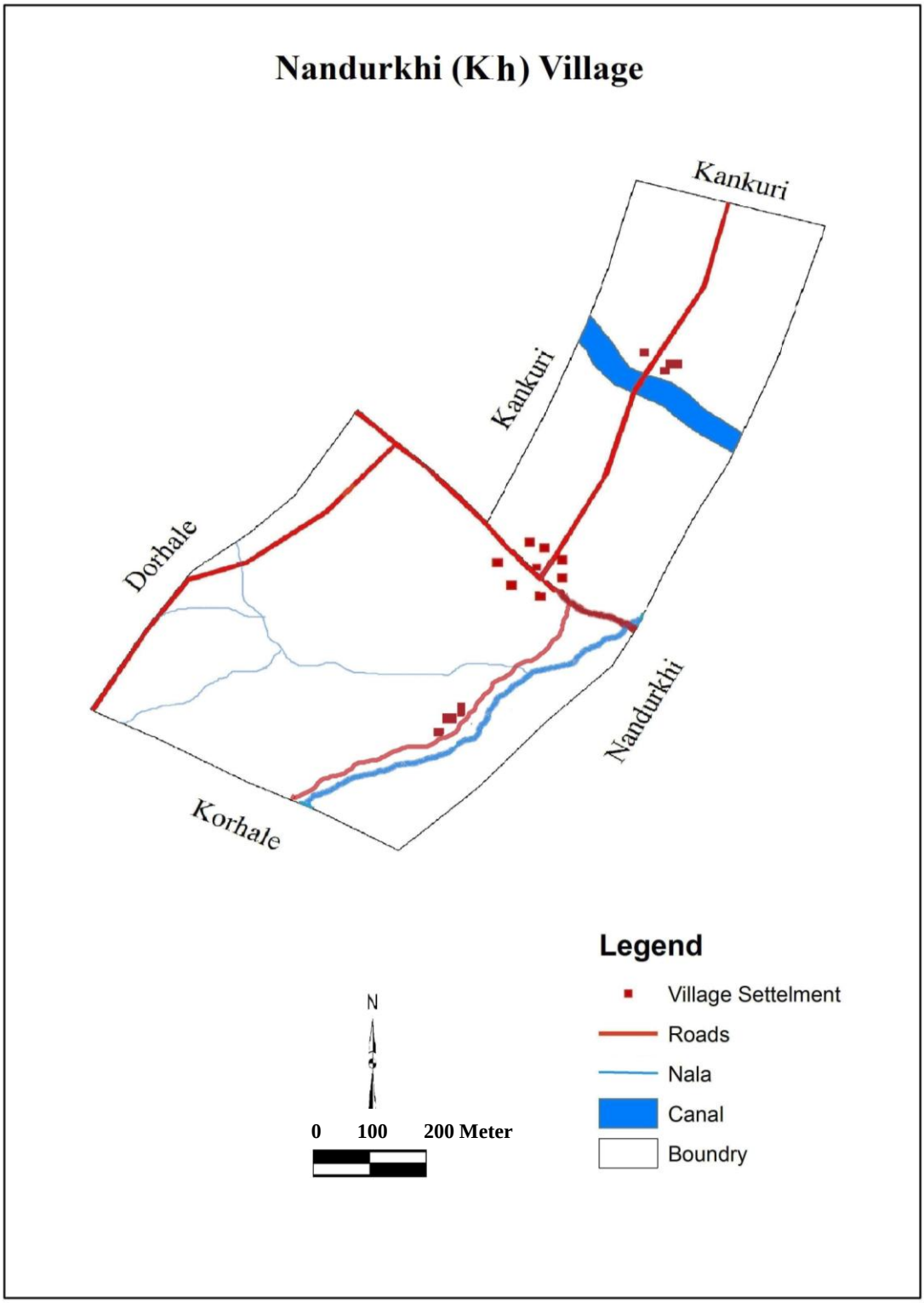
N
0 10 20 30
Km.
20°0'0"N
19°30'0"N
19°0'0"N
18°30'0"N
18°0'0"N
73°30'0"E
74°0'0"E
74°30'0"E
75°0'0"E
75°30'0"E

Fig: 7.1



Source: Talathi office Nandurkhi (Kh) Fig: 7.2

Fig. 7.3 shows the soil types in the village. The northern portions of the village have best deep black soil, locally known as *kali*. This soil has covers 34 percent area which is ideally suited to sugarcane, wheat and maize cultivation. It becomes pasty during rainy season and develop crack in summer. Its moisture retaining capacity is so high that it can produce crops in littlie irrigation. The medium black soil covered 29 percent area and appears in south-eastern part of village. In this soil bajra, maize and soyabean grow in *kharif* season and wheat, gram, maize and onion in *rabi* season. The coarse shallow soil is confined in the south-western part of village covering 37 percent area. Locally this soil is known as *bardi*. It is relatively less fertile than earlier soil types. In *kharif* season bajra, groundnut, soyabean and maize cultivated while in *rabi* season jowar is the predominant crop in this soil. In this soil without irrigation *rabi* crops are not grown and in rainfall failure condition *kharif* crops require irrigation.

7.3.2 Demography

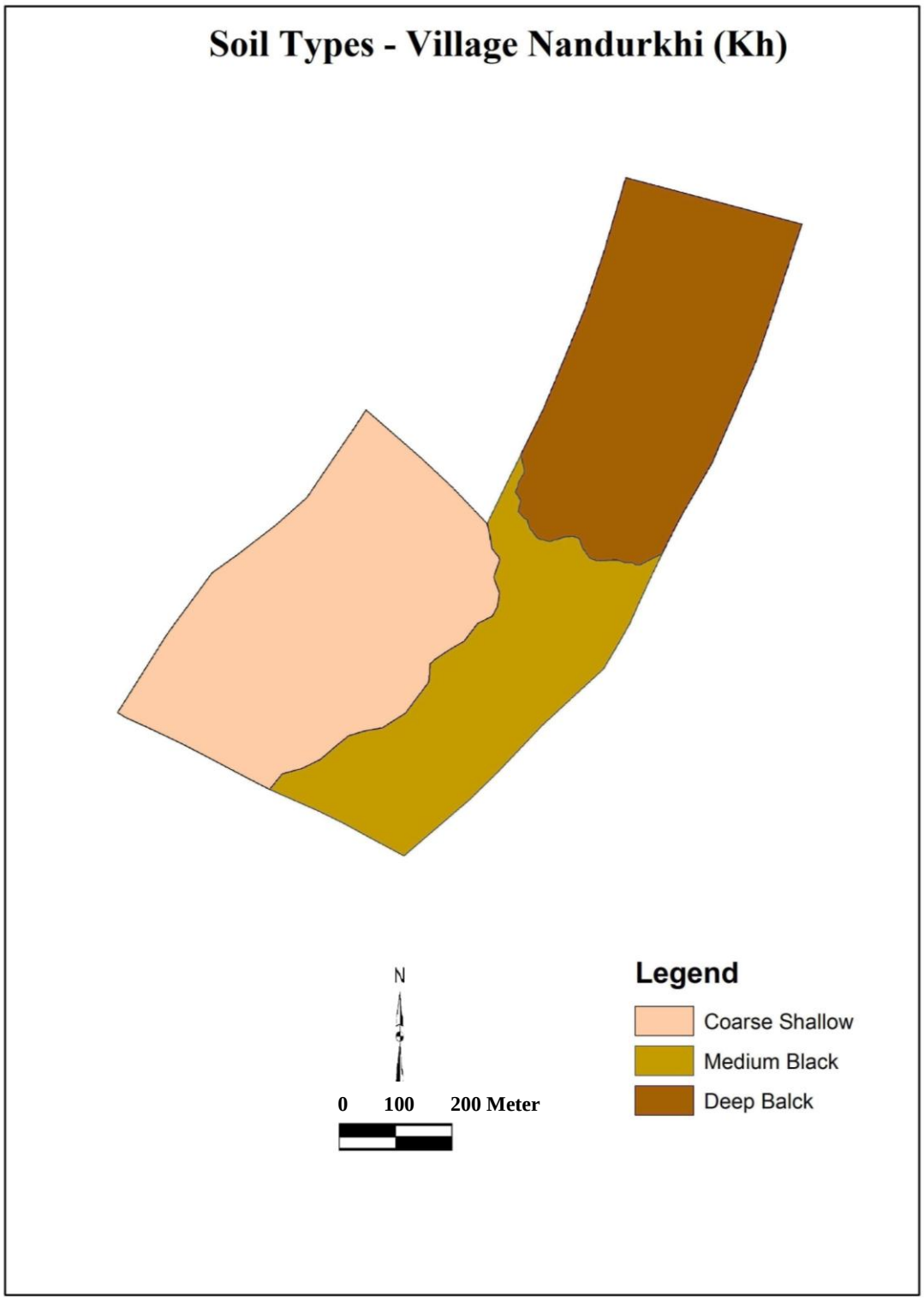
Table 7.3 and fig. 7.4 revealed demography of village Nandurkhi (Kh). Nandurkhi (Kh) village covers about 227.36 hectare area. According to 2011 census village have 1259 population out of this 665 males and 594 are females.

Table 7.3 Demography of Village Nandurkhi (Kh)

Sr. No	Description	Male	Female	Total	Percent to total
1	Number of Households	--	--	260	--
2	Total Population	665	594	1259	100
3	SC Population	21	21	42	3.34
4	ST Population	20	16	36	2.86
5	Literates	518	415	933	74.11
6	Total Workers	367	132	499	39.63
A	Main workers	347	74	421	84.37
B	Marginal worker	20	58	78	15.63
i	Cultivators	190	34	224	44.89
ii	Agricultural labour	55	71	126	25.25
iii	Other workers	128	21	149	29.86

Source: Census 2011

The village has got three clusters consisting about 260 households. One is *gaothan* second is Hanumanwadi and third is Mhasobawadi. The distance between



Source: Agriculture officer village Nandurkhi (Kh)

Fig: 7.3

each other is about half km. Out of total population 39.63 percent is classified as working population and 60.37 percent is dependent (fig. 7.4) while 29.86 percent population engage in other activity. It means that pressure of dependant population is on higher side. In this village 70.14 percent of the total work force is engaged in agriculture. This work force is classified as cultivators (44.89 percent) and agricultural labour (25.25 percent). Thus agriculture is the major claimant of workforce and income source of villagers. There are two schools, one is primary and the other is high school. The total literate persons are 933, out of which 518 males and 415 females in 2011. The literacy rate of village is 74.11 percent, which is higher than rural literate of tehsil (71.67 percent) and district (67.35 percent).

7.3.3 General Landuse Pattern

Table 7.4 and fig. 7.5 shows a summary of the proportion of the village land under various uses. Plain surface, fertile soil and irrigation facilities have determined the general land use pattern of village. Godavari river right bank canal flows in north part of this village. In this village 100 percent area is irrigated by canal, wells and tube wells (table 7.5). Northern part of village irrigated by canal tributary and south and south-west part by farmer's co-operative lift irrigation scheme and privet pipe lines from canal.

Due to availability of irrigation and plan topography land use pattern of village is quite simple. Net sown area accounts 91.58 percent of total geographical area and no land is kept fallow or given a period of rest (table 7.4). Area under forest and cultivable wasteland are not found in village. Land not available for cultivation accounts 8.42 percent, it cover by *nala*, canal, houses, school building, temples, roads etc.

Table 7.4 General Landuse Pattern village Nandurkhi (Kh)

Sr. No	Land use Pattern	Area in hectare	Percent to total
1	Area under forest	--	--
2	Land not available for cultivation	19.14	8.42
3	Cultivable wasteland	--	--
4	Follow land	--	--
5	Net sown area	208.22	91.58
	Total geographical area	227.36	100.00

Source: Talathi office village Nandurkhi (Kh) (2012-13)

Demography Village Nandurhki (Kh) - 2011

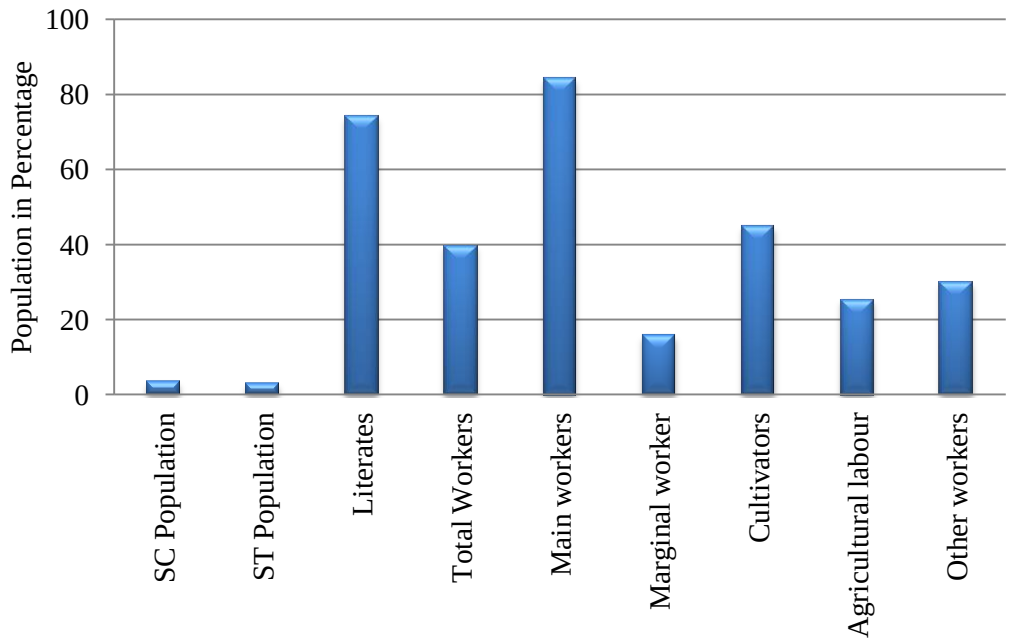


Fig. 7.4

General Land Use – Village Nandurkhi (Kh) (2012-13)

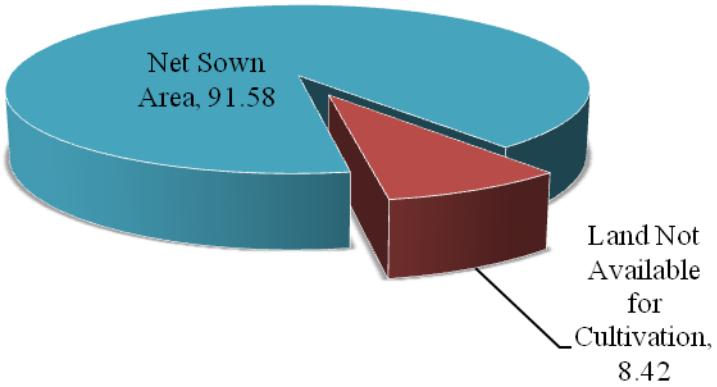


Fig. 7.5

Note: Area in Percentage

Table 7.5 Sources of Irrigation and Irrigated Area in Village Nandurkhi (Kh)

Sr. No	Source	Irrigated area (Hectare)	Percent to NSA
1	Canal	85.10	40.87
2	Well	107.00	51.39
3	Tube well	16.12	7.74
Total		208.22	100

Source: Primary data (2012-13)

7.3.4 Cropping Pattern

Table 7.6 and fig. 7.6 A and B reveals the cropping pattern of village. In *kharif* season out of net sown area 100 percent area is under cultivation. In *kharif* season bajra, maize, soyabean, groundnut, fodder, fruit and vegetables are the major crops. In this season cash crops share has lager than food and fodder crops. The cash crops i.e. soyaben, maize, groundnut and fruit, vegetables and flower occupied 51.42, 13.45, 2.59 and 3.74 percent area of net sown area respectively. Fruit and vegetables included pomegranate, chilly, brinjal, ladyfinger, cabbage and coriander. These vegetables are sold in weekly market at Shirdi or Rahata. Flowers such as rose, marigold, periwinkle and basil are grown in village. These flowers sold in daily market at holy place Shirdi. Bajra is the only food crop grown in *kharif* season and cultivated over 16.31 hectares area. Alfalfa, hybrid grass and *kadwal* (green jowar) is the major fodder crops occupied 11.14 percent area, it cultivated in both season.

Table 7.6 Cropping Pattern Village Nandurkhi (Kh)

Kharif Season			*Rabi* season		
Crops	Area (Hectare)	% to NSA	Crops	Area (Hectare)	% to NSA
Bajra	16.31	7.83	Wheat	74.00	35.54
Maize	28.01	13.45	Jowar	28.64	13.82
Soyabean	107.07	51.42	Maize	16.00	7.68
Sugarcane	20.45	9.82	Onion	23.00	11.05
Groundnut	5.39	2.59	Gram	15.00	7.20
Fodder	23.2	11.14	Sugarcane	20.45	9.82
F, V, F*	7.79	3.74	Fodder	23.2	11.14
--	--	--	F,V,F*	7.93	3.74
Total	208.22	100.00	Total	208.22	100.00

Source: Primary data (2012-13)

Note: (i) NSA - Net Sown Area (ii) F, V, F* = Fruits, Vegetables and Flowers

Cropping Pattern -Village Nandurhi (Kh) (2012-13)

***Kharif* Season**

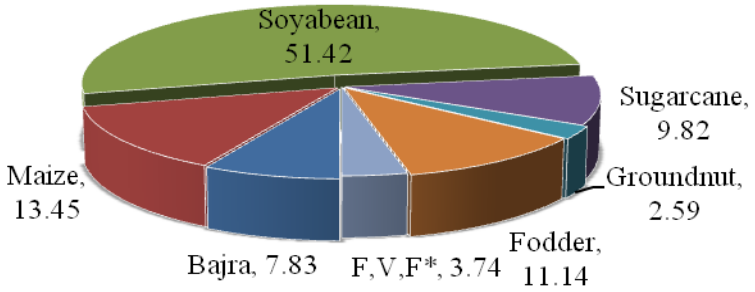


Fig. 7.6 A

***Rabi* Season**

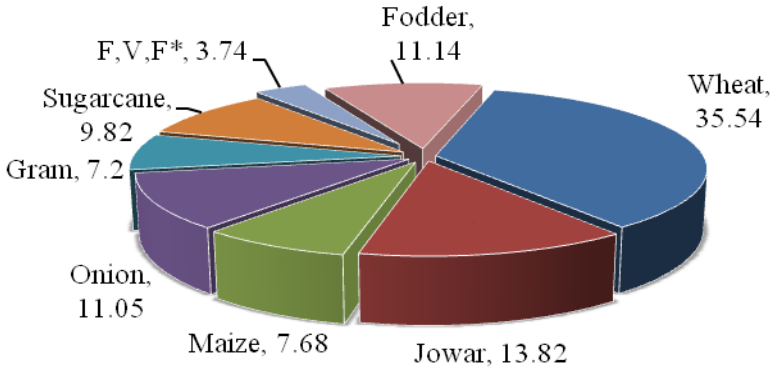


Fig. 7.6 B

Note: (i) Area in Percentage (ii) FVF* - Fruits, Vegetables and Flowers

In *rabi* season wheat, jowar, maize, onion and gram are grown in village. These crops occupied 100 percent net sown area. Among these crops wheat takes the lion share (35.54 percent) followed by jowar, onion, maize and gram. Sugarcane is the perennial cash crop cultivated in north part of the canal and east part of village *nala*. It covers 9.83 percent land to net sown area. As compare to number of cultivators farm size is too small (1.01 hectare) because of this farmers can pay greater attention of crops.

7.3.5 Crop Production

The table 7.7 makes it clear that the production of all crops is higher. Due to fertile soil, adequate irrigation facility, modern farm implements and also use of high yielding variety seeds, chemical fertilizer, farm manures, pesticides and timely irrigation. In this village number of tractors is 18 and most of the agricultural practices done through tractors. For the purpose of irrigation farmers are use electric pumps for lifting water. Chemical fertilizer and high yielding variety seeds use are also high. Its share of per hectare has 1.86 and 1.13 quintals respectively (table 7.8). The share of non physical determinants is high per hectare so production of crops is high.

Table 7.7 Average Production of Major Crops per Hectare in Quintals / Ton

Kharif season		*Rabi* season	
Crops	Quintals per hectare	Crops	Quintals per Hectare
Bajra	31	Wheat	49
Maize	65	Jowar	12
Soyabean	20	Onion	116
Sugarcane	116(ton)	Gram	13
Groundnut	23	--	--

Source: Primary data (2012-13)

Table 7.8 Non Physical Determinants village Nandurkhi (Kh)

Particular	Number	Per Ha	Particular	Number	Per Ha
Iron plough	26	0.13	Chemical Fertilizer	387 (Quintal)	1.86
Tractors	18	0.09	Bullock	56	0.27
Electric pump	189	0.91	Cow	398	1.91
HYV seeds	236 Quintal)	1.13	Buffaloes	22	0.11

Source: Primary data (2012-13) Note: Ha - Hectare

The average production of bajra is 31 quintals per hectare while maize production 65 quintals per hectare. The production of soyabean is 20 quintals per hectare while groundnut and sugarcane production is 23 (quintals) and 116 (tons) per hectare respectively. *Rabi* crops such as wheat, jowar and gram production is 49, 12, and 13 quintals per hectare respectively.

7.3.6 Livestock

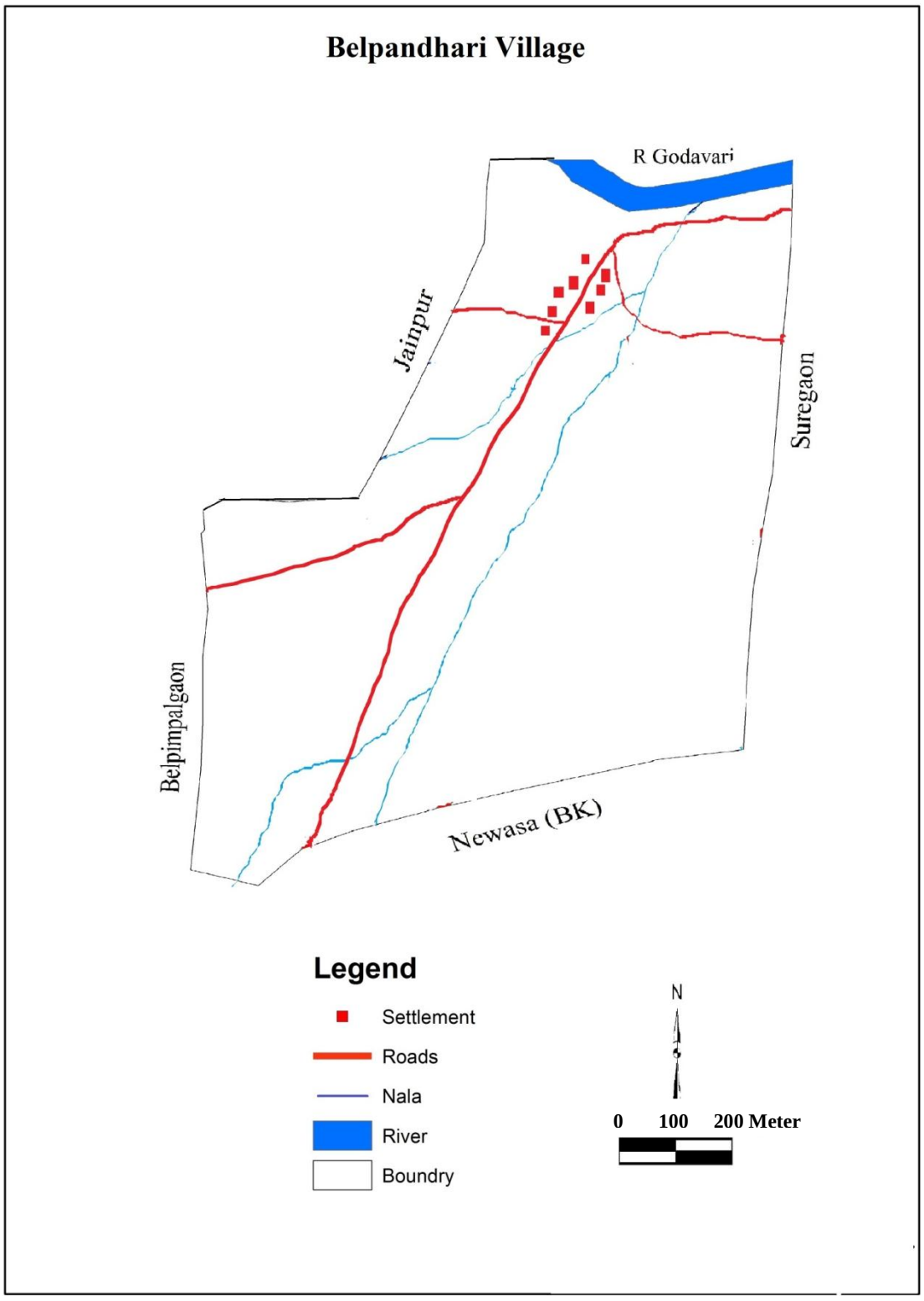
Livestock occupy an important position in economy of village. In this village bullock number is 56 it rear by small farmers and some work such as ploughing, sowing and transportation carried by bullocks. The cows and buffaloes are the important as producers of milk. The numbers of cow and buffaloes are 398 and 22 perceptively (table 7.8). Dairy activity is the main subsidiary occupation of cultivators. All the farmers rearing standard breed cow and buffaloes. There are two milk collection centers and they collect daily near about 1600 liter milk. This has become a major source of the economy of village. The agricultural point of view dung and urine of livestock area mostly use as manure, it is better for increasing production of crops.

Resume

In village Nandurkhi (Kh) agriculture is the major occupation of people, out of total population 70.14 percent population involve in this activity. The total geographical area of village is 227.36 hectares out of this 208.22 hectares area under cultivation. The cropping pattern of village is governed by irrigation. Soyabean, wheat, maize, onion, fodder and sugarcane are the major crops. Compare to district production of these crops is also high. Farmers of this village use modern farm implements for agricultural practices. Various governments subsides schemes related to agriculture such as farm ponds, drip irrigation, small tractors, fruit crops are widely accepted by farmers. Village has farmers cooperative credit society, it provide loan to farmers. Dairy activity is the major subsidiary occupation of cultivators. Some time there is long gap in canal rotation that time farmers faces the problem of water scarcity, its adverse effect on crop yield and also load shedding is the second major problem of village.

7.4. Belpandhri Village

Belpandhri is a fairly large village, about 13 km. from tehsil place Nevasa (fig.7.7). The village is situated on the south bank of the river Godavari having area about 988.34 hectares. It is situated at 19^0 39´16´´ north latitude and 74^0 52´ 18´´ east



Source: Talathi office village Belpandhari

Fig: 7.7

longitude. Village lies 5 kilometers north from Shevgaon - Ghoti state highway. The village is flanked by river Godavari by north, on the west by Belpimpalgaon and Jainpur village, Nevasa (Bk) in south and on the east by Suregoan village. According to 2011 census population is 1242 and density of 1.26 persons per hectare. The gaothan is at south within the village area. Belpimpalgaon is a weekly market centre located four kilometers from this village.

7.4.1 Physiography, Climate and Soil

Average height of the village is 480 meters above sea level. The entire northern portion of village presents almost a flat level plain and southern portion have some slope. The general direction of slope is towards north. It is evident from the *nalas* flowing to north. The southern and south-west side of the village is upland and three small streams flows from this upland in the northern and eastern directions. These streams have water in only rainy season.

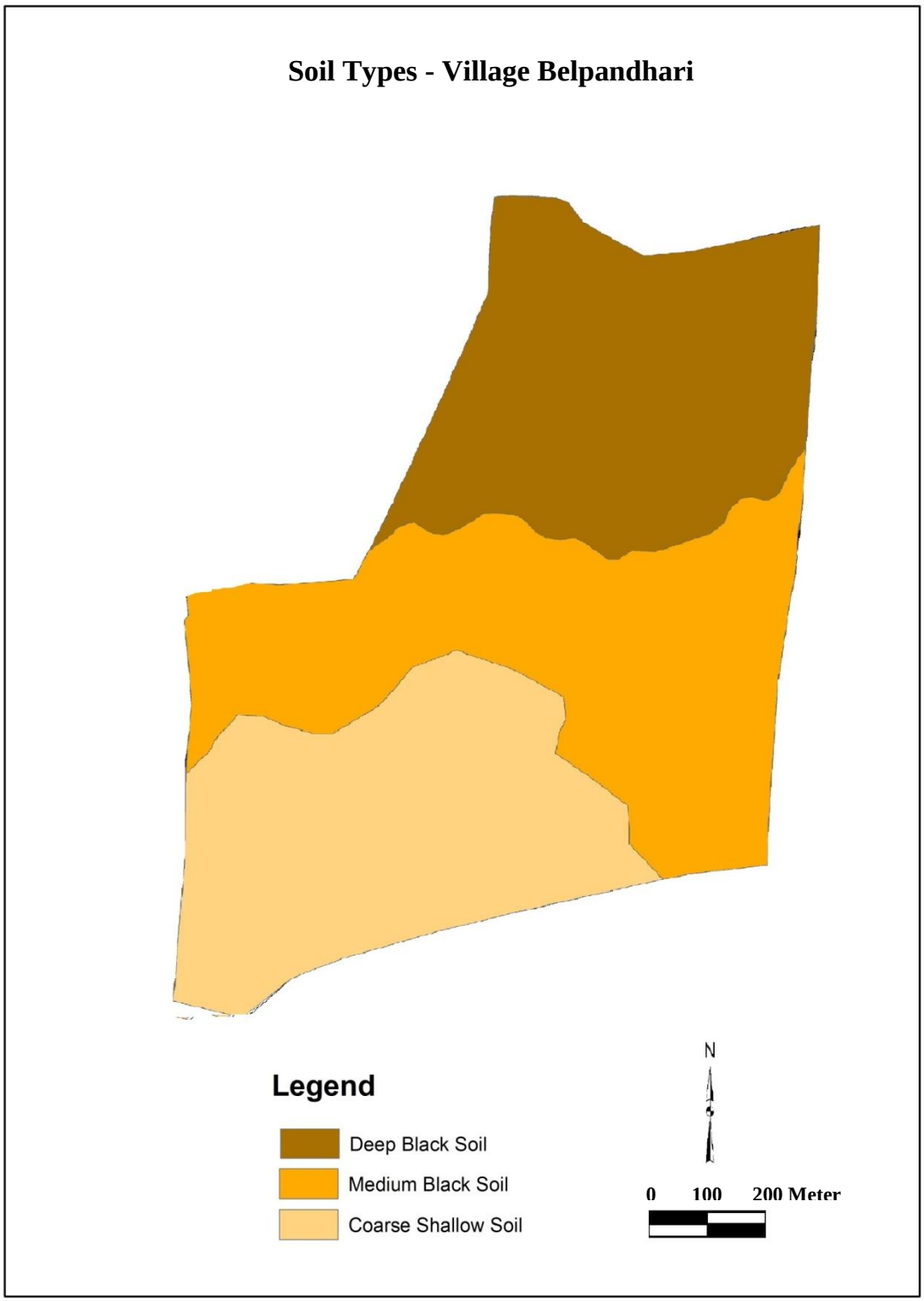
Average annual rainfall in this area is about 599 mm and nearly 88.48 percent of the total annual rainfall is received during the period June to October from south-west monsoon (table 7.9). The winter season is experience in November to February and summer from March to May. Out of total rainfall during winter and summer average rainfall of this area is about 7.35 and 4.17 percent respectively. The mean maximum temperature of this area goes up to 37.1^0 C during the summer season, while in the winter season it comes down to the mean minimum of 20.7^0 C.

Table 7.9 Average Rainfall

Station	Annual Rainfall	June- Oct.		Nov.-Feb.		March-May	
		mm	%	mm	%	mm	%
Nevasa	599 mm	530	88.48	44	7.35	25	4.17

Source: Irrigation department, Nevasa (2012-13)

Soils of village are classified into three categories, namely, coarse shallow, medium black and deep black (Fig. 7.8). Coarse shallow soil occupies south parts of village. It covers approximately 26 percent of total area. Crops like jowar, bajra, wheat, onion and maize are grow in this soil. Medium black is found in central part of village on 39 percent area. Cotton, sugarcane, jowar, onion, gram, maize and fodder are grown in this soil. Deep black soils occupied 35 percent area of north parts of village. Sugarcane and cotton are the main crops grow in this soil.



Source: Agriculture officer village Belpandhari

Fig: 7. 8

7.5.2 Demography

Table 7.10 and fig. 7.9 revealed demographic characteristic of village Belpandhari. The village has 261 householders with a population of 1242 out of which 52.42 percent male and 47.58 percent female according to 2011 census. It is an agricultural village where nearly 97 percent population directly or indirectly depends on agriculture. The literacy rate of village is 70.61 percent. Male literacy rate is higher than female. In this village out of total population 48.15 percent population is working population while 51.85 percent is dependent. It means that the dependant population is on higher side. Out of total working population 93.63 percent work force engaged in agriculture, out of this 51.83 percent are cultivators and 41.80 percent are agricultural labours and 6.36 percent population engaged in other activities. It evident shows that human recourse utilization is most poor. The village got 178 numbers of scheduled cast persons and 120 numbers of scheduled tribe persons and they contribute 14.33 and 9.66 percent respectively to the total population. The number of females in both the categories is less than males. The occupation of this population is agricultural labourers while some tribal population engaged in seasonal fishing activity.

Table 7.10 Demography of Village Belpandhari

Sr. No	Description	Male	Female	Total	Percent to total
1	Number of Households	--	--	261	--
2	Total Population	651	591	1242	100
3	SC Population	98	80	178	14.33
4	ST Population	71	49	120	9.66
5	Literates	485	392	877	70.61
6	Total Workers	366	232	598	48.15
A	Main workers	364	223	587	47.26
B	Marginal worker	2	9	11	0.89
i	Cultivators	192	118	310	41.83
ii	Agricultural labour	145	105	250	41.80
iii	Other workers	29	9	38	6.35

Source: Census, 2011

7.4.3 General Landuse Pattern

The area and it percentages of the various uses of the land to the total geographical area of the village have been shown in table 7.11 and fig. 7.10.

Demography Village Belpandhari – 2011

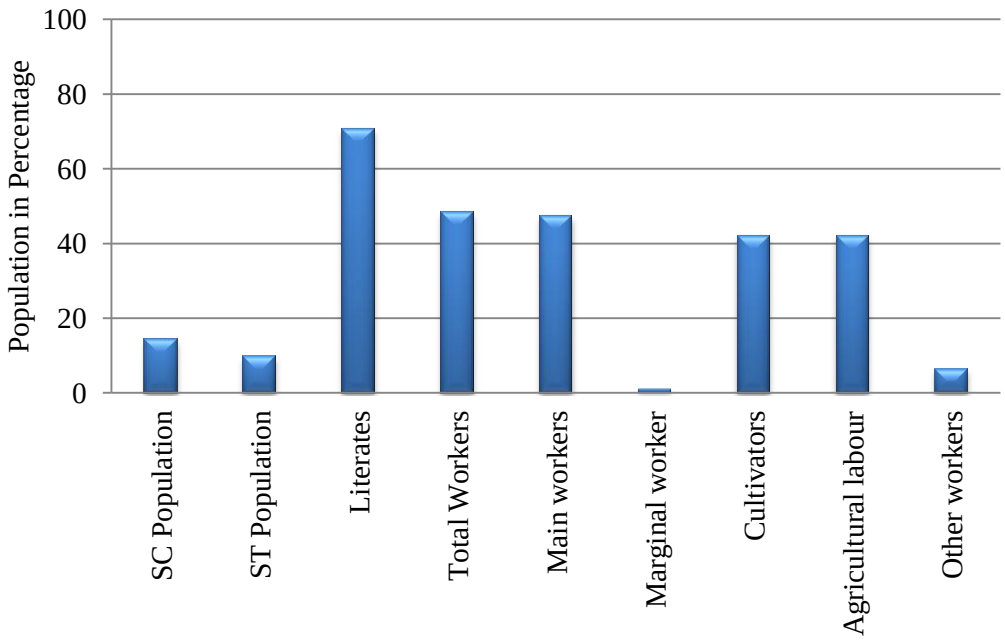
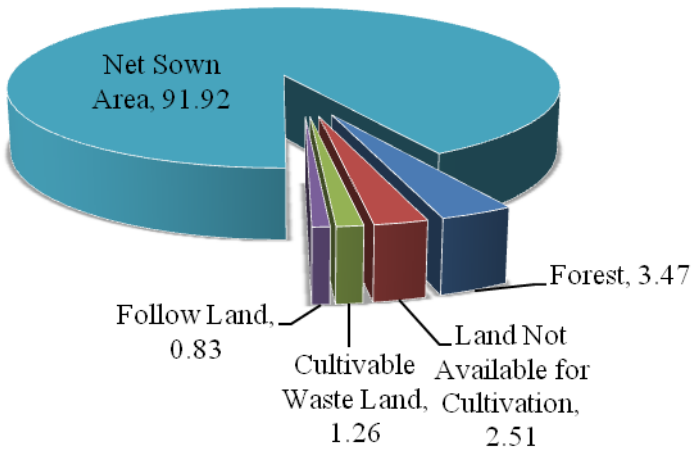


Fig. 7.9

General Land Use – Village Belpandhari (2012 13)



Note: Area in Percentage Fig. 7.10

Table 7.11 General Landuse Pattern Village Belpandhari

Sr. No	Land use Pattern	Area in hectare	Percent to total
1	Area under forest	34.32	3.47
2	Land not available for cultivation	24.83	2.51
3	Cultivable wasteland	12.44	1.26
4	Fallow land	8.23	0.83
5	Net sown area	908.52	91.92
Total geographical area		988.34	100.00

Source: Talathi office village Belpandhari (2012-13)

Plain topography, soil types and availability of irrigation facility are the major controlling factors of present general land use pattern of village. The total area of the village is 988.34 hectares, out of which 34.32 hectares or 3.47 percent to total geographical area is under forest. It found in two patches located in north-west part and coastal area of river Godavari. About 2.51 percent of the total geographical area is classified as area not available for cultivation. Cultivable waste land occupied 12.44 hectares or 1.26 percent to total geographical area of village while 8.23 hectares land is left fallow. Net sown area has significant hectarage, out of total geographical area 908.52 hectare or 91.92 percent is under cultivation, spread within the village.

Wells, tube wells and river is the major source of irrigation. The village has 98 wells, 203 bore wells and 23 pipelines form river. Wells and tube wells have been found suitable for irrigation in both *kharif* and *rabi* season but in summer season water has gone down. Most of the wells and tube wells located in south part of the village area are become dry during summer season. Lift irrigation is the perennial source of irrigation found in north part of village where sugarcane is the dominant crop. In this village out of net own area 72.10 percent area is irrigated (table 7.12) while rest of the area is rain fed which are found in south part of the village.

Table 7.12 Sources of Irrigation and Irrigated Area

Sr. No	Source	Irrigated area (Hectare)	Percent to NSA
1	Well	178	19.59
2	Tube well	265	29.17
3	Lift from river	212	23.33
Total		655	72.10

Source: Primary data (2012-13)

7.4.4 Cropping Pattern

The cropping pattern of village is outcome of soil types, irrigation facilities, distribution of rainfall, traditional and technological approach of agricultural practices. Table 7.13 and fig. 7.11 A and B gives an overall picture of cropping pattern of village Belpandhari.

Table 7.13 Cropping Pattern Village Belpandhari

Kharif Season			*Rabi* season		
Crops	Area (Hectare)	% to NSA	Crops	Area (Hectare)	% to NSA
Bajra	103.46	11.39	Jowar	246.1	27.09
Cotton	226.14	24.89	Wheat	112.24	12.35
Sugarcane	259.48	28.56	Gram	89.22	9.82
Soyabean	76.74	8.45	Onion	58.64	6.45
Maize	49.86	5.49	Sugarcane	259.48	28.56
Onion	26.45	2.91	Fruits & Vegetables	9.54	1.05
Tur	5.48	0.60	Fodder	56.76	6.25
Groundnut	5.1	0.56	--	--	--
Fruits& Vegetables	11.24	1.24	--	--	--
Fodder	65.47	7.21	--	--	--
Total	829.42	91.29	Total	831.98	91.58

Source: Primary data (2012-13) Note: NSA - Net Sown Area

The agricultural year is divided into two main seasons i.e. *kharif* and *rabi*. *Kharif* season is most important season, out of net sown area nearly 91.29 percent areas is sown under different crops. This season start with the advent of the monsoon, generally in the first or second week of June. The principal *kharif* crops are bajra, cotton, sugarcane, soyabean, groundnut, maize, tur, onion and vegetables. Almost all the *kharif* crops except sugarcane are grown without irrigation. But sometime long gap in rainfall farmers gives one or two rotation of irrigation to crops. Sugarcane is perennial crop and stands first ranking crop occupying 28.56 percent area to net sown area. It is the most important cash crop of village. It is sown on deep black to medium black soils appears in central and northern parts of village. The growing period of sugarcane varies from 9 to 12 months. It requires frequent watering. Almost all the farmers it ratooned two to three times. Cotton stands as second ranking crop occupying 24.89 percent area to net sown area. It is mainly concentrated in the central part. The cultivation of bajra is observed in mainly central and south parts on medium

Cropping Pattern -Village Belpandhari (2012-13)

***Kharif* Season**

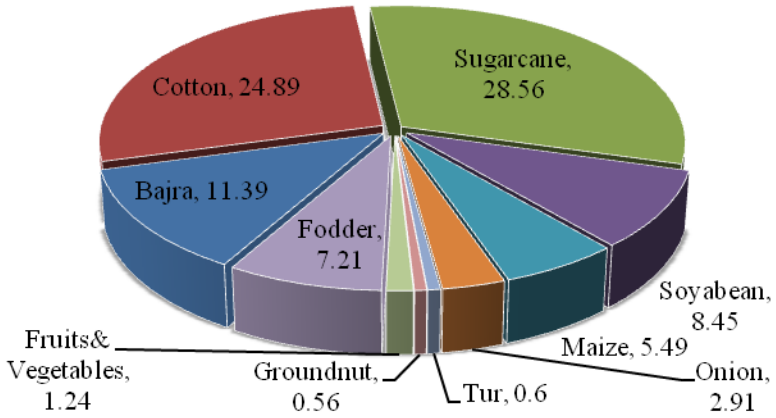
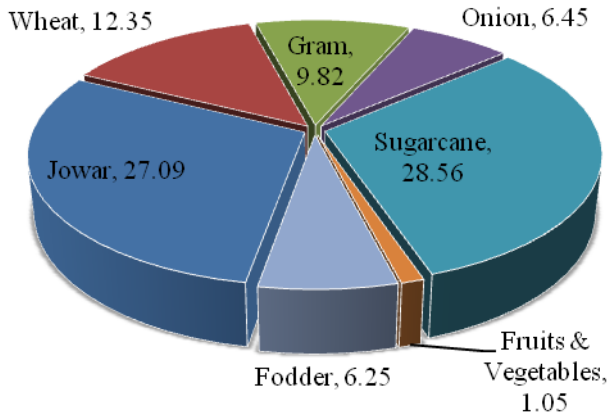


Fig. 7.11 A

***Rabi* Season**



Note: Area in percentage

Fig. 7.11 B

deep black and coarse shallow soils. It stands third rank and occupying 103.46 hectare or 11.39 percent area to net sown area. Soyabean is sown on 8.45 percent to net sown area followed by fodder (7.21 percent), maize (5.49 percent), onion (2.91 percent), fruit and vegetables (1.24 percent), tur (0.60 percent) and groundnut (0.56 percent) distributed in patches mainly in central and south parts. Under fruit, newly planted three pomegranate garden found in south part, it covered 2.5 hectare land. During *kharif* season out of net sown area 8.71 percent land kept fallow for *rabi* jowar.

Table 7.13 revealed interesting features regarding the use of agricultural land in the *rabi* season. The *rabi* season start from October and are harvested in March to April. The major crops of this season are jowar, wheat, gram, onion, fodder, fruit and vegetables. All the crops in this season are grown either on irrigation from various previous discussed sources or on the moisture available in the soil after the monsoon rainfall. With the exception of jowar and gram almost all the crops are irrigated at least four to five times while jowar and gram irrigated at least once during the growing period. The overall cropping pattern in *rabi* season shows that out of net sown area nearly 49.26 percent land is devoted to cereals, 36.06 percent land under cash crops and 6.25 percent land is under fodder crops. Jowar stands first rank occupying 27.09 percent area to net sown area. It cultivated in central and south parts. Out of net sown area wheat and gram occupied 12.35 and 9.82 percent area respectively. It has mainly concentrated in the central part of the village. Onion is the major cash crop covered 6.45 percent land to net sown area. It cultivated in late harvested cotton land mainly in central part. Most of the farmers cultivated vegetables i.e. brinjal, chilly, leafy vegetables, lady fingers etc. for home consumption. Fodder crops (*kadwal*, alfalfa, hybrid green grass, maize) occupied 6.25 percent land to net sown area. Fodders and vegetables distribution found in many patches disintegrated within the village area. During *rabi* season 8.42 percent land to net sown area is kept fallow because of late harvesting of cotton.

7.5.5 Crop Production

Table 7.14 revealed production of major crops cultivated in Belpandhari. The production of crops per hectare is owing to the variation in the rotation of irrigation, difference in the quality of soil, use of high yielding variety of seeds, use of chemical fertilizer and amount of rainfall. All farmers use modern method of agricultural practices. The production of sugarcane per hectare is varies from 90 to 102 ton. The production of sugarcane is less than previous discussed village due to three reasons.

First is the farmers take this crop again and again in same field, second is the over irrigation from river and third is the framers use high doses of chemical fertilizers. Its adverse effects on soil productivity due to this sugarcane productivity decease year by year. The average yield of cotton ranges from 8 to 12 quintals per hectare while bajra production 24 quintals per hectare which is certainly lower than developed tehsils in Ahmednagar district. The production of soyabean is 22 quintals per hectare while groundnut, maize and tur production is 18, 28 and 6 quintals per hectare respectively.

Table 7.14 Average Production of Major Crops per Hectare in Quintals / Ton

(*Kharif* season)		(*Rabi* season)	
Crops	Quintals per Hectare	Crops	Quintals per Hectare
Bajra	24	Jowar	11
Cotton	10	Wheat	32
Soyabean	22	Gram	9
Groundnut	18	Onion	112
Sugarcane	96 (ton)	--	--
Maize	28	--	--
Tur	6	--	--
Onion	76	--	--

Source: Primary data (2012-13)

Onion is the major cash crop cultivated in both *kharif* and *rabi* season and its average production 76 quintals and 112 quintals per hectare respectively. Jowar is the major food crop in rabi season sown in September to October and harvested in February to March. The average production of jowar is 11 quintals per hectare while wheat production 32 quintals per hectare. Economic statuses of framers have sound so all the framers have used modern farm implements. Village has 16 tractors and 324 electric pumps. Agricultural input such as high yielding variety of seeds and chemical fertilizers use is 0.47 and 2.22 quintal per hectare respectively (table 7.15). Framers give two doses of chemical fertilizers for sugarcane during first four month of growing period.

7.4.6 Livestock

There is no grazing land to support the livestock population i.e. goat and sheep so share of this types of livestock is negligible. Almost all the cultivators and agricultural labours keeping breed cows and buffaloes for the purpose of production

of milk. It is the subsidiary occupation of villagers. People keep stall feeding livestock within the limit to provide fodder from agricultural residue. Livestock population of the village is 951 units of which 80.76 percent are cows. Bullock's number is 118. They are useful for various agricultural operations (table 7.15). Buffaloes are mainly kept by scheduled cast and tribal agricultural labours. There are two milk collection centers they collect daily near about 3200 liter milk per day. The farmers devote large area in both seasons to fodder crops. Jowar is a highly cultivated crop in this village, it dried stems is use for fodder. Most of the farmers have use sugarcane as a green fodder.

Table 7.15 Non Physical Determinants Village Belpandhari

Particular	Number	Per Ha	Particular	Number	Per Ha
Iron plough	60	0.07	Chemical Fertilizer	2015(Quintal)	2.22
Tractors	16	0.02	Bullock	118	0.13
Electric pump	324	0.36	Cow	768	0.85
HYV seeds	425(Quintal)	0.47	Buffaloes	65	0.07

Source: Primary data (2012-13)

Note: Ha – Hectare

Resume

The village is representative of moderate agricultural productivity region. Agriculture is the main occupation of villagers, involving 93.63 percent working forces to total working population. It is observed that sugarcane is the major cash crop occupied 28.56 percent land to net sown area. Cotton and *rabi* jowar is the dominant crops it raised on 24.89 percent and 27.09 percent to net sown area respectively. Cotton, wheat and gram are major *rabi* crops. It is observed that high economic value crops are raised on deep black and medium black soil while low economic values crops are raised on coarse shallow soil. Wells, tube-wells and river is the sources of irrigation. Dairy is the subsidiary occupation of villagers. Due to over irrigation from river groundwater is saline. It is the major problems for agriculture. Cultivators have limited options to grow crops of adoptable to saline water. Due to saline water people face problem of drinking water. There is need to change cropping pattern. Awareness among the farmers, about crop rotation and irrigation is the major work for sustainable agricultural development in this village.

7.5 Jakhangaon Village

The village Jakhangaon lies almost exactly at the crossing of 19° 12´ 45´´ north latitudes and 74° 33´ 12´´ east longitudes. The village is about 15 km. west of the tehsils place Nagar. The Ahmednagar – Kalyan state highway passes through this village. A number of small shops found on either side of the road. Road transport is more prominent here as the village is well connected by metalled road. Village is confined by Hingangaon and Hamitpur in north, Nimgaonwagha in east, Pimpalgaonwagha in south and Takli and ideal village Hiverebazar in west (Fig.7.12). The village extends over 1034.32 hectares land with a population of 1896 in 2011.

7.5.1 Physiography, Climate and Soil

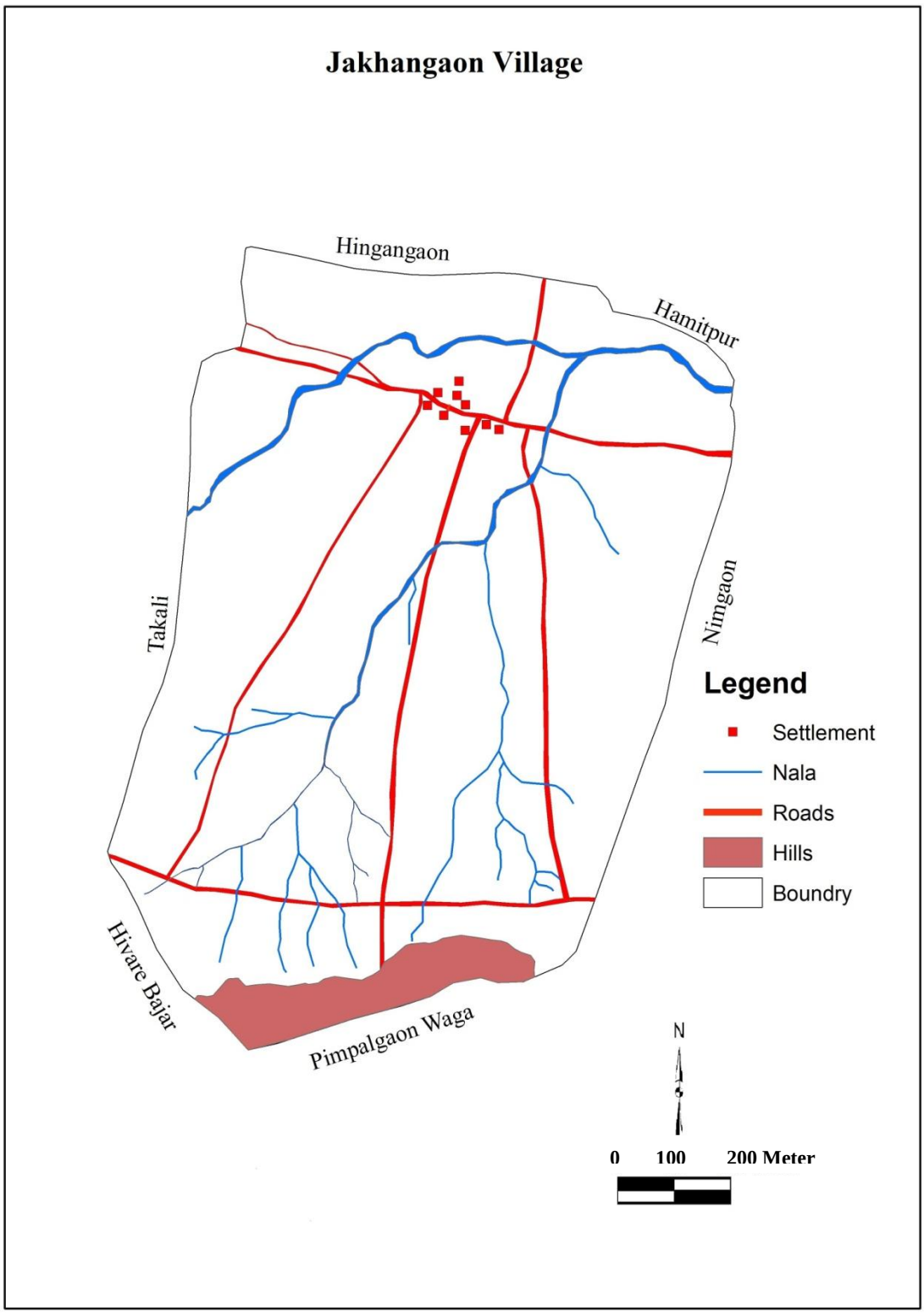
Jakhangaon lies at 678 meters above mean sea level. The general slope direction of village is from south to north. About 75 percent part of the village is plain. From central part to north entire portion of village is flat level plain and homogeneous in character. Southern portion of village is occupied by small hill, which height is about 760 meters above sea level. There are three seasonal streams within geographical area of village, out of them two streams origin from southern hill range, they flows from south to north and joined each other near south side of gaothan. Third stream enter in village area from west side, it flow some distance toward south and taking right turn and flow toward east in north part of the gaothan.

Village experiences typical hot and dry climate. The summer season experiences from month of March to May. Monsoon beings in the month of June to which lasts up to October and winter season is experienced in November to February. The highest temperature (40.23^0 C) is recorded in month of May. The mean maximum temperature of the village goes up to 38.53^0 C during the summer season, while in the winter season it comes down to the mean minimum of 18.15^0 C. Average annual rainfall of this area is about 520.22 mm. Out of total rainfall 89.85 percent received during the period from June to October while 4.67 and 5.46 percent during period of winter and summer respectively (table 7.16).

Table 7.16 Average Rainfall

Station	Annual Rainfall	June- Oct.		Nov.-Feb.		March-May	
		mm	%	mm	%	mm	%
Ahmednagar	520.22 mm	467.46	89.85	24.32	4.67	28.44	5.46

Source: Department of Agriculture Panchyat Sammittee, Ahmednagar (2012-13)



Source: Talathi office village Jakhangaon Fig: 7.12

The physiography of the village plays predominant role in soil formation process. This village has major three types of soil namely, deep black, medium black and coarse shallow (fig. 7.13). The deep black soil covers 31 percent area and occupied northern portion of the village. Bajra, *rabi* jowar, cotton, maize and vegetables are mainly grow in this soil. Water holding capacity of this soil is comparatively high so it can produce crops without irrigation. The medium black soil covered 42 percent area and appears in central part of village. In this soil bajra, maize, and fodder crops have grown in *kharif* season while jowar, wheat, gram, onion in *rabi* season. The coarse shallow soil is found in the south part of village covering 27 percent area. In this soil in *kharif* season groundnut, bajra, and some pulses are cultivated while during *rabi* season it kept fallow.

7.5.2 Demography

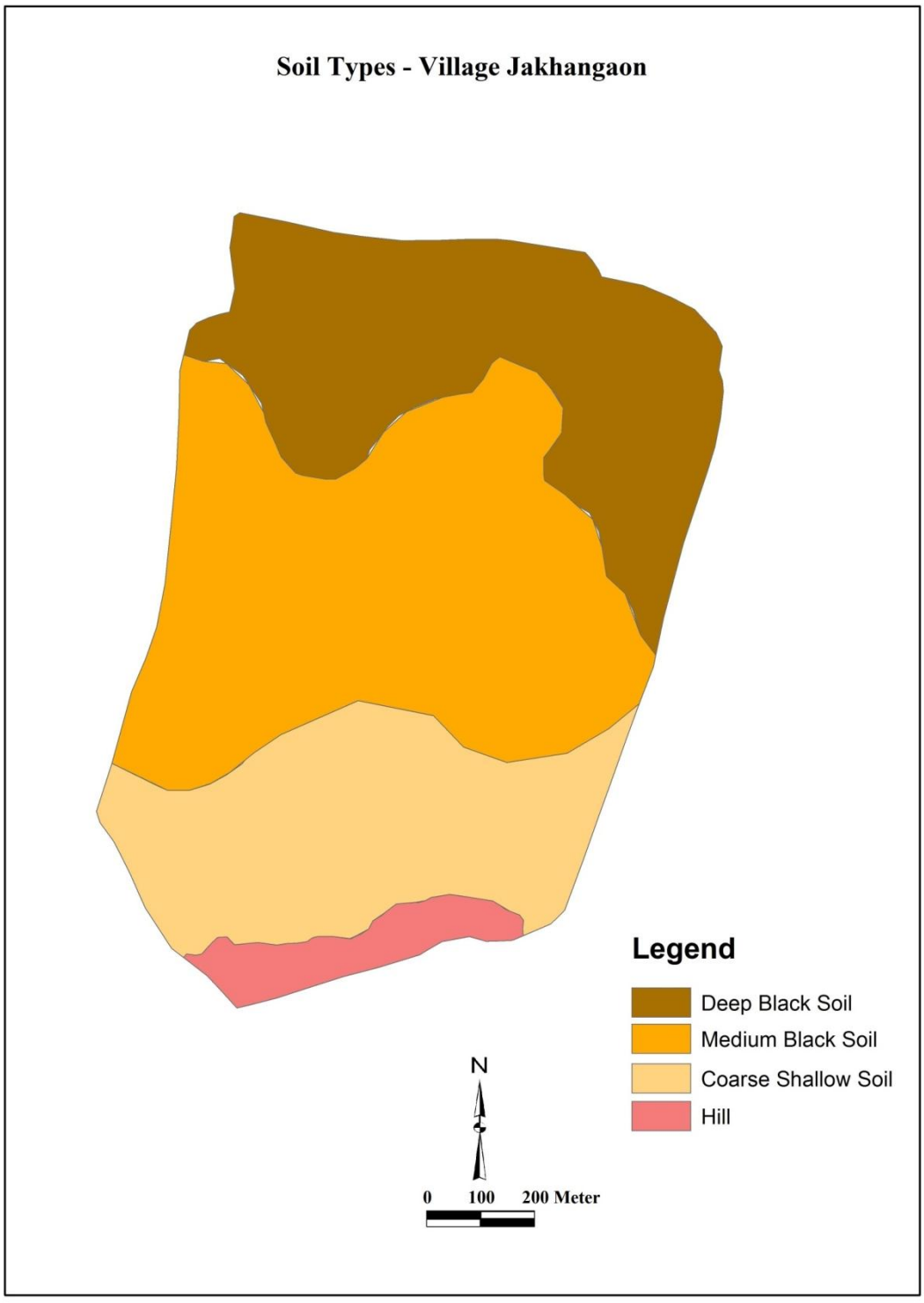
Table 7.17 revealed demographic characteristic of village Jakhangaon. According to census 2011, total population of village is 1896 out of these 51.10 percent male and 49.90 percent female. It shows that male population is dominant than female population.

Table 7.17 Demography of Village Jakhangaon

Sr. No	Description	Male	Female	Total	Percent to total
1	Number of Households	--	--	384	--
2	Total Population	969	927	1896	100
3	SC Population	101	101	202	10.65
4	ST Population	76	63	139	7.33
5	Literates	754	572	1326	69.94
6	Total Workers	546	417	963	50.79
A	Main workers	519	369	888	46.84
B	Marginal worker	27	48	75	3.96
i	Cultivators	372	235	607	63.03
ii	Agricultural labour	125	114	239	24.82
iii	Other workers	90	27	117	12.15

Source: Census, 2011

Out of total population 69.94 percent is literate (fig.7.14). Male literacy rate is higher than female. In this village 50.79 percent population classified as working population while 49.21 percent is dependent. It means that the near about 50 percent population is dependant. In this village out of total working population 87.85 percent work force is engaged in agriculture. This work force is classified as cultivators



Source: Agriculture officer village Jakhangaon

Fig: 7.13

(63.03 percent) and agricultural labours (24.82 percent). Thus the agriculture is the major occupation and source of income of villagers.

7.5.3 General Landuse Pattern

Table 7.18 and fig. 7.15 revealed that the general land use pattern of village Jakhangaon. The rugged as well as plain topography, availability of irrigation and types of soil have contributed present landuse pattern of village. Wells and tube wells are the major source of irrigation. Its irrigation capacity mostly depends on rainfall receive during monsoon season. Both sources are seasonal and having water only six to eight month. In this village out of net sown area 34.52 percent area is irrigated by various sources (table 7.19).

Table 7.18 General Landuse Pattern Village Jakhangaon

Sr. No	Land use Pattern	Area in hectare	Percent to total
1	Area under forest	3.24	0.31
2	Land not available for cultivation	65.82	6.36
3	Cultivable wasteland	8.92	0.86
4	Fallow land	35.16	3.40
5	Net sown area	921.18	89.06
Total geographical area		1034.32	100.00

Source: Talathi office village Jakhangaon (2012-13)

Table 7.19 Sources of Irrigation and Irrigated Area Village Jakhangaon

Sr. No	Source	Irrigated area (Hectare)	Percent to NSA
1	Well	296	32.13
2	Tube well	22	2.39
Total		318	34.52

Source: Primary data (2012-13)

Note: NSA – Net Sown Area

Forest covers are found in south parts of village, it occupied only 0.31 percent geographical area. Land not available for cultivation is accounts 6.36 percent, it cover by *nala*, houses, school building, temples, roads etc. Cultivable waste land covers 0.86 percent area. It found in small patches throughout the village. Fallow land occupied 3.40 percent to total geographical area (fig. 7.15). It appears in two patches, one patch appears in south part of village, running in east-west direction. Second patch is found in south west part, running north-south direction. The net sown area

Demography Village Jakhangaon - 2011

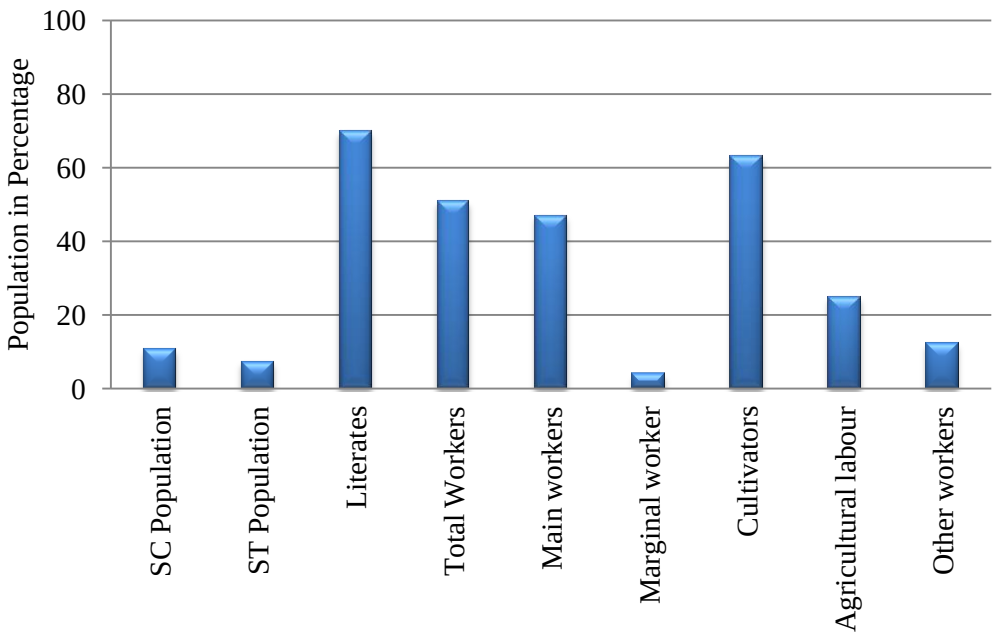
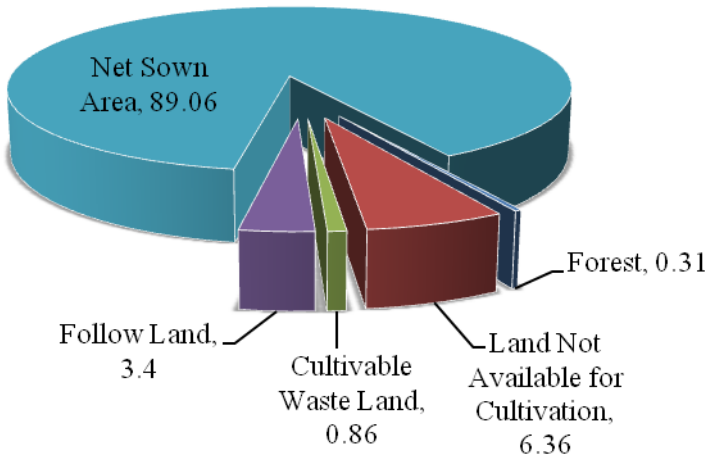


Fig. 7.14

General Land Use Pattern – Village Jakhangaon (2012-13)



Note: Area in percentage

Fig. 7.15

accounts 89.06 percent to total geographical area. Except southern hill range rest of the village land is under sown.

7.5.4 Cropping Pattern

Table 7.20 and fig. 7.16 A and B reveals the cropping pattern of village.

Table 7.20 Cropping Pattern Village Jakhangaon

Kharif Season			*Rabi* season		
Crops	Area (Hectare)	% to NSA	Crops	Area (Hectare)	% to NSA
Bajra	298.42	55.60	Jowar	342.58	57.35
Cotton	78.26	14.58	Safflower	76.19	12.76
Onion	48.23	8.99	Gram	55.74	9.33
Maize	23.61	4.40	Wheat	55.89	9.36
Groundnut	41.12	7.66	Onion	14.26	2.39
Mung	98.56	18.36	Maize	12.14	2.03
Fruits, Vegetables & Flowers	18.16	3.38	Fodder	18.24	3.05
Fodder	41.25	7.69	--	--	--
Total	647.61	70.30	Total	575.04	62.42

Source: Primary data (2012-13)

Note: NSA – Net Sown Area

Cropping pattern in Jakhangaon village is a reflection of physiography, soil type, slope, irrigation and socio-economic factors. Lack of irrigation is the major controlling factor of cropping pattern. Most of the crops depend on monsoon rainfall. Farmers in this village cultivated drought resistance varieties of crops. Thus cropping pattern of the village is quite simple.

In *kharif* season out of net sown area 70.30 percent area is under various crops and rest of land is kept fallow for *rabi* jowar. In *kharif* season bajra, cotton, *mung*, onion, maize, groundnut, fruits, vegetables, flowers and fodder are the major crops. These crops cultivated throughout the village area. In this season bajra is the single largest crop it occupied 55.60 percent area to net sown area. Different types of cash crop are cultivated in village but its individual share of land holding is quite small. These crops are cotton, onion, maize, groundnut, *mung* and fruit, vegetables and flowers which individual share is 14.58, 8.99, 4.40, 7.66, 18.36 and 7.69 percent respectively to net sown area (fig.7.16 A). Fruit and vegetables included orange, sweet lime (Citrus limetta), chilly, brinjal and ladyfinger. These fruits and vegetables

Cropping Pattern -Village Jakhangaon (2012-13)

***Kharif* Season**

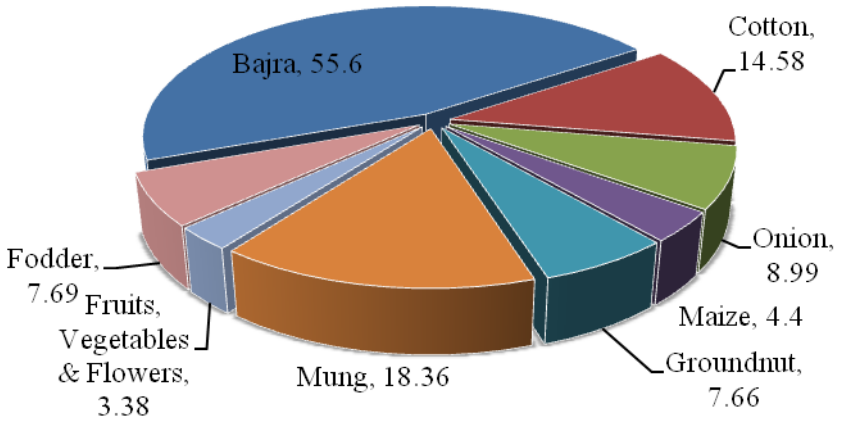
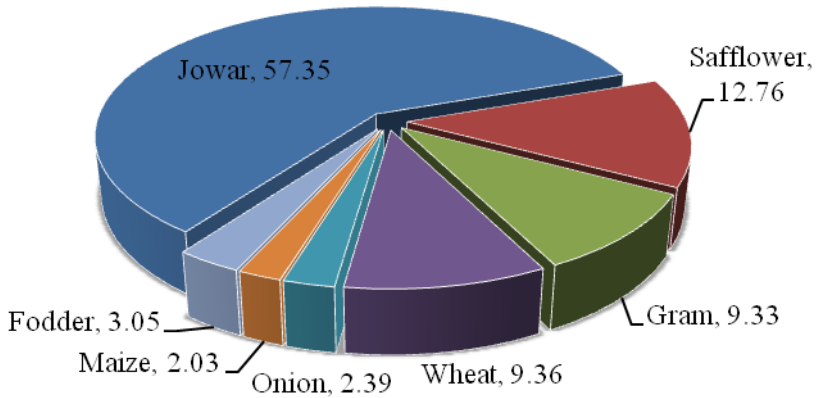


Fig. 7.16 A

***Rabi* Season**



Note: Area in percentage

Fig. 7.16 B

are sold in daily market at Ahmednagar. Flower i.e. marigold cultivated by some farmers, it sold at either Ahmednagar or Kalyan (New Mumbai). Fodder crops i.e. alfalfa and *kadwal* (green jowar) are the major crops. It occupied 7.69 percent area to net sown area. Some framers cultivated maize for the purpose of fodder.

In *rabi* season jowar, safflower, gram, wheat, onion, maize and fodder are cultivated. These crops occupied 62.42 percent area to net sown area. Among these crops jowar takes the lion share (57.35 percent) followed by safflower, gram, wheat, onion and maize (fig. 7.16 B). In this season southern part of the village is kept fallow because of poor quality soil and unavailability of irrigation. Jowar and safflower are grown throughout the central and northern part of village while wheat, onion and maize are cultivated in north part where seasonal irrigation facility is available. Gram is cultivated at both side of the seasonal stream. There is good quality fertile soil. Fodder crops such as maize and green grass cultivated in central and western part of the village. Orange and Sweet lime is the perennial cash crop but in summer long spell of water most of trees destroy. It makes adverse effect on productivity and farmer's income.

7.5.5 Crop Production

Table 7.21 revealed production of major crops in village Jakhangaon.

Table 7.21 Average Production of Major Crops per Hectare in Quintals / Ton

Kharif season		*Rabi* season	
Crops	Quintals per Hectare	Crops	Quintals per Hectare
Bajra	18	Jowar	16
Cotton	9	Safflower	12
Onion	65	Gram	8
Maize	23	Wheat	21
Groundnut	16	Onion	96
Mung	9	Maize	18
Fruits	3 (ton)		

Source: Primary data (2012-13)

Crop production is comparatively low of this village because most of the agriculture depends on rainfall. The southern part of village occupied by rugged topography and poor quality shallow soil, due to this farmers cultivate there traditional crops i.e. bajra and *mung*, the production of these crops is quite low.

Central and northern part of the village have black to deep black soil and seasonal irrigation facility due to this farmer use innovative ideas to increase production of crops. Economic status of farmers is not sound so most of the farmers use traditional farm implements i.e. iron plough. A modern farm implement i.e. tractor share per hectare (0.03) is very low while electric pump share is 0.26 per hectare to net sown area. Agricultural input such as high yielding variety of seeds and chemical fertilizer use per hectare was also low. It was 0.71 and 1.11 quintal per hectare respectively (table 7.22). In this village about nine hectare land under drip irrigation which is occupied by fruit crops.

Table 7.22 Non Physical Determinants Village Jakhangaon

Particular	Number	Per Ha	Particular	Number	Per Ha
Iron plough	58	0.06	Chemical Fertilizer	1018(Quintal)	1.11
Tractors	25	0.03	Bullock	112	0.12
Electric pump	243	0.26	Cow	1178	1.28
HYV seeds	658 (Quintal)	0.71	Buffaloes	57	0.06

Source: Primary data

Note: Ha - Hectare

7.5.6 Livestock

The village Jakhangon is located near ideal village Hivrebazar. In Hiverbazar grazing is prohibited, this rule is also followed by people of Jakhangaon. Due to this goat, sheep and desi cattle population share is negligible. Most of the farmers rearing breed cows and buffaloes for the purpose of Production of milk. The numbers of cow and buffaloes are 1178 and 57 respectively (table 7.22). In this village daily near about 2600 liter milk was collect by three milk collection centers while some farmers sold milk in urban center at Ahemadnagr. Thus, the dairy is the subsidiary occupation of farmers. In this village bullock number is 112 and most of the work such as ploughing, sowing and transportation carried by bullocks. The farmers devote large area in both seasons to fodder crops. Jowar is a highly cultivated crop in this village, it is fit for fodder. The green and dried stems of jowar are locally called as *Kadwal* and *Kadba* respectively are use as a fodder. Apart from this green maize, straws of bajra are also used as dry roughages for livestock.

Resume

The total geographical area of village Jakhangaon is 1034.32 hectares out of this 921.18 hectares area under cultivation. Some time there is long spell in rainfall that time farmers facing the problems of water scarcity, its adverse effect on crops yield. Summer season in month of May villagers faces problem of drinking water. To increase the agricultural productivity of this village, the emphasis should be laid on technological change, irrigation development and adequate flow of funds for agriculture development. However, education to farmers about crops varieties and breeds which are suitable for the geo-climatic conditions of the village. At the same time, increase awareness among the farmers about selection of crops, new farming methods and irrigation techniques. Government will take initiative to construct *nala* banding and small dames to increase ground water and also increase irrigation facility.

7.6 Comparative Study of Sample Villages

The comparative study of sample villages shows variation in various aspects of agriculture (table 7.23). Village Nandurkhi (Kh), Belpandhari and Jakhangaon are the representative of high, moderate and low agricultural productivity region respectively. Population point of view village Nandurkhi (Kh), Belpandhari and Jakhangaon has total population 1259, 1242 and 1896 respectively. Village Nandurkhi (Kh) literacy rate is 74.11 percent while Belpandhari and Jakhangaon have 70.61 and 69.94 percent respectively. Dependency ratio is high in village Nandurkhi (Kh) which is 60.37 percent. Occupation structure of the villages is the indicator of development. It is also indicator of standard of living of rural population. Maximum (63.03 percent) cultivators found in low productivity village while maximum (41.80 percent) agricultural labour noticed in moderate productivity village. In village Nandurkhi (Kh) out of total population 29.86 percent population engaged in other than agricultural activity it means that dependency on agriculture is comparatively low.

General landuse pattern of villages shows, area under forest not found in village Nandurhki (Kh) while Belpandhari and Jakhangaon registered 3.47 and 0.31 percent to total geographical area. There is not much difference in area under sown in three villages while maximum fallow land observed in village Jakhangaon (3.40 percent). Out of net sown area in village Nandurkhi (Kh) 100 percent area is irrigated while Belpandhari and Jakhangaon registered 72.10 and 34.52 percent area respectively.

Table 7.23 Comparative Information of Sample Villages

Particular	Parameter	High Productivity Region	Moderate Productivity Region	Low Productivity Region
Name of village		Nandurkhi (Kh)	Belpandhari	Jakhangaon
Tehsil		Rahata	Nevasa	Nagar
Geographical area	Hectares	227.36	988.34	1034.32
Annual rainfall (2012-13)	mm	489.44	530.00	520.22
Number of households		260	261	384
Total population		1259	1242	1896
Literate	Percent to total population	74.11	70.61	69.94
Total workers		39.63	48.15	50.79
Main workers		33.44	47.26	46.84
Marginal worker		6.20	0.89	3.96
Cultivators	Percent to total worker	44.89	51.83	63.03
Agricultural labour		25.25	41.80	24.82
Other workers		29.86	6.35	12.15
Area under forest	% to total geographical area	--	3.47	0.31
Land not available for cultivation		8.42	2.51	6.36
Cultivable wasteland		--	1.26	0.86
Follow land		--	0.83	3.40
Net sown area		91.58	91.92	89.06
Irrigated area by canal	Percent to net sown area	40.87	--	--
Irrigated area by well		51.39	19.59	32.13
Irrigated area by tube well		7.74	29.17	2.39
Irrigated area by river		--	23.33	--
Total irrigated area		100	72.10	34.52
Bajra	Percent area under crops to net sown area *(kharif* season)	7.83	11.39	55.60
Maize		13.45	5.49	4.40
Cotton		--	24.89	14.58
Soyabean		51.42	8.45	--
Sugarcane		9.82	28.56	--
Groundnut		2.59	0.56	7.66
Onion		--	2.91	8.99
Mung		--	--	18.36
Fodder		11.14	7.21	7.69
F, V, F*		3.74	1.24	3.38
Total cultivated area		100	91.29	70.30

Continue……

Table 7.23 Comparative Information of Sample Villages

Particular	Parameter	High Productivity Region	Moderate Productivity Region	Low Productivity Region
Wheat	Percent area under crops to net sown area (*rabi* season)	35.54	12.35	9.36
Jowar		13.82	27.09	57.35
Maize		7.68	--	2.03
Safflower		--	--	12.76
Onion		11.05	6.45	2.39
Gram		7.20	9.82	9.33
Sugarcane		9.82	28.56	---
Fodder		11.14	6.25	3.05
F,V,F*		3.74	1.05	--
Total cultivated area		100	91.58	62.42
Sugarcane	Production in ton	116	96	--
Bajra	Production in quintal (*kharif* season)	31	24	18
Maize		65	28	23
Soyabean		20	22	--
Groundnut		23	18	16
Cotton		--	24	9
Onion		--	76	65
Mung		--	--	9
Tur		--	6	--
Wheat	Production in quintal (*rabi* season)	49	32	21
Jowar		12	11	16
Onion		116	112	96
Gram		13	9	8
Maize		47	--	18
Safflower		--	--	12
Iron plough	Share per hectare to net sown area	0.13	0.07	0.06
Tractors		0.09	0.02	0.03
Electric pump		0.91	0.36	0.26
HYV Seeds		1.13	0.47	0.71
Chemical fertilizer		1.86	2.22	1.11
Bullock		0.27	0.13	0.12
Cow		1.91	0.85	1.28
Buffaloes		0.11	0.07	0.06

Source: (i) Census, 2011
(ii) Talathi office of selected villages
(iii) Primary data Note: FVF*- Fruit, Vegetables and Flowers

During *kharif* season bajra recorded first rank in village Jakhangaon while sugarcane take first rank in village Belpandhari while soyabean is the first ranking crop in village Nandurkhi (Kh). In *kharif* season out of net sown area village Nandurkhi (Kh), Belpandhari and Jakhangaon recorded 100, 91.29 and 70.30 percent area under various crops. During *rabi* season wheat take lion share in village Nandurkhi (Kh), while in village Belpandhri and Jakhangaon sugarcane and jowar take first rank respectively. In *rabi* season in village Jakhangaon noticed out of net sown area 62.42 percent area under various crops while rest of the area is fallow because of non availability of irrigation.

On the basis of production, village Nandurhi (Kh) found high production compare to other selected villages while per hectare production of Soyabean is high in Belpandhari (22 quintals) than Nandurkhi (Kh) (20 quintals). Sugarcane is major cash crop in village Nandurkhi (Kh) and Belpandhari while it is not taken in village Jakhangaon because of unavailability of irrigation. The production of sugarcane in village Nandurkhi (Kh) and Belpandahri recorded 116 and 96 ton per hectare respectively. High production of jowar (16 quintals) registered in village Jakhangaon. Safflower and mung are cultivated in only Jakhangaon village and production of these crops is 12 and 9 quintals per hectare respectively.

Agricultural implements such as iron plough (0.13) and tractors (0.09) per hectare high density found in village Nandurkhi (Kh). Agricultural input such as high yielding varieties seeds per hectare 1.13 recorded in village Nandurkhi (Kh) while per hectare high share of chemical fertilizer (2.22) recorded in village Belpandhari. In village Jakhangaon high yielding varieties seeds and chemical fertilizer per hectare share have 0.71 and 1.11 respectively. Livestock population per hectare share registered high in village Nandurkhi (Kh) compare to other selected villages. Dairy is the subsidiary occupation of farmers in selected village. In village Nandurkhi (Kh), Belpandhari and Jakhangaon per hectare share of bullocks is 0.27, 0.13 and 0.12 respectively, most of the agricultural work such as ploughing, sowing and transportation carried by bullocks. Load shading is the major problem of village Nandurkhi (Kh). Saline water and non availability of irrigation is the major problems in village Belpandhari and Jakhangaon respectively.

CHAPTER - VIII

CONCLUSION AND SUGGESTIONS

8.1 General Introduction

8.2 Conclusion

8.3 Suggestions

8.1 General Introduction

The present research work has been carried out to assess, analyze and interpret the pattern of saptio-temporal changes in land use as well as agricultural productivity of Ahmednagar district with a view to investigate the influence of certain physical and nonphysical variables on agricultural productivity. The objective of present chapter is to summarize the major observations and gives suggestions for planning and development.

8.2 Conclusion

Ahmednagar district, the study region is agriculturally one of the most developing districts of Maharashtra. The district occupies central position of western Maharashtra and consists of fourteen tehsils namely, Nagar, Rahuri, Shrirampur, Nevasa, Shevgaon, Parhardi, Karjat, Shrigonda, Jamkhed, Parner, Akole, Sangamner, Kopargaon and Rahata. District has a total area 17048 sq. km. and supports a population of 45, 43,083 while density of population is 267 persons per square kilometer (Census, 2011). District is situated partly in upper Godavari and partly in Bhima basin. Physiographicaly district is divided into three physical divisions (i) Plain (ii) Plateau and (iii) Sahyadri hill ranges i.e. Kalsubai, Adula, Baleshwar and Harishchandragad which is a sources of rivers flowing from the district. Northern part of district is cover by river Godavri and its tributary i.e. Pravara, Mula, Dhora while south parts cover by river Bhima and its tributary Ghod, Kukadi and Sina. District appears four types of soil (i) deep black (ii) medium black (iii) coarse shallow and (iv) red. District lies in drought prone zone, it monsoon climate, characterized by hot summers, cool winters, and seasonal rains. Average annual rainfall is 578.8 mm which of them 77 percent receives during the south-west monsoon. The distribution of rainfall is highly uneven and bears some relationship with relief.

The growing population of the district is engaged directly or indirectly in agriculture and sugar factories of district which depends on agriculture for raw material. There is more and more demand of food grain and raw material. This situation force farmers to pay special attention towards the improvement of their agricultural output by increasing use of technological inputs.

In Ahmednagar district during the period of investigation irrigated area is increased by 5.05 percent, it has 29.42 percent to net sown area, out of this 31.41 percent irrigated by surface sources and 68.59 percent by underground sources. However, the distributional pattern of irrigated area is highly uneven.

The use of the components of traditional and modern technology of agriculture in the district has been considerably changes in the last two decades beginning from 1990-91. The traditional agricultural implements such as wooden plough, iron plough and oil engines per hundred hectare density decreased by 0.68, 4.07 and 0.06 respectively while density of modern farm implements such as tractors and electric pumps has increased by 0.76 and 0.31 respectively. However, the distributional patterns of all the modern and traditional components are not uniform throughout the district leading to inter tehsil disparities in agricultural productivity.

During the period of two decades the percentage share of cattle to total livestock has decreased by 6.44 percent because of farmers change their attitude they adopt machines for agricultural practices and domesticate less number but high milch cow for dairy and manure purpose. The percentage share of buffaloes to total livestock was increased by 4.46 percent. It changing pattern shows that negative change was registered in Akole tehsil while rest of the tehsils registered positive change. The percent contribution of goat and sheep to total livestock has increased by 8.20 percent, it spatial pattern of volume change shows except Jamkhed and Shrigonda tehsils rest of tehsils recorded positive change. Other livestock percentage share to total livestock has decreased by 6.40 percent, during study period all tehsils noticed negative change pattern.

In Ahmednagar district agriculture is the main stay of the population where 79.90 percent population residing in rural area. Agriculture is major claimant of workforce and source of income of rural masses. The distribution pattern of rural-urban population noticed except Nagar tehsil rest of the tehsils has more than 70 percent population residing in rural area. During the period of investigation rural population was decreased by 1.28 percent. Crude and physiological density of population noticed positive change in all tehsils while agricultural density of population registered negative change in Nagar tehsil and rest of the tehsils noticed positive change. The distribution pattern of population varies between tehsil to tehsil leading to inter tehsil disparities in agricultural productivity.

Distributional pattern of high yielding variety seeds and chemical fertilizers are not uniform throughout the district leading to inter tehsil variation in agricultural productivity. The northern high irrigated parts of district recorded high share in use of high yielding seeds and chemical fertilizers than southern and rainfed parts of district.

During the period of two decade 1 major, 5 sub and 40 weekly market centers are increased in district. District has 197 kilometers railway route and 12975.49 kilometers length of roads. There are two national highways and five state highways having a length of 61 km. and 1662.46 km. respectively while dictrict roads, village roads and other road have a length of 11110.03 km.

General landuse pattern of study region has been slight change in the last two decades beginning from 1990-91. A marked decreased was observe in categories of forest and land not available for cultivation by 1.45 and 1.31 percent respectively to total geographical area whereas cultivable waste land and fallow land has increased by 0.70 and 1.56 percent respectively. In study region net sown area is the most important type of land use and excels all the other land use categories. Proportion of such land is higher in both years i.e. 69.79 percent in 1990-91 and 70.28 percent in 2010-11. During the period of two decade net sown area has increased by only 0.48 percent to total geographical area. This situation suggests that horizontal expansion of agriculture is not significant because of the limited area available for agriculture. Expansion of agriculture productivity is the only way for transforming agriculture of the district by applying all the modern inputs of agriculture in right quantity and at the right time.

The spatial pattern of general land use has much variation in district it depends on various physical and non physical determinants. During the period of two decades area under forest has increased in three tehsils namely, Pathardi (4.34 percent), Nevasa (1.01 percent) and Shevgaon (0.90 percent) but significant positive change recorded in only Pathardi tehsil. Land not available for cultivation noticed significant negative change in tehsils of Nevasa, Jamkhed, Karjat, Shrigonda, Parner and Akole while in tehils Nagar, Rahuri, Shrirampur, Shevgaon, Pathardi, Sangamner and Kopargaon noticed significant positive change. In the category of cultivable waste land highest negative change noticed in tehsil Jamkhed (6.51 percent) while highest positive change found in tehsil Karjat (8.04 percent). In the category of fallow land highest negative change was found in tehsil Shrirampur (11.35 percent) while highest positive change recorded in tehsil Jamkhed (30.82 percent). In the category of net sown area tehsil Akole recorded highest upward change whereas tehsil Jamkhed recorded highest downward change. In study region increase or decrease in the agricultural land use shall be in close association with the success and / or failure of monsoon.

Ahmednagar district experience two agricultural seasons viz. *kharif* and *rabi*. In *kharif* season bajra, soyabean, maize, cotton, groundnut, vegetables, sugarcane, tur and fodder crops are grown while in *rabi* season major crops are jowar, wheat, gram, maize, onion, fruits, vegetables and fodders. In canal command area summer crops i.e. maize, groundnut, fruits and vegetables are grown. Sugarcane is the perennial crop it mostly cultivated in canals command area of district.

The temporal pattern of volume change in area under crops registered significant positive change in sugarcane (5.94 percent), other cereals (1.03 percent), fruits, vegetables, condiments and spices (3.66 percent), cotton (7.49 percent) and fodders (1.33 percent) while significant negative change recorded in jowar (9.99 percent), bajra (1.21 percent), wheat (0.44 percent), pulses (0.97 percent) and oilseeds (6.83 percent). This change is indicating that the farmers have changed their attitude from food crops to cash crops.

Jowar is a major staple food grain and grown in *rabi* season in throughout district. It highly concentrated in south and north-east parts of the district. During the period of investigation area under jowar declined in tehsils Nevasa and Kopargaon (above 20 percent) while tehsils Jamkhed, Shrirampur, Pathardi, Rahuri, Nagar, Akole, Sangamner, Karjat and Parner recorded below 20 percent negative change Two tehsils namely, Shevgaon (32.30 percent) and Shrigonda (2.14 percent) niticed positive change.

Bajra is the second dominant crop in district. Area under bajra declined in tehsils of Shevgaon (29.52 percent), Nevasa (20.88 percent), Kopargaon (17.69 percent) and Parhardi (10.66 percent) while highest positive change recorded in Nagar tehsil (28.26 percent).

In canal command area of northern part in district noticed significant positive change in area of wheat while significant negative change noticed in tehsils of Nevasa (8.61 percent) and Pathardi (4.59 percent). Area of other cereals recorded significant positive change in tehsil of Rahuri, Shrigonda, Sangamner and Kopargaon whereas significant negative change noticed in tehsil Shrirampur and rest of tehsils recorded insignificant change.

Area under pulses increased in Shrirampur, Jamkhed and Parner tehsils while in rest of the tehsils recorded declined trend. Sugarcane is important cash crop in district and mainly cultivated in canals command area. The area under sugarcane noticed significant positive change in thesils Nevasa (44.46 percent), Rahuri (13.14

percent) and Shrigonda (4.26 percent) whereas rest of the tehsils found insignificant change.

Except Nagar tehsil rest of the tehsils recorded positive change in area of fruits, vegetables, condiments and spices. Excluding Sangamner tehsil rest of the tehsils registered positive change in area of cotton. Area under oilseeds has increased in two tehsils namely, Kopargaon (12.89 percent) and Shrirampur (2.25 percent) while rest of the tehsils recorded negative change. During the study period area under fodder crops was increased by 1.33 percent, it positive change found in only Akole tehsil.

Crop combination (Doi's technique) results shows that during the year 2010-11, jowar is a monoculture crop found in three tehsils, namely, Shevgaon, Karjat and Shrigonda whereas two crop combination was found in four tehsils namely, Nagar, Nevasa, Parner and Sangamner. Three crop combination found in Parhardi, Jamkhed and Akole tehsils. Four crop combination found in Rahuri and Rahata tehsils. In Rahuri tehsil sugarcane is combined with bajra, wheat and jowar, while in Rahata tehsil oilseeds is combined with bajra, sugarcane and wheat. Tehsil Shrirampur found five crops combination i.e. bajra, oilseeds, sugarcane, wheat and jowar. Six crops combination found in Kopargaon tehsil i.e. oilseeds, bajra, wheat, fruits and vegetables, cotton and other cereals are entered in this combination.

The result of crop combination shows number of crops in combination has increased southward to north. It means that increase the intensity of irrigation increases the number of crops in combination. This situation suggests growing variety of crops in district to fulfill the demand of growing population by increasing irrigation facility.

The results of productivity indices revealed that there are spatial and temporal changes in agricultural productivity. On the basis of Kendall's productivity index during the period of investigation seven tehsils shows changes in their productivity level. Four tehsils namely, Shrirampur, Nevasa, Karjat and Sangamner recorded negative change. They shifted high to moderate productivity grade. Two tehsils namely, Parner and Shevgaon shifted low to moderate productivity category while tehsil Pathardi shifted moderate to high productivity region.

On the basis of Bhatia's productivity index nine tehsils recorded changes in their productivity level. Two tehsils namely, Jamkhed and Karjat shifted high to moderate grade while three tehsils namely, Shrigonda, Shrirampur and Nevasa shifted

high to low category. Two tehsils Kopargaon and Nagar shifted moderate to low productivity region. Tehsil Shevgaon shifted moderate to high while tehsil Sangamner shifted low to high productivity region.

On the basis of Standard Nutrition Unit's index ten tehsils indicated a change in level of productivity. Two tehsils namely, Akole and Rahuri shifted high to moderate category while three tehsils namely, Shrirampur, Shrigonda and Jamkhed shifted high to low productivity grade. Tehsils Karjat, Nagar and Pathardi shifted moderate to low productivity region. Kopargaon tehsil shifted moderate to high category whereas tehsil Sangamner shifted low to high category.

Enyedi's productivity index noticed change in productivity level in ten tehsils. Tehsil namely, Kopargaon shifted moderate to high category while Akole and Sangamner shifted low to high grade. Tehsil Shevgaon shifted low to moderate productivity. Tehsils Nevasa and Shrirampur shifted high to moderate category while tehsils Shrigonda, Karjat and Jamkhed shifted high to low productivity region. Nagar tehsil shifted moderate to low productivity region.

On the basis of Shafi's modified productivity index eight tehsils recorded change in their productivity level. Tehsil Akole shifted high to moderate productivity region while tehsils of Shrigonda and Jamkhed shifted high to low category. Tehsil Kopargaon shifted moderate to high grade while tehsil Nagar and Karjat shifted moderate to low category. Tehsils of Sangamner and Shevgaon shifted low to high and moderate productivity region respectively.

According to Calories per Capita index six tehsils noticed change in their productivity level. Four tehsils namely, Sangamner, Rahuri, Shevgaon and Parner registered positive change while Shrigonda and Pathardi tehsil recorded negative change, these shifted high to moderated productivity region.

On the basis of Sapre and Deshpande's productivity index, nine tehsils recorded change in their productivity level. Two tehsils namely Sangamner and Shevgaon recorded upward change they shifted low to high category while Shrigonda and Kopargaon tehsils shifted moderate to low region. Tehsils namely, Jamkhed, Karjat and Shrirampur noticed negative change they shift high to moderate grade while Nevasa tehsil shifted high to low category. Tehsil Pathardi recorded upward change.

On the basis of composite productivity during the period of investigation negative change noticed in four tehsils namely, Nagar, Shrirampur, Nevasa and

Karjat. Tehsil of Nagar and Shrirampur shifted moderate and high to low productivity region respectively while tehsil Nevasa and Karjat shifted high to moderate region. Positive change noticed in three tehsils namely, Shevgaon, Sangamner and Kopargaon. Tehsil Shevgaon shifted low to moderate region while tehsil of Sangamner and Kopargaon shifted low and moderate to high region respectively. Rest of the six tehsils namely, Rahuri, Pathardi, Jamkhed, Shrigonda, Parner and Akole noticed no change in their productivity region.

An input (independent variables i.e. physical and non physical determinants) and output (productivity) analysis revealed that, Bhatia's productivity index positively significant correlated with number electric pump, number of tractor, use of chemical fertilizer and agricultural credit per hundred hectare of net sown area at 0.05 % level of significant. Standard Nutrition Unit's index has very significant correlation with electric pump, tractor, agricultural density of population and use of chemical fertilizer per hundred hectare of net sown area at 0.01% level of significant. Even for this productivity index positively correlated with irrigation, physiological density of population, use of high yielding variety of seeds and agricultural credit at 0.05 % level of significant. Enyedi's productivity index highly positive correlated with agricultural density of population at 0.01 % level of significant while positive correlated with irrigation, high yielding variety of seeds and use of chemical fertilizer at 5 % level of significant. Shafi's modified productivity index highly positively correlated with net irrigated area, number of tractor, agricultural density of population, use of high yielding variety of seeds, use of chemical fertilizer and agricultural credit at 1 % level of significant. This index positive correlated with number of electric pump, crude density of population and physiological density of population at 5 % level of significant. Calories per Capita index high negative correlated with population density at 0.01 % level of significant while negative correlated with physiological density of population at 0.05 % level of significant. This index has high positive correlated with number of wooden plough per hundred hectare of net sown area at 0.01 % level of significant.

High productivity region, sample village (Nandurkhi-Kh) study reveals that out of total population 70.14 percent population is involved in agriculture. Out of net sown area 100 percent area is irrigated and 100 percent net sown area is under various crops during both *kharif* and *rabi* season. In this village maximum area is under cash crops (soyabean, sugarcane, onion, vegetables and flowers). Farmers of this village

use modern farm implements for agricultural practices. Various governments subsides schemes related to agriculture such as farm ponds, drip irrigation, small tractors, fruit crops has widely accepted by farmers. The agriculture is done on modern line so productivity of agriculture is quite high. The dairy activity is the major subsidiary occupation of cultivators.

Second sample village Belpandhari is representative of moderate agricultural productivity region. Out of total working population 83.63 percent work force engaged in agriculture, out of this 41.83 percent are cultivators and 41.80 percent are agricultural labours. In this village 72 percent area is irrigated. During the *kharif* and *rabi* season out of net sown area near about 90 percent area under various crops. Sugarcane, cotton and jowar are the dominant crop of this village. Due to over irrigation from river groundwater is saline. Cultivators have limited options to grow crops of adoptable to saline water. There is need to change cropping pattern and awareness among the farmers, about crop rotation and irrigation are the major work for sustainable agricultural development.

Third sample village Jakhangaon is the representative of low agricultural productivity region. The cropping pattern of this village is governed by physigraphy, soil type, distribution of rainfall and seasonal irrigation facility. In this village out of net sown area only 34.52 percent area is irrigated. Well and tube well are the major source of irrigation. Out of net sown area during *kharif* season 70.30 percent area is under various crops, bajra is the dominant crop in this season while in *rabi* season 62.42 percent area under various crops and jowar is the dominant crop in this season. Farmers do the agriculture on traditional line so out of net sown area maximum area is under cereal crops and productivity of these crops is also low.

The finding of this research verifies hypothesis that the spatio-temporal changes in agricultural productivity in Ahmednagar district which is a result of geographical, economical, technological and social factors which causing spatial inequalities in the agricultural productivity. Although changes in agricultural productivity is not uniform and there is variation among the different tehsils of district. These variations are due to the variation in the physical and non physical determinants. The availability and use of physical and non physical determinants in all the tehsils is not uniform and so is the productivity.

8.3 Suggestions

With the help of above study an attempt is made to suggest remedies to overall development of agriculture in Ahmednagar district. The suggestions made by researcher on the basis of research findings, site visits and discussion with farmers. These suggestions are listed below.

1. According to national forest policy (1952) out of total geographical area 33.33 percent land under forest is necessary. In study region at present only 8.64 percent areas under forest, which less by 24.69 percent. To overcome this problem there is need to impliment social forestry programmes more efficemntly. Under this programme medicinal, fruit, soil binder, fodder and green manure plants must be planted on barren land, road side, canal side and on village common grazing land. In this work there should be active participation of villagers. The available forest must be protected from cutting and cattle grazing.
2. During the period of investigation fallow land increased by 1.59 percent of the total geographical area of the district. It has significant increased in Jamkhed, Shrigonda and Kopargaon tehsils. Lack of irrigation is the basic reason to increase fallow land. To overcome this problem creating irrigation facilities is the only solution. For this water conservation techniques must be use. Government may take immediate steps to provide extensive facilities such as drip irrigation and sprinkler irrigation to the farming community for efficient use of the available water for agricultural purpose to reduce fallow land and boost up agricultural productivity.
3. In south parts of district, tehsils Nagar, Parner, Karjat and Jamkhed most of agriculture depends on erratic nature monsoon. Productivity of these tehsils was comparatively low so regular training should be provided to the farmers regarding selection of crops and their drought resistant varieties and method of cultivation.
4. In study region there is need to impart knowledge regarding High Yielding Variety of seeds to the farmers through Mhatma Phule Krishi Vidypeeth, Rahuri, which is located in district. The improved seeds should be distributed through farmer's co-operative societies or gram panchayat in all the villages in entire district.
5. In river basin of Godavri, Pravara and Mula and these canals command area (Rahata, Shrirampur, Nevasa and Rahuri tehsils) sugarcane is predominant crop.

It requires high amount of chemical fertilizer and water. The overdoses of chemical fertilizers and over irrigation are responsible for soil degradation in this area. To overcome this problem use of organic manure, management of fertilizer and irrigation and also selecting alternative suitable crops is prime requirement in this area.

6. The tehsils viz. Parhardi, Shevgaon, Jamkhed, Karjat, Parner and Nagar have less area under irrigation due to this agricultural productivity of these tehsils have comparatively low. It is therefore necessary to increase the area under irrigation by constructing minor irrigation projects like Kolhapur type weirs, percolation tanks, check dams and construction of bunds in farm land.
7. Godowns and warehouses should be construct to store grain and onion in entire study region and fruits and vegetable storage facility be provided in Sangamner, Kopargaon and Akole tehsil.
8. The per hectare yield of some crops such as wheat, bajra, cotton, sugarcane oilseeds, fruit and vegetables has increased in all tehsils in study region. It is necessary to provide suitable marketing facilities and support their prices based on cost of production.
9. Area under sugarcane is significantly increased so optimum recovery of sugarcane needs to increase crushing capacity of existing sugar industries which are located in district.
10. In view of the potential to increase farm income and provide employment to rural masses, it is essential to stepped horticulture activity under the scheme of National Horticulture Mission in Sangamner, Rahata Rahuri and Nevasa tehsils.
11. Electric power must be supplied properly with suitable voltage for agricultural purposes otherwise per hectare yield will decrease and food supply fall short of demand.
12. At the time of field vistis some farmers complaint about crops insurance scheem. The government officers not conduct proper panchnama of distroyed crops so affected farmer do not get proper benifit of insurance and other government scheem. To overcome this problem each village should have a seprate Talathi and agriculture officer. This will enhance the efficency of the Talathi's and agriculture officers and maximum benefit of government scheems will reach to the farmers.
13. The persent agricultural system of the study region is highly specilized in crop production but least in livestock production. The district has enormous livestock

wealth, so that the location of livestock enterprises may be encouraged in all tehsils in district. It is also helpful to increase farmres income and solve the problem of rural unemployment.

It is hoped that, analysis and findings of present study may help to provide valuable information for further studies, planning and applications. It is also helpful to find agricultural backward area for proper agricultural planning and to increase agricultural productivity. The results of present study become useful tool to find suitable crops according to suitability and availability of physical and non physical variables.

REFERENCES

1. Adnaik, N. S. (2005): "Spatio-Temporal Changes in Agricultural Productivity in the Drought Prone Region in Maharashtra State: A Geographical Perspective", Unpublished Ph.D. Thesis, Submitted to Shivaji University Kolhapur.
2. Adnaik, N. (2012): "Changes in General Land Use Pattern in The Drought Prone Region of Maharashtra", A Research Volume on Population and Resources, Edited by Raymane, A. S., Vol: 2, pp: 267-275.
3. Bhatia, S.S. (1967): "A New Approach to Measurement Agricultural Efficiency in Uttar Pradesh'', Economic Geography, Vol: 43, No: 3, pp: 224-260.
4. Bhattacharya, R. (1994): "Changing Land Use and Cropping Pattern in Bihar", New Dimensions in Agricultural Geography, Vol: 4, Concept Publication, New Delhi, pp: 283-312.
5. Brij, Kishore (1981): "Components and Determinants of Agricultural Productivity: A Case Study of Gurgaon District", Unpublished Ph.D. Thesis Submitted to Centre for The Study of Regional Development School of Social Sciences, Jawaharlal Nehru University, New Delhi.
6. Chand Ramesh, Garg Sanjeev and Pandey Lalmani (2009): "Regional Variations in Agricultural Productivity: A District Level Study of India", Research Project, Submitted to National Centre for Agricultural Economics and Policy Research (Indian Council of Agricultural Research), New Delhi.
7. Choudhuri, T. (2012): "Agricultural Productivity and Regional Imbalances", Abhijeet Publication, New Delhi, pp: 98-99.
8. Choudhuri, T. (2012): "Agricultural Productivity and Regional Imbalances", Abhijeet Publication, New Delhi, p: 152.
9. Choudhuri, T. (2012): "Agricultural Productivity and Regional Imbalances", Abhijeet Publication, New Delhi, p: 157.
10. Chouhan, J. S. (2012): "Agricultural Land Use Planning", Shruti Publication, Jaipur.
11. Chouhan, T. S. (1987): "Agricultural Geography", Academic Publisher, Jaipur, p: 27.
12. Chouhan, T. S. (1987): "Agricultural Geography", Academic Publisher, Jaipur, p: 125.

13. Chouhan, T. S. (1987): “Agricultural Geography”, Academic Publisher, Jaipur, p: 214.
14. Coppeock, J. T. (1968): “The Geography of Agriculture”, Journal of Agricultural Economics, Vol: 19, pp: 153-175.
15. Date, V. S. and Pawar, N. S. (1988): "Agricultural productivity: A Micro Level Study of Two villages in Pune District, Maharashtra. Transactions Institute of Indian Geographers, Vol: 10, No: 1, Jan. 1988. pp: 1-7.
16. Date, V. S. (1984): “Spatial Analysis of Agricultural Land Use in Poona District”, Unpublished Ph. D. Thesis, Submitted to University of Poona, Pune.
17. Dayal, Edison (1984): “Agricultural Productivity of India: A Spatial Analysis”, Annals of the Association of American Geographers. Vol: 74, No: 1, pp: 98-120.
18. Doi, K. (1957): “The Industrial Structure of Japanese”, Pretectures, Proceeding of the IGU, Regional Conference in Japan.
19. Enyedi, G. Y. (1964): “Geographical Types of Agriculture”, Applied Geography in Hungary, Edited by Pecsi, M., Budapest, p: 61.
20. FCC (Fact Finding Committee), (1973): “Report of Fact Finding Committee for Survey of Scarcity Areas of Maharashtra Stare”, Govt. of Maharashtra, Vol: 1, pp: 140-144.
21. Freeman, T. W. (1968): "Geography and Planning", Book Publish by Hutchinson, University Library, Hutchinson, London. P: 74.
22. Gambhire, D. B. (2000): “Critical Study of Agricultural Productivity in Osmanabad District”, Unpublished Ph.D. Thesis, Submitted to Dr. Babasaheb Ambedkar Marathwada University, Aurangabad.
23. Gangaiah, C. (2011): “Area, Production and Productivity of Horticulture Crops”, Serials Publication, New Delhi.
24. Ganguli, B. M. (1938): “Trends of Agriculture and Population in the Ganges Valley: A study in Agricultural Economics”, London, p: 93.
25. Ghodke, B. D. (2006): “The Planning and Development of Agriculture in Daund Tehsil- A Study in Rural Geography”, Unpublished Ph. D Thesis Submitted to Pune University, Pune,
26. Ghodke, B. D. (2009): “Determination of Agricultural Productivity in Daund Tahasil of Pune District”, International Journal, Shodh, Samiksha aur Mulyankan, Vol: II, No: 6 (Feb.09-April.09), pp: 857-858.

27. Gopalan, C., Ramasastri, B.V., Balasubramaniam, S.C. (2004): "Nutritive Value of Indian Foods", National Institute of Nutrition, Indian Council of Medical Research, Hyderabad, India, p: 104.
28. Gupta, G. M. (1992): "Land-use and Rural Development: A Case Study of Navi Jithardi Village", Agriculture and Rural Development, Book edited by R. N. P. Sinha, Concept Publishing Company, New Delhi, pp: 97 – 106.
29. Hifzur, Rehman (2003): "Energy Use in Agricultural Productivity", Concept Publishing Company, New Delhi.
30. Hifzur, Rehman (2003): "Energy Use in Agricultural Productivity", Concept Publishing Company, New Delhi. pp: 38
31. Hifzur Rehman, Abdul Waheb and Asif (2008): "Agricultural Productivity and Productivity Region in Ganga – Yamuna Doab", The Geographer, Connect Journals, Vol: 55, No: 1, pp: 10-21.
32. Husain, M. (1996): "Systematic Agricultural Geography", Rawat Publication, Jaipur, p: 128.
33. Hussain, M. (1976): "Agricultural Productivity of India: An Exploratory Analysis", The National Geographical Journals of India, Vol: XXII, No: 3 & 4, pp: 113-123.
34. Hussain, M. (1996): "Systematic Agricultural Geography", Rawat Publication, Jaipur, p: 122.
35. India, (2012): "India Annual Report-2012", Publication Division, Ministry of Information and Broadcasting, Govt. of India, p.110.
36. India, (2012): "India Annual Report-2012", Publication Division, Ministry of Information and Broadcasting, Govt. of India, p.71.
37. India, (2012): "India Annual Report-2012", Publication Division, Ministry of Information and Broadcasting, Govt. of India, p.366.
38. Isitekhale, H., Aboh, S. I. and Ekhomen, F. E. (1014): "Soil Suitability Evaluation for Rice and Sugarcane in Low Land Soils of Anegbette, Edo State, Nigeria", The International Journal of Engineering and Science, Vol: 3 No: 5 pp: 54-62.
39. Jena, D. (2012): "Agricultural Productivity in Kalahandi District of Orissa Over the Decades: A Temporal Assessment", International Journal of Management, IT and Engineering, Vol: 2, No: 4, April 2012, pp: 230-239.

40. Kasid, D. L. (2010): “Study of Agricultural Productivity in Sindhudurg District A Geographical Analysis”, Unpublished Ph.D. Thesis, Submitted to the Shivaji University Kolhapur.
41. Kathare, H. N. (2012): “Impact of Rural Electrification and Agricultural Development”, Serials Publications, New Delhi, pp: 76-128.
42. Kendall, M.G. (1939): “The Geographical Distribution of Crop Productivity in England”, Journal of the Royal Statistical Society, Vol: 102, No: 2, pp: 21-48
43. Kumbhare, A. R. (1978): “Agricultural Land Use in Upper Godavari Basin”, Unpublished Ph. D. Thesis, Submitted to University of Poona, Pune.
44. Lahiri, Sulekha (1994): “Land Use in the Eastern Himalayan Region”, New Dimensions in Agricultural Geography, Vol: 4, Concept Publication, New Delhi, pp: 205-225.
45. Madhuri, S., Ramanaiah, Y.V., Dasaratharamaiah, K. (2007): “Agricultural Land Use Intensity and Diversity for Sustainable Agricultural Development: A Case Study of Rayalaseema Region, Andhra Pradesh, India”, Sustainable Agriculture in Drought Prone Region, Edited by, Dasaratharamaiah, K and Jayaraj, M., Serials Publication, New Delhi, pp: 66-74.
46. Mir, G. M. (2006): “Irrigation Efficiency and Sustainable Agricultural Productivity in Central Asian States”, Environment Agriculture and Poverty, Concept Publication, New Delhi, Vol:2, pp:254-267
47. Mohammad, N. and Majeed, A. (1992): “Determinants of Agricultural Productivity in Arid Region”, New Dimensions in Agricultural Geography, Vol: 8, Concept Publication, New Delhi, pp: 102-123.
48. Mohammad, N. and Thakur, R. (1992): “Spatial Variation and Determinants of Agricultural Productivity in Bihar”, New Dimensions in Agricultural Geography, Vol: 8, Concept Publication, New Delhi, pp: 185-204.
49. Mohammad, Noor (1992): “Anthropogenic Correlates and Determinants of Agricultural Productivity”, New Dimensions in Agricultural Geography, Vol: 8, Concept Publication, New Delhi, p: 139.
50. Mohammad, Noor and Raza, Moonis (1972): “Agricultural Metrological Database and Agricultural Productivity”, New Dimensions in Agricultural Geography, Vol: 2, Concept Publication, New Delhi, pp: 245-265.

51. Motebennur, S. S. (2012): “Spatial Variation in Agricultural Productivity in Dharwad District of Karnataka”, Pariex, Indian Journal of Research, Online Journal, Vol: 5, No: 5, November 2012, pp: 53-56.
52. Munir, A. and Taufique, M. (2006): “Regional Disparities in Agricultural Productivity: A study of Utter Predesh, India”, Environment Agriculture and Poverty, Concept Publication, New Delhi, Vol: 2, pp: 425-439.
53. Munir, A. (1992): “Agricultural Productivty and Regional Devlopment”, New Dimensions in Agricultural Geography, Vol: 8, Concept Publication, New Delhi, pp: 85-102.
54. Naidu and Venkatalakshmi (2007): “Problems of Sustainable Dry Land Agricultural Practice: A Study in Drought-Prone Regareddy District (A .P)”, Sustainable Agricultural in Drought-Prone Region, Edited by K. Dasaratharamaiah and M. Jayraj, Serial Publication, New Delhi, pp: 41-51.
55. Narkhede, D. S. (2010): “Agricultural Land Use and Land Degradation in Raigarh District (Maharashtra): A Geographical Perspective”, Unpublished Ph.D. Thesis Submitted to Shivaji University, Kolhapur.
56. Navneet, S. (2008): “Measurement of Agricultural Productivity and Spatial Variation: A Geographical Study of Implications and Alternative Strategies in District Bulandshahr (Uttar Pradesh)”, Unpublished Ph.D. Thesis Submitted to Department of Geography, NREC College, Khurja Bulandshahr (U.P.)
57. Ogle, S. B. (2013): “Spatio-Temporal Analysis of Agricultural Land Use and Productivity of Baramati Tehsil, Pune District (Maharashtra)”, Unpublished Ph.D. Thesis Submitted to Tilak Maharashtra Vidyapeeth, Pune.
58. Patil, S. G. (2012): “Spatio-Temporal Analysis of Agricultural Land Use Pattern In Pune District”, Unpublished Ph. D. Thesis Submitted to Tilak Maharashtra Vidyapeeth, Pune.
59. Pandey, D. C. (1992): “Stratification of Crop Combination Region: A Parametric Prelude to Integrated Rural Development”, Geography and Rural Development, Edited by Sinha, R.N.P., pp: 71-80
60. Patil, A. A. (2002): “Changes in Agricultural Productivity in Upper Bhima and Upper Krishna Basin in Maharasthra: A Geographical Analysis”, Unpublished Ph.D. Thesis, Submitted to the Shivaji University, Kolhapur.

61. Patil, K. K. (2007): “Growth Performance of Sugarcane Crop in Maharashtra State”, Some Aspects of Agricultural Development in Maharashtra, Edited By Bhise, V. B., Serials Publication, New Delhi, pp: 45-54.
62. Pawar, A. N. (2007): “Impact of Irrigation on Agriculture”, Some Aspects of Agricultural Development in Maharashtra, Edited by Bhise, V. B., Serials Publication, New Delhi, pp: 87-112.
63. Rahane, B. B. (2011): “Spatio-Temporal Analysis of Agricultural Landuse in Thane District” Unpublished Ph. D. Thesis, Submitted to Tilak Maharashtra Vidyapeeth, Pune,
64. Raut, S. K. (2013): “Land Use Changes and Agricultural Growth in India, Navyug Book International, New Delhi.
65. Reed, L. G. (1964): “Agricultural Geography: Progress and Prosess”, Canadian Geographer, Vol: 8, pp: 51
66. Rehman, A. (2004): “Role of Technology for Sustainable Deployment of Agriculture in Rohilkhand Region of Utter Pradesh”, Unpublished Ph. D Thesis Submitted to Aligarh Muslim University, Aligarh.
67. Reserve Bank of India (2009): Annual Report -2009, p: 9
68. Sapre, S.G. and Deshpande, V.D. (1964): “Inter District Variations in Agricultural Efficiency in Maharashtra State”, Indian Journal of Agricultural Economics, Vol: 19, No: 1, pp: 242-252.
69. Saha, S. (2011): “Spatio Temporal Changes in Agricultural Productivity of Birbhum District of West Bangal”, Geo Analysis, Online Journal, Vol: 1, No: 2, pp: 44-48.
70. Shafi, M. (1960): ‘‘Measurement of Agricultural Efficiency in Uttar Pradesh’’, Economic Geography, Vol: 36 No: 4, pp: 296-305.
71. Shafi, M. (1972): “Measurement of Agricultural Productivity of the Great Indian Plains”, the Geographer, Vol: XIX, No: 1, pp: 4-13.
72. Shafi, M. (1974): “Perspective on the Measurement of Agricultural Productivity”, The Geographer, Vol: 21, No: 1, pp: 1-10
73. Shafi, M. (1983): “Agricultural Productivity and Regional Imbalances: A Study of Uttar Pradesh”, Concept Publishing Company, New Delhi, pp: 155-168.
74. Shah, R. K. (2014): “Agrarian Crises in India: Causes and Remedial Measures”, Indian Agriculture Issues and Challenges, Kunal Books Publisher and Distributers, New Delhi, pp: 23 – 43.

75. Sharma, T. C. and Countinho, O. (1974): "An Analysis of the Changes in Area, Production and Productivity of Jowar in Karnataka", Agricultural Situation in India, Vol: XXXX, No: 9, pp: 637-647.
76. Shivaram, M. R., Jayalakhshmi, S. H. and Raymane, A. S. (2012): "Land Utilization in Gadge District: A Geographical Analysis", A Research Volume on Population and Resources, Edited by Raymane, A. S. Vol: 2, pp: 471-478.
77. Siddiqi, A. N. (1971): "Land Classification for Agricultural Planning, A Study in Methodology", The Geographer, Vol: XVIII, p: 102.
78. Singh, V. R. (1979): "A Method for Analyzing Agricultural productivity", Transactions Institute of Indian Geographers, Vol: 1, No: 1 Jan.1979, pp: 39.
79. Singh, I. and Singh, S. (2006): "Agricultural Geography of India", Shrishti Book Distributers, New Delhi, p: 48
80. Singh, J and Dhillon, S. S. (1989): "Agricultural Geography", Tata McGraw-Hill Publishing Company Limited, New Delhi, p: 115.
81. Singh, J and Dhillon, S. S. (1989): "Agricultural Geography", Tata McGraw-Hill Publishing Company Limited, New Delhi, p: 100.
82. Singh, J and Dhillon, S. S. (1989): "Agricultural Geography", Tata McGraw-Hill Publishing Company Limited, New Delhi, p: 232.
83. Singh, J. and Dhillon, S.S. (1989): "Agricultural Geography", Tata McGraw-Hill Publishing Company Limited, New Delhi, p: 43.
84. Singh, J. (1974): "An Agricultural Atlas of India: A Geographical Analysis", Vishal Publication, Kurukshetra, Haryana, India.
85. Singh, Jagtar. (2009): "Agricultural Location and The Market (Revisiting Von Thunen in Indian Context)", Regal Publication, New Delhi, pp: 22-32.
86. Singh, Jasbir (1974): ''The Green Revolution in India: How Green it is'', Vishal Publication, Kurukshetra, India.
87. Singh, Jasbir (1976): "An Agricultural Geography of Hariyana", Vishal Publication, Kurukshetra, India.
88. Singh, Jasbir (1972): "A New Technique for Measuring Agriculture Efficiency in Hariyana, India", The Geographer, Vol: XIX, No: 1, pp: 14-27
89. Singh, S. B. and Singh, B. N. (1987): "Planning for Socio-economic Activities in Ghaziapur Tehsil, U.P.", National Geographical Journal of India, Vol: 3, No: 1, p: 89.

90. Singh, S.B. and Kareriya, B. R. (2006): “Human resources and agricultural development of Lumbini Zone, Nepal”, Environment Agriculture and Poverty, Concept Publication, New Delhi, Vol: 2, pp: 281-294.
91. Singh, V. R. (1979): “A Method for Analyzing Agricultural productivity' Transactions Institute of Indian Geographers, Vol: 1, No: 1, p: 39.
92. Sinha, U. P. (2011): “Sustainable Resource Development Policy, Problem and Prescription”, Concept publishing Co., New Delhi, p: 319.
93. Sinha, U. P. (2011): “Sustainable Resource Development Policy, Problem and Prescription”, Concept publishing Co., New Delhi, p: 360.
94. Stamp, L. D. (1958): “The Measurement of Land Resources”, The Geographical Review, Vol: 48 No: 1, pp: 110-116.
95. Stamp, L. D. (1962): “The Land of Britain, It’s Use and Misuse”, Longmans, London, p: 426.
96. Tallalli, B. G. and Nagaraj, H. (2012): “Regional Disparities in Agricultural Productivity: A Case study of Karnataka”, Research volume on Population and Resources, Edited by, Prof. Raymane, A. S., Vol: 2, pp: 234-244.
97. Thompson, R. J. (1926): “The Productivity of British and Danish Farming”, Journal of the Royal Statistical Society, Vol: 89, No: 2, p: 218.
98. Todkari, G. U. (2012): “Impact of Irrigation on Agriculture Productivity in Solapur District of Maharashtra State”, International Journal of Agriculture Sciences, Vol: 4, No: 1, pp: 165-167.
99. Trewartha, G. T. (1953): “A Case Study of Population Geography”, Annals of Association of American Geographer, Vol: 43, pp: 94-95.
100. Vaid, Varsha (1989): “Agricultural Productivity of Maharashtra: A Spatio-Temporal Analysis”, Unpublished Ph.D. Thesis, Submitted to the University of Pune.
101. Vaidya, B. C. (1997): “Agricultural Land Use in India”, Manak, Publication Pvt, Ltd, New Delhi.
102. Vaidya, B. C. (1997): “Agricultural Land Use in India”, Manak, Publication Pvt, Ltd, New Delhi, p: 101.
103. Wani, B. K. (2009): “Climatic Water Budget of Rahata Tehsil in Ahmednagar District (Maharashtara)”, Unpublished M. Phil. Dissertation Submitted to Tilak Maharashtra Vidyapeeth, Pune, p: 16.

104. Weaver, J. C. (1954): “Crop Combination Region in the Middle West”, Geographical Review, Vol: 44, No: 2, pp: 176-181.
105. Zimmerman, W. (1951): “World Resources and Industries”, Harper and Row Publisher, New York, p: 91
106. Zvorykin, K. V. (1963): “Scientific Principles for an Agro-Production Classification of Lands”, Geographiya Khozyaistva, Transaction in Soviet Geographer, Review and Translation, Vol: 4, pp: 3-10.

Appendix- 1

Spatial Distribution of Agricultural Landuse

Tehsils	Jowar			Bajra			Wheat			Other cereals			Pulses		
	1990-91	2010-11	Volume Change	1990-91	2010-11	Volume Change	1990-91	2010-11	Volume change	1990-91	2010-11	Volume change	1990-91	2010-11	Volume change
Nagar	59.76	49.51	-10.25	10.75	39.31	28.56	5.38	5.15	-0.23	0.33	0.68	0.35	7.84	1.80	-6.04
Rahuri	20.24	9.50	-10.74	21.17	25.66	4.49	10.29	18.61	8.32	0.92	1.95	1.03	9.91	4.66	-5.25
Shrirampur	27.95	13.11	-14.84	18.50	19.39	0.90	13.26	13.41	0.15	1.76	0.85	-0.92	8.50	8.95	0.45
Nevasa	33.63	1.50	-32.13	22.34	1.46	-20.88	11.33	2.72	-8.61	0.39	0.67	0.28	7.13	3.42	-3.71
Shevgaon	30.49	62.79	32.30	36.82	7.30	-29.52	3.99	1.13	-2.86	0.27	0.09	-0.17	10.35	0.84	-9.51
Pathardi	33.10	22.22	-10.88	41.10	30.45	-10.66	5.68	1.09	-4.59	0.08	0.21	0.13	4.64	1.79	-2.85
Jamkhed	63.25	46.36	-16.90	5.29	6.33	1.04	1.09	0.55	-0.54	0.55	0.44	-0.11	7.30	24.87	17.57
Karjat	70.80	67.42	-3.38	3.94	18.26	14.32	2.77	2.63	-0.13	0.56	0.02	-0.55	5.44	4.83	-0.61
Shrigonda	66.74	68.88	2.14	2.41	2.97	0.56	6.40	10.46	4.07	0.33	1.78	1.45	3.15	2.05	-1.10
Parner	52.05	45.97	-6.08	24.55	32.53	7.98	3.08	2.55	-0.53	0.19	0.23	0.04	5.41	7.73	2.32
Akole	0.71	0.01	-0.71	29.08	22.85	-6.23	2.11	2.14	0.02	16.45	16.86	0.42	7.07	3.23	-3.84
Sangamner	8.30	1.79	-6.52	58.43	54.84	-3.59	6.97	5.88	-1.09	0.90	2.88	1.98	5.33	5.26	-0.07
Kopargaon	33.38	3.59	-29.79	34.44	16.75	-17.69	6.46	12.85	6.38	0.49	8.27	7.77	8.92	6.20	-2.72
Rahata	--	4.95	--	--	24.67	--	--	11.09	--	--	2.26	--	--	6.18	--
District	**41.05**	**31.06**	**-9.99**	**23.54**	**22.33**	**-1.21**	**5.80**	**5.36**	**-0.44**	**1.41**	**2.45**	**1.03**	**6.66**	**5.69**	**-0.97**

Source: (i) Socio economic abstract Ahmednagar district (1990-91) (ii) Agriculture department of each tehsil (2010-11)

Note: Figures in Percentage

Continue …..

Appendix- 1

Spatial Distribution of Agricultural Landuse

Tehsils	Sugarcane			FVCS*			Cotton			Oilseed			Fodder		
	1990-91	2010-11	Volume change	1990-91	2010-11	Volume change	1990-91	2010-11	Volume change	1990-91	2010-11	Volume change	1990-91	2010-11	Volume change
Nagar	1.40	0.26	-1.13	2.03	1.40	-0.63	0.00	0.04	0.03	11.58	1.31	-10.27	0.92	0.53	-0.39
Rahuri	15.03	28.17	13.14	1.80	5.07	3.27	0.32	0.62	0.30	5.66	0.74	-4.91	14.67	5.02	-9.65
Shrirampur	12.96	14.79	1.83	2.50	6.01	3.51	0.55	2.69	2.14	12.98	15.23	2.25	1.04	5.57	4.52
Nevasa	10.15	54.60	44.46	1.33	10.84	9.51	0.09	22.17	22.08	12.33	1.31	-11.01	1.29	1.31	0.02
Shevgaon	5.90	9.29	3.39	0.98	1.01	0.03	1.20	16.60	15.40	9.70	0.14	-9.56	0.30	0.80	0.50
Pathardi	1.25	2.59	1.34	0.96	2.86	1.90	0.14	38.03	37.89	13.05	0.28	-12.76	0.00	0.48	0.48
Jamkhed	0.81	2.11	1.31	1.37	2.49	1.13	0.15	13.85	13.70	19.66	1.78	-17.87	0.54	1.21	0.67
Karjat	1.56	1.75	0.19	1.02	3.47	2.45	0.00	0.53	0.53	13.55	0.38	-13.17	0.37	0.71	0.35
Shrigonda	3.17	7.43	4.26	1.69	5.14	3.45	0.02	0.50	0.48	15.62	0.71	-14.91	0.48	0.07	-0.40
Parner	0.71	1.02	0.31	2.37	4.28	1.91	0.01	0.03	0.02	8.82	5.05	-3.77	2.82	0.63	-2.19
Akole	4.32	2.60	-1.72	1.94	6.30	4.36	0.00	0.00	0.00	5.77	0.77	-5.00	32.54	45.24	12.71
Sangamner	7.29	8.32	1.03	4.81	11.89	7.08	0.22	0.17	-0.05	5.58	3.92	-1.66	2.17	5.06	2.89
Kopargaon	6.69	7.62	0.92	2.93	12.38	9.46	0.00	8.44	8.44	6.19	19.09	12.89	0.49	4.82	4.33
Rahata	--	11.68	--	--	7.41	--	--	1.65	--	--	26.11	--	--	4.00	--
District	**4.79**	**10.73**	**5.94**	**1.97**	**5.63**	**3.66**	**0.17**	**7.66**	**7.49**	**10.92**	**4.09**	**-6.83**	**3.69**	**5.02**	**1.33**

Source: (i) Socio economic abstract Ahmednagar district (1990-91) (ii) Agriculture department of each tehsil (2010-11)

Note: (i) Figures in Percentage (ii) FVCS* - Fruits, Vegetables, Condiment and Spices

Appendix –II

Doi's Crop Combination Critical Values

	Rank of Elements									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
	Critical Values									
Cumulative percentage of higher ranking elements	**90**							8.84	7.60	6.67
	85				12.93	10.00	8.17	6.91	5.99	5.29
	80			13.83	10.00	7.85	6.46	5.49	4.78	4.23
	75		16.67	10.57	7.75	6.13	5.06	4.32	3.76	3.33
	70	27.64	12.25	7.93	5.96	4.65	3.85	3.29	2.87	2.55
	68	23.54	10.73	6.98	5.17	4.11	3.11	2.85	2.43	2.15
	65	18.38	8.66	5.63	4.19	3.34	2.77	2.73	2.07	1.84
	60	11.27	5.46	3.59	2.68	2.14	1.78	1.52	1.33	1.18
	55	5.38	2.68	1.73	1.29	1.04	0.86	0.74	0.64	0.57
	50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Source: Vaidya, B.C. (1997) 'Agricultural Land Use in India' Manak Publication (P) LTD, New Delhi, pp. 165

Appendix- III

Productivity Indices – 1990-91

Tehsils	Kendall's Productivity Index	Bhatia's Productivity Index	SNU Productivity Index	Enyedi's Productivity Index	Shafi's Productivity Index	Calories Per Capita	Sapre and Deshpande Index
Nagar	8.00	92.66	3.09	93.72	1.01	518855.92	7.98
Rahuri	6.06	109.32	3.82	115.34	1.26	764674.77	5.21
Shrirampur	5.63	115.26	4.24	129.13	1.40	553686.57	5.17
Nevasa	5.63	108.36	3.71	120.02	1.22	1077635.46	5.27
Shevgaon	8.31	93.04	2.70	83.98	0.89	946109.60	8.17
Patherdi	7.19	101.56	3.16	94.11	1.04	1494229.38	6.80
Jamkhed	7.69	123.13	3.94	119.91	1.30	1947394.79	3.36
Karjat	6.50	115.26	3.62	112.98	1.19	1462837.96	3.75
Shrigonda	6.75	106.37	3.93	111.14	1.29	1495889.96	5.51
Parner	8.25	77.69	2.14	75.10	0.70	1201538.29	9.79
Akole	8.50	89.23	4.53	93.07	1.49	581789.33	8.15
Sangamner	5.94	73.91	2.68	78.07	0.88	572994.85	9.82
Kopargaon	6.94	104.32	2.94	98.50	0.97	584060.04	6.92

Source: Compiled by researcher

Appendix- IV

Productivity Indices – 2010-11

Tehsils	Kendall's Productivity Index	Bhatia's Productivity Index	SNU Productivity Index	Enyedi's Productivity Index	Shafi's Productivity Index	Calories Per Capita	Sapre and Deshpande Index
Nagar	11.13	89.85	3.80	77.96	1.25	516487.81	9.92
Rahuri	4.00	128.02	5.45	142.87	2.34	967958.44	2.31
Shrirampur	7.88	102.80	4.51	110.59	1.78	481770.90	6.93
Nevasa	7.25	97.70	4.85	94.66	1.61	874359.18	8.27
Shevgaon	8.50	130.77	4.60	97.11	1.51	1097207.91	4.70
Patherdi	6.13	113.44	4.59	108.09	1.51	741505.67	4.31
Jamkhed	9.38	109.44	4.04	82.01	1.33	1142071.42	7.14
Karjat	7.38	107.01	3.84	79.32	1.26	1093622.27	6.70
Shrigonda	6.50	94.99	3.90	82.29	1.28	945644.52	8.92
Parner	7.25	93.91	3.75	77.79	1.23	1473211.61	8.32
Akole	10.13	89.49	4.93	144.58	1.62	369440.31	8.78
Sangamner	7.38	123.59	6.49	129.83	2.14	885730.40	3.75
Kopargaon	8.13	98.63	6.82	134.14	2.24	640481.18	8.52
Rahata	3.75	119.85	6.72	137.25	2.21	547162.89	3.34

Source: Compiled by researcher

Appendix –V

Frequency Table

Tahsils	Kendal's Productivity Index			Bhatia's Productivity Index			SNU Index			Enedy's Productivity Index			Shafi's Productivity Index			Calories Per capita Index			Sapre and Deshpande Index			Total Frequency		
	H	M	L	H	M	L	H	M	L	H	M	L	H	M	L	H	M	L	H	M	L	H	M	L
Nagar			1			1			1			1			1			1			1	0	0	7
Rahuri	1			1				1		1			1				1		1			5	2	0
Shrirampur		1				1			1		1		1					1			1	1	2	4
Nevasa		1				1		1			1			1			1			1		0	6	1
Shevgaon		1		1					1		1			1			1		1			2	4	1
Patherdi		1			1				1		1			1			1		1			1	5	1
Jamkhed			1		1				1			1			1	1				1		1	2	4
Karjat		1			1				1			1			1		1			1		0	4	3
Shrigonda		1				1			1			1			1		1				1	0	2	5
Parner		1				1			1			1			1	1					1	1	1	5
Akole			1			1		1		1				1				1			1	1	2	4
Sangamner		1		1			1			1			1				1		1			5	2	0
Kopargaon		1				1	1			1			1					1			1	3	1	3
Rahata	1			1			1			1			1					1	1			6	0	1

Source: Compiled by researcher Note: H = High M = Moderate L = Low

Appendix - VI

QUESTIONNAIRE FOR TALATHI AND GRAMSEVAK

1. Name of the village - ---------- Tehsil ----------.
2. Population ----------
3. Number of households -
4. Geographical Area -
5. Geographical background of the village -

   [a] Location (Site and situation) :

   [b] Local physiography:

   [c] Soil type and its distribution:

6. Village Landuse (Area in Hectare)

Landuse Type	Area	Landuse Type	Area
Area Under Forest		Cultivable Waste	
Not Available for Cultivation		Follow Land	
Net Sown Area		Area Under Multiple cropping	

7. Size of Holding

Land Size (Hectare)	Number of Holders	Area in Hectare
0 to 0.99		
2 to 1.99		
2 to 4.99		
5 to 9.99		
10 and above		

8. Details regarding crops -

Kharif Crops	Area (Het/Acre)	Production	*Rabi* Crops	Area(Het/Acr)	Production

9. Irrigation details

Sr. No.	Type	Area in *kharif*	Area in *Rabi*	Perennial area
1.	Canal			
2.	River			
3.	Well			
4.	Tube well			
5	Other			

10. Agricultural Implements in Village

Implement	Numbers	Implement	Numbers
Iron plough		Eclectic Pump	
Wooden plough		Diesel Pump	
Tractor		Cart	

11. Livestock Details

Livestock Type	Numbers	Daily Milk (Lit)	Livestock Type	Numbers
Cow			Bullock	
Female Buffaloes			Male Buffaloes	
Goat / Sheep				

12. Village roads and communication -

Place	Distance (Km)	Place	Distance (Km)
Tehsil place		Provision shop	
Weekly market		Vegetable market	
Agro-service centre		Other	
Cattle market			

13. Group discussion with farmers on the issues of agriculture

Appendix - VII

QUESTIONNAIRE FOR FARMER'S

1. Name of the village - ---------- Tehsil –
2. Name of the head of the family ----------
3. Family Details -

Sr. No.	Name of the person	M/F	Age	Educational Status	Occupation	Income
1.						
2.						
3.						
4.						
5.						
6.						
7.						
8.						

4. Details regarding the land holding –

   [A] Size of land owned by family (Total) : (Hect//Acre)

   [B] Irrigated land : _____ Ha/Acre [C] Unirrigated : _____

5. Irrigation details

Type	Well	Tube well	Canal	River	other
Area in Acre					

6. Cropping details

Kharif Crops	Area (Acre)	Production (Qui)	*Rabi* Crops	Area (Acre)	Production (Qui)

7. Details regarding expenditure (Amount in Rs.)

Crops	Seeds	Fertilizers	Pesticides	Labour	Irrigation	Total

8. Agricultural Implements

Implements	Iron plough	Wooden plough	Eclectic Pump	Diesel Pump	Tractor	Other
Number						

9. Livestock detail

Livestock Type	Number	Livestock Type	Number
Cow		Male Buffaloes	
Female Buffaloes		Bullock	
Goat / Sheep			

10. State your personal / regional problems with probable solutions.

Sr. No.	Field	Problems	Probable solutions
1.	Agriculture		
2.	Irrigation		
3.	Dairy		
4.	Market		
5.	Employment		
6.	Migration		
7.	Other		