Impact of physical and socio-economical factors on agricultural scenario of Nashik District (MS) 1991 – 2011

A thesis submitted to,

Tilak Maharashtra Vidyapeeth, Pune

For the Degree of Doctor of Philosophy (Ph.D)

In

Department of earth Science (Geography)

Under the board of Faculty of Moral and Social Science studies

Submitted By

Pandurang Dnyanadev Yadav

Under The Guidance of

Dr. Nanasaheb R. Kapadnis

February 2016

DECLARATION

I hereby declare that the thesis entitled **"IMPACT OF PHYSICAL AND SOCIO-ECONOMICAL FACTORS ON AGRICULTURAL SCENARIO OF NASHIK DISTRICT (M.S.) 1991 to 2011."** completed and written by me has not previously been formed as the basis for the award of any degree or other similar title upon me of this or any other Vidyapeeth or examining body.

(PANDURANG DNYANADEV YADAV)

ResearchStudent

Place: Pune

Date: February,2016.

CERTIFICATE

This is to certify that the thesis entitled **"IMPACT OF PHYSICAL AND SOCIO-ECONOMICAL FACTORS ON AGRICULTURAL SCENARIO OF NASHIK DISTRICT (M.S.) 1991 to 2011."**Which is being submitted herewith for the award of the Degree of Vidyavachaspati (Ph.D.) in Earth Science (Geography) of Tilak Maharashtra Vidyapeeth, Pune is the result of original research work completed by **Mr. Pandurang Dnyanadev Yadav** 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 upon him.

(DR. NANASAHEB R. KAPADNIS)
Research Guide

Place: Pune
Date: February, 2016.

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Date: **Mr.Pandurang Dnyanadev Yadav**

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Undertaking

(For Ph.D. Student)

1. I PandurangDnyanadevYadav, have registered my name for the Ph.D. Course EARTH SCIENCE (GEOGRAPHY) in the year 2011.
2. The undertaken research is entitled as:**IMPACT OF PHYSICAL AND SOCIO-ECONOMICAL FACTORS ON AGRICULTURAL SCENARIO OF NASHIK DISTRICT (M.S.) 1991 to 2011.**
3. I have gone through extensive review of literature of the related published/ unpublished research works and the use of reference made have been acknowledged in my thesis.
4. The title and content of research is original.
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CONTENTS

LIST OF TABLES

LIST OF ILLUSTRATION

CHAPTER IV

CHAPTER V

“IMPACT OF PHYSICAL AND SOCIO-ECONOMICAL FACTORS ON AGRICULTURAL SCENARIO OF NASHIK DISTRICT (M.S.) 1991 to 2011.”

ABSTRACT:

Agriculture is the main stay of the economy of India. It still forms the backbone of the Indian economy, despite concerted efforts towards industrialization in the last three decades. Agriculture is one of the fundamental activities of mankind. It is considered as one of the oldest and most important of all the economic activities of man. Agriculture is related to the raising of domesticated plants and animal as activities to satisfy man’s needs. Nowadays agriculture has become the world’s most important industry.

Agriculture is the main stay of the economy of India. It still forms the backbone of the Indian economy, despite concerted efforts towards industrialization in the last three decades. Agriculture contributes a high share of net domestic product by sectors in India. Further it is not surprising that in the Indian economy, with agriculture as the dominant activity, the main source of livelihood is agriculture. Agriculture also has been the source of raw materials to India’s leading industries. Agriculture is the main stay of the economy of the study region. Agriculture still forms the backbone of the Indian economy, despite concerted efforts towards industrialization in the last twodecades. Agriculture is one of the fundamental activities of mankind. It is considered as one of the oldest and most important of all the economic activities of man. Agriculture is related to the raising of domesticated plants and animal as activities to satisfy man’s needs. Nowadays agriculture has become the world’s most important industry.

Agro-environmental studies of various kinds are essential for the future development of the areas where the population pressure is great. In recent times various methods have been developed for research in agro-environmental studies.

To cope up with ever increasing population, enhancement of the agricultural production is a great concern in a country like India where more than two-third of people depends upon agriculture for live hood. After independence, the breakthrough in crop yield, because of green revolution has made our nation self-sufficient in food grains. However, even today the national average yield of various crops is miserably

poor and incomparable to that of yield obtained in other countries. Agricultural depends on many physical factors such as topography, soils, climate etc. as well as socioeconomic conditions of the people. The physical factors directly influence agriculture, whereas the socioeconomic conditions have an indirect influence. Appropriate knowledge of these components and optimum use of them with better management will be of immense help to optimize the output from the agriculture.

There is great scope to enhance the output by comprehensive scientific knowledge of all the factors and proper planning. Therefore, it is proposed to assess the impact of physical, environmental and nonphysical factors on the agricultural scenario of Nashik district of Maharashtra State.

Every agro geographical reality is transformed with three groups of factors, 1) Man in a certain Socio-economic environment, 2) Natural Environmental, 3) Degree of Socio-economic progress of a reason. All these factors influence land-use.

In connection with the study areas, study of agricultural land-use of village level will focus light on the spatial disparities in Nashik District and also point out the causes responsible for the temporal variations. Thus study of agriculture land-use has become multidimensional spatio temporal analysis of agricultural land-use forms integrate part of agricultural development.

Region selected for study purpose is Nashik District. (Maharashtra). Intraregional diversities in physical and cultural settings of Nashik District and regional imbalance in economic development of region are the outstanding features of the district. Basically agricultural landscape is widespread throughout the study region.

Lastly, while geographers have been pursuing topics concerning axel patterns of human activity and the relationship of man to his environment, they have failed to analyze systematically the geographical impact and dynamics of one force in the world today the policies of comply human organizations, most importantly Governments. In a developing country levels through ever changing rules curbs as well as through national/ state plans of development in a positive sense. The resultant agricultural land-use pattern, thus is a product of such diversified approaches and conditions these days.

STUDY AREA:

Nashik District is one of the important districts of Maharashtra state lies between 19º 35' and 20º 52' North latitude and 73º 16' and 74º 56' east longitude with an area of 15530 sq. k.ms. On the basis of Physiography, Historical and cultural relation, Political background, as well as geographical regional characteristics, Nashik District terms district unit. It is rhomboidal in shape with the longer diagonal of about 170 k.ms. from south west to north east and an extreme breadth of about 170 k.ms. from North to South. The study area has a steep scarp of the Sahyadris to the west and gentle slope towards the east. The district occupies North-West position in western Maharashtra with Dang and Surat Districts of Gujrat state to the North-west, Dhule district to the North, Jalgaon and Aurangabad district to the east, Ahmednagar district in the South and Thana district to the South-West.

The total geographical area of the Nashik District has 15,530 sq. k.ms. which is 5.06 percent of total area of Maharashtra state and its population is 2991739 in (1991), 49,93,796 in (2001)and 61,07,187 in (2010-11).According to area Nashik rank 5th and as per population it ranks 4thamong the 35 districts of Maharashtra state. In other words Nashik is one of the largest district in the Maharashtra state, both in area and in population.

OBJECTIVIES:

1) To assess the impact of physical factors on Agricultural land-use.
2) To analyses the correction between socio-economic factors and Agricultural land-use.
3) To examine spatial variation in the agricultural and crop land-use with view to evaluate the influence of certain physical factors.
4) To investigate the changing agricultural and crop land-use pattern in study area with special references to changes.
5) To find out to problems related to agriculture in area under study.
6) To find out the agricultural productivity and distributional pattern of agricultural input.
7) To examine the infra-structural facilities available for the agriculture.

METHODOLOGY:

The data of various villages falling within the tehsil have been obtained from unpublished record of the revenue department of talukas concerned for the agricultural year 1991 to 2011. The data of individual crop area was processed and converted into percentage to net sown area and have been used for mapping.

The methodology applied in the studies is mostly statistical. Statistical techniques are very essential in this research. Statistical techniques are three types.

1) Descriptive Techniques 2) Sampling Techniques 3) Inferential Techniques.

The raw material of any statistical analysis is a set of data. Descriptive techniques aim to summarize raw data of any size of value in terms of space for providing a single comprehensive index or a graph of it. These facilitate accurate description and observation and also comparison.

In contrast to descriptive techniques, sampling techniques are often formed desirable in much of social science research for basing their hypothesis on data that are not a complete set of observation on a specific phenomenon. Sampling decides the smallest size of observation. If the sample is drawn from a total set of observation some another method is required to draw conclusions about the characteristics of the total from the characteristics of the sample. The method of drawing such inferences from numerical data are known as inferential techniques. The essential tool in inferential techniques is probability theory and it is useful to major changes of selecting a particular sample.

The change of agricultural and crop land-use in the study area studied from geographical point of view. For examining the influence of some physical and socio-economic variables on agricultural and crop land-use, correlation matrix technique used. For enhancing the quality of the work further the smallest variable administrative unit of tehsil has been used. Tabulation and analysis of data, use of competitive techniques, use of statistical method such as T- test, Chi- square test, random sample method, regression equation, index method used. Land-use efficiency find out by using the land-use efficiency index. Weaver's, Bhatiya and Doi's method used for crop combination. Jasbir Singh's technique used for crop diversification. Use

of cartographic techniques, Computer techniques and GIS, G.P.S. Software used for the preparation of maps.

The significance of Spatio-temporal analysis of agricultural land-use in a predominantly agricultural country like India can never be overstated. Man's main purpose for using land is to gain some sort of satisfaction, such as earning an income or providing recreation rather than "bending with nature" moreover farmers viewed as income optimizers behave like "economic men" and therefore their decisions depend ultimately on two things, production functions and the prices of inputs and outputs.

DATA BASE:

Present study mostly relies on the Primary and Secondary data.

A) PRIMARY DATA :

1) Primary Data sources 2) Interviews of farmer to crop check their reliability.

The inaccessible and unpublished by designing relative questionnaire. This questionnaire covers crops grown in the frame made and methods of agriculture practices, types of irrigation facilities, economic condition of the farmers and loan facilities. The designed questionnaire where circulated among village officials like Sarpanch, Deputy Sarpanch, Gramsevak, Society Chairman, Patkari, Farmers and students. Thus Primary data have been collected by field study, questionnaires and interviews with the farmers, Head of local Institutional and personal observation during the field work.

B) SECONDARY DATA:

The data for purpose of analysis as collected from various sources published by the government and report prepared by Agriculture Development, District Statistical Department of Nashik Dry-land Farming Research Center, Abstracts, Journals, Articles, Periodicals, Statistical Abstracts, Census Hand Book 1991 and 2011, Gazetteer of Nashik District, National Sample Survey and Soil Survey etc.

OTHER SOURCES:

1. Census atlas of Maharashtra ,1991 and 2011 and District Gazetteer
2. Map of Nashik District, published by the Government of Maharashtra.
3. Village maps prepared by land survey and Records office, Nashik.

4. Topographical maps of the survey of India, (1:250,000,1:63360,1:50000,1:10,000 international series and 1:250000,46H,47E and1:50000-46H- 6,7 and 46 L -4,12,14,15.) ARC GIS Software.

FIELD WORK

Field work is essential and very important part of this research work. All information regarding the area under crops, irrigation and specially the area under changing crops and fruits, vegetable are collected from farmers by filling the questionnaires. In the initial stages of the work, in order to collect data relating to village level agricultural land-use. Tehsil headquarter, irrigation project, rain gauge stations were visited, information was also collected and observations were noted while travelling. Many villages were visited by making several trips. Field work in completed by visited each and every Taluka places and sample villages of each Tehsils.

ARRANGEMENT OF TEXT.

The entire study is arranged into seven chapters. This study is concerned with the spatial analysis of agricultural land-use in Nashik District of Maharashtra state. Thus the study of agricultural land use patterns and their spatial variation form the core of the project undertaken. It is proposed to consider the spatial variation in the agricultural land-use in Nashik District with a view to evaluate the influence of certain environmental and economic factors on the distribution pattern. The currently evolving and changing agricultural land-use patterns in the District with special reference to changes that have taken place. An attempt is also made to represent the various parameters of land and socio-economic phenomena and the resulting agricultural location. The work has its limitations imposed by choice of region and other factors. Several aspects are omitted and the author is fully aware of such omissions which result from lack of data and other resources including time to be devoted for such work.

Chapter – I, deals with physical setting. Since the underlying purpose of the study is to evaluate the influence of physical environment on agricultural patterns.

The first chapter begins with the introductions to the study area, followed by the description of physiography through a general study of relied, geology, and drainage. Climate the distribution of weather elements are also considered along with soils and natural vegetation.

Chapter-II, includes the socio- economic and cultural setting. Further, different aspects of population are also studied. The persons engaged in the agricultural activity are studied along with other agricultural elements like land tenure, land holding, farm implements, Marketing, transportation and irrigation.

Chapter-III, and IV, are devoted to the discussion of general land utilization (Forest, Net sown Area, Area Not Available for Cultivation, Cuturable Waste and Fallow Land) and agricultural land utilization i.e. distribution of main crops.

Chapter- V deals with regionalization of Agriculture i.e. the associations between the agricultural land-use and various Environmental factors. In this chapter different element of physical and cultural environment their spatial distribution and their impact on agricultural land utilization are assessed.Regionalization of agriculture has been discussed in detail. (Ranking of crops, crop Combinations, Diversification of crops, ranking of crops etc.) in chapter.

Chapter- VI Summary and conclusion. This chapter attempts to summary of the work done. It attempts to summarize the finding and highlights the problems, prospects and suggestions.

Chapter- VII Problems, Prospects and suggestions Studies at micro level. No. of Suggestions are given by research student, collecting from farmers.

Research Scholar, **Research Guide**

Pandurang D. Yadav. Dr. Nanasaheb R. Kapadnis

INTRODUCTION

0.1) <u>INTRODUCTION</u>: - Agriculture is the main stay of India. It still forms the backbone of the Indian economy, despite concerted efforts towards industrialization in the last two decades. Agriculture contributes a high share of net domestic product by sectors in India. Further it is not surprising that in the Indian economy, with agriculture as the dominant activity, the main source of livelihood is agriculture itself. Agriculture also has been the source of raw materials to India's leading industries. Agriculture is one of the fundamental activities of human-life. It is considered as one of the oldest and most important of all the economic activities of man. Agriculture is related to the raising of domesticated plants and animals as activities to satisfy man's needs. Nowadays agriculture has become the world's most important industry.

The credit of introducing this pioneering approach in Agricultural Geography goes to L.D. Stamp (1962) several land-use studies followed studies in India. Chatterjee (1941) And M. Shafi (1951) focused attention on the needs of land utilization survey. The influence of physical factors, especially, morphological factors on land-use, was emphasized by Deshpande, Bhatt and Malvinkurve (1959). The importance of land-use surveys has been explained in detail by Ganguli (1964). The micro-studies to high light the need of proper utilization of land and the connected agricultural problem have carried out by Karimi (1050) and Lahiri (1950). Mr. Shafi (1960) carried out extensive field work in Uttar Pradesh and came up with actual land-use maps at micro or even Nano-levels. The changing land-use and recent trends have also been studied .M. Shafi (1965) has studied the changing land-use patterns. Noor Mohammed (1971), A.R. Kumbhare (1976), S.D. Shinde (1980). Indrapal and Lakshmi Shulka (1981) have focused their attention on the land-use of specific regions.

Environment and man has been the central theme in Agriculture Geography. Environment plays an important role in agriculture. Environmental factors exert direct and indirect influence on the agriculture land-use and yield of crops. The reason is not just the constantly changing relationship of man, agriculture and environment

overtime and space, but also the fact that a large and increasing proportion of the population. Environment influences the yield directly by affecting the structural characteristics of the crops such as density of plants, number of tillers, vegetative growth, weight of grains per etc. It is known that environmental factors like relief, slopes, accessibility, distance from crest, precipitation, temperature, sunshine etc. have a profound influence on the agriculture and agriculture land-use.

Agro-climatological studies of various kinds are essential for the future development of the areas where the population pressure is great. In recent times various methods have been developed for research in agro-climatological studies. Environment-crop relationship studies have been carried out in U.K., U.S.A. and to some extent in India. The methodology applied in these studies is mostly statistical. A methodological note for studying the influence of weather on crop yields. (Seth, Sardana, and Mallik 1970, 1-6) where in results and techniques used by several research workers have been included. According to these authors, these techniques may be broadly grouped, under three heads.

1. Fisher's techniques of fitting distribution constants.
2. Fitting of probability distribution to meteorological variables.
3. Correlation and regression studies during different phases of plant growth.

Fishers (1924) developed a novel approach for undertaking crop-weather relationship studies. His approach is based on the consideration that in studying the influences of a weather factor such as rainfall on crop yield. He studied the relationship between rainfall and yield of wheat for a period of 60 years collected from the Rothamstead experimental station U.S.A. . . . The effect of the amount and distribution of sunshine on the yield was studied by Tippet (1926). The partial regression of Barley yield on the distribution constants of rainfall was studied by Wishart and Mackenzie (1930).

Venkatranam in 1930 studied the effect of rainfall on the yield of cotton of Koilpatti (Madras). A series of cotton yields from Akola Farm for a period of 28 years was studied by Kalamkar and Stakopan (1935) in relation to rainfall. Devis and

Pallesen (1940) studied the influence of rainfall and evaporation on yield of spring wheat at Dickinson, North Dakota for the period 1898-1934.

Crop -weather relationship was also studied by Nair and Bose (1945), Gangopadhhya and Sarkar (1965), and I.C.A.R. Scheme (1965).

Correlation and regression methods to study the effect of one or more of environmental factors on yield were used by many research workers. In these studies the independent variables are either the observation of one or more environmental factors taken during a specified growth period of the crop or during the different phases of the crop growth.

Kincer and Mattice (1928, 53-56) used the method of multiple correlation analysis in the study of weather influence on crop yields. Unakar (1929, 145-161) studied correlation between weather and wheat in the Punjab. Again Kincer (1930, 190-196) on the basis of twenty years data (1909-1928) studied cotton production in relation to environmental factors in the states of North Carolina, Alabama, and Texas etc.

Ramakrishna (1934, 43-54) obtained correlation of weather conditions and yield of cotton in the "Northern" and western tracts. Ramamurti and Banerjee (1966), Singh, Sheshagiri, Kapshe (1970) have studied the relationship between environmental factors and crop land-use.

All these relationships between crop yield and environmental factors (Climatic factors) give a clear idea and these studies suggest ways and means of improving the land-use and crop yield for the ultimate good of human welfare.

The significance of Spatial-temporal analysis of agricultural land-use in a predominantly agricultural country like India can never be overstated. In the context of the alarming increase of population and the relatively low rate of economic growth it is increasingly accepted that the proper and efficient utilization of land resources could be the answer to the problems faced by the country. This is particularly significant even from the modern theoretical view that considers land-use patterns as

dynamic and not static. Man's main purpose for using land is to gain some sort of satisfaction, such as earning an income or providing recreation rather than "bending with nature." Moreover, farmers viewed as income optimizers behave like "economic men" and therefore their decisions depend ultimately on two factors, production functions and the prices of inputs and outputs. (found-1971)

Lastly, while geographers have been pursuing topics concerning axel patterns of human activity and the relationship of man to his environment, they have failed to analyze systematically the geographical impact and dynamics of one force in the world today, the policies of comply human organizations, most importantly Governments (James Osborn 1974). In a developing country levels through ever changing rules curbs as well as through national/ state plans of development in a positive sense. The resultant agricultural land-use pattern thus is a product of such diversified approaches and conditions these days.

Every agro geographical reality is transformed with three groups of factors, 1) Man in a certain Socio-economic environment, 2) Natural Environment, 3) Degree of Socio-economic progress of a reason. All these factors influence land-use.

In connection with the study areas, the study of agricultural land-use at village level will focus light on the spatial disparities in Nashik District and also point out the causes responsible for the temporal variations. Thus the study of agriculture land-use has become multidimensional Spatial-temporal analysis of agricultural land-use forms integrale part of agricultural development. It has remained as a base for further planning for the welfare of human beings. Keeping in mind these perspectives further study has been attempted.

The region selected for study purpose is Nashik District (Maharashtra). Intraregional diversities in physical and cultural settings of Nashik District and regional imbalance in economic development of the region are the outstanding features of the district. Basically agricultural landscape is widespread throughout the study region.

0.2) ARRANGEMENT OF THE TEXT:-

The entire study is arranged into seven chapters. The study is concerned with the spatial analysis of agricultural land-use in Nashik District of Maharashtra state. Thus the study of agricultural land use patterns and their spatial variation form the core of the work undertaken. It is proposed to consider the spatial variation in the agricultural land-use in Nashik District with a view to evaluate the influence of certain environmental and economic factors on the distribution pattern. The currently evolving and changing agricultural land-use patterns in the District with special reference to changes that have taken place. An attempt is also made to represent the various parameters of land and socio-economic phenomena and the resulting agricultural location. The work has its limitations imposed by the choice of region and other factors. Several aspects are omitted and the author is fully aware of such omissions which result from lack of data and other resources including time to be devoted for such work.

Chapter – I, deals with physical setting. Since the underlying purpose of the study is to evaluate the influence of physical environment on agricultural patterns, the first chapter begins with the introductions to the study area, followed by the description of physiography through a general study of relied, geology, and drainage. Climate and the distribution of weather elements are also considered along with soils and natural vegetation.

Chapter-II, includes the socio- economic and cultural setting. Further, different aspects of population are also studied. The persons engaged in the agricultural activity are studied along with other agricultural elements like land tenure, land holding, farm implements, marketing, transportation and irrigation. The pattern of irrigation is the subject matter which covers such aspects as evolution, circumstances and limitations for irrigation development, characteristics and spatial-temporal perspectives of different modes of irrigation.

Chapter-III, and Chapter-IV, are devoted to the discussion of general land utilization (Forest, Net sown Area, Area Not Available for Cultivation, Cuturable Waste and Fallow Land) and agricultural land utilization i.e. distribution of main crops.

Chapter- V, deals with regionalization of Agriculture i.e. the associations between the agricultural land-use and various environmental factors. In this chapter different elements of physical and cultural environment, their spatial distribution and their impact on agricultural land utilization are assessed.

Chapter- VI, Summary and conclusion

Chapter- VII, Problems, Prospects and suggestions Studies at micro level.

The last chapter attempts to summarize of the work done. It attempts to summarize the finding and highlights the problems, prospects and suggestions.

0.3) CHOICE OF THE REGION:-

The scale problem is fundamental in geographic studies. In agricultural geography data are collected and generalization made most frequently at different levels of observation. A district study would provide as with a frame on which further research can be based .Keeping this view in mind, the Nashik District was chosen as an area of investigation. The choice was influenced by several considerations. Such a study would provide a useful approach to obtain a more complete understanding of the problems of agriculture in the region.

Secondly Nashik District has a significant location in respect to the Sahyadri ranges. It is a good representative of Maharashtra State in many respects viz. geology, physiography, drainage, natural vegetation and soils. Therefore the study of the agricultural land-use of Nashik District will help to certain extent to understand the agricultural geography of the state.

Thirdly, the district has special physical base. i.e. It represents large variations in topography (Mountains, hill-ranges, plains, flat topped interfluves, steep slopes and gentle slopes etc.) and climate (rainfall from above 50mm to below 4000 mm.) Thus it is possible to evaluate the influence of various environmental factors upon the agricultural land-use.

Environmental factors such as relief, slopes, climate, soils, rainfall etc. play an important role on land-use patterns of the district. The amount of rainfall has

decreased day by day from 1951 to 2011. It is necessary to understand the continuing process of the physical parameter of land on the on the one hand and the human use of it on the other. Thus utilization of land for agricultural use is a function of physical environment such as location, relief, climate and soil as also of human attributes which are supposed to strike a balance between the environment and its use.

All these considerations have led to the choice of Nashik District as the region for this study in order to understand the agricultural land-use of the region in time space perspective.

0.4) <u>METHODOLOGY</u>:-

The spatial aspects of agricultural land-use in Nashik District are studied from geographical point of view .This necessitates the development of a regional frame for the analysis and compilation of village level data. Gibb's Formula $(1966)^2$, Arithmetical Increase Method and Incremental Increase Method are used for population projection. Measures of population changes and the spatial patterns of land-use revealed through maps were based upon quantitative analysis. Topographical maps are used for mapping.

The data collected through primary and secondary sources were processed and represented by statistical and cartographic techniques. The various methods and techniques used are explained in the relevant sections in the text. Concentration and yield index is applied to calculate the intensification of agricultural weightage method for multiplication, while diversification index is used for calculating the diversification of crops. For calculating the levels of development indicators of various parameters are used. Association among them to each other has been tested through correlation analysis, and correlation matrix have been formed and represented graphically by angular relationship to increase the precision of findings.

The work of systematic analysis has been accomplished mainly through the use of the cause and effect models of analysis avoiding passive description, as possible. A spatial analysis based on this methodology covering a period of Reference years 1991 and 2011, has thus facilitated the understanding of land-use behaviors of the region .For enhancing the quality of the work further the smallest viable administrative unit of taluka (Tehsil) has been used in the study.

Weaver's method and Doe's method of crop combination are used in this study. Jasbir Singh's Formula has been applied.

SOURCES OF DATA:

It was proposed to assess the impact of environment since the plan period the average for the year 1991 and 2011 have been abstracted in order to avoid the climatic hazards on different variables. The main body of the data used is collected from the primary and secondary sources. Taluka is considered as a unit of observation to understand the special variation in the agricultural land-use.

PRIMARY SOURCES:

Taluka and village level statistics were collected through different sources for which special questionnaires were designed and circulated to village farmers, village offices and Tahasildar offices. The information collected through interviews and discussion with experienced farmers have also been added to test the validity of the results.

SECONDARY SOURCES:

They include published and unpublished reports and abstracts, such as socio-economic reviews and District statistical abstracts, census handbook, Gazetteers, Agricultural bulletins published by the Department of Agriculture, Maharashtra state, Nashik periodicals published by ground water survey and development agency , Government of Maharashtra , and some unpublished documents by irrigation and power departments . These documents provide a rich back ground material in the form of vast amount of information, which is both comprehensive at village, taluka and District as units of reference. Season and crop report published by the Government of Maharashtra formed a major source of data on land-use and cropping patterns at District level. District census handbooks (1981, 1991, and 2011) of Nashik District compiled by the Maharashtra census office, Bombay were the other important sources of data at village level, population, occupational classes and general land utilization.

The gram panchayat office in the village and the offices of Talathi's provide information regarding the distribution of crops, landholding, irrigation, wells, general land utilization, population distribution and settlements at village level.

However, certain limitations of data have restricted the scope of the study. Taluka is the area unit in this study. Certain data like yield per hectare, consumption of fertilizers and pesticides, size of operational holdings and land tenures system, information relating to the cultivation of crops, crop weather calendar, agricultural practices and farmers input, output budget etc. was collected by the author through interviews with local farmers during his field work in the region.

Data of some aspects of irrigation and transport were collected from the office of the executive engineer and office of the superintendent, engineer departments of irrigation, Nashik, Band C. department, Maharashtra Engineering Research Institute (MERI) Nashik, and R.T.O. of Nashik region.

0.5) <u>OTHER SOURCES</u>:-

1. Census atlas of Maharashtra ,1991 and 2011 and District Gazetteer
2. Map of Nashik District, published by the Government of Maharashtra.
3. Topographical maps of the survey of India,

   (1:250,000,1:63360,1:50000,1:10,000 international series and

   1:250000,46H,47E and1:50000-46H- 6,7 and 46 L -4,12,14,15.)

0.6) <u>FIELD WORK</u>:-

Field work is very important part of this research work. All information regarding the area under crops, irrigation and specially the areas under changing crops and fruits, vegetable is collected from farmers by filling the questionnaires. In the primary stage of the work, in order to collect data relating to village level agricultural land-use. Tehsil headquarter, irrigation projects, rain gauge stations were visited, information was also collected and observations were noted while travelling. Many tehsil places and some sample villages were visited for correct information regarding cropping patterns, changing patterns of crops and the area under different crops. The correct information of replaced crops of the study region is also found out.

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Chapter No. 1

ENVIRONMENTAL SETTING OF AGRICULTURAL RELEVANCE

Nashik District is one of the important districts of Maharashtra state. Nashik was considered as a gateway to the western coastal belt of Maharashtra and Gujarat as well as to the central Maharashtra for all the invaders descending from the north during the Mughal period. It lies between 19^{o} 35' and 20^{o} 52' North latitude and 73^{o} 16' and 74^{o} 56' east longitude with an area of 15530 sq.k.ms. On the basis of Physiography, Historical and cultural relation, Political background, as well as geographical regional characteristics, Nashik District terms district unit. It is rhomboidal in shape with the longer diagonal of about 170 k.ms. from south west to north east and an extreme breadth of about 170 k.ms. from North to South. The study area has a steep scarp of the Sahyadris to the west and gentle slope towards the east. The district occupies North-West position in western Maharashtra with Dang and Surat Districts of Gujrat state to the North-west, Dhule district to the North, Jalgaon and Aurangabad districts to the east, Ahmednagar district in the South and Thana district to the South-West. (Fig.-N0.1.1)

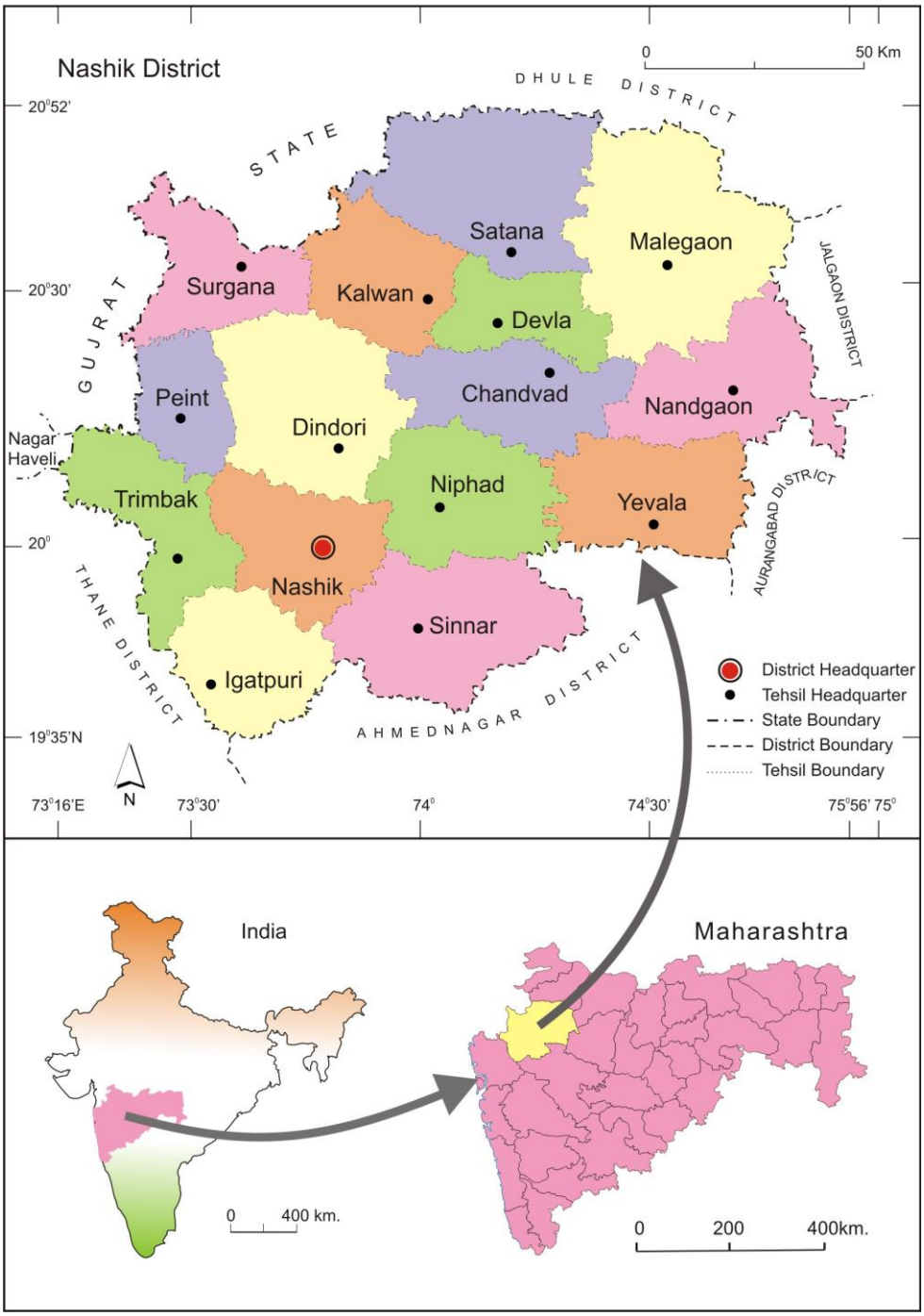
The total geographical area of the Nashik District has 15,530 sq. k.ms., which is 5.06 percent of the total area of Maharashtra state and its population was 2991739 in (1991), 49,93,796 in (2001) and 61,07,187 in (2010-11). According to area Nashik rank 5^{th} and as per population it ranks 4^{th} among the 35 districts of Maharashtra state. The Nashik district was formed in the year 1869 with the city of Nashik as its district headquarter. In other words Nashik is one of the largest districts in the Maharashtra state, both in area and in population.

1.1) HISTORICAL BACKGROUND:-

Nashik has a mythological importance. Due to its mythological, historical, social and cultural importance Nashik has its own personality. The district derives its name from that of its headquarters' town, for the origin of which the following interpretations are given. The town is sited on the nine peaks or NAVA-SHIKHARA and hence the name is derived. The other relates an incident in the Ramayana, where the place Lakshmana is said to have cut the nose (Nasika) of Shurpanakha. Nashik has a rich historical past as the mythology has it that Lord Rama, the king of Ayodhya made Nashik his adobe during his 14 years in exile. In prehistoric times, like the rest Deccan, Nashik region formed a part of the Dandakaranya, suggesting that the region

was inhabited by the tribes. The region had a well-organized administration in the second century A.D. when it was ruled by the Shalivahanas.

FIG. NO. 1.1: LOCATION MAP OF NASHIK DISTRICT



The area passed to the hands of Muslims in the early fourteenth century through a succession of dynasties viz, the Shalivahanas, Vakatakas, Rashtra-kutas, Chalukyas and the Yadavas. Thereafter a new Muslim dynasty called the Bahamani dynasty was established in the Deccan. The Bahamani Empire was integrated at the close of the fifteenth century. The area witnessed the rise of Maratha power in the seventeenth century, which with all its ups and downs continued till the eighteenth century when the Marathas were finally defeated and the region passed into the hands of the British. During the Seventeenth and eighteenth centuries under the British rule Nashik was an important place. Nashik thus continued to hold a significant position in the administrative and cultural life of western Maharashtra throughout the British rule and later even in the post-independence period. The Nashik headquarter as a city is situated on the bank of the Godavari river (Dakshin Ganga) making it one of the holiest places for Hindus all over the world. After every 12 years "Sinhastha Kumbh Mela" is successfully organized.

ADMINISTRATIVE HISTORY:

Nashik district is the third largest district in Maharashtra state. The territory now including Nashik District was formerly partly in Khandesh District and partly in Ahmednagar District. Yeola was known as Patoda taluka. In 1837-38 parts of Ahmednagar district consisting of Sinnar, Chandwad and Dindori. Nashik including Igatpuri and Peint taluka were made into sub collectorate under Ahmednagar. The sub collectorate of Nashik was, however, abolished in 1856 and its talukas were incorporated in Ahmednagar district in 1861. Nimar peta under Sinnar and Vanipeta under Dindori were abolished and **a** new sub- division was formed with headquarters at Niphad. Headquarters of Karnai taluka included in Trimbak peta were transferred to Igatpuri town in the year 1861-62 and the name of the taluka was changed from Karnai to Igatpuri taluka. In 1869 Nashik was made a full-fledged district, with Eight sub-divisions of Ahmednagar (viz. Nashik, Sinnar, Igatpuri, Dindori, Chandwad, Niphad, Yeola and Akole) and three sub-divisions of Khandesh district (viz. Nandgaon, Malegaon, Baglan) together with Peint taluka. Shortly afterwards Akole taluka was returned to Ahmednagar. In 1875 Baglan was divided into two talukas Baglan (Satana) and Kalwan. After some period for some reasons Peint state became British territory and was made a sub-division in 1878.

There were no major changes in the district or taluka boundaries between 1901 and 1948 consequent upon the merger of the Indian states a new Mahal known as Surgana Mahal consisting of the former princely state of Surgana, was created in 1949. In 1950, 11 enclave villages which formed a part of Nandgaon taluka were transferred to Aurangabad district. Two villages (Salher and Vaghamba) from Surat district were added to this district. Four Villages were transferred to west Khandesh or present Dhule district.

1.2) ADMINISTRATIVE UNITS:-

For administrative purposes the district has been divided into thirteen talukas (1991). Recently two talukas were created in the district making the total talukas fifteen (2011). According to the 2011 census, there are 23 towns (including Nashik city) and 1960 villages in the district. Out of the total of 61, 07,187 persons in the district about 35, 09,814 live in the rural areas and 25, 97,373 in the urban areas.

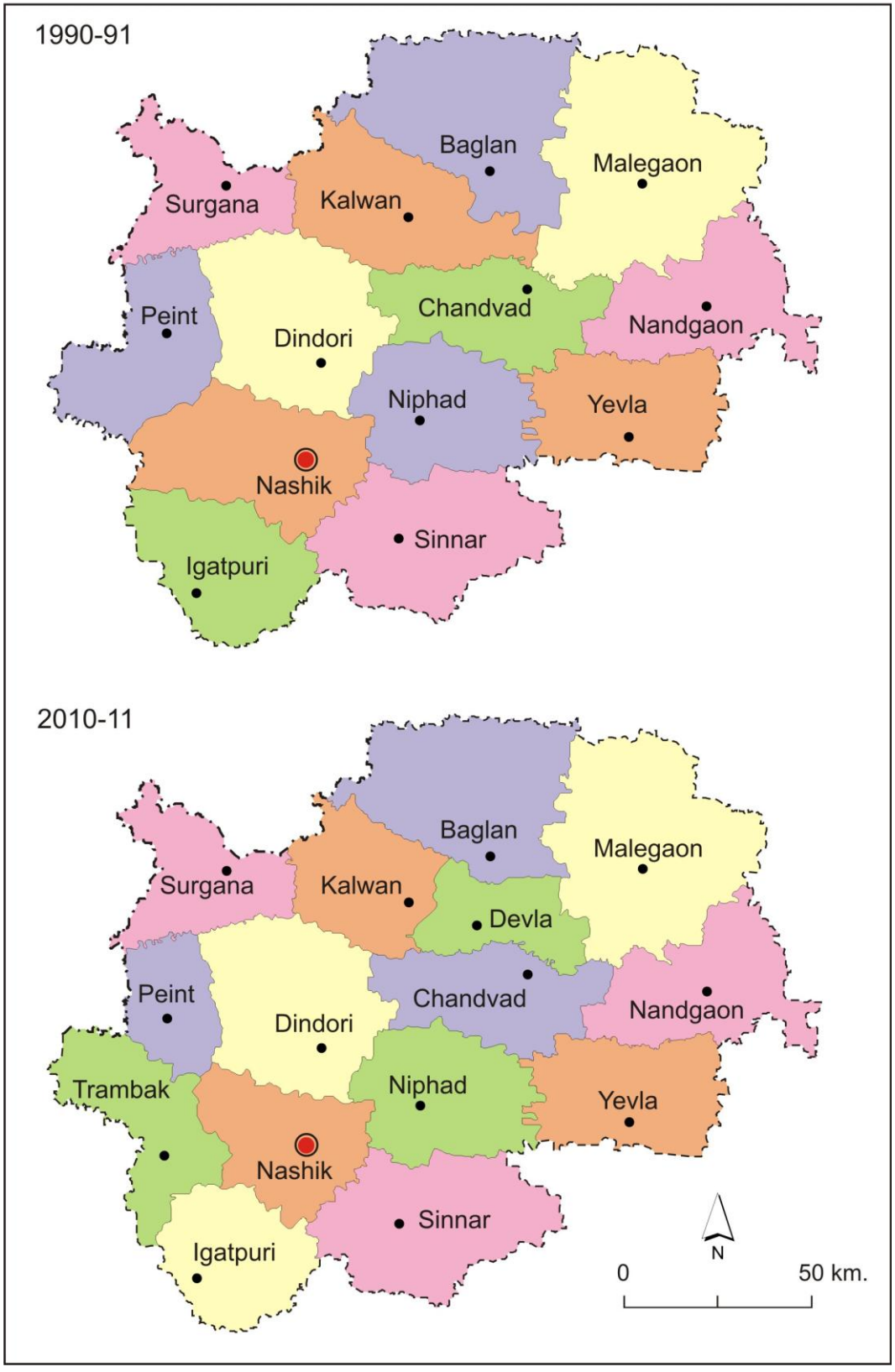
Table No.1.1 Nashik District- Administrative Units

Sr.No.	Name of Talukas 1991	Name of Talukas 2011
1	Nashik	Nashik
2	Peint	Peint
3	Dindori	Dindori
4	Surgana	Surgana
5	Kalwan	Kalwan
6	Baglan	Baglan
7	Malegaon	Malegaon
8	Chandwad	Chandwad
9	Nandgaon	Nandgaon
10	Yeola	Yeola
11	Niphad	Niphad
12	Sinnar	Sinnar
13	Igatpuri	Igatpuri
14	----	Trimbak
15	----	Deola

Source: i) District Census Handbook, Nashik District (1991 and 2011)

ii) Socio-Economic Review and District Statistical Abstract of Nashik District.

FIG. NO. 1.2: ADMINISTRATIVE UNITS - NASHIK DISTRICT



1.3) GEOLOGY:-

The area under study forms a part of Deccan Trap region of peninsular India. The Deccan Trap covers an area of half a million sq. k.ms. in the western and central parts of Indian peninsula. The study area is located mainly in the western part of the state that is commonly known as the Trap region or the Trap country. The great trap region of the Deccan covers the whole district. The district falls in the seismic zone.

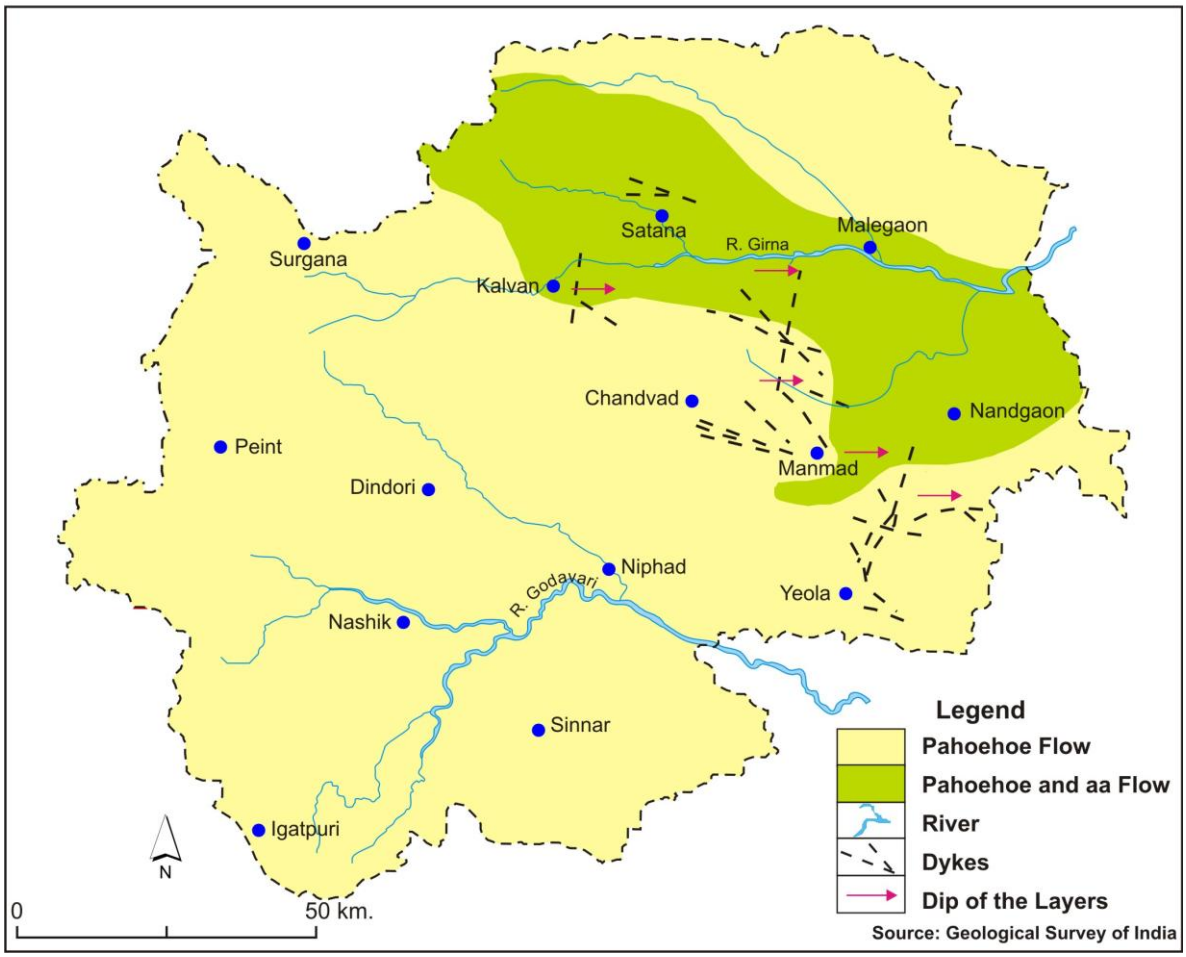
It is entirely of volcanic formation. The volcanic portion consists of compact, stratified basalts, and an earthy trap. The basalts are the most conspicuous geological feature to the west. They lie in flat topped ranges, separated by valleys, trending from west to east. In some flows the basalt is columnar and then it weathers into fantastic shapes. The formation of the base of the trap is chiefly amygdaloidal, containing quartz in vertical veins, crystals and zeolites minerals, especially apophyllite weathering into a gray soil. The absence of laterite, which caps the summits of the hills to the south is a curious in the geology of the study area.

The thickness of the basalts varies greatly in the Trap region, the maximum thickness of 2120 m. to 3030 m. is found in the western part of the study area. G.P.I. Walkar has estimated that the thickness of the trap is 2424 m. near Trimbak (Nashik).

The Deccan trap was formed due to consolidation of lava flows that were extruded on the surface through gigantic fissure eruption during the late Cretaceous and early Eocene periods. Most of this tectonic activity took place in the early Eocene period about 60 to 65 million years ago. The flows, however, were erratic and occurred at different times. This has resulted in the complex nature of the Deccan basalt, which shows a remarkable variation in its lithological character. Basically the basalt formations are derived from the sub-aerial flows of the lava.

The western part of the area is dominated by the Sahyadri ranges marked by the preservation relics of the original plateau and the ancient surface of erosion. The Sahyadri ranges have igneous rock structure in the crust, with red soil top surface. The eastern plains of the district have basalt base.

FIG. NO. 1.3A: GEOLOGICAL MAP



The Sahyadri ranges themselves form the water divide separating the east flowing rivers of the study area and the west flowing rivers in nearby Konkan region.

The recent alluvial deposited by the river action is observed in all major river basins and flood plains of the numerous tributaries.

1.4) PHYSIOGRAPHY:-

Nashik district is situated astride the eastern flank of Sahyadri ranges. The district boasts of some of highest peaks of the ranges like Kalsubai, Salher and Saptashrungi. Satmala is sub ranges. The relief of the presents some interesting features. The western margin of the district is the Crestline of the Sahyadris which divides the Konkan (Coastal lowland) from the upland of Maharashtra and acts as a main watershed of the peninsular rivers separating the west flowing and east flowing rivers. This narrow crest zone has a width varying between 10 and 20 k.ms. and is

called the “Ghats” section. The Crestline is marked by many saddles occurring, generally at the altitudes of 625 to 850 meters from M.S.L. The general land slope is in east- southeast direction and is indicated by Godavari basin slope.

Consequently the “trap” country, as a whole, shows a general east wars 1 slope and the Crestline of Sahyadri a steep western slope. The Crestline itself is believed that has moved considerably due to head ward erosion.

Head ward erosion by the major rivers and their tributaries, river captures, emergence of Ghats (i.e. saddles) in the north-south alignment of the Sahyadris and variations in the altitudes of the Crestline itself are some of the important characteristics associated with the western portion of the peninsular plateau of India, of which the study area forms the region to east of the Sahydris.

FIG. NO. 1.3B: RELIEF

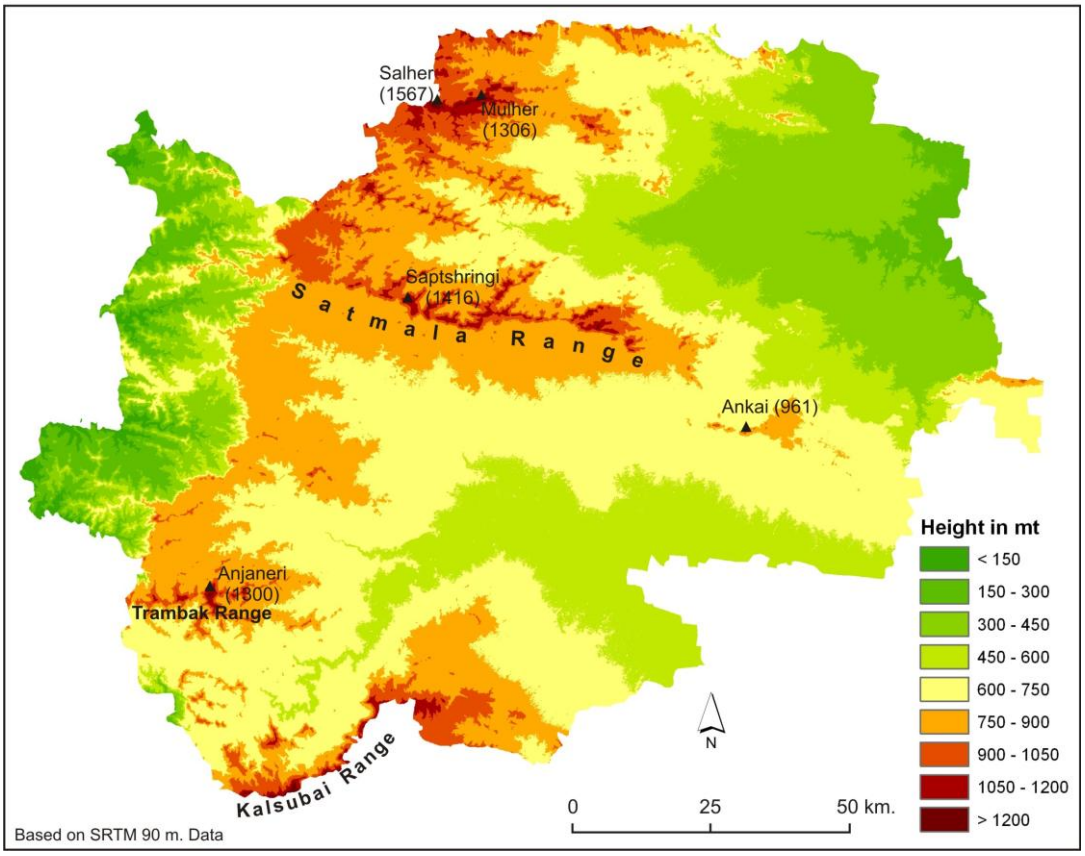
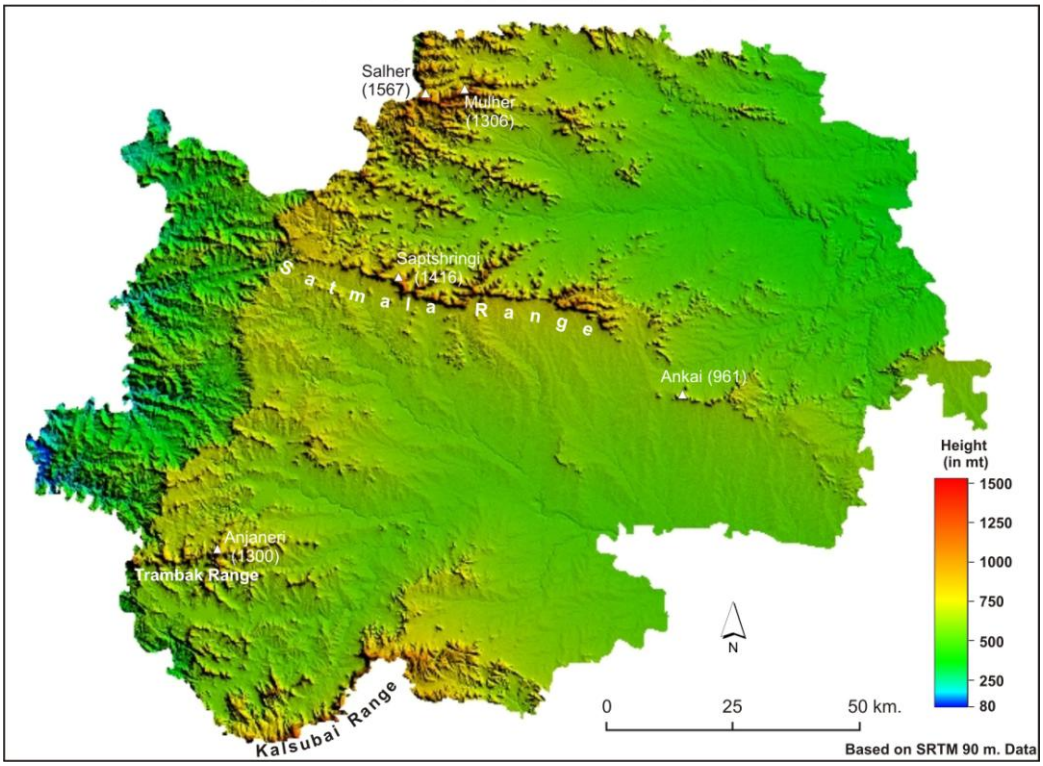


FIG. NO. 1.3C: DIGITAL ELEVATION MODEL



Eastward of the Ghats, the study region is dominated by the peaks of Sahyadris rise above 1000 m. occasionally and by river valleys divided by flat topped interfluves. A number of such mesas overlook the valleys, but are separated from them by steep slope or scarps. Dembris has accumulated on lower slopes of the mesas leading to the terraces. The major interfluves and spurs from water divides between the major rivers and their tributaries. To the east lie the broad valleys interspersed with tongue-like spurs that originate from the Sahyadris and generally extend in north west-south east direction. (Fig. No.1.3)

PHYSIOGRAPHIC REGIONS:

The physical environment of the study area is well diversified. The study region is dominated on the west by the Sahyadris. The main system of hill is the Sahyadri and its offshoots. The main Sahyadrian range runs from north to south on the western portion of the district. From the main Sahyadrian range three prominent spurs stretch cut to the east. The central part shows a combination of small and big hill ranges, mesas and buttes and inselbergs, and present generally highly dissected landscape. The central part is also marked by upper courses of the major rivers such as Godavari and Girana. The eastern part shows a comparatively level landscape.

The western part generally has an altitude of more than 900 meters, the central part from 600 to 900 meters, and the eastern part less than 600 meters. It is therefore, customary to divide the study area into three regions based on altitudinal levels. Broadly these altitudinal zones correspond to the western, central and eastern parts of the study area. Such a division is of course based upon the predominance of particular altitudinal class in each section. It is therefore to be noted that altitude variations are observed in each of these Eocene on account of the diversity of relief in terms of the distribution of valleys and divides (Fig. No.1.3)

REGIONS:

The district may broadly be divided into three major regions.

1) Western hilly area (Down Ghats).

2) Transitional zone.

3) Rolling upland. (Godavari and Girana basins).

1) WESTERN HILLY AREA:-

Western mountainous zone is characterized by rugged terrain and heavy rainfall. This region is essentially the Crestline of the scarp face and could be generally identified with the Sahyadri Mountain with altitudinal levels exceeding meters. The Sahyadri itself forms the extreme western edge of the Deccan plateau. It straddles the entire study region. It forms the water divide between the west flowing rivers of the Konkan lowlands and the east flowing rivers which dominate the study area.

The physiographic region follows a sinuous line probably caused by the unequal reclusion of the scarp. The Crestline locally known as the “Ghat Matha”, has different altitudinal levels, but processing may saddles through which the lines of communications pass.

This much dissected region lying to the west of the Sahyadri edge of the Deccan plateau in the district partakes of the nature of the Kokan tract. It includes the extreme north western portion of Nashik, the whole of Paint, the north western part of Dindori and Surgana except a small area to the east and south of the chirai.

With the exception of the Sahyadris, the general direction of mountain ranges is from west to east or south west to north east and the higher portion being near the west. The highest point of the study area is KALSUBAI PEAK (1646 meters or 5400 feet.) It is situated on the southern boundary of the district.

From north to south in the study area, there are many high peaks (Mesas) such as SALHER (1567 meters), MULHER (1306 meters), SAPTASHRUNGI (1416 meters), KEM (1177 meters) and BHORGAD (1080 meters). At the extreme north of the district is the SELBAI range. The highest peaks are found in this range. MANGI-TUNGI (1331 meters) is the highest peak. At the east of the Mangi-Tungi hill is situated the selbari pass. At further east are situated the HINDALBARI pass and THERMAL FORT. Near the extremity of this range within the district is situated the GALNA FORT (710 meters), which has given its name to this line of hills.

DHOLBARI range is another range of the study area. The name is derived from the village Dholbari situated near the pass. This range contains several high peaks such as, HATIMAL (1315 meters), Kutradongar (1190 meters), Kumbaria (982 meters), Nochalas dongar (hill-1122 meters), Adolia (777 meters) and Dhodbla (550 meters).

The Satmala- Chandwad or Ajanta range is right across the district. It differs from the rest of the mountains in the north by the number and shape of its peaks. These peaks are visible from a greater part of the district and form prominent landmarks. The highest of them are DHODAP (1451 METERS), SAPTASHRUNGI (1416 meters), INDRAI (1410 meters) and CHANDVAD (1410 meters). Further to the south-east are the twin forts of Ankai and Tankai (960 meters). The Satmala range branches off from the Sahyadris in an easterly and south-easterly direction.

The Trimbak-Anjaneri range stretches nearly eastwards from Bhaskargad (1080 meters), on the Sahyadris. About 5 km. east of Bhaskargad is Harish fort (1113 meters) and Brahma dongar (1201 meters). However as in other ranges, the greatest heights are attained some distance away from the Sahyadrian scarp at Trimbak (1294 meters) and Anjaneri (1300 meters).

Many big and small ranges emanate from the Sahyadris showing tongue like spurs in the easterly, northeasterly and southeasterly direction. All above and many

other small hill ranges in the study area are interspersed with broad valleys of lower tubes.

Thus the western hilly area (Sahyadri region) presents a complex and varied landscape, characterized by high and low hilly ranges, plateaus and comparatively steep slopes. (Fig. No.1.3).

2) TRANSITIONAL ZONE:-

The second physiographic region, lying to the east of the Sahyadrian scarp. To the east of the mountainous high region is the zone of predominantly 600 to 900 meters altitude. This can be considered as the central or middle region. This is a transitional zone between the higher western region and the lower region. Nearly half of the area of the northern Nashik is formed by this zone.

The physiographic region is marked by Chandwad range or Ajanta range which is the natural divide between the two major river systems, viz. the Girana in the north and Godavari in the south.

Separating the larger river of the district are several other ranges similar to the Dholbari, Anjneri and Sinnar plateau which form the southern and central part of this physiographic region. Anjaneri is a fine mass or trap rock, with lofty upper and lower scarps each resting on a wide and well wooded plateau. Its top is flat and of considerable area. From Anjaneri hill there is a spur extending southwards for about 3 k.ms. from which three branch spurs resembling a Trishul are shown out. The western arm curves in a semicircular form with the crest over 900 meters. The central one is short and straight trading due south. The eastern makes a smaller semicircle whose other end extends eastwards as Ghargad and continues after a couple of gaps into the ridge which contains the Bahulla fort and ends in a series of isolated small hills. The eastern of these is the Shiva dongar just at the west of Deolali cantonment. A little to the north of the hills is a very long narrow low ridge about 50 meters above the surrounding plains which is suggestive of a dyke.

The southern part of the district known as the Sinnar plateau is one of reddish brown soils on rough Sloping ground.

In short this physiographic region is characterized by major and minor hill ranges with varying slopes, Sinnar plateau generally presenting dissected landscape.

3) ROLLING UPLAND:-

The last physiographic region is also known as eastern low region and it is below six hundred meters in altitudinal level. It consists of Godavari and Girna basin.The region is gently sloping plateau occupying a north eastern, central and southern part the study area. In general eastern “low” region is associated with the broad valleys of the two major rivers and some of their tributaries. The Girana in the north and Godavari in the central and southern part have curved broad valley through extensive erosion of the basaltic rock. The black soils formed due to the dis-integration of basalt rocks have been responsible for the fertile nature of the land in this region.

The Girana valley presents a small part of the upper basin mainly in the Kalwan and Baglan talukas. It occupies the northern part or the study area. The Godavari basin lies to the south of the Satmalas and east of the Sahyadrian scarp. This region is the most prosperous one. This valley presents a part of the upper basin mainly in the talukas of Nashik and Niphad. It is the zone of high fertility which increases towards the east. Apart from these upper valleys, the region as a whole presents gently sloping landscapes disturbed occasionally by spurs, dotted by knolls and inselbergs.

SLOPE:-

The study area as a whole, shows a general eastward gentle slope and a steep westward slope. The eastward slope in the study area as a whole is gentle i.e. about 3 meters to 1 k. m. But the slope in the western part near the escarpment varies between 50 and 500 meters per kilometer. Thus there are great variations in the general slope in the study area and characteristically, in many micro areas the slope variation is by far greater than the Berge’s, all this shows spatial variations in slopes to a great degree.

1.5) DRAINAGE:-

The drainage pattern and trend lines of the ridges depend upon the structure of the underlying basaltic rocks of the district. These rocks, interblended with ash layers, have developed three sets of master joints, running approximately in north-south, north-west and north-northeast-southwest directions. The streams of the region have taken advantage of these planes of weakness in curving their valleys as is shown by the following streams generally running one or other of these three sets of directions, the bends at the confluences of almost every rill with its main streams are generally rectangular, and courses of most valleys are almost straight.

Source: (B. Arunachalam: - Shifting of the water divide in the Igatpuri-Trimbak Ghats. Bombay Geographical Magazine Vol. XII No. I, p12.)

The district is situated partly in the Tapi basin and partly in the Upper Godavari basin. Nandgaon, Kalwan, Baglan and Malegaon talukas are drained in the north and north-east by Girana River (tributary of Tapi) and its tributaries. The talukas lie in the Tapi basin. Remaining talukas lie in the Godavari basin and are drained by the Godavari River and its tributaries. The Satmala range of hills prove a watershed between the above two basin. Apart from Godavari and Girana, there are a number of small Konkan rivers draining westwards into the Arabian Sea.

The district is drained by two main rivers, the Girana and the Godavari and their tributaries. Godavari rises near Trimbakeshwar and drains Nashik and Niphad talukas, is the most important river and is known as “Southern Ganga”. Apart from these rivers there are a large number of small konkan rivers draining westward into Arabian Sea among which the Vaitarna is the only useful river which has been harnessed for generating electricity in Igatpuri taluka. The other important rivers are Darna, Mosam, Kadava, Unanda and Kashyapi.

GODAVARI BASIN:-

The proper Godavari River comprises the talukas of Nashik and Niphad. It originates on the high slopes of the Sahyadris at Brahmagiri near Trimbakeshwar, where rainfall is heavy. (19^{o} 56’ N and 75^{o} 31’ E.). It flows south eastwards and is joined by many tributaries such as Darana, Kadawa, Banganga etc. Vaki, Unduhol,

Valdevi, Dev, Jham and Pimpalad are tributaries such Darana and Kadawa. The upper valley of the Godavari only is included in the study area. With the slope it flows to southeast as the other rivers do.

In the source region Godavari river first flows north-east. Debouching form Brahmagiri, the river Godavari collects main tributaries like Kadawa, Banganga from the north and Darana, Nasardi, from south, which is the other most important tributary. Apart from these important tributaries, the Godavari is fed by many second and third order streams and the drainage pattern is of the dendritic type. All the rivers and tributaries of the Godavari's system have considerably eroded the western and central portion of the Nashik district. In the eastern part of the study area, the Godavari has formed a broad valley with considerable alluvial deposits on the bank.

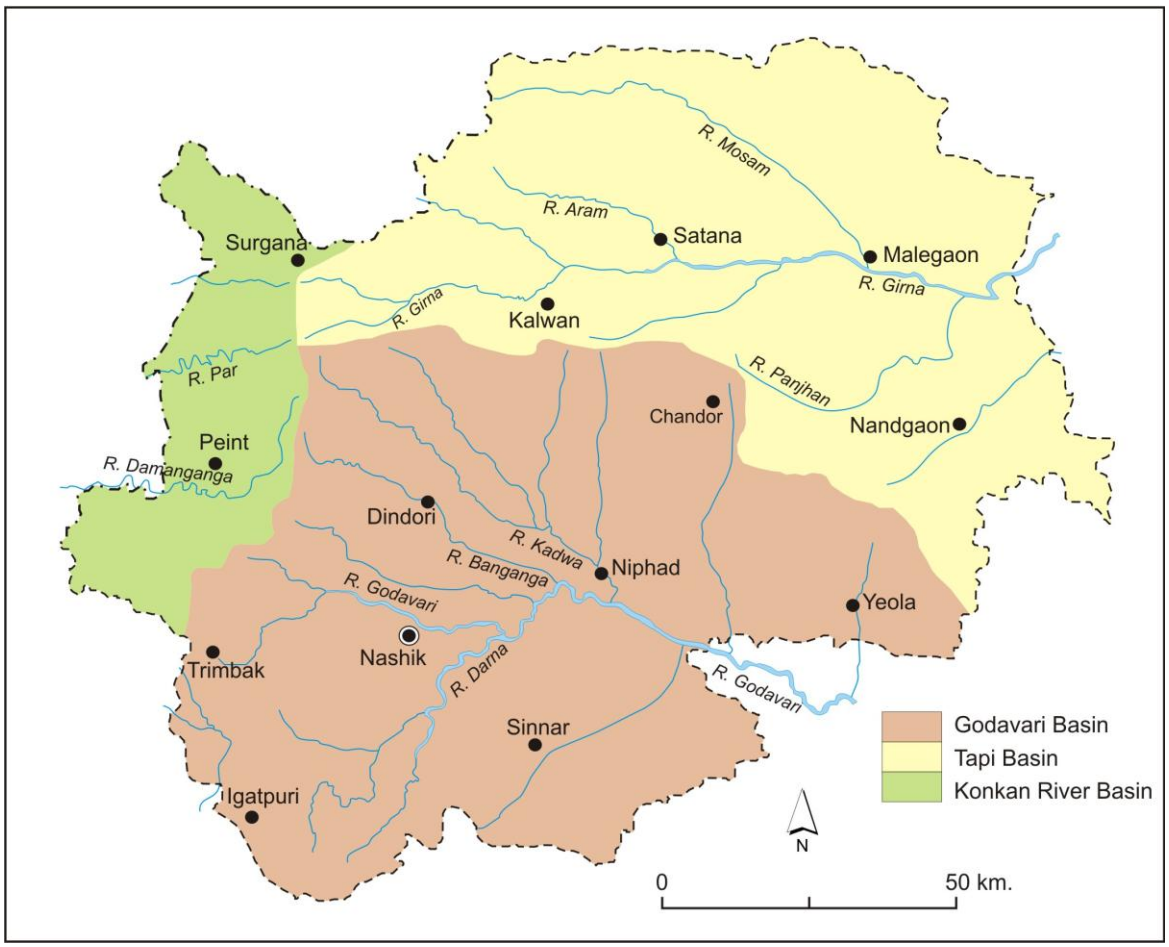
KASHYAPI: The Kashypi (Kas) river rising a little above Wagira in the Sahyadris and augmented by the waters of the Wotki and the Muli, is the next stream to join the Godavari. Just at this confluence is constructed the Gangapur dam, whose storage backs up both the main river and its tributary, the Kashyapi. 5 km. further to east, at Jalalpur, the Godavari is met by the Alandi, a small stream flowing from the north, a few hundred meters below the meeting point.

About 3 km. below Nashik, the Godavari receives the Nasardi on the right, a small but important stream rising 16 km. west of the town in the Anjaneri range. From this stream the chief water supply of Nashik is drawn, being conducted by a channel to a sort of basin in the town. Below this the main stream widens, but rocks still obstruct its course. The banks continue high, but become earthier as the river flows east.

DARNA**:** The Darna rises on the northern slopes of the Kulang hill fort in the Sahyadris about 13 km. south-east of Igatpuri. Though the straight line distance from the source to its influence with the Darna is only about 50 km.; it has a very long and winding course as much as half of that distance. Its banks are like those of the Godavari below Nashik, of no great height, but broken by scores of small streams, making the passage along the banks of the river very difficult for laden carts.

On the right bank, at Belu, the river Darna receives the Kadva, not a large river, but a small stream flowing north-eastwards between Mhordan-Katlia hills on the west and Kalsubai-Bitangad Patta range on the east in the south-eastern part of Igatpuri taluka. On the left bank the Darna has only three tributaries of any size, and they hold little water during the hot season. They are the Waki, the Undukol and the Valdevi.

FIG.NO. 1.4: NATURAL DRAINAGE PATTERN



BANGANGA: Among the north bank tributaries, the Banganga rises a little to the north-west of Ramsej hill and flows in a general easterly course passing by Ozar, where a dam crosses it to divert the water into canals on both sides for irrigation. After passing Sukene it joins the Godavari.

KADVA**:** The Kadva rises in the Sahyadris to the north-west of Dindori in the angle between the former and the Satmala range, and crosses Dindori from north-west to south-east. It is rocky both in bed and bank, but the bed is wide, and the average

volume of water is small compared with the area through which it flows. Irrigation works of considerable importance have been constructed on it.

1) GIRANA BASIN:-

THE Girana is the second important river of the study area. It rises at the west of the district in Surgana taluka, just south of Cherai village at about 8 k.ms. south west of Hatgad in the Sahyadris and flows nearly east along wide bed, with high banks in Kalwan, Baglan and Malegaon talukas. It winds its way northwards as it nears the Jalgaon frontier. In the upper course, Girana receives several rivers of nearly equal size as itself. Girana collects main tributaries like Tamboli, Punand, Aram and Mosam from north and Panjan from south. Mosam is the northernmost tributary of the Godavari and rises in the Sahyadris south of Hanuman hill. The river runs eastwards through Baglan and Malegaon talukas. It is joined by a number of effluents especially from the northern side. i.e. Tungadnala, Bhevarinala, Alwainala and Vatolinala. Important among south bank tributaries of the Mosam is the Knagarinala joining at Askheda. Mosam joins Girana near Chandanpuri about 3 k.m. below Malegaon .Panjan and Manyad are eastern most tributaries, which are much larger in size than the other.

Borinadi (river) is an independent tributary of the Tapi, rises a little above Mahad and Chirai on the southern slope of the Galana hills and it has a small course eastwards within the study area.

1. M.S. Krishnan (1960): Geology of India and Burma.
2. G.P.L. Walkar (1969): Some observations and in perpetrations of Deccan Trap- University of Saugor.

1.6) CLIMATE:-

Nashik district experiences moderate temperatures that averagely range from 12^0C to 30^0C. Winters are fairly cold and temperatures are known to drop down to 15^0C. (Maximum temperature recorded 45^0C and lowest temperature recorded 1^0C at Malegaon). The climate of the study area is characterized by dryness except in the south-west monsoon season. It has a typical monsoonal climate. The climate of Nashik district can be classified as follows.

1) Cold season – December to February.
2) Hot season – March to May.
3) South-west monsoon season–June to September.
4) Post monsoon season – October and November.

1) COLD SEASON:

This season extends over a period of three months from December to February. It is generally characterized by cool, bracing and dry weather with occasional short spells of moderate rainfall resulting from the storms that originate over the Bay of Bengal or the Arabian Sea. Another feature of this season is that diurnal range of temperature is even exceeding 18 to 15 at times. There are some interesting facts as regards the mean maximum and mean minimum temperatures of the district. It is observed that during winter season there is a sharp fall in temperature which occurs in the district because it is an impact of cold waves coming from the north. The fig.no.1.9 shows the lowest minimum temperature. Relative humidity for selected stations such as Malegaon and Nashik is lower than in other seasons.

2) The Hot Season:-

The period between March and May is known as hot weather season. It is characterized by spells of excessive heat and drier weather. The temperature of the district is fairly high i.e. above 42^0C on the typical hot summer days.The temperature rapidly rises from the month of March and reaches maximum in the month of May,with the mean daily maximum temperature 41^oC at Malegaon and 38^oC at Nashik. The heat is intense in the height of summer and on some days the maximum temperatures may go above 46^oC in the eastern part of the district [locally known as Malmatha] i.e. Malegaon plateau, with comparatively lower elevations. The highest maximum temperature recorded was 46.7^oC on May 23rd, 1916 at Malegaon while it was 42.4^oC on May 12th, 1960 at Nashik. The lowest minimum temperature at Malegaon was 0.1^oC on February 1st, 1929 and at Nashik it was 0.6^oC on January 7th, 1945. The latest information of minimum temperature is-1^oC at Kundewadi on 1st January 1991.

3) SOUTH-WEST MONSOON SEASON (June to September):

It is also known as rainy season. It extends over a period of 5 months. The mean maximum and the mean minimum temperature shows a general decline from June to August as a result of the prevailing monsoon weather. The mean maximum temperature then rises during September and October with the weak erring of the monsoon, but the mean minimum temperature continues to fall through these months.The mean relative humidity also increases from June to August and declines through September and October. The annual rainfall is 1013 mm. The eastern portion experiences drought conditions frequently.

The south-west monsoon 'breaks' by about 10th June over a large part of the area in Western Maharashtra and by the last week of June it is usually well established. There are spatial variations of rainfall because of variations of relief.

4) POST MONSOON SEASON (October and November):-

The climate of Nashik is generally pleasant compared with the climate of Bangalore and Pune. However, in recent years the temperature of Nashik has increased slightly due to deforestation and industrialization. The climate of Nashik is characterized by dryness except in the south-west monsoon season. The year may be divided into four seasons. The cold season from December to February followed by the hot season from March to May and the south-west monsoon season from June to September followed by the post-monsoon season during October and November.

About 88 percent of the annual rainfall in the district is received during the rainy season from June to September. July is the rainiest month. During May, October and November there is some rainfall, mainly in the form of thundershowers.

Source :- (Meteorological Department of the Government of India, Poona, Nashik and Malegaon).

TEMPERATURE:-

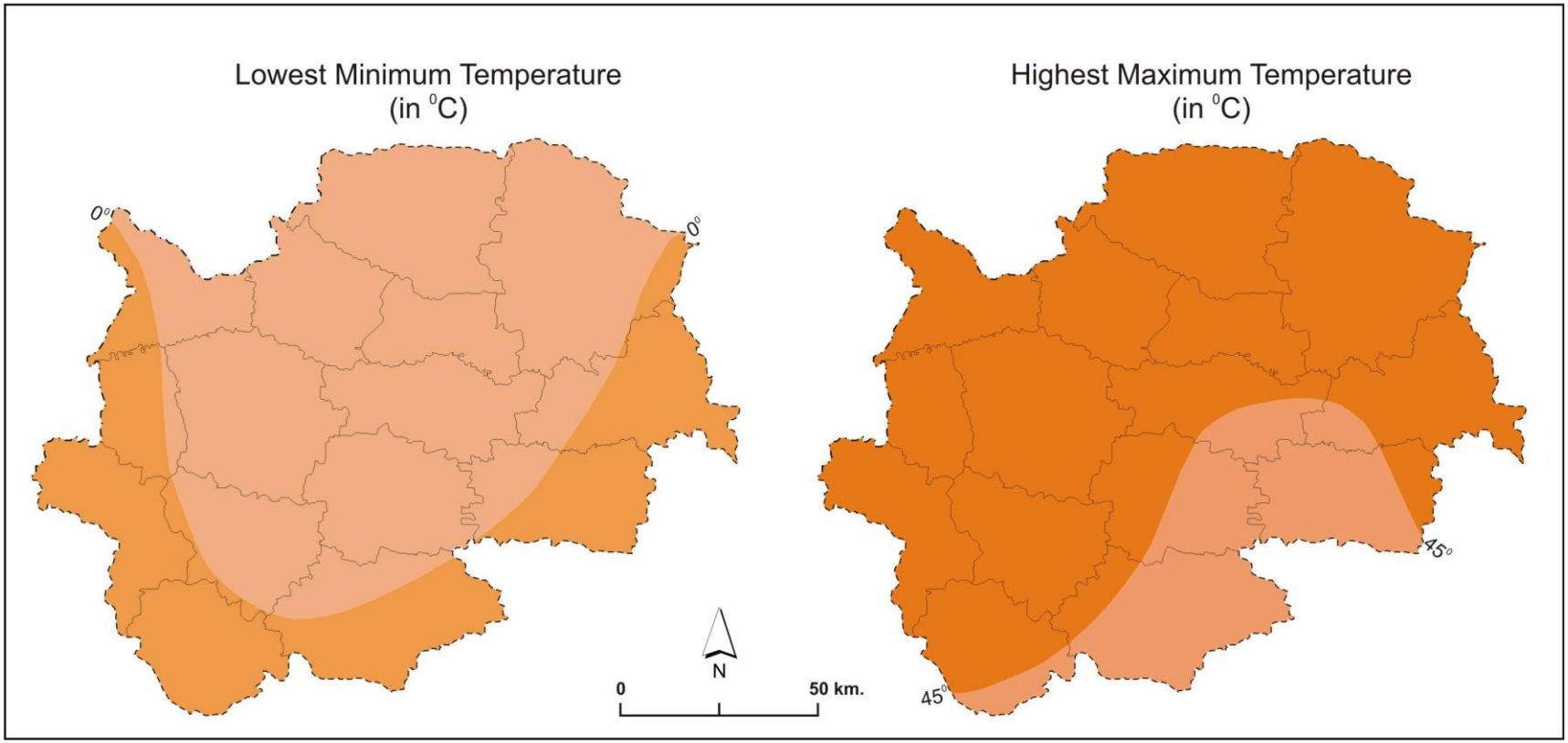
There are only two meteorology observatories in the district, at Nashik and the other at Malegaon, from where temperature and other climatological records are available. These may be taken as representatives of the climatic conditions in the district in general. The maximum temperature in summer is 42.5^{o}c and minimum temperature in winter is less than 5.0^{o}c. Relative humidity ranges from 43 percent to 62 percent. The climate of the Nashik is generally compared with that of Bangalore and Pune. However, in recent years it is noticed that the temperature is increasing and the rainfall is decreasing due to industrialization and fast deforestation.

After half of February the temperatures rise rapidly till May, which are usually the hottest months. While days are generally the hottest during April with a mean daily maximum at about 40.7^{o}C (Malegaon), 38^{o}C (Nashik), and nights are usually warmer during May or June than in April. On some days the maximum temperature may go above 46^{o}C in the eastern part of the district with comparatively lower elevations. (Table No. 1.2).

With the onset of the south-east monsoon early on the 1st of June, there is rapid drop in the day temperature, but nights still continue to be about as warm as during April and May, and with the increased humidity of the monsoon, are at times uncomfortable. Towards the end of the monsoon season, in September and October, there is a slight increase in the day temperature, but the nights become progressively cooler.

After the withdrawal of the monsoon early In October the nights become cooler, but there is no appreciable drop in the day temperature. December is generally the coldest month with the mean daily maximum temperature in this month 28.4^{o}C at Malegaon and 32^{o}C at Nashik. The mean daily minimum temperature is 12.4^{o}C at Malegaon and 6.5^{o}C at Nashik. During cold season, cold waves affect the district and minimum temperature sometimes drops to the freezing point, though this occurs occasionally.

FIG. NO. 1.5: TEMPERATURE



The highest maximum temperature recorded was 46.7^{o}C on May 23, 1916 at Malegaon. The lowest minimum temperature at Malegaon was 0.1^{o}C on February 1, 1929 and at Nashik it was 0.6^{o}C on January 7, 1945.

The latest recording of temperature at different observatories in the district on 1st January 1991 reveal sudden fall to about +1^{0}C to -1^{o}C. Especially at Malegaon, Kundewadi and Niphad which is at the east and central part of the district, though this was a very exceptional case.

HUMIDITY:-

The air is very humid during the monsoon season. In the post monsoon, cold and summer seasons the air is dry. The summer is the driest part of the year with relative humidity between 20 percent and 25 percent only in the afternoon.

CLOUDINESS AND WINDS:-

The skies are heavily clouded during the monsoon season. In the rest of the year the skies are most clear. Winds are generally light to moderate with some strengthening in wind force during the latter part of the summer season and in south-west monsoon season winds are north-westerly or westerly in south monsoon season. In the hot season winds are from directions between south-west and north-west.

EXCESSIVE RAINFALL AND DROUGHT PRONE AREA:-

The variability of rainfall is very important for agricultural planning. Particularly in the dry track, when rainfall is marginal. In such areas the variations in the amount of rainfall are responsible for either a bumper crop or a total crop failure.

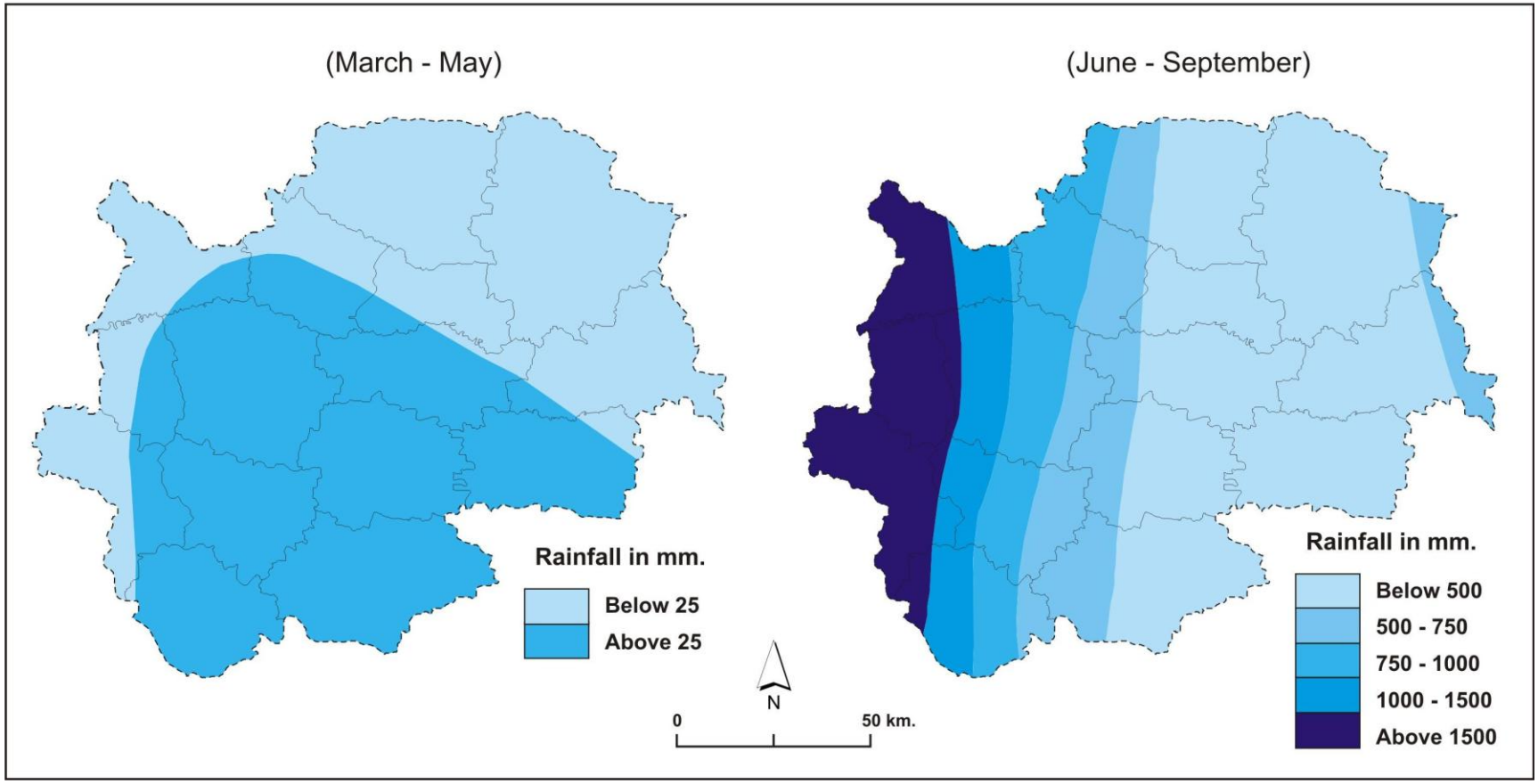
Spatial-temporal variation in the rainfall is a usual feature of monsoon. Table number 1.3 furnishes useful information about rainfall variations. It is revealed from the table that the highest recorded rainfall during the spell of fifty years was less than double the normal values for all the stations in the direct. As for the lowest value it is observed at Malegaon.

Rainfall records of the study area are available for a good network of thirty stations for a long period. The average annual rainfall in the district is 1034.5mm.In the narrow strip of the district in the close proximity of the Western Ghats the rainfall is very much heavier than in the rest of the district. On an average, the rainfall in this narrow strip increases from 2351.6mm. at Peint in the north to 3341.6m.m.at Igatpuri in the south. There is remarkable spatial variation in the rainfall distribution [Fig.No.1.6. & 1.7]. The crest, the western margins of the district receives the maximum rainfall. Peint [2351.6mm.], Igatpuri [3341mm.], are all located in the Western Ghats. The precipitation decreases very remarkably from the western edge of the upland towards the east. There is a sharp decline in the rainfall amount over a distance of about 40 km. from the crest i.e. Nashik [835m.m.], Dindori [753.1mm.] and Satana [477.3mm.] located in the rain shadow area which receive considerably less rainfall. In the plateau region to the east of the Western Ghats the rainfall in general decreases from the west towards the east with some local variations due to topography, and receives, less than 500 mm.rainfall. [Fig.No.1.6.]

Annual rainfall exceeding 125 percent of the normal is considered as excessive rain. Excess of rainfall generally leads to severe floods and "Wet- famine". During 75 years periods (1901-1975) excessive rainfall was experienced in Nashik district.

"A period of drought is defined as a year or season in which total rainfall is less than 75 percent of the normal. It may further be classified as a year or season of "moderate drought" if rainfall deficit is between 26 percent and 50 percent and a year or a season of "severe drought" when it is more than 50 percent". During the 75 years (1901 to 1975) Nashik district experienced five drought years. Considering the period from 1901 to 1950 Niphad and the eastern talukas of the district had such low rainfall during the five years from 1904 to 1908. The period 1920 to 1923 was in general a period of low rainfall over most part of the district. In the period from 1951 to 1981 it is observed that at least the years of 1965, 1966, 1972 and 1973 were characterized by famines. As the figure under references shows a large part of the study area constitutes the drought cold area.

FIG. NO. 1.6: RAINFALL



RAINFALL ZONES:-

The rainfall in Nashik district is uneven. Within the district, the monsoon shows tremendous variations. It is not uniform in all parts of the district. The rainfall is high in the western part and decreases towards the east. Broadly speaking, the study area can be divided into five rainfall regions. Rainfall region is determined by different controlling factors such as alignment variations, the alignment of hill and mountain ranges and the rain shadow. The ridge and valley topography adds to the rain shadow effect throughout the area. Though the average rainfall of the district is between 2600 mm. and 3000 mm. there is wide variation in the rainfall received at various blocks. Most of the rainfall is received at various blocks in months from June to September.

The district can be divided into distinct zones according to coefficient of variation. The variability values are as less as twenty percent in the mountainous west meaning thereby that the reliability of monsoon is 80%. However, it falls to 30 percent. It covers the drier tract of the east, where the agriculture is balanced. The variability increases to the east.

Unevenness in its seasonal and aerial distribution causes the problem of regions in suitable zones.

However, on the basis of rainfall returns for the series of years justify the different zones of the region as follows:

i) Western zone of very heavy rainfall

ii) Ghats zone of high rainfall.

iii) Central zone of medium rainfall.

iv) Eastern zone of uncertain rainfall.

v) The scarcity zone.

i) WESTERN ZONE OF VERY HEAVY RAINFALL:-

This zone comprises the western hilly talukas with 2500 to 3000 m. m. rainfall per annum. The rainfall is relatively heavy and assured. This zone is also called as paddy zone. The boundary of the region is the 2500 m. m. isohyet. However, the region has generally very heavy rainfall as in Igatpuri it is 3341 m.m., Surgana-2926 m. m., Peint-2351.6 m. m. It is also known as the Sahyadrian zone, which receives more than 80% of rainfall during the south-west monsoon season. During June-September the high rainfall and low temperature are the characteristic features. In the month of May the weather is generally dry and hot. However, due to the altitude the severity is not felt. The humidity is very high during rainy season, but is low in the post monsoon period, the cool season and summer.

The Sahyadri Mountain, its higher slopes and windward location make this region, a region of very heavy rainfall. Bounded by 2500 m. m. isohyet, the region is located in the extreme western margins of the area such as western part of Igatpuri, Surgana and Peint talukas.

ii) GHAT ZONE OF HIGH RAINFALL :-

This zone receives rainfall between 1500 and 2500 m. m. The region corresponds to the eastern slope of the Sahyadri and occupies the west central part of Surgana, Peint and Igatpuri talukas. Roughly it lies in a narrow strip. The summer of this zone is mild and cool due to the effect of the altitude. The variation in rainfall entirely depends on orographic influence. Thus, Peint has 2351 m. m. and Surgana 2916 m. m. (Fig. No.1.6).

iii) CENTRAL ZONE OF MEDIUM RAINFALL:-

The central talukas have been included in this zone which have 750 to 1500 m. m. rainfall. This region forms the transition between the high rainfall regions in the west to the comparatively low rainfall region in the east. The region as a whole covers the west central part of Nashik, Dindori, Kalwan and Baglan talukas and also west part of Sinnar taluka. This zone is roughly parallel to Ghats's zone.

FIG. NO. 1.7: RAINFALL DISTRIBUTION: NASHIK DISTRICT

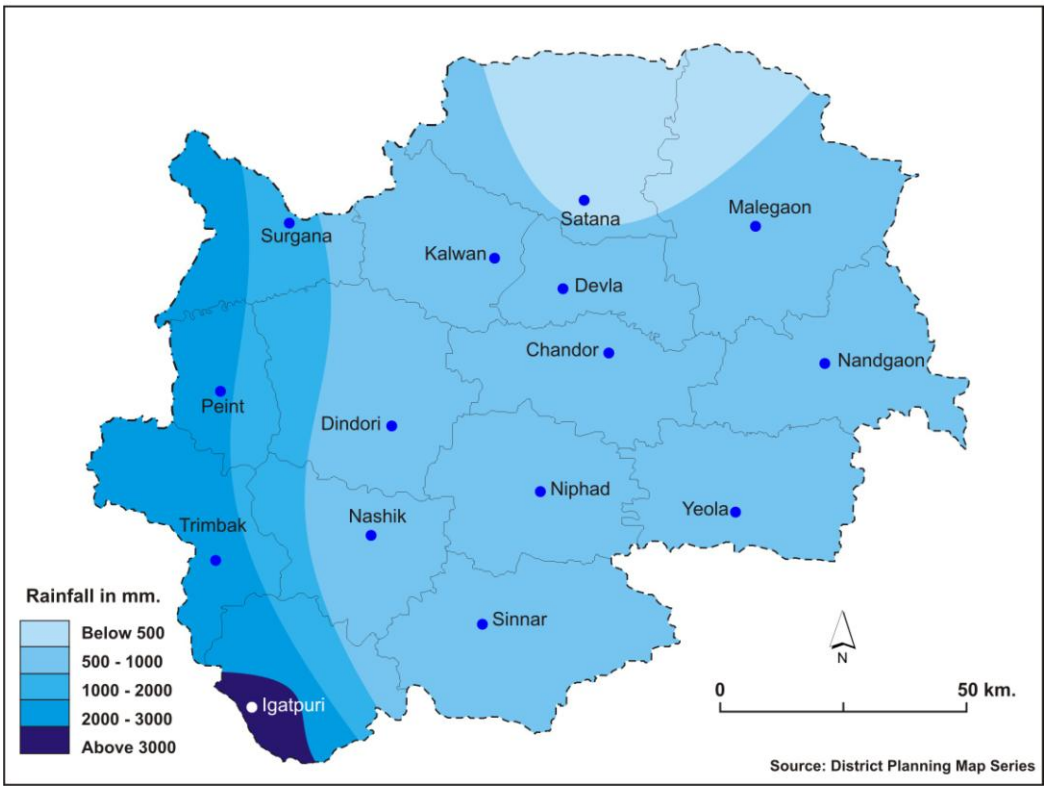
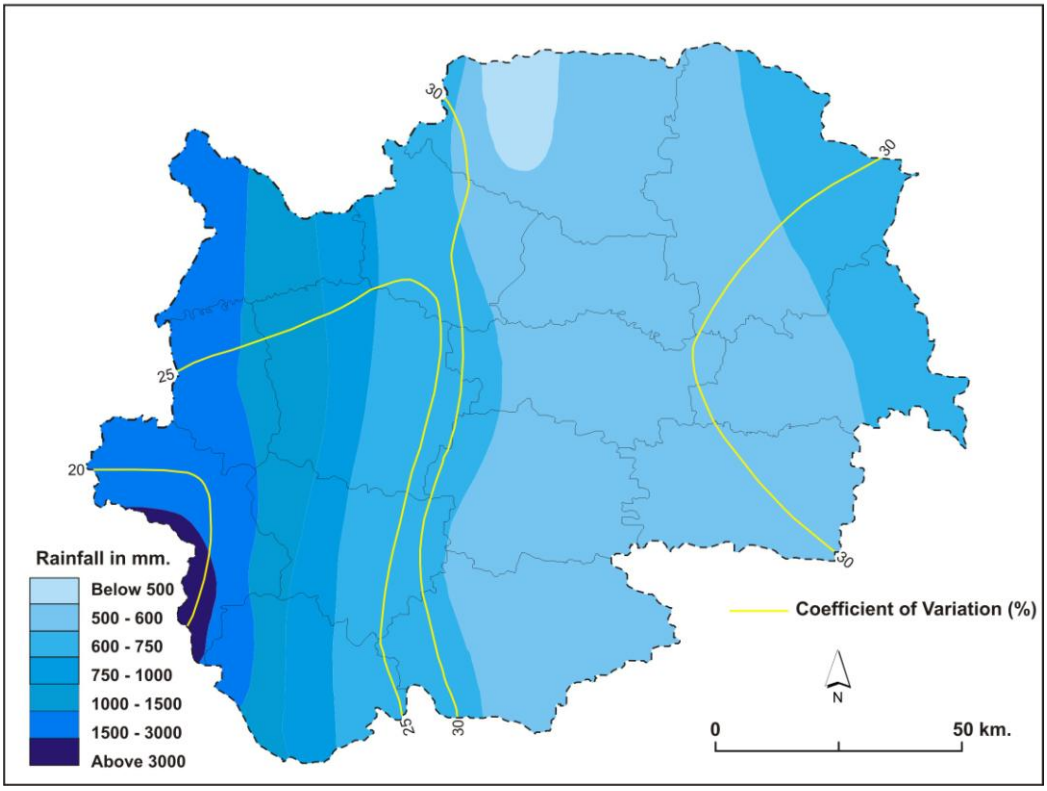


FIG. NO. 1.8: NORMAL ANNUAL RAINFALL AND COEFFICIENT OF VARIATION



The region coincides with the middle and lower slopes of the Sahyadri. The region comes under rain shadow area and the rainfall variation is greater. Thus Kalwan (751 mm.), Dindori (788 m.m.), Ambapur (Baglan-760 m.m.), some places of Sinnar, Baglan and Nashik talukas receive rainfall between 750 mm. and 1500 mm. The rainfall variability in this region also shows that it lies between 15 percent and 40 percent of the normal rainfall.

iv) ESTERN ZONE OF UNCERTAIN RAINFALL:-

It is also known as the dry zone of the study area. The central and eastern talukas of the study areas come under dry zone. The yearly average rainfall of this zone is less than 750 mm. for example Nashik- 507 mm., Baglan-498 mm., Chandwad- 654 mm., Sinnar- 567 mm., Niphad- 565 mm., Malegaon- 536 mm., Yeola-550 mm. and Nandgaon-566 mm. This region on the whole occupies 65 percent of the study area.

v) THE SCARCITY ZONE:-

It is also known as Mal-Matha. About 40 villages from Malegaon taluka in most of the local region cover northern and north eastern portion of the Malegaon taluka. It receives the rainfall less than 500 m. m. This is a zone of the lowest rainfall. 5 percent of the area is covered by this zone. (Fig No. 1.6 & 1.7)

CONCLUSION**:**

The amount of rainfall varies from less than 500 m. m. to more than 2500 mm. Most of the region nearly 65 percent area of the study region has rainfall of 500 to 1000 mm. But the rainfall also fluctuates greatly in terms of beginning, spread and as well as amount. Out of the total annual rainfall nearly 80 percent is derived from south west monsoon making it the most influential aspect of climate affecting agricultural land-use of the district.

1.7) NATURAL VEGETATION :-

The forests are found in every tehsil of the district. However, the major area under forest is in the tehsils like, Surgana, Peint, Dindori, Kalwan, Trimbakeshwar and Igatpuri. The area under forest is also one important factor that affects the climatic and rainfall condition of the region. The total forest area in the district during 1979-80 is 3473.19 sq.km. i.e. 22 percent of the total geographical area. In 1989 the area under forest was 327818.60 hectares. As per the new definition of forest the area

under forest in 2004-05 is 260284.64 hectares. There is a reduction in area under forest. The forest produce is divided into two main classes i.e. major and minor. The major forest produce is timber, mostly found in Peint, Surgana and part of Dindori tehsil. The minor forest produce like Tendu, Bamboo and gum etc. are found in large quantity in almost all tehsils. The floristic comparison in the district varies with rainfall, altitude, biotic factors, and local microclimates. The forest types are mainly four viz.

1) Evergreen forest.

2) Semi-evergreen forest.

3) Tropical deciduous forest.

4) Deciduous forest.

1) Evergreen forest:-

This type of forest is found in the western part of the study area, which receives a rainfall of more than 2500mm. annually and supports the evergreen rain forest. Thus in the westernmost part of Igatpuri, Peint and Surgana talukas, the vegetation is mainly evergreen.” Rose wood”,” Paan”, “Aini” and “Telsut” are important varieties.

2) Semi-Evergreen Forest:-

This type of forest is observed in the western part of the area having a rainfall 2000 mm. to 3000 mm. It occurs in the narrow strip with north-south extension on the eastern slopes of the Sahyadri. Bamboos, Ain, White kindal, and Hiirada are found in this area.

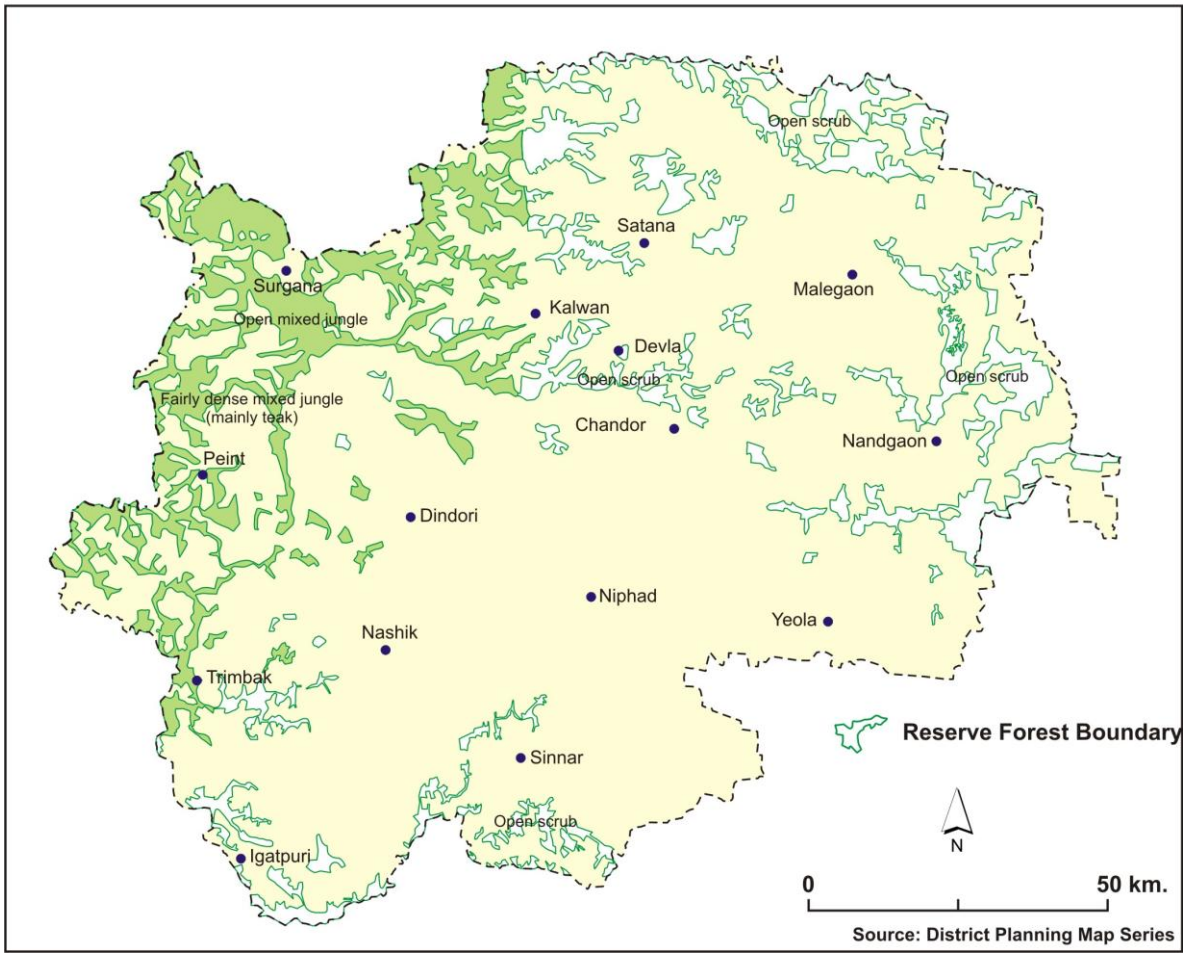
3) Tropical Deciduous Forest:-

This type is found in the region marked by an annual rainfall of 1000 mm. to 1500 mm. immediately to the east of tropical semi-evergreen vegetation type. The trees in this type shed their leaves for about 6-8 weeks during the hot and dry weather. The trees are between 60 to70 feet high. Teak is the main useful species. The area also has a variety of grasses, the most common of which is Rosh grass, musal, Kunda, Sukal and Teak.

4) Deciduous forest:-

60 percent area of the study area is covered by this type.It occurs in the central and eastern parts. This type is associated with areas receiving rainfall less than 1000 mm. It degenerates into shrub type of vegetation where the rainfall is less than 600mm. Bar , Polati, Nephad, Vagati ,are all typical species of this scrub and thorny area . The growth of this species is usually small and stunted. Babhul is also found in this type. The dry deciduous forests occurring in patches and are found in the areas with 500-750 mm. rainfall.

FIG. NO. 1.9: NATURAL VEGETATION



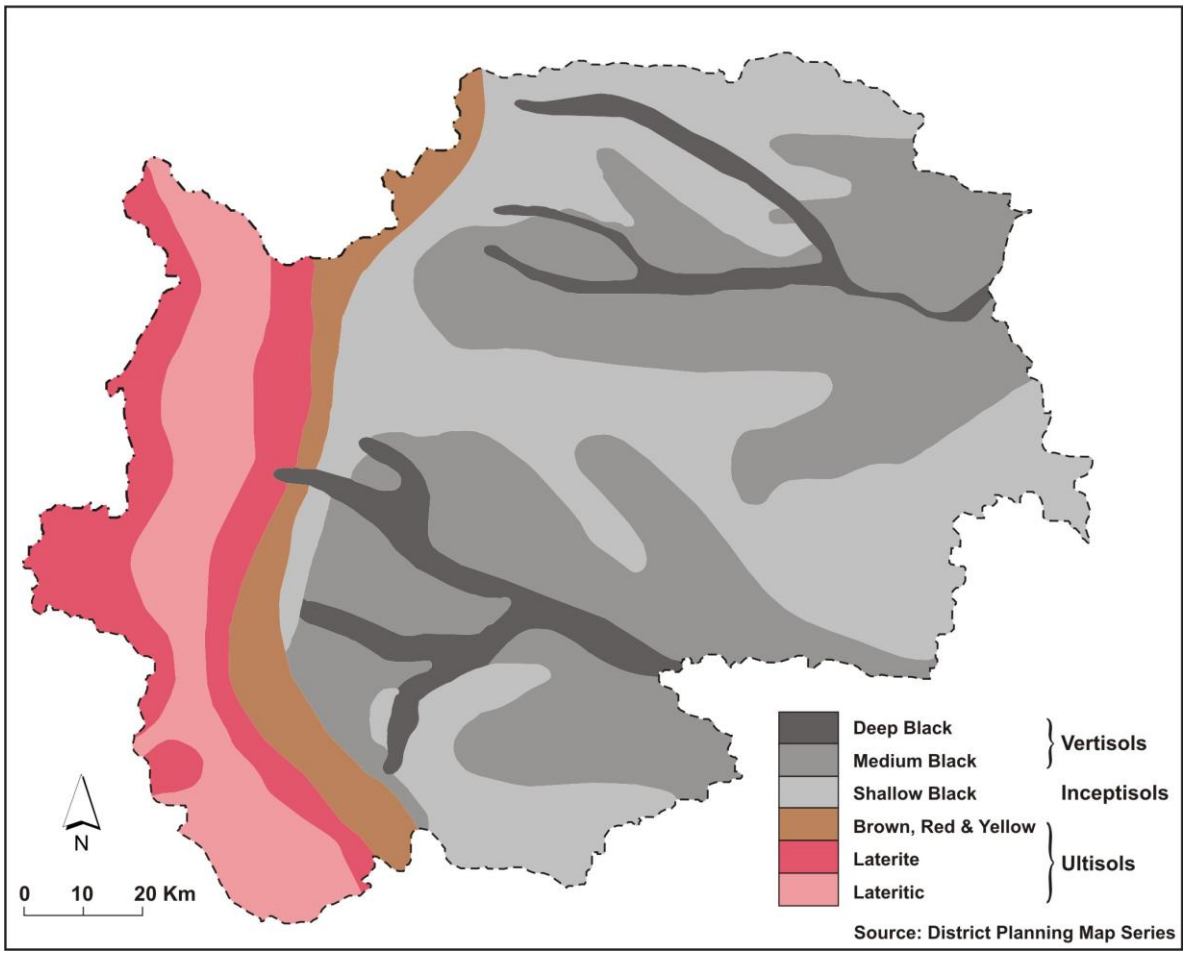
1.8) SOIL:-

Soil is one of the factors that determine the fertility of land and the crop to be taken in the region. “Soils constitute the physical basis of an agricultural enterprise and playa a very important role in the agricultural economy of a region. Differences in soil texture, drainage and fertility are of major importance in explaining contrasts in agriculture. COPPOCK-1964). Unlike climate, however, soil differs considerably within short distance. In many parts where topography shows sharp irregularities in the slope of the land it is not uncommon to find bare rocks lying adjacent to depressions cored with deep soil, while in between there may be hill slopes and even plateau tops covered with stony rock as in the west part of the district. Agricultural productivity is the result of inter relationships among a number of growth factors and soil is one of them. Knowledge of soil productivity and fertility is an essential prerequisite for its agricultural use. Soil productivity is the capacity of the soil to produce plants under a specified program of management. Fertility is defined as the potential of a soil for supplying nutrient etc. in amount and proportions required for ideal plant growth. Generally highly fertile soil should be productive but this is not necessarily true in all instances.

Nutrient loons occur in the soil in mineral or organic compound absorbed to exchange surfaces and in the soil solution. The soluble and absorbed nutrients are extracted readily by plants roots. There are sixteen elements essential to plant growth. The major elements are carbon, hydrogen, oxygen, nitrogen, phosphorus, potassium, calcium, magnesium and Sulphur, while minor elements include iron, copper, manganese, Zink, molybdenum, chlorine boron.

Methodological difficulties are involved in studying the soils of the region. For they have not yet been scientifically surveyed. Even if one tries to connect the officers in the Government Soil Department or Department of Agriculture, as the author did during his field-work at several places, substantial information was not available. Therefore the discussion on soils is a generalized one and based largely on government of Maharashtra publications (district Gazetteers, District Census book). The characteristics and the distribution of soil in Nashik district are influenced essentially by the nature and intensity of weathering and mode of rapidity of fluvial transports.

FIG. NO. 1.10: SOIL TYPES



The topographical variations, climatic differences, especially amount and period of rainfall and drainage of the area under study are the important environmental factors influencing the formation and characteristics of soils.

Predominantly four major soil zones are identified in the area. The classification generally depends upon special variations of rainfall and relief features. (Fig. No.1.5)

1) Laterite and lateritic soil.
2) Reddish brown soil.
3) Medium black soil.
4) Deep black soil.

1) Laterite and lateritic soil:-

Laterite and lateritic soils cover roughly nine percent of the total geographical area of the district occupying 90 percent area of Peint and percent area of Surgana taluka. The warm humid climates and the forest vegetation have accounted for these types of soils. They are derived from the basalt rocks. The heavy rains in the region thoroughly leach the soils turning them acidic in reaction and devoid of calcium carbonate. Although they are rich in sesquioxide, these soils are generally poor in their contents of phosphate and potash, the two importants oil nutrients. Hence these soils are very poor in fertility. However, the soils from the forest region are well supplied with nitrogen and organic matter.

Further, these soils are located on the high reaches of the western Sahyadris and are under constant leaching. But the degree of laterisation is not the same everywhere and varies greatly according to the intensity of the rainfall.

These soils vary in color from red to brownish red (due to the preponderance of hydrated iron oxides) and are loamy in texture (Fig. no.1.5).

2) Reddish brown soils:-

These are also known as non-lateritic soils. These soils occur in the western part of the study area of 90 percent area of Igatpuri, north and southern portion of Nashik, 50 percent western area of Dindori and the extreme west part of Kalwan and Baglan talukas of the district. These soils cover 20 percent area of the study region, and are derived from the Deccan trap (basalts) under conditions of intense leaching. They vary in depth from a few centimeters on steep slopes to more than one metro in valleys. They have normally a brown color with a reddish tinge. The soils are formed in the region receiving a rainfall more than 1000mm. annually. The brown soils are comparatively rich and fertile .Generally, they show a granular structure. They are neither acidic nor alkaline and show a neutral reaction.

3) Medium black soils:-

The medium black soil cover roughly 60 percent of the total geographical area of the district, mostly the central and eastern parts. These soils vary in texture from sandy loam to clay loam and color from light brown to greyish black. They are characterized by their high contents of free calcium carbonate, which may appear as a lime ban or which may be uniformly distributed throughout the profile.

Though these soils show a general similarity in the fundament and properties, there exists a lot of spatial variation in depth and texture. These spatial variations are interlaid due to the variations in relief or local topography .Hence the shallow soils of lighter shades and textures are associated with the ridges. But the greyish black soils of heavy texture are round in the low-lying lands. (Fig. No.1.51)

4) Deep black soils:-

The deep black soils mainly occur in the north central and the south central parts of the district along the banks of the major rivers and their tributaries. They are dark brown to greyish black in color. The black soils or "regur" genetically range between residual soil with a mature profile and the river born alluvium of the flood plains to which a large amount of alluvium is also contributed particularly on the margins of the valleys where it is likely to interfere with alluvium (Dikshit-1971). Deep black soils have a clayey texture with 40 percent to 60 percent of clay and show a cloddy structure in often laminar with slanting cleavages. The soils are calcareous, neutral to mild alkaline in reaction, high in caution exchange capacity and low in organic matter. The carbonate contents of the black soils range from 0.5 percent to 3.0 percent.

Along the banks of the major rivers and their tributaries are found very deep black soils. They are also derived from basaltic rock. They are more fertile and deeper than the other medium black soils. In the basins as well as on the banks of the master streams of the area such as Godavari, Girana, Kadava, Mosam and Aram are found vast stretches where these deep black soils are observed. Ten percent area of the district is covered by deep black soils mainly of the eastern Baglan, southern Malegaon, Niphad, Nashik and Kalwan (Fig. No. 1.5).

In general, the soils of the high rainfall zone are slightly acidic, low in their contents of soluble salts and nearly free from CaCO3. The contents of exchangeable bases are also relatively low.The soil reaction becomes more and more alkaline from west to east .The total salts also increase in the same manner , showing a zone of accumulation in the lower layers . The exchangeable actions show a similar increase in divalent bases accounting for more than 75 percent of exchangeable actions and in deep phase, there is a tendency towards sodiumisation. The soils are fair in their contents of nitrogen, available phosphate and available potash.

The description and chemical analysis of typical profiles are given below.

DEPTH IN CM:

0-15: Yellowish brown salty clay loam, single grained, friable, slightly moist, black concretions present.

15:30: Dark yellowish brown clay, slightly moist, blacker concretions, yellowish murum, pebbles present. Below30: Redish murum

Phase: Very deep (Ghoti- Igatpuri

Depth in cm:

0-17.5: Yellowish-brown, clay loam, compact, black and white concretions present.

17.5-50: Greyish brown, clay loam, slightly moist and massive, black and white concretions in increased quantity present.

50-120: Dark greyish yellow, clay loam, more moist and massive, compact, profuse black and white concretions present.

ZONE II: TRANSITION TRACT.

Phase: Medium deep (Dindori taluka)

Depth in cm:

0-22.5: Dark brown clay with reddish colour and hard.

22.5-40: Darker in color, clayey, cloddy, and harder than above, mixed with murum.

Below 40: Disintegrated murum.

Phase: Deep (Dindori taluka).

Depth in cm:-

0-24: Reddish brown clay, clods breaking into grannies, loose murum here and there.

24-29: dark brown clay, friable, granular slightly compact, murum bits present

Below 49: Yellowish disintegrated murum.

Phase: Very deep (Dindori taluka).

Depth in cm:

0-25: Dark brown clay, clods breaking into crumbs, variable, mixed with lime nodules.

25-47.5: Dark gray clay, same as above, murum bits and lime nodules present.

47.5-62.5: Greyish black clay, friable, profound murum bits.

Below 62.5: Same layer continues.

ZONE III: Scarcity tract.

Phase: Medium (Chandwad taluka).

Depth in cm.

0-14: Yellowish brown sandy loam; single grained, friable, mixed with sand.

14-29: Whitish brown sandy Ipam, single grained, loose.

Below 29: Disintegrated murum.

For chemical analysis of the soils in Nashik district.

FERTILITY STATUS OF SOILS:-

Fertility status here refers to the availability of nitrogen (N), Phosphorus (P) and Potash (K), the essential ingredients for the growth of crops. There are about 18 elements which are essential for plant growth. The presence of nitrogen, phosphorus and potash in soil contributes towards higher crop yields. Nitrogen is absorbed in soil from atmospheric air and is very essential, especially in the early stage of crop growth. The nitrogen starved plants are always stunted in growth. Phosphorus also plays an important role in root production, in energy transformation and photosynthesis which effects the developments of crops.

MAINTENANCE OF SOIL FERTILITY:-

Misuse of land in the region by excessive deforestation, overgrazing of hill slopes and monoculture has caused heavy soil erosion in many parts. However, very little information exists about the extent of soil erosion in this region.

Adequate and timely supply of nutrients, which are lost due to continuous cultivation, is one of the several factors influencing crop production. Nitrogen, phosphoric acid and potash are the “big three” which increase the soil fertility. Hence the growth of crops and their production centers round the supply of these “big three” nutrients. Due to high temperature, generally all soil types in the study area have a very low percentage, especially of nitrogen. The response to nitrogen is of a high order provide there is assured water supply. It is here that the area suffers in a large measure. Apart from other measures adopted to increase soil fertility such as crop rotation, use of natural and compost manures etc. the chemical fertilizers with assured and timely supply of water are most important factors affecting the fertility of the soils in the study area.

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CHAPTER II

SOCIO -ECONOMIC AND CULTURAL ENVIRONMENT

The Nashik district, situated on the north-west side of Maharashtra is vulnerable to various kinds of hazards like sudden fluctuation in environmental factors, climatic changes i.e. cyclones, hailstorms, heat waves and cold waves, earthquakes, Volcanoes, floods, droughts and road railway accident, chemical hazards, communal violence, epidemic etc. The broad limits of agricultural activities are determined by physical environment of the region, but the individuals or farmers must conduct their enterprise within a frame-work of socio-economic and cultural considerations which may favor or restrict agricultural activities. The social system sets its imprint on holding and field systems and on settlement pattern with its related problems of accessibility to fields. Likewise social differences within communities and differences between communities affect the scale and type of farming operations together with the choice of enterprise (Morgan and Monton, 1971). Thus the size shape, and layout of farms, the farm worker's densities, the agricultural implements in use, the extent of irrigation, the location of markets, transportation, the attitude of farmers, applications of farm fertilizers etc. all these influence the way in which agricultural land is used.

2.1) POPULATION:-

Agricultural land use is the end product of human response to physical-socio-economical, as well as technical and organizational factors. The land use is constantly modified by man according to his requirements. These modifications must be studied in conjunction with the various aspects of population, its distribution, growth, demographic characteristics and occupational structure. The relation between population and land-use is reciprocal, for instance, the changes in farm population pattern influence the utilization of the land, and later changes in the agricultural controls to a great degree also determine the pattern of farm population (Singh, 1974).

Nashik district has been settled for a long time and therefore the population of the region has its distinct characteristics, influenced by environmental factors of land, relief, the monsoonal rhythm and also the culture, shaped by maritime traditions in the past.

The district is inhabited by 29, 91,739(1981) people spread over area of 15530 sq.km. This gives the region a density of 193 persons per sq.km. compared to the state density of 204 persons per sq.km. The variation in the distribution of population is largely resource oriented, varying with the productivity of land, urbanization, and degree of industrial development. As per census of 2011 the population of Nashik district was 61, 07,187. The population density stands at about 393 persons per sq. km. The district has a majority of Hindu population. However, there are pockets of Muslims and new Buddha population. Other communities like Sikhs and Christians are sparse in number.

GROWTH OF POPULATION:-

In an overall consideration of population position over the last few census decades, it may be said that the district has shown a constant growth of population from the beginning of the 20th century, except during the severe influenza epidemic, which took a heavy toll of life in the second decade of the century. In the last four decades population has increased at a very high rate. It was primarily due to the growth of Nashik city which attracted migrants. The net percentage increase in the population of the district, from 1901 to 2011, is higher than that of the Maharashtra state as a whole.

Table No.2.1 The population of the district and decade variation rates since 1901. (District as a whole).

Years	Total Population	Decade variation	Percentage of decade variation
1901	8,23,080	----	----
1911	9,15,698	+92,618	+11.25
1921	8,45,783	-69,915	-07.640
1931	10,09,583	+1,63,800	+19.37
1941	11,27,597	+1,18,014	+11.69
1951	14,29,916	+3,02,319	+26.81
1961	18,55,246	+4,25,330	+29.75
1971	23,69,221	+5,13,975	+27.70
1981	29,91,739	+6,22,518	+26.28
1991	38,50,000	+ 8,58,261	+22.37
2001	49,93,796	+1,143,796	+22.90
2011	61,07,187	+1,090,044	+17.91

Source:- i) District Census Hand Book, Nashik District. ii) Socio-Economic Review and district Statistical Abstract of Nashik District.

DENSITY OF POPULATION:-

Population density values were calculated as ratios of total population to total area (sq. k.ms). In 1991 the density of population was 149, and it was 393 in reference year 2011. In general density of population was along the western margin of the district. The lowest density (172 persons per sq.km) is recorded in Surgana taluka, and highest density (2509 persons per sq. k.ms.) in the Nashik taluka (Nashik and Trimbak).

On the eastern side, population density increases gradually. Density of 100 to 200 persons per sq. k.m. is observed over most parts of the district. (Table No.2.1 and Fig.No.2.1)

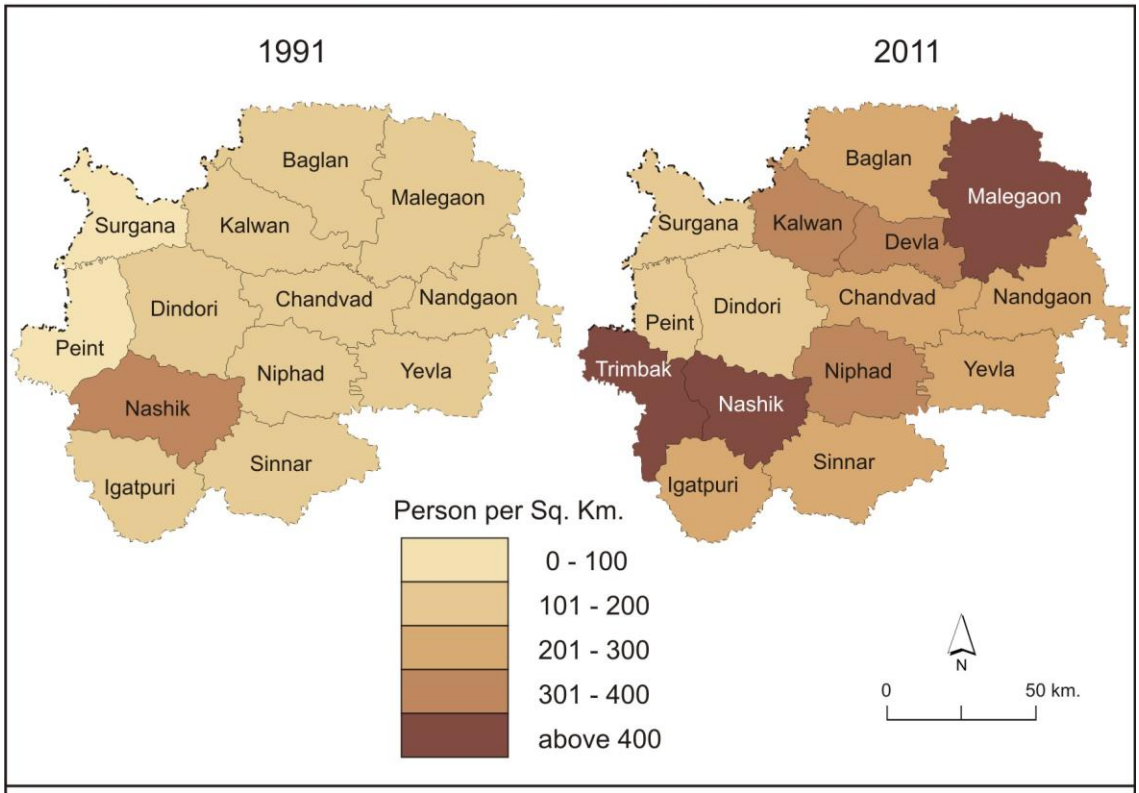
Table No. 2.2

Density of Population (Taluka wise) per sq.km.

Sr. No.	Name of Talukas	Years	
		1991	2011
1	Nashik	177	2509
2	Peint	95	173
3	Dindori	110	197
4	Surgana	87	172
5	Kalwan	108	390
6	Baglan	119	211
7	Malegaon	174	432
8	Chandwad	128	214
9	Nandgaon	138	217
10	Yeola	135	221
11	Niphad	137	397
12	Sinnar	130	215
13	Igatpuri	159	270
	Nashik District	149	393
	Maharashtra State	170	204

Source: Socio-Economic and Statistical Abstract, of Nashik District.

FIG. NO 2.1: DENSITY OF POPULATION



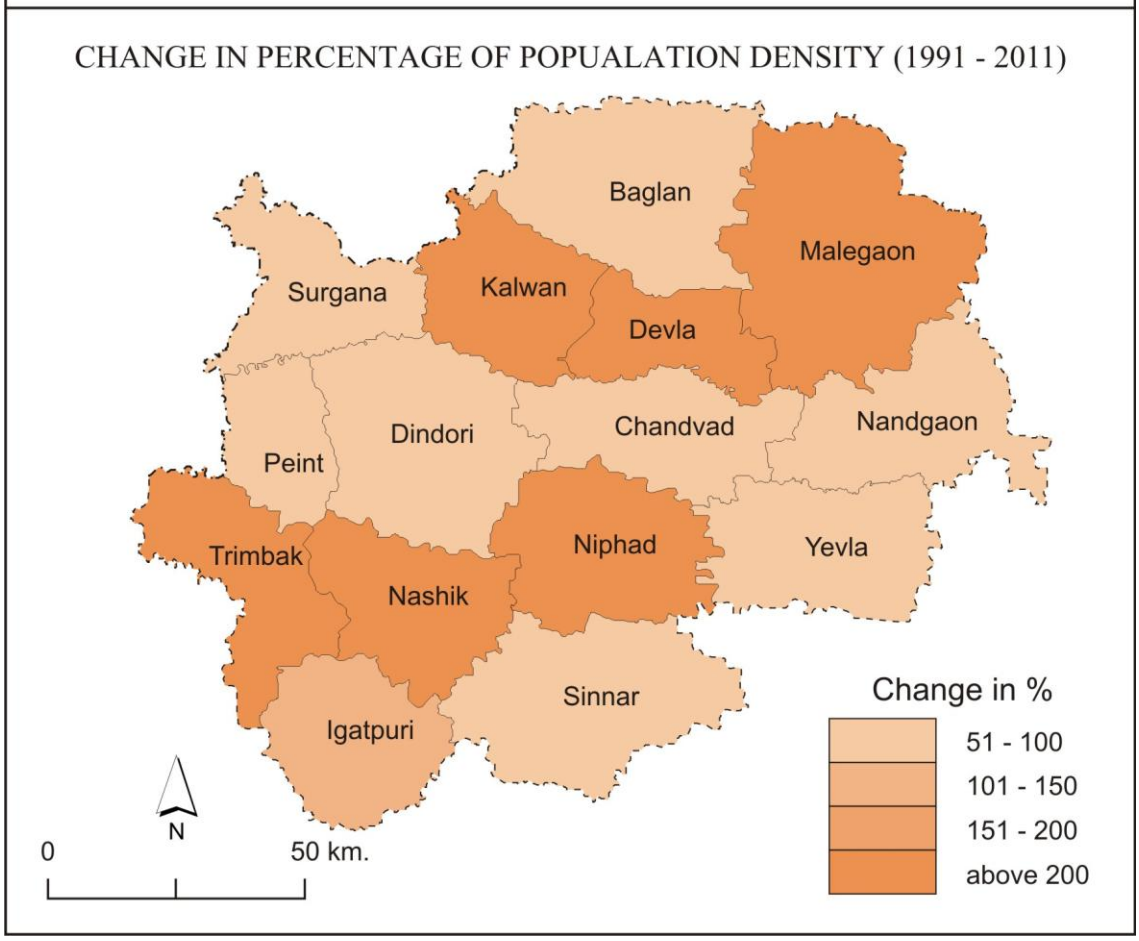


Table No. 2.3

Spatial analysis of talukas on the basis of population density.

Category (Range of population density)	Total No. of talukas 1991	Total no. Of talukas 2011	%of talukas to total No. of density talukas1951	%of talukas to total No. of density taluka 1981
1-100	2	--	15.3	00.00
101-200	10	3	77.0	23.10
201-300	--	6	--	46.10
301-400	1	2	7.70	15.40
Above 401	--	2	--	15.40
Total	13	13	100.0	100.0

Table No. : 2.4 Tendency of talukas towards increases and decreases in area under population density.

	Category	**Total No. of talukas Increases (+ve)**	**Total No. of talukas Decreases (-ve)**	**Percentage of the total No. of Increase talukas**	**Percentage of the total No. of Decrease talukas**
Very Low	51.00 to 100.00	Peint, Dindori, Surgana, Baglan, Chandwad Nandgaon Yeola, Sinnar = 8	Nil	61.50	0.00
Low	101.00 to 150.00	Igatpuri = 01	Nil	7.70	0.00
Medium	151.00 to 200.00	Nil	Nil	0.00	0.00
High	201.00 to 250.00	Nil	Nil	0.00	0.00
Very High	Above 250.00	Nashik, Kalwan, Malegaon, Niphad=4	Nil	30.80	0.00

SPATIAL ANALYSIS:-

Though the spatial distribution of population interlaid, is largely determined by physical environment, it is especially significant in agricultural environment constituting the markets where the demands for various agricultural products are met.

The Fig No. 2.1 and Table No. 2.4 show the spatial distribution of density of population talukawise. There are five categories so for as the density of population is concerned.

1) The first Category:-

This is a category of very low population density with density between1-100. It is found in two talukas in 1991 reference year. These talukas can be found only in the western part. The western region is made up of three talukas. Out of them Surgana & Peint come under this category. All of them are located in the north-south extension on the western margin of the study area. These are located in high relief zone with steep slopes and mountainous terrain of the Western Ghats. These talukas come under high rainfall zone i.e. more than 1500 to 2000 mm. There is a lot of soil erosion so that the soil cover is very thin. Further, the talukas are forested .Hence the possibilities of agriculture and agricultural development are limited. Hence they constitute the lowest density area. Surgana taluka has the lowest density (87 persons per sq.km.) in the entire study area. Peint taluka had the maximum density (95 persons per sq.km.) in the western region in the reference year 1991. Not a single taluka belongs to this category.

2) The Second Category:-

The second category is of the talukas with density between 101 to 200 persons per sq.km. Out of total talukas of the study area 11 talukas (84.60 percent-1991) and 3 talukas (23.10 percent 2011) are included in this category. These can be divided into three sections such as central, southern, and Northern as well as eastern. The northern region has three talukas which are more or less continuous .The density of population is comparatively higher in relation to the first category. It is due to generally sloping land, medium to low rainfall, better soils in the valley floors and above all irrigation facilities.

As per reference year 1991 Kalwan taluka has the lowest density (108 persons per sq. k.m.) and Nashik has a maximum density (197 persons per sq.km). The central and eastern regions are made up of 6 talukas .Though the talukas lie in Central and Eastern parts where rainfall is medium to low, the soils are also medium. Irrigation is available on large scale as in Baglan and Kalwan talukas that is the reason why the density is between 100 & 200 persons. The influence of cash crops, especially sugarcane in the eastern and central part is another reason why the density is 100 to 200 persons as in Baglan & Kalwan talukas. The central parts of the area are generally continuous .They extend towards east as well as southward in a continuous belt. Two talukas of the western part i.e. Dindori, Kalwan and Igatpuri are located on the western part, where the rainfall is heavy and soils are poor .But the high percentage of density of population is due to better land management.

As per reference year 2011 three talukas i.e. Peint, Dindori and Surgana belong to this category. Causes are the same as above.

3) The Third Category:-

As per reference year 2011 six talukas (46.10 percent) i.e. Baglan, Chandwad, Nandgaon, Yeola, Sinnar and Igatpuri account for this category. This category consists of talukas with density between 201 to 300 persons per sq.km. This would be considered as a high density range. These talukas can be conveniently divided into the north eastern and central region. All talukas receive high to medium low rainfall, but have irrigation facilities. The soils are medium and deep black, hence agriculture is the main economic activity. Industrialization and sugar factories are also responsible for the density of the population of this category. Not a single taluka belonged this category in reference year 1991.

4) The Fourth Category:-

The fourth_category of high population density ranging from 301 to 400 persons per sq.km. is found in the year 2011 i.e. in Kalwan and Niphad due to education facilities, development of sugar factories and increased agricultural production.

5) The Fifth Category:-

The highest density category ranging more than 401 persons per sq.km. Nashik and Malegaon taluka belong to this category. Both talukas have the highest density in the study region .This is a result of the urban influence and industrialization. Besides urban influence of Nashik city, the taluka has the location in the Godavari flood plains and irrigation facilities are available. M.I.D.C area of Nashik city is also responsible for high density of population. Malegaon M.I.D.C. is also responsible for increasing density of Malegaon city. No of persons migrate from other talukas to Nashik and Malegaon city. The spatial variation in the density pattern is closely related to availability of land for cultivation, irrigation facilities, soil fertility, adequate rainfall and industrial development.

2.2) OCCUPATIONAL STRUCTURE:-

The total availability of labor (as a resource) and its division over different economic activities can be considered as a measure of the overall economic development .A study of the work force engaged in a primary, secondary, and tertiary type of productions will be significantly useful for this purpose .In reference year 1991, the worker and dependents were not separated, so there was very high proportion of total workers in the population. Therefore no significant variations in the distribution of total workers are observed .The lowest proportion of workers in total population is 91.18 % and highest is 100 % The ratio of total workers to the total population exhibits a specific spatial pattern. The western high rainfall zone shows higher values in the northern and central parts as well as the southern part of the transitional zone and therefore the proportion of total workers decreases.

The pattern changes slightly in the reference year 2011 with the proportion of total workers decreasing fast over the entire district. Only in the western high rainfall zone (Igatpuri, Surgana & Peint talukas) the ratio is higher, but the decadal variation is negative in the central and eastern zone, so the proportion of the total workers further declines. The temporal variation in the ratio of working force to total population thus reveals the gravity of the problem of ever growing population and pressure on land causing unemployment and underemployment.

FARM WOKERS AND THE TOTAL WORKFORCE:-

Most of the working population is engaged in farming, either as cultivators or as agricultural laborers in the rural area of the district. Population census, 1991 divides the total population of the district in the following classes.

1) **Agricultural class**:-
   a) Cultivators of land wholly or mainly owned and their dependents.
   b) Cultivators of land wholly or mainly unowned and their dependents.
   c) Cultivating laborers and their dependents.
   d) Non-cultivating owners of land, agricultural rent receivers, and their dependents.

2) **Non- agricultural classes**:-

   a) Production other than cultivation
   b) Commerce.
   c) Transport.
   d) Other services and miscellaneous.

This classification fails to record the actual number of persons engaged in agricultural activity including their dependents, the sum of classes a, b and c defines the class of farm workers and their dependents in the year 1991. There is a high proportion of the farm workers and dependents to the total of the other, in the western high rainfall zone of the district. On the other hand the proportion decreases in the central and eastern part. Around the parts of Nashik city the values are still lower.

This spatial distribution does not give us a correct picture of the farm workers in the total work force as the “dependents” inflate the actual strength of workers.

The following occupational classes in the district are recorded in the year 2011 population census.

1) **Total workers**:
   a) Cultivators b) Agricultural laborers c) Mining, quarrying livestock, fishing hunting etc. D) Household industry. e) Manufacturing other than household industry f) Construction g) Trade and commerce h) Transport, storage, and communication i) other services.

2) **Farm workers**:

Cultivators and agricultural laborers together make up the class of farm workers. The proportion of farm workers to the total workers in 1991 has been high percentage in the Western zone and low in the central and eastern zone.

In 2011 there is slight change in workers. The class of mining and quarrying workers has been separated from the workers in livestock, orchards, forestry, fishing etc. Secondly, the class of household industry has been excluded. Except these two changes other classes remain unaltered. The ratio values have increased in northern and central parts of the western high rainfall zone. The low ratio values are observed around Nashik city, and a few patches of central and eastern part of the district.

Spatial distribution of the proportion of total farm workers in the years 1981, 1991, and 2011 thus reveals the importance of agriculture as a source of employment in the rural areas. In the western high rainfall and high relief zone more than 85 percent of the total working force, is still absorbed by the agricultural activity. In the central and eastern part, a few patches of areas have quite high. The only exception to this trend is the development of a belt around Nashik city, Ozar Township, the areas around the sugar factories, Nashik Road and Deolali Cantonment, where due to the availability of alternative employment in the industrial, commercial & administrative sectors the employment of agriculture is about 50percent to 60percent of the total workforce. Recently (2015) this belt has extended in the western and eastern part of Nashik along the Nashik- Bombay road (Ambad), Nashik- Poona road and Nashik-Trimbak road (Satpur) link, which is also an industrial area.

2.3) CULTIVATORS:-

Cultivators are the main part of the farm workers. The category of cultivators includes both the owner cultivator and the tenant cultivators. Along with workers directly working on the land, are also included persons who are engaged in supervision or direction of cultivation.

The spatial distribution of cultivators in 1951 indicates that out of the total farm workers the cultivators and their dependents share a larger proportion. Higher values were found in the western high rainfall zone, but around the city the proportion has decreased. The distribution in 2011 shows a further decrease in the proportion of cultivators all over the district. There are higher values in the western part and lower values in the central and eastern parts of the district.

AGRICULTURAL LABOURERS:-

For the sustained development of agriculture, the supply of agricultural laborers is essential. During the peak (crop) season the shortage of agricultural laborers may adversely affect the agricultural production. There has been an increase in the percentage of the agricultural laborers of the total workers in 2011.

The reference year 1991 shows low percentage in some talukas of the eastern and the central parts of the district i.e. Nashik, Sinnar and Igatpuri, medium percentage in Yeola taluka from the eastern part and Surgana from the western part of the district Higher and Highest percentage concentration of agricultural labors is observed in Peint and Dindiori talukas from the western part and Baglan, Malegaon, Niphad, Chandwad and Nandgaon from the central and eastern part of the district. The highest percentage is found in Peint taluka and the lowest percentage in Nashik taluka

A phenomenal increase in the proportion of the agricultural labors is observed in the year 2011. With 1991 as the base percentage of agricultural laborers there is a rise by 10 percent to 60percent all over the district. The highest percentage is found in Niphad taluka and the lowest in Surgana taluka Lower percentages are found in the western part of the district i.e. Peint, Surgana and Igatpuri taluka.

In general all over the district the proportion of agricultural labors is increasing rapidly. It also exhibits a spatial pattern viz to the highest percentage in the north central and eastern talukas, high in the central and south central part and low in the west. Probable explanation of this occurrence is that the population of the entire district is growing fast. So the pressure of population on land increases, land is also divided. A class of small holders and land less agricultural laborers evolves. Irrigation is also responsible for increasing the agricultural laborers. In the irrigated tracts, the size of land holding is larger. As the water supply is assured, multiple cropping is possible, which initiates the seasonal as well as permanent demand for agricultural laborers and for different types of agricultural activities.

2.4) LAND TENURE:-

In consideration of any agricultural society or region the forms of land tenure of the past and present have an important role, as the tenure by which it occupies its land has a vital bearing on agriculture. The tenurial aspects concern the complex relation between lands on the one hand and the various interests in on land- cultivators, owners, government- on the other hand. It governs the conditions under which the land is exploited and inputs are used (Khusro, 1973).

The land concept of land tenure is defined as a system of individual agreement under which land is held or occupied. It includes all forms of tenancy and ownership.

Land tenure systems have far reaching effects on the land use patterns as the degree of independence the farmer has, to take farming decision, is basically related to the extent of ownership of the land. Numerous tenure systems can be identified on the basis of such freedom from making decisions, though three basically distinct classes viz. ownership, communal ownership and tenancy can be easily identified (Morgan and Monton, 1971 pp.55)

There are a number of economic advantages of ownership. Farmers have freedom to choose the system of production, full benefits of the returns from all investments, increasing capital gains with rising prices of land consequently increasing capacity to borrow. The farmer has freedom of making his own decision. The form of tenancy based on short or long lease on the other hand limits the freedom to a considerable extent as the total returns are not directly available to the farmer and he has to share them with the land owner. Tenancy of freedom depends on the conditions of lease and in the worst case the farmer is apparently reduced to a kind of laborer when the land lord provides the equipment and accommodation. Very short leases mean insecurity for the tenants. On account of the very limited period of lease, the tenant usually plans for immediate returns so as to get maximum returns during the short tenure. There are mainly four types of tenures 1) Zamindari tenure 2) Inam tenure 3) Mahalwari tenure and 4) Rayotwari tenure.

Rayotwar tenure accounted for a major portion of the occupied land in Nashik district and a minor portion was occupied by Inam tenure (District Gazetteer) .Land may be held in single independent holdings under the rayotwari system. The

individual holders are severally responsible to the state for the payment of land revenue .The occupant had a right to hold the land perpetually so long as he paid the land revenue to the government , He had full powers to sell, mortgage or dispose of the land. In inam tenure the land is held on a reduced assessment not liable to revision and in some cases even free of assessment.

Land was cultivated either by owner or tenants in both these tenure systems. There were four modes of tenant cultivation in operation in the district viz. cash rent, crop share rent , a fixed quantity of produce as a rent and a rent in service involving some combination of the foregoing forms of rent. The main forms of rent are cash rent and crop share rent.

The relation between land lords and tenants were governed by the provision of the Bombay land Revenue Code of 1879. Many tenants who held the same lands for generations had no permanent right to tenancy, but were continued to be tenants –at-will, liable to be deprived of their tenancy at the will of their landlords. The Bombay Tenancy Act of 1939 was amended in 1946 and further the Act itself was replaced by the Bombay tenancy and agricultural Lands Acts of 1948.Finally the agricultural land tenancy was legally abolished in 1957 and is permitted only in a few specific cases. Hence, cultivation of land is done mostly by peasants who own lands. This land reform aimed at redistribution of the ownership of holding form the view point of social justice and of reorganizing operational holding from the view point of social justice and optimum utilization of land. The entire concept of land reforms aims at the abolition of intermediaries and bringing the actual cultivators in direct contact with the state. There are three categories of the total number of operational holdings in the district

1) Owner operated (92percent of holdings).
2) Partly owned and partly rented (6.5 percent)
3) Wholly rented (1.5 percent).

SIZE OF LAND HOLDINGS:-

The size of land holding is an important factor in determining the efficient use of the resources available to a farmer. An analysis of per capita rural agricultural holding provides the key to the enormity and seriousness of the land problems in the

predominant agrarian economy of Nashik district. For the size of farm decides the degree of risk-taking and possible effects of specialization, the quantity and size of equipment and power. Moreover, size is related to population pressure, to economic requirements, such as the farmer's resources, capacity, attitude, crop pattern, type of farming, to land quality and to historical tradition. In Nashik district, as in the rest of India, a definite standard size of farm suitable to a definite type of farming cannot be maintained because of the increasing burden of population on agricultural land and the working of the Hindu Laws of inheritance .These result in the division of a large proportion of cultivated holdings into small, often widely separated fragments which fail to conform to any reasonable economic standard.

The main cause of low agricultural efficiency in India is fragmentation and subdivision of holdings. Apart from population pressure, the small size of farm could be attributed to laws of inheritance, decline of joint family system, absence of alternative employment opportunities in the form of handicrafts and village industries, lack of capital investment and attachment to landed property. The results are existence of numerous small size farms and widely scattered pieces of land which are uneconomic. These uneconomic farms give rise to wasteful methods of farm operations.

There are many disadvantages of fragmentation and scattered holdings, like wastage of time in the need to supervise and difficulty of working with a tractor, Weed and pest control is made difficult and there are limitations in mechanization and experimentation. On the whole it is a serious impediment to the agricultural progress and acts as a deterrent to full utilization of land and farm force (Jusbir sing, 1974).

The average size of the holdings (2011) in the district is 4.2 acres. Other districts in the state show large variation in size i.e. from 03.00 (Kolhapur) to 10.00 acres for Yawatmal. (Government of Maharashtra). The number of small holders (holding size below 05.00 acres) was appreciable in the districts i.e. 55.00 percent, 20.00 percent operated in Medium sized holding (05.00 – 10.0 acres). Large size holding (10 – 15 acres) found to 15.00 percent and landlords and only 10 percent holders belong to very high size of holding (above 15 acres) These figures demonstrate the unequal distribution of land holdings i.e. a large number of small holders occupying a smaller area and very big holders (landlords) occupying a large area.

LAND CONSOLIDATION:-

The fragmentation is a very big problem of India. A possible solution to this problem is in the consolidation of holdings, so as to enable a farmer to save his time, labor charges and energy. So the Govt. Of Bombay enacted a law called the Bombay Prevention of Fragmentation and Consolidation of Holdings Act. At present the work has been completed in some parts of the districts, but it is lagging behind in the western part.

The provisions of the Bombay prevention of Fragmentation and Consolidation of Holdings Act. 1947 were applied to the district in 1949 .The scheme is to arrange mutual exchange of small and scattered fragments of holdings and to make the land holdings as compact as possible.

CEILING ON HOLDINGS OF AGRICULTURAL LAND:-

The Maharashtra Agricultural Lands (ceiling on holdings) Act came in force from 26th January 1962.It lays down the ceiling limit of 7.5 -35 hectares. For a family of more than five members the ceiling is raised to a maximum of double this limit. But

Ceiling is on an individual holding and not on a family holding. The level of ceiling on agricultural holding has been brought down further in the light of the national policy evolved in 1972. Amended act (Act No. II of 1976) has been brought into force with effect from 2nd October, 1975, which sets the limits at 18 acres for irrigated lands and 54 acres for dry crop land. The unit of application of lowered ceiling is now a family unit consisting of husband, wife and minor children (Government of Maharashtra 1977).

According to the Maharashtra Agricultural Land Act, Sinnar and Malegaon talukas have been notified in the district with different ceiling areas for dry crop land, viz. 96 and 84 acres, respectively.

2.5) AGRICULTURAL IMPLEMENTS:-

Although the region under study experiences adoption of improved implements, the use of traditional implements associated with subsistence agricultural is common. Increased investment of traditional inputs does not lead to levels of output high enough to make a breakthrough for self –sustained agricultural development (Daniel – 1976).

Various implements are used by farmers in carrying out the agricultural operations with an object of reducing labor and improving the agricultural productivity. Tillage implements are used to work the soil and control the weed. The most common tillage operations are ploughing, harrowing, levelling ridging, hoeing and inter cultivation. Operations like harvesting, threshing, winnowing and finally the transport of agricultural produce involve the use of implements and machinery worked by animate and inanimate power. Other farm machines and appliances used by the farmers include various kinds of water lifts, cane crushers, chaff cutters, rice hullers, groundnuts decorticators, sprayers and dusters. The type of implements and alliances used on a farm are a good indicator of the type of farming and economic and social status of a farmer.

1] WOODEN PLOUGHS:-

The basic tillage implement commonly used by the Indian farmer is the plough. Wooden plough is a traditional implement which is widely used by the farmers all over the district, but mainly the western tehsil i.e. Dindori, Peint and Igatpuri. Very high concentration with more than 15,000 wooden ploughs is confined to the western and central talukas such as Dindori, Kalwan, Baglan and Igatpuri. High concentration occurs in the zone which stretches in north south direction in the central section of the study area. Adjacent talukas to the east and southern portion of the districts have moderate proportion of this side (Yeola, Nandgaon and Chandwad), the high proportion of wooden plough in the hilly parts and central western parts is due to its patentability and suitability for the poor soils.

The wooden ploughs usually made up of babul wood, are in common use in the district. They are cheap and are usually manufactured and repaired locally by the village carpenters.

2] IRON PLOUGH:-

In spite of the advantages of the wooden ploughs, the farmers in the district are slowly adopting the iron plough. The iron ploughs are more efficient and particularly suitable for heavy soils. The iron ploughs facilitate deep ploughing as compared to wooden ploughs. According to their capacity for deep ploughing the iron ploughs are pulled drawn by either two, four or more pairs of bullocks depending on the type of soil. The heavy iron ploughs are preferred in medium to deep black alluvial soils. In black cotton soil the land is ploughed deep (22 to 30 cm.) once in three or four years to destroy weed growth and to break the hard pan layer. Instead of

the plough, blade harrows (Kulav, Aut or pharat, wakhar) are commonly used to prepare land in the black and medium black soil tracts. The indigenous harrows are quite cheap and easy to construct and repair. They can also be put to variety of uses like breaking clods and smoothing, covering seed, preparing seed beds and levelling (Locally this instrument is known as DANKHYA and WAKKAR).

3] SEED DRILL:-

Seed drills (Pambhar or Teephan) help the sowing of seeds in line in a field at uniform depth.

4] KOLPA:-

It is slit hoe and used for inter culturing crops like Bajara, Jowar etc. This is a miniature blade harrow and is used to work in between lines of crops to stir the soil so as to remove the weeds, loosen the soil, conserve moisture and aerate the soil.

Other tillage implements common in the district are Kurhad (axe), Kudali (pick axe), Koyata (bill hook), Vila (sickle), Pahar (crow bar), Phavada (spade), Khurpi (weeding hook) and phantole (rake), Sickle is used for harvesting.

Threshing is commonly done by treading the crop by teams of bullocks or bullock-carts. The threshed material has to be winnowed for separating grain from chaff. Traditionally farmers depends on wind breeze for this operation. For lifting water from wells, mhotes made of iron or leather are used. Nowadays they are replaced by diesel engines and electric pumps. Bullock carts are also important implements for carrying, the agricultural products, and also play an important role in the rural transport system.

5] TRACTORS:-

It is the most important implement in the mechanization of agriculture. The mechanical power in the form of tractor, diesel engines and electric pumps is a pre requisite for augmenting the productivity of land. Tractor, a labor saving input, is used for several operations in agriculture. It has become an essential vehicle for transportation.

A temporal review of the changes in the agricultural implements and appliances, thus enables one to judge the progress of an agricultural region. It has been observed that along with the number of ploughs in the district the proportion of iron ploughs to the wooden ploughs has also increased. Sugarcane Crushers, worked by bullocks or power operated, were in large numbers in the reference year 1991.Their number has declined (because of development of sugar factories) over the

year 2011. In the district oil engines and electric pumps have multiplied in the last two decades. Both are increased in the reference year 1991. But numbers of oil engines declined in the year 2011 because they were replaced by electric pumps, so the number of electric pumps increased in the year 2011, because of the rural electrification programme). There was a similar increase in the number of tractors in 2011.

ROAD ACCESSIBILITY:-

The success of agriculture depends upon a good network of roads in the countryside .Roads connect the area of production and consumption, which facilitate the flow of agricultural commodities. In the Godavari, Girana and Mosam Basins, road transportation is dominant, and is overburdened by heavy vehicular traffic of trucks, tractors and carts. Train transport is also useful for transporting agricultural products like vegetables, fruits, grapes etc.

The district had 14075 k.ms. road length (N.H., S.H., D.H. and all types of roads), in the year 1991, and in the reference year 2011 it was 14203 k.ms.

The road accessibility in the district is uneven. The Godavari basin, Girana and Mosam basin or the industrial zone of Nashik have attained better accessibility of roads within 5 km from main roads because of the concentration of sugarcane and other important agricultural products like fruits and vegetables. The talukas Baglan, Malegaon, Niphad, Nashik, Kalwan and Dindori have this advantages position due to efforts made by the sugar factories and also the state government. In contrast, the western hilly talukas i.e. Peint, Surgana and Igatpuri are inaccessible (beyond 10 km.). This poor accessibility can be attributed to rugged topography and consequently poor development of roads. The moderate accessibility (5 to 10 km) is confined to the eastern and northern talukas (Nandgaon, Yeola and the east part of Chandwad) in the district.

2.6) TRANSPORT AND COMMUNICATION:-

A well-developed network of means of transport is indispensable for the economic development of the country. Inadequacy of transport puts bottlenecks in growth, since production and distribution are dependent upon efficient, reliable, competitive and quick transport systems. (Arunachalam)

Economic development of the region depends on good means of transport and communications. Transport facilities have great impact on the location and intensity of farming systems. The agricultural produce requires efficient communication networks for reaching the markets situated in different parts. Nashik district is also no exception. It is obvious that the western part of the district has comparatively less transport facilities because of hilly and mountainous area, on the other hand the central and eastern parts have better communication facilities, both roads and railway routes being predominant in these parts. (Fig. No. 2.2)

ROAD TRANSPORT:-

Road transport has played a significant role in the economic growth of the study area since historic times. The road network is relatively well spread in the district. The road development in the district on a larger scale started in the second half of the nineteenth century. Initially the main trunk lines connecting the neighboring areas were constructed. With the growth of economic activities in the district, the production and market centers had to be connected with district headquarter. Nashik is on the intersection of two National Highways i.e. Mumbai-Agra National Highway-3 and the Nashik – Pune National Highway- 50.

In 1991 the district had 13839 k.ms. (Except N. H.) of road. The road systems was maintained by (i) State Government, (ii) District local Board and (iii) Municipal Bodies. In the last two decades road mileage has doubled itself. Nowadays roads are maintained by B and C department, Zilla Parishad and Municipalities and Municipal Corporations.

In the central and eastern part of the district, road network is more complex. Road accessibility is improved, but the village roads still are not maintained properly and in some cases, in the rainy season they are not motorable, thus isolating the area from the main transport link. In the western part the road position is very poor in the rainy season. In the rural area of the district, chief mode of transport is bullock cart. Agricultural produce from the farm to house and then to the market is transported by carts.

RAILWAY TRANSPORT:-

Railway transport is one of the fastest means of communication. The total railway length in the district in the year 1991 was 243 k.ms. Further the railways were classified into broad gauge, meter and narrow gauge categories. The broad gauge lines were subdivided into single, double and triple gauge. In 2011 Nashik district had a total length 287 k.ms. of railways. (Table No. 2.6). The railway serve only a smaller area as compared to roads in the district, but both these media of transport are important for the district. Manmad is an important junction. Nashik Road railway station is a major railway station and Igatpuri, Lasalgaon are also important railway stations. Nashik is directly connected to various major cities in India. Like Mumbai, New Delhi, Kolkata, Nagpur, Chennai, Kanpur and Guwahati etc. We may conclude that the entire development and efforts to increase accessibility are mostly linked with the extension of the road system. The extension of roadways in the present inaccessible areas will bring a large portion of area and population in the main stream of the economic growth of the district.

Table No. : - 2.5

Length of Various Types of Road in Nashik District in k.ms. (1991 And 2011)

Sr. No.	**Name of Roads**	**Total Length of Road in k.ms. 1991**	**Total Length of Road in k.ms. 2011**
1	National Highway	**236**	**289**
2	State Highway	**1,735**	**1,690**
3	Main District Road	**2,141**	**2,227**
4	Other District Road	**2,192**	**2,400**
5	Rural Road (Gramin Road)	**6,981**	**7,575**
	Total Length of All Types of Roads in k.ms.	**14,075**	**14,203**

Table No. : - 2.6 Length of Railway route in Nashik District. (1991 and 2011).

Sr. No.	**Type of Railway route**	**Total length in k .m.**	
		1991	**2011**
1	Broad Gauge	243	243
2	Metre Gauge	44	44
Total		287	287

FIG. NO. 2.2: TRANSPORT

Airways: - Ozar is an important airport in Nashik district. It is located at a distance of 20 k.ms. from the city center. This will boost the connectivity and tourism. Nashik also has another airport namely Gandhinagar airport. There is a military airport in Deolali cantonment.

2.7) IRRIGATION:-

Water is the most important single requirement for the growth of plants. Crops can be raised successfully only if water is available in adequate quantity.

Irrigation is one of the important inputs and socioeconomic basis of agriculture. It is SINE QUA NON for intensive and more economic agricultural operation. The success of agriculture depends to a large extent on how successfully water requirements of various crops are met (Arora, 1976) Availability of perennial water or irrigation encourages Farmers to adopt more scientific techniques and intensive cultivation. "Farming Without irrigation is very limited and if rainfall decreases to less than 300 m. m., agriculture is impossible without irrigation" (King, 1953).

Irrigation helps to augment yield per unit area and increase the cropped land through the transformation of agriculture and increasing production, agriculture offers new opportunities for employment. "Due to irrigation, farmers can make additional investments in cattle, farm implements, on more valuable crops and the total employment of farmers and labors" (Gadgil, 1945). Obviously it increases the land value and leads to additional use of land. Thus irrigation plays a vital role, particularly in changing the agrarian structure from subsistence to commercial. An attempt is made to highlight the spatial pattern of irrigation facilities in the district.

Irrigation and irrigational facilities have become more and more significant in the agriculture development, especially in Nashik district, where the monsoonal variations, both the intensity and period are prone to fluctuations; irrigation assumes a very vital role in agricultural performance and planning. Most of the central and eastern parts of the study area show fluctuations in rainfall and its distribution and are periodically under servere drought conditions. These and even the western part therefore need irrigation on a massive scale, if steady agricultural production is the aim.

Irrigation is artificial supply of water for growing crops and it has been practiced in India since time immemorial. For successful farming, irrigation is essential in one form or the other particularly in the areas receiving scanty rainfall. In many less developed countries areas receiving a well distributed rainfall of 750 mm. or more, conducive to high level crop production are relatively rare (Hoyles,ed, 1974).

Availability of irrigational facilities will not only ensure a sustained Kharif agriculture production, but will enable enterprising farmers to take up Rubbi production on a reasonable scale. The uncertain or fluctuating rainfall and the ever changing crop production could then be successfully tackled. However, in the study area extension and development of irrigation facilities are not commensurate with planning processes and the actual performance. It is thus a prime need to extend the irrigational facilities. This will result in an all-round development of agriculture and other allied activities.

There are two main sources of irrigation.

1] SURFACE IRRIGATION:-

Rivers, canals, tanks, ponds, lakes and artificial reservoirs provide surface water for irrigation. Canals are drawn from dams constructed across the rivers and if the dam is high enough to form a large reservoir, water is available throughout the year. Tanks which form an important source of irrigation are mostly rain-fed. The water from the artificial source is carried to the fields by flow due to gravity. In the reference year 1991 surface irrigation was 25060 percent and it was 24.10 in the reference year 2011.

2) WELL IRRIGATION (Ground Water):-

The nature of topography and the characteristics of geological formations influence the amount of underground water available. The subterranean water is tapped by digging wells. The depth of these wells vary with the nature of underlying beds and the level of permanent water table. From this source water has to be lifted before it is used for irrigation and various water lifting devices have to be applied. The appliances to lift water worked by human or bullock power in the district are Mhote and Rahat (Persian wheel). Nowadays oil engines and electric pumps are most common.

The district has 25.70 percent area under irrigation of the net sown area in the reference year 1991. The area under irrigation decreased in the year 2011 i.e. 17.80 percent.

Other sources of irrigation occupied a very significant position i.e. 24.90 percent in the reference year 1991 and the irrigated area by other sources decreased in the reference year 2011. It was only 06.08 percent.

Table No.:- 2.7

Percentage of irrigated area by different sources in Nashik District (year 1991 and 2011)

Category	**Years**	
	1991	**2011**
Well irrigation	49.5	69.82
Surface irrigation	25.6	24.10
Other	24.9	6.08
Total	**100**	**100**

IRRIGATION PROJECTS IN THE DISTRICT:-

Planning for irrigation development is done at central and state government levels. For the optimum utilization of water potential of the river basins, three types of irrigation projects are planned.

1. MAJOR PROJECTS

2. MEDIUM PROJECTS

3. MINOR WORKS

A major project in a river basin alone cannot exploit all the water potentials of the basins. Therefore, to bring maximum area under irrigation, medium and minor works are also planned along with the major works.The following important irrigation projects and major works play an important role in developing the agriculture of the district. (Fig. No. 2.6)

Table No. 2.8 MAJOUR IRRIGATION PROJECT IN NASHIK DISTRICT

Name of Project	Location of project	Maximum Storage(in millimeter)	Irrigable area completed project in (half)	Area irrigated at present (in Hect.)	
				perennial	Seasonal
Gangapur	Gangawadi(NSK)	215.80	15960(H)	1558	23095
Chankpur	Chankpur (KAL)	79.92	13365(H)	977	4258
Panzan	Panzan (NAND)	524.0	3347(H)	-----	1043
Karanjwan	Karanjwan (DIN)	175.56	1574(H)	-----	------
Waghad	Waghad (DIN)	76.48	6750(H)	-----	1451
Ozarkhed	Ozarkhed (DIN)	67.96	10400(H)	------	2260
Palkhed	Palkhed (DIN)	21.24	59400(H)	5278	7585
Darna	Darna (IGET)	226.79	33170 (H)	2931	2217

Table No. 2.9 MEDIUM IRRIGATION PROJECTS IN NASHIK DISTRICT

Name of Project	Location of project	Maximum Storage(in millimeter)	Irrigable area completed project in (half)	Area irrigated at present (in Hect.)	
				perennial	Seasonal
Daraswadi	Pimpaled(CHAN)	3.14	840(H)	------	150
Bhajapur	Bhajapur (SINN)	21.62	4580(H)	------	1861
Mosam	Wadel (MALE)	----	3150(H)	-----	530
Haranbari	Ambapur (BAG)	37.78	9726(H)	-----	6159
Kelzar	Kelzar (BAG)	17.23	3640(H)	-----	1651
Alandi	Sakotewadi(NSK)	40.60	2916(H)	------	2916

Source: - Irrigation Department, Nashik Division.

GODAVARI PROJECT:-

The Godavari project is an important project of the district. It has long been under the consideration of the government. It has now been matured as a scheme for irrigation on the right bank of the river from Nandur Madhameshvar to Rahata. The weir will be of Mosonry. It will be half a mile long and thirty feet high on a rocky barrier in the river-bed and the canal will be a hundred miles long. It will protect an area of about 56000 hectares (1, 40,000acres) almost wholly in that part of the Deccan, which is especially liable to suffer from drought. It is built across the Godavari.

PALKHED CANAL**:-**

The large works, which are under the Public Work Department, are the Palkhed canal in Dindori and Niphad entirely new scheme. The Vadali canal in Niphad, the Ozar Tambat canal in Dindori and Niphad, an old scheme improved and enlarged. The Palkhed canal in supplied from the Kadwa River. The weir and head works are of rubble masonry.

The wall, which is twenty feet high at the center and eight hundred feet long, is built on a rocky barrier in the river about 30 k.ms. above its meeting the Godavari. The canal, which is 18 k.ms. long, lies on the right bank, and with 15 k.ms. of side

channels, commands an arable area of about 8000 hectares (20000 acres) in Dindori and Niphad. The work was begun in 1968, but on account of two accidents due to excessive floods, it was not opened till 1973-74. The total cost was Rs. 1, 48,720. The discharging capacity at the head is 63 cubic feet a second. The river has a large and never failing supply for six months.

FIG. NO. 2.3: IRRIGATION PROJECTS

VAGHAD AND KHIRDI RESERVOIRS:-

The Vaghad and Khirdi reservoirs were begun in 1978 as famine relief work. The Vaghad reservoir is 20 k.ms. north of Nashik. It is now completed, but the work of the Khirdi reservoir, 12 k.ms. from Yeola has been stopped for want of funds. The Vaghad reservoir is designed to store rain water for the canals below. It consists of an earth dam across the Kadva River. It is 4160 feet long and 90 feet high at the center. The dam impounds 625 million cubic feet of water within an area of 320 hectares (800acres), Water, when required, will be let out by a masonry culvert and will flow

along the channel of the river to the Palkhed, Vadali and Ozar Tambat canals to aid their supply. The work will cost about Rs. 2, 27,500 and by a further expenditure of about the same amount can be made of twice its present capacity. The design of the Khirdi reservoir is to build an earthen dam, 2465 feet long and 49 feet high across the Narindi River. The estimated cost is about Rs.1, 33,100.

GANGAPUR DAM:-

This Earthen dam is situated near Gangapur village, 15 k.ms. to the north – west of Nashik city. It is built at the confluence of the Godavari and the Kashyapi rivers. It is 12500 feet long and 145 feet high from the base and 30 feet wide. The first stage of this work was completed in 1961 at a cost of Rs.361.57 lakh. The second stage was completed in 1965-66. Its storage capacity is 215.80 million M. feet with a catchment area measuring 138 sq. miles. It has two canals, viz. the right bank canal and the left bank canal with a total length of 25 k.ms. and 45 k.ms. respectively. The right bank canal commands a gross area of 4400 hectares and the left bank canal 13200 hectares.

GIRNA DAM:-

The dam is built across the river Girna near Panzan village in Malegaon taluka. This is the biggest dam in the district. The catchment area of the dam measures about 730 hectare. But this dam is not useful for Nashik district.

NANDUR MADHAMESHWAR PROJECT:-

It is situated near the village Nandur Madhameshwar, a bandhara has been built on the confluence of the Godavari and the Kadava rivers. However, most of the area in Ahmednagar district is benefitted by the project. It is one of the oldest irrigation projects in the district.

DARNA DAM:-

This project was completed in 1915-16. It envisaged the construction of a gravity dam across the river Darna, about 25 k.ms. South of Nashik city. Below the dam 65 k.ms. away is a pickup weir at Nandur Madhameshwar from which two canals viz. the Godavari left bank and Godavari right bank, take off. The dam has a storage capacity of about 226.79 million M. ft.

The Godavari left bank canal emanating from the above weir has a culturable area of 35200 hectares under its commands which falls in Niphad and Yeola talukas of the district.

The Godavari right bank canal takes off from the Nandur Madhameshwar weir and is about 95 k.ms. long. It has the irrigated area of 33170 hectares under its command. It falls in Niphad and Sinnar talukas of the district.

CHANKAPUR PROJECT:-

The project was completed in 1911 at the cost of Rs.17, 69,596. A dam is constructed across The Girna River near Chankapur village in Kalvan taluka. About 35 k.ms. below the Chankapur dam is a pick-up weir at Thengode village in Baglan taluka. Two canals i.e. The Girna right bank and the Girna left bank take off from this weir. At present the dam has a storage capacity of 1056 m. cu. ft.

The Girna left bank canal is 30 k.ms. long. It takes off from the Thengode weir. It has an irritable area of 13365 hectares, all of which falls in Malegaon taluka. The Girna right bank canal also takes off from Thengode weir. Its total length is 10 k.ms. and has 600 hectares under its command. The whole area falls in Malegaon taluka.

HARANBARI DAM:-

This dam is situated near the village Ambapur. It is built across the river Mosam. There are two canals i.e. the Mosam right canal and Mosam left canal. The dam has a storage capacity of 37.78 mm. and irrigates an area of 9726 hectares.

MOSAM RIGHT BANK CANAL:-

A medium size Bandhara has been constructed across the Mosam River near the village Vadel. The construction work of the bandhara and the canal was started in 1956-57 and completed in 1962-63. The total outlay on this project was of the order of Rs.34, 18,000. From the bandhara a canal 10 k.ms. in length and distributaries 15 k.ms. long has been constructed. They together cover all villages and the area expected to be brought under wet crop is 3150 hectares. (Fig. No. 2.4)

Nashik district has many minor projects, bandharas and tanks which are useful for irrigation. There are Parsul tank, Khirdi tanks and the Khad tanks and a number of other small tanks existing in the district. By the end of 1981, there were 35 major tanks in the district. In the first five year plan 12 bandharas, in the second 7 bandharas and in the third 3 bandharas were constructed. They together irrigated an area of 530 hectares.

IRRIGATION AND CROPPING PATTERN:-

WALDEVI DAM:-

Waldevi Dam, is an earth fill dam on the Waldevi River near Nashik in the state of Maharashtra in India. The height of the dam above its lowest foundation is 36.4 m (119 ft.) while the length is 1,890 m (6,200 ft.). The volume content is 1,304 km^3 (313 cu mi) and the gross storage capacity is 33,720.00 km^3 (8,089.86 cu mi).The main purpose of this dam is irrigation.

DHANER DAM-

Dhaner Dam is a gravity dam on Tapi river near Nandgaon, Nashik district in the state of Maharashtra in India. The height of the dam above the lowest foundation is 27.7 m (91 ft.) while the length is 425 m (1,394 ft.). The gross storage capacity is 141,000.00 km^3 (33,827.70). The main aim is to provide water in the local area.

KADWA DAM:-

Kadwa Dam, is an earth fill dam on Kadwa River near Igatpuri, Nashik district in the state of Maharashtra in India. It is situated in Igatpuri tehsil. The height of the dam above the lowest foundation is 31.84 m (104.5 ft.) while the length is 1,660 m (5,450 ft.). The volume content is 1,245 km^3 (299 cu mi) and gross storage capacity is 59,590.00 km^3 (14,296.40 cu mi).The purpose of this dam is irrigation.

KASHYPI DAM:-

Kashypi Dam, is an earth fill dam on Kashyapi River near Rajapur, Nashik district in the state of Maharashtra in India. The height of the dam above the lowest foundation is 41.75 m (137.0 ft.) while the length is 1,291 m (4,236 ft.). The volume content is 2,761 km^3 (662 cu mi) and gross storage capacity is 52,690.00 km^3 (12,641.00 cu mi).[2]

Downstream this dam is the Gangapur Dam, which opened in 1965. Due to silt deposition in the reservoir area, the storage capacity of the Gangapur Dam has gradually reduced. The right side canal running towards Nashik is also closed due to the high civilization in the area. For these two reasons, the Kashypi Dam was constructed. The purpose is of this dam also is irrigation.

PUNAD DAM**:-**

Punad Dam, is an earth fill dam on Punad River near Nashik. The height of the dam above the lowest foundation is 29.62 m (97.2 ft), while the length is 1,820 m (5,970 ft). The volume content is 123 km3 (30 cu mi) and gross storage capacity is 19,080.00 km3 (4,577. 54 cu mi).The purpose of the dam is mainly for irrigation.

BHAVALI DAM:-

Bhavali Dam, is an earth fill dam on Bham River near Igatpuri, Nashik district in the state of Maharashtra in India. The height of the dam above the lowest foundation is 33.97 m (111.5 ft) while the length is 1,550 m (5,090 ft). The volume content is 329 km^3 (79 cu mi) and gross storage capacity is 75,050.00 km^3 (18,005.45 cu mi)

ALANDI DAM:-

Alandi Dam, is an earth fill dam on Alandi River in Nashik district in the state of Maharashtra in India. The height of the dam above the lowest foundation is 29.3 m (96 ft.), while the length is 1,690 m (5,540 ft.). The volume content is 2,782 km^3 (667 cu mi) and gross storage capacity is 29,600.00 km^3 (7,101.42 cu mi).[1]

MUKANE DAM:-

Mukane Dam, is an earth fill dam on Aaundha River near Igatpuri, Nashik district in the state of Maharashtra in India. The height of the dam above the lowest foundation is 26.93 m (88.4 ft.), while the length is 1,530 m (5,020 ft.). The volume content is 2,271 km^3 (545 cu mi) and gross storage capacity is 214,160.00 km^3 (51,379.72 cu mi).The purpose of the dam is drinking water supply as well as irrigation.

NAGYASAKYA DAM:-

Nagyasakya Dam, is an earth fill dam on Panzan River near Nandgaon, Nashik district in the state of Maharashtra in India. The height of the dam above the lowest foundation is 23.09 m (75.8 ft.), while the length is 1,440 m (4,720 ft.). The volume content is 292 km^3 (70 cu mi) and gross storage capacity is 15,620.00 km^3 (3,747.44 cu mi).The purpose is also for drinking water supply and irrigation.

NAVDURI DAM:-

Nanduri Dam, is an earth fill and gravity dam on Tapi River near Ama Local Nallaher, Nashik district in the state of Maharashtra in India. The height of the dam above the lowest foundation is 20 m (66 ft.), while the length is 2,186 m (7,172 ft**.).** The volume content is 1,381.25 km^3 (331.38 cu mi) and gross storage capacity is 42,056.00 km^3 (10,089.77 cu mi. The purpose is irrigation.

The water requirements of crops differ widely and for a given type of soil the amount of water required varies with the type and makeup of crops. They depend mainly on the plant species, and its physiological and the growing season. Most of the crops require larger quantities of water during later stages of growth than in early stages. Grain crops require maximum irrigation during the time earthed are forming. Many annual crops do not require irrigation, in their maturity stage. Sugarcane requires heavier irrigation, or more frequent irrigation from seven to eight months onwards. In the case of many fruit trees, irrigation has to be stopped during their resting period.

Among the irrigated crops sugarcane and cotton are more significant as they have a very high proportion of the area occupied by these crops under irrigation. It means that in the district sugarcane and cotton entirely depend upon irrigation pm. The areal spread of these two crops may be insignificant if compared to that of cereals, but they are economically more important. Next to Sugarcane and Cotton, Wheat Jowar, Vegetables and fruits, exhibit a higher proportion of their area under irrigation. Rice, Bajara, oilseeds and other nonfood crops account for a relatively smaller irrigated area.

ANALYSIS OF IRRIGATION LAND:-

An analysis of the temporal variation in the irrigated area under different crops reveals an overall increase in the last two decades. The increase is spectacular in case of cotton, high in case of wheat and sugarcane, and moderate in rice and oilseeds. Bajara has neither gained much nor are the losses in its area under irrigation. Thus the maximum increase is realized in cotton, sugarcane, fruits and vegetables, which are cash crops. With the exception of wheat, other food crops have shown a steady increase from 1981 and 1991 onwards.

One may conclude that within a given a setup of environmental factors, the future of agricultural development lies in the optimum utilization of available water resources. Irrigation can promote the efficiency of agriculture through increase in the crop yields. The total agricultural production can be busted by taking two/ three crops in a year, with the application of water in the seasons other than monsoon. Irrigation may also bring about changes in cropping patterns resulting into an increase in the farmer's income and standard of living in the district.

2.8) POWER SUPPLY (ELECTRICITY):-

Nowadays the availability of electricity in talukas of the district is considered to be a prime need for the development of agricultural utilization and overall progress of the study area. It has direct bearing on the efficiency of irrigation and in turn economic returns from the irrigated farms. Utilization of electric power has become a sign of efficiency of man in various fields.

Electricity is provided to the villages of the district by M.S.E.B. since the year 1965. After the establishment of this board, the process of electrification has accelerated. Authentic information received from the concerned officer clearly reveals the fact that 99percent villages of the Nashik district have been electrified.

The number of electrified towns in the district was only eleven (11) in the reference year 1951. No village was electrified up to the end of March 1961. The population of these electrified places was 23.28 percent of the total population of the district. The per capita consumption was naturally lower than the state average, as only 11 towns in the district had been electrified. The electric supply in the district

was from the five private concerns and one municipal power house. Out of these six stations of Yeola, Malegaon, Manmad, Nashik, Deolali and Sinnar were running on diesel oil, while the electric supply company of Igatpuri gets supply from the power station of the central railway at Kaylan.

After the establishment of Maharashtra state Electricity Board, Nashik was an independent Divisional office to look after the implementation of the schemes of electric supply in the district. There was fast development in power supply after 1965.

A temporal analysis of villages which have been electrified before 2011 clearly pointed out the following views.

Nearly 1579 villages were electrified before 1991. These villages occur especially in the central and eastern part of the district. Other villages which were electrified in the same period belong to Dindori and Igatpuri talukas. The highest percentage of villages which were electrified in between the period of 1971 and 1991 nearly 85 percent villages were electrified in that period.

Thus up to the year 2011 nearly 90 percent villages are electrified except some villages of the western a talukas. Majority of the villages were electrified. Remaining un electrified villages were electrified later on because such villages occur in hilly areas of the western part and they are situated far away from the major transportation systems of the district.

Electric power supply plays an important role in the development of agriculture. After the establishment of M.S.E.B. the percentage of irrigated land is increased only because of electric supply provided to the farmers.

2.9) <u>MARKETING</u>:-

Agriculture geography, which is an important branch of geography, studies spatial variations in agriculture and nowadays the definition is extended to cover all the agriculture activities from sowing and harvesting to marketing. Surplus and exchange are two important aspects of modern commercial economy. So it is very important to understand the spatial distribution of market centers and surrounding

area of the market centers. In the rural areas, agricultural commodities dominated the goods traded at the market centers.

A weekly market is the central economy institution in most rural areas particularly in the developing economies (Diddee, 1978). In the country side where most settlements are purely agricultural, the weekly markets perform important economic and social functions. Weekly markets essentially are distributing rather than collecting centers, for significant volumes of agricultural produce flow only through the largest weekly markets and regulated markets.

The spatial distribution of weekly markets is influenced by physiography, population density, agricultural productivity and accessibility. Generally most weekly markets are not more than 4 to 10 k.ms apart and the range is also governed by the round trip distance people can walk in a day. The sequence of market days is adjusted to reduce competition as far as possible among the neighboring villages.

The distribution of markets is uneven in the western hilly area with high rainfall. Market centers are absent on account of low marketable surpluses, low population density, poor accessibility and low purchasing power of farmers (Surgana, Peint and Igatpuri) In the central part of the district or in irrigated area the number and size of weekly markets are increased. (Niphad, Baglan, Malegaon etc.)

In the district, market is held only in 270 villages. It is also observed that in four talukas namely Peint, Surgana, Dindori, Nandgaon, Yeola and Igatpuri very few villages have this facility. Among the 1460 villages where market is not held the same is available at a distance of up to five k.ms. for 460 villages, 5 to 10 k.ms, for 695 villages and beyond 10 k.ms. Mostly weekly markets are found in the villages below five thousand population. Krushi Utpanna Bajar committee plays a dominant role for agricultural production. Because of the market committee farmers sell the agricultural production directly in the market and get more profit.

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CHAPTER No. 3

GENERAL LAND-USE

3.1) GENERAL LAND-USE:- Land-use is an important aspect of geographic studies particularly relevant to agricultural geography. However, this concept has been used in so many different ways that no generally accepted scheme of classification exists despite many years of land-use studies by geographers (Kariel and kariel, 1972). And in most such schemes, activity on the land has been the major criterion for classifying land-use, which is essentially a qualitative rather than a quantitative variable. Moreover , the problem how land resources are used and how much production comes from various major uses is exceedingly complex, being determined by several inter-related factors, like the environmental, the socio-economic and also the historical background of the land-use (Anderson, 1969). But the impact of environmental control is too subtle and often interwoven with socio-economic forces from which the farmer cannot be easily divorced for a geographical investigation of the current land-use patterns and changes therein.

The concept of land-use is related to the use to which land is put in a certain region at a given period of time. Land-use studies are important as they are aimed at explaining the occurrences of different uses in different areas. They generally aim at explaining the constant interactions between available land resources on the one hand and human needs and efforts on the other. Land-use thus is an expression of permanent struggle in which human efforts are applied to the land resources for the satisfaction of human needs. The competition between various types of uses is the result of quality of land. Some land is better than the other land for a specific use depending on physical, economic and cultural characteristics of the land to which its suitability for a particular use is related. Therefore, in agricultural geography it is essential to understand the variations in the land-use as a human reaction towards the satisfaction of human wants.

The agricultural land-use dominates the rural land-use pattern. As a result of ever increasing population pressure on land, the land resources are depleting fast. In such a situation, even the marginal lands are brought under cultivation further extension being impossible. Efforts are made towards optimum utilization of land through more intensive methods of cultivation. Through the basic land resources are more or less permanent, the application of technology and changing social and economic conditions introduce changes in the land-use patterns in course of time. This chapter proposes to examine the general land-use pattern of the district with the

help of the area data from the census hand books of the district. Land-use statistical figures for the reference period 1991 to 2011 have been abstracted from the annual socio-economic review and district statistical abstract, prepared by the Bureau of Economics and Statistics, Government of Maharashtra, Bombay. Tehsil level statistical figures have been used for analyzing the distributional patterns of general land-use and changes therein or even for ranking of land-use. The spatial variations in the utilization of land are then studied with respect to the tehsil. Village level data obtained from the district census hand book (1991 & 2011) are then compared to understand the spatial variation in the land-use types in relation to the physical regions.

Table No. 3A

GENERAL LAND-USE: - Nashik district as a whole.

PERENTAGE OF GENERAL LAND-USE TO TOTAL GEOGRAPHICAL AREA.

Sr. No.	Category	Year	
		1991	**2011**
1	Forest	21.70	21.28
2	Fallow Land	08.42	08.54
3	Net sown area	55.92	43.82
4	Culturable waste	04.06	06.17
5	Area not available for cultivation	07. 13	06.17

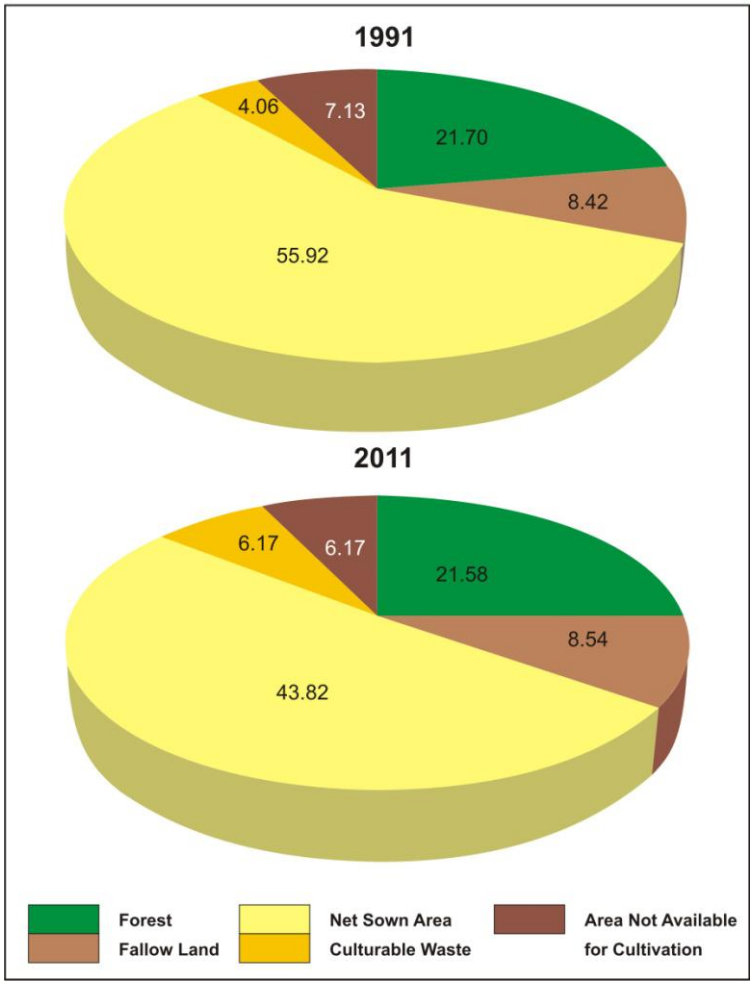
CLASSIFICATION OF GENERAL LAND-USE:-

The general land-use classification was adopted by all the states in.1950 as per the recommendations of the Technical Committee on Co-ordination of Agricultural Statistics. Census of India has classified land utilization in nine different categories, but in the present study these have been grouped into five major land-use categories, as the percentage of the area under individual categories is relatively insignificant. On the basis of the statistical data abstracted from the sources referred to above, the Nashik district may be divided into five major land-use categories. Thus the total geographical area has been classified as under:-

1) Area under Forest. 2) Net Sown Area (N.S.A.) 3) Culturable Waste.

4) Fallow Land. 5) Area Not Available for Cultivation.

FIG. NO. 3.1: GENERAL LAND UTILISATION - NASHIK DISTRICT



AREA UNDER FOREST:-

The category includes all areas actually under forest whether state owned or private and classed or administered as forest under a legal enhancement dealing with the forest. If any portion of such land is not actually wooded, but put to some agricultural use, that is included under the appropriate heading of cultivated or uncultivated land.

Nashik Forests were separated from Khandesh in1871. Before this separation, it was called "The Nashik Forest Circle". Before 1871 the total area was about 3028 sq. k.ms. (Including Khandesh). Of this forest area, 2068 sq.k.ms. had been set aside and the remaining area of 960 sq. k.ms. was added in1878 under a section of new forest lands. Besides this declared forest area there remained among the supplementary selections 335 sq.k.ms. of occupied land. In Peint taluka a further area of 256 sq. k.ms., which might be increased to 770 sq.km., had been set apart, which raised the total to 4130 sq.k.ms. of the area was protected and all was reserved.

Nowadays for the purpose of forest administration the district has been divided into two forest divisions. Each division is manned by the Divisional Forest Officers and other administrative and technical staff. The area under forest in the district has remained more or less constant since 1981 up to 2011, but the area under Forest slightly increased (21.83 percentage) in 2011. (Table N0.3.1)

The forest is classified into three types.

1. Forest.
2. Reserved Forest.
3. Protected Unclassified Forest.

Reserved forest are intended mainly for timber production, and grazing, cultivation is generally not allowed in them. Rights of grazing and cultivation under certain limitations and restrictions are allowed in protected forests. The unclassified forests refer to the inaccessible forests or unoccupied waste.

Relevant data for the reference years 1990-91 & 2010-11 has been collected and interpreted below. An attempt has been made to find out and analyze the changes occurred during the period under consideration. The forests in the district covered an area 325200 hectares, i.e. about 20.80 percent in the reference year 1991, and 344000 hectares, i.e. about 22.00 percent in the year 2011 of the total geographical area.

The distribution of forest Lands in the study region is as follows. Fig. No. 3.1 shows the distribution of forests. According to the record of the year 1991, all talukas possessed some, area under forest (Table No. 3.1).

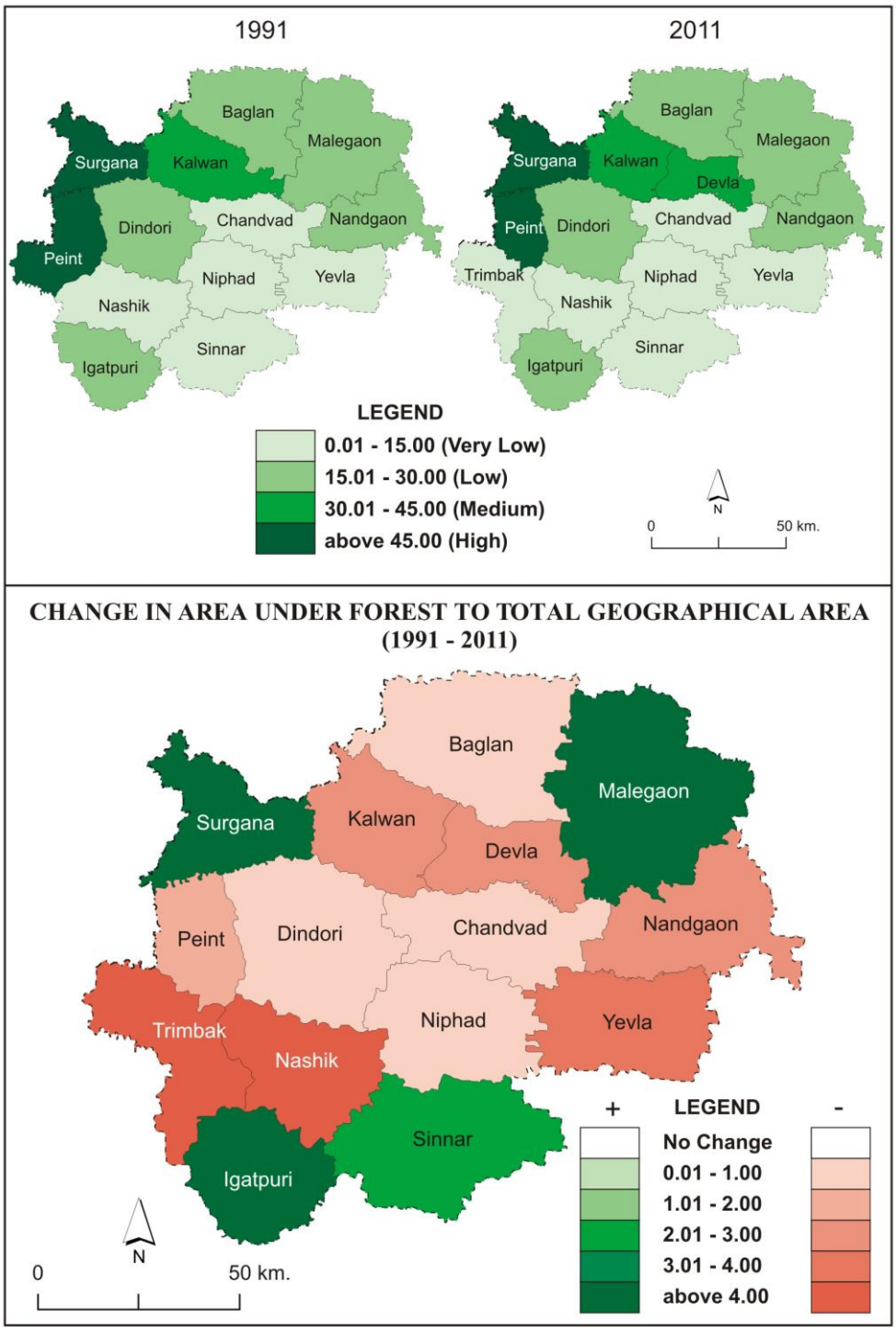
A spatial analysis of these talukas points out the following facts nearly 38.50 percent talukas are included in the very low category of distribution i.e. 0.01 to 15 percent land under forests, mostly in the central, south and eastern parts. This is the direct result of low and variable rainfall as well as variable relief. Out of these talukas 38.50 percent, talukas have less than 15 percent of land under forests. The lowest percentage is found in the Niphad taluka, which is located in the central part of the study region. It is only 1.07 percent.

Five talukas (38.50 percent) mostly located in the north eastern and western part, have 15.01 percent to 30.00 percent of land under forest. The distribution of this category is also the effect of rainfall and relief.

Two talukas have above 51 percent of forest land of the total geographical area. The talukas are Peint (52 percent) and Surgana (54 percent), both of these are on

the western margins of the study area and come in the highest rainfall belt. (Table No. 3.2). Trimbak and Deola talukas are recently formed new tahsils, so separate forest area is not measured. It is included with in Nashik and Kalwan talukas respectively. Further spatial analysis for the reference year 2011 clears the following aspects of the pattern of distribution.

FIG. NO 3.2: % OF AREA UNDER FOREST TO TOTAL GEOGRAPHICAL AREA



The first category with less than 15 percent land under forest is mainly in the central and eastern part of the study area. Five talukas (38.50 percent) come under this category i.e. Nashik (Nashik & Trimbak 8.92 percent), Chandwad (10.02 percent), Yeola (9.93 percent), Niphad (1.04 percent) and Sinnar (7.83 percent). They are located in the central, eastern and south central part of the district and have 0.01 to 15.0 percent of the land under forest. This is the direct result of low and variable rainfall. Nearly 38.50 percent talukas lie in the low category (15.01 percent to 30.0 percent). These talukas are located in the south west, east and north parts of the district. Kalwan (Kalwan & Deola 33 percent) is the only taluka from the western part of the district which comes under medium category (30 percent to 45.0 percent). Peint and Surgana talukas come under high category (above 45.0 percent). These talukas come in the highest rainfall zone and hilly area (Table No. 3.2and Fig. No3.1)

Generally, it is quite clear that the spatial distribution of forests in the study region is clearly influenced by physical environment. The western part receives maximum rainfall and it is here that the percentage of land under forests is high.

The volume of change in the forested area during the two decades (1991 to 2011) is depicted in the adjoining map in Fig. No.3.2. Although no large scale variations are marked in the pattern, the region has undergone some change in the forest cover, varying from 0.01 percent to above 45.0 percent increase and decrease. (Table No. 3.2).

The tendency of talukas towards changes shows the following results.

Four talukas are involved in the positive change. Nearly 30.76 percent talukas belong to low category of increase, which varies from 01.01 percent to above 3.01 percent (Table No. 3.3). These talukas lie in the western and south central part of the study region. The forest area in these talukas has increased owing to systematic efforts of afforestation. Two talukas (15.38 percent) from high category (above 03.0 percent) lie in the western part of the district. i.e. Igatpuri and Surgana. Malegaon from low category and Sinnar from medium category are located in the north eastern and south parts of the study area.

The tendency of the talukas of decrease

The tendency of the talukas of decrease is as follows: Nine talukas (69.23 percent) are involved in the negative change. Nearly 30.76 percent talukas belong to the very low category of decrease, which varies from 0.01 percent to 1.0 percent (Table No. 3.3). These talukas lie in the western and central parts of the district. Nashik (Nashik & Trimbak) and Yeola talukas from the central and eastern part

respectively belong to a high category of decrease, with which varies from above 3.01 percent. Kalwan (Kalwan & Deola) and Nandgaon located in western and eastern part of the district comes under medium category (2.01 to 3.0 percent). Peint taluka lies in low category. The pressure of population and legal and illegal cutting of forests, are responsible for decrease in the area under forest. (Table No. 3.3).

Higher values of percentage of increase and decrease are observed in very few number of talukas, where the conditions tend to be able to be more favorable for increase and unfavorable for decrease. The tendency of talukas towards decrease is higher than that of increase due to afforestation. Reasons are described as above. Trimbak and Deola talukas are recently formed new tahsils, so separate forest area is not measured. It is included in Nashik and Kalwan talukas respectively.

Table No. : 3.1

PERCENTAGE OF AREA UNDER **FOREST** TO **TOTAL GEOGRAPHICAL AREA**. FOR YEAR 1991 AND 2011 AND CHANGE (Talukawise)

Sr. No.	**Name of Talukas**	**Percentage 1991**	**Percentage 2011**	**+**	**-**	**No Change**
1	Nashik	08.92	01.19		07.73	
2	Peint	48.18	4 7.01		01.17	
3	Dindori	16.40	16.19		00.21	
4	Surgana	51.61	57.07	05.46		
5	Kalvan	32.80	30.38		02.51	
6	Baglan	29.52	29.03		00.49	
7	Malegaon	0 9.92	21.15	11.23		
8	Chandwad	0 0.02	09.30		00 .72	
9	Nandgaon	25.35	22.61		02.74	
10	Yeola	09.43	05.54		03.89	
11	Niphad	01.04	00.79		00.25	
12	Sinnar	07.83	10.83	02.30		
13	Igatpuri	01.25	25.63	04.38		
14	Trimbak					
15	Devla					
Dist.	**Total**	**20.80**	**22.00**			

Table No. : 3.2 SPATIAL ANALYSIS OF TALUKAS ON THE BASIS OF AREA UNDER FOREST TO TOTAL GEOGRAPHICAL AREA. (1991 -- 2011)

Category	Value	Total No. of Talukas (1991)	Total No. of Talukas (2011)	Percentage of the total No. of talukas (1991)	Percentage of the total No. of talukas (2011)
Very Low	00.01to 15.00	Nashik, Chandwad, Yeola, Niphad, Sinnar = 5	Nashik, Chandwad, Yeola, Niphad, Sinnar = 5	8.50	8.50
Low	15.01to 30.00	Dindori, Baglan, Malegon, Nandgaon, Igatpuri = 5	Dindori, Baglan, Malegon, Nandgaon, Igatpuri = 5	38.50	38.50
Medium	30.01to 45.00	Kalvan =1	Kalvan =1	.70	.70
Very High	Above 45.01	Peint, Surgana =2	Peint, Surgana =2	5.30	5.30

Table No. : 3.3 TENDENCY OF TALUKA TOWORDS INCREASES AND DECREASES IN AREA UNDER **FOREST**.

	Category	Total No. of Talukas Increases (+ve)	Total No. of Talukas Decreases(-ve)	% of the total No. of Increase talukas	% of the total No. of Decrease talukas
Very Low	00.01 to 01.00	Nil	Dindori, Baglan, Chandwad, Niphad =4	00.00	30.76
Low	01.01 to 02.00	nil	Peint = 1	07.70	07.70
Medium	02.01 to 03.00	Sinnar = 1	Kalwan, Nandgaon =2	07.70	15.40
High	03.01 to 04.00	Nil	Yeola = 1	00.00	07.70
Very High	Above 04.01	Surgana, Malegaon Igatpuri = 2	Nashik = 1	15.40	07.70

3.3) NET SOWN AREA:-

This category constitutes the extent of cropped land in any region and therefore, is of vital significance in the studies relevant in years 1991 and 2011 of the total geographical area of the study region (Table No. 3A).

Traditionally agriculture is practiced intensively on a large scale. Hence net sown area exists in all talukas from reference year 1991 to 2011 (Table No. 3.4). Spatial analysis of talukas under this category of land-use for the year 1990-91 focuses light on the following aspects.

The highest percent of talukas (46.1 percent) are included in the moderate category (45.01 percent to 60 percent), and lowest percentage of talukas (23.1 percent) lie in the middle category. (Table No. 3.4). Not a single tehsil lies in the lowest category (0.01 percent to 15.00 percent).

Three talukas have less than 45 percent of land under net sown area. These talukas are located in the western part of the study region. This category has the lowest percentage of net sown area because of heavy rainfall, diversified relief and poor soils and urbanization. The heavy rainfall in the western part gives rise to poor soils due to unchecked soil erosion, making the soil poor. Besides the soils here are lateritic and do not retain moisture. The heavy iron content and leaching make the soils poor in plant nutrients. The lowest percentage of net sown area is in Peint taluka (31.26 percent) and Surgana taluka (41.82 percent). (Table No. 3.4)

The category having 45.01 percent to 60.00 percent of net sown area counts six talukas, and three talukas lie in 30.01 percent to 45.00 percent of net sown area. The net sown area is the actual area under crops, counting areas sown more than once in the same year, only once.

In the country having a dominantly agricultural economy, perhaps no other elements in its geography are more important than the agricultural land-use and within it net sown area is at once the most significant.

The general impression regarding the net sown area in the study region is as a result of a long period of agricultural occupancy, fertility of land resources and lack of diversification in economy and use of irrigational facilities causing a very high proportion of net sown area of talukas in the district. Spatial and temporal changes

occurred during the reference year 1990-91 and 2011. The magnitude of changes varies from place to place. Hence to analyses these changes further detailed study has been attempted. The explanation for variations in net sown area is based upon mainly the previous background of the following environmental factors.

i) Relief ii) Climate iii) Soil iv) Natural Drainage.

These are main aspects of physical environment of Nashik district. The other factors are like surface transport, industrial expansion, availability of electricity, irrigation, population distribution etc.

The net sown area (NSA) accounts for 44.70 percent in reference year 2011. 46.01 percent tehsils come under moderate category (30.00 percent to 45.00 percent). It is located in the south western and eastern part of the district, where rainfall is heavy and the soil is poor. Out of the six talukas of moderate category, excepting Nandgaon taluka, which is in the eastern part, the others are located in the north central, south central and western parts of the study area. The spatial distribution of this category closely has diversified relief and medium to heavy rainfall. Nandgaon taluka (31.50 percent) comes under this category because of low rainfall, undulating topography and very poor soils.

The high category with 45.01 percent to 60.00 percent of the net sown area of the total geographical area is made up of five talukas. This category could be considered as highly agricultural owing to the high percent of net sown area. All these talukas are located in the central and east part. Generally all these talukas have a low relief and do not have a highly dissected topography as in the western part.

The very high category (above 60.00 percent) of net sown area consists of only one taluka i.e. Chandwad (61.00 percent). It is located in the central part of the district, and has very high percent of net sown area because of fairly fertile soil, though the taluka is located in the medium to low rainfall region.

TEMPORAL ANALYSIS:- A temporal analysis of the net sown area brings out the following facts. All these talukas of Nasjik district are involved in either positive or negative changes. (Table No.3.6)

The tendency of the talukas towards positive change

The tendency of the talukas towards positive change has been pointed out as follow.

Two talukas (15 percent) are involved in the positive change. Of these Kalwan (Kalwan & Deola) taluka has increased the net sown area from 48.62 percent to 54.52 percent, and Peint taluka has located in western part of district increased from 31.26 percent to 59.00 percent (Table No, 3.6) irrespective of rainfall and soil condition. Peint talukas from the west part of the district belongs to the high category mainly due to the area under grass included in the net sown area.

Hereafter the tendency of the talukas towards negative change throws light on the following facts.

Eleven talukas (85 percent) are involved in the negative change. Of these nearly 45.5 percent of each are included in the first and second categories (0.01percent to 5.00 percent and 5.01 percent to 10.00 percent). The talukas of low category of decrease are located in the western part of the district, where the rainfall is high and pressure of population is low to high. Not a single taluka belongs to the moderate category of decrease.

The highest percentage in decrease of net sown area is found in six talukas. (Above 20 percent). The net sown area of Nashik taluka (Nashik & Trimbak) has decreased because of the urban influence and a high percentage of land is not available for cultivation. Some area is reserved for industrial development as well as for construction purpose. Out of decreased talukas Malegaon, Nandgaon, Yeola, Niphad and Sinnar talukas are located in the eastern and southern part of the district.

The proportion of the net sown area is relatively small in the hilly areas in the western part of the district receiving rainfall above 1500 mm. In some talukas in the central and eastern part of the district, the land available for cultivation is very small. The high rainfall zone and transitional zone display much higher proportion to the net sown area than the adverse physiography would permit. This is mainly due to the fact that the area under grass (Fooder), which has been included in the net sown area, is considerable in Surgana and Peint talukas. This grass area is unfit for crop production.

There are many causes of decrease in the net sown area in the district. The influence of Scarcity condition is reflected in some categories of land-use. The drought years display in crisps in the area under follows: pastures and grazing lands. Net sown area shows a marked decrease at times of scarcity.

Lastly, the remarkable change in the area sown more than once can be attributed to the human efforts in the direction of intensification of agriculture. This indicates the socio-economic and technological changes that took place during the last three decades.

Table No. : 3.4

PERCENTAGE OF AREA UNDER **NET SOWN AREA** TO **TOTAL GEOGRAPHICAL AREA**. FOR YEAR 1991 AND 2011 AND CHANGE (Talukawise)

Sr. No.	**Name of Talukas**	**Percentage 1991**	**Percentage 2011**	+	–	**No Change**
1	Nashik	44.36	23.37		20.99	
2	Peint	31.26	59.00	27.74		
3	Dindori	05.53	46.33		09.00	
4	Surgana	46.82	36.87		04.95	
5	Kalvan	48.62	54.52	05.90		
6	Baglan	51.79	49.73		02.06	
7	Malegaon	58.36	36.04		22.32	
8	Chandwad	68.37	61.00		08.36	
9	Nandgaon	57.60	31.50		25.10	
10	Yeola	73.30	50.18		23.12	
11	Niphad	71.58	35.95		35.63	
12	Sinnar	46.49	36.24		10.25	
13	Igatpuri	52.89	44.99		07.90	
14	Trimbak					
15	Devla					
Dist.	**Total**	**55.92**	**43.82**			

FIG. NO 3.3: % OF AREA UNDER NET SOWN AREA TO TOTAL GEOGRAPHICAL AREA

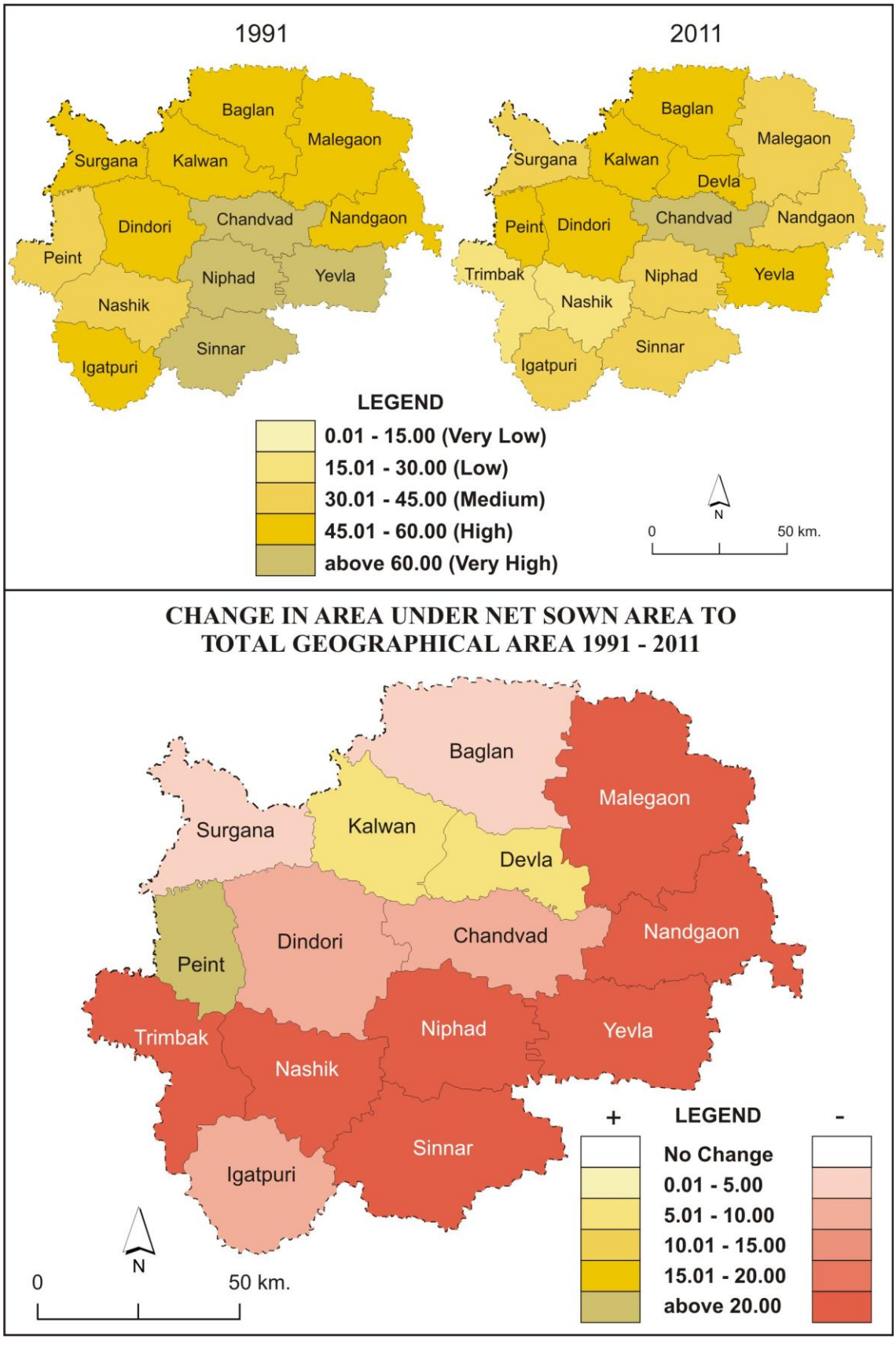


Table No. : 3.5

SPATIAL ANALYSIS OF TALUKAS ON THE BASIS OF AREA UNDER **NET SOWN AREA** TO **TOTAL GEOGRAPHICAL AREA**. (1991 -- 2011)

	Category	**Total No. of Talukas (1991)**	**Total No. of Talukas (2011)**	**Percentage of the total No. of talukas (1991)**	**Percentage of the total No. of talukas (2011)**
Very Low	00.01 to 15.00	Nil	Nil	00.00	00.00
Low	15.01 to 30.00	Nil	Nashik =	00.00	07.70
Medium	30.01 to 45.00	Nashik, Peint = 02	Surgana, Malegaon Nandgaon Niphad, Sinnar, Igatpuri =	15.40	46.10
High	45.01 to 60.00	Dindori, Surgana, Kalvan, Baglan, Malegaon Nandgaon Igatpuri =	Peint, Dindori, Kalvan, Baglan, Yeola = 05	53.80	38.50
Very High	Above 60.01	Chandwad Yeola, Niphad, Sinnar = 04	Chandwad = 01	30.80	07.70

Table No. : 3.6

TENDENCY OF TALUKA TOWORDS INCREASES AND DECREASES IN AREA UNDER **NET SOWN AREA**.

	Category	**Total No. of Talukas Increases (+ve)**	**Total No. of Talukas Decreases (-ve)**	**Percentage of the total No. of Increase talukas**	**Percentage of the total No. of Decrease talukas**
Very Low	00.01 to 05.00	Nil	Surgana, Baglan = 02	00.00	15.40
Low	05.01 to 10.00	Kalvan = 01	Dindori, Chandwad, Igatpuri = 03	07.70	23.10
Medium	10.01 to 15.00	Nil	Nil	00.00	00.00
High	15.01 to 20.00	Nil	Nil	00.00	00.00
Very High	Above 20.01	Peint = 01	Nashik, Malegaon, Nandgaon, Yeola, Niphad, Sinnar = 6	07.70	46.10

3.4) CULTURABLE WASTE:-

Culturable waste is defined as the land which is either fallow or covered with useless shrubs and jungles, and that which is available for cultivation whether taken up for cultivation or not taken up for cultivation once, but not cultivated during the current year, and for the last five years or more in succession.

Thus Culturable waste is and could be useful for agriculture. Further Culturable waste lands generally have poor soils, medium and heavy soil erosion, poor rainfall and low irrigation facilities. Still with better management of land and proper financing these lands could be made useful for agriculture.

Culturable waste is one of the most important aspects of the generally land-use. Its importance is growing day by day as it is actual wastage of cultivable land. Wastage is because of the natural factors such as inadequate rainfall, or waterlogged condition, and socio-economic factors such as utilization of the agricultural land for nonagricultural uses. Nonagricultural uses include houses, industries, transportation network, defense occupations etc.

As far as Nashik district is concerned, it accounts for about 4.83 percent (75600 hectares) under this category of land-use as per reference year 1991. This percentage has slightly decreased by 1.92 percent from the reference year 1991 to 2011. It has become 2.91 percent in the reference year 1991 and 6.04 percent in the year 2011. (Table No. 3A)

SPATIAL ANALYSIS:-

Spatial analysis of talukas in the reference year 1991 put forth the following aspects.

All the talukas of Nashik district possess certain area under Culturable waste in the study area (Table No. 3.7). Of these nearly 53.8 percent (7 talukas) talukas occur in the very low category of distribution (0.01 percent to 3.0 percent). These talukas occur widely in the eastern, central and south western parts of the district. In most of these talukas, net sown area is above 45 percent. The talukas of this category are like Kalwan (Kalwan & Deola 0.33 percent), Dindori (0.25 percent), Nandgaon (1.56 percent), Chandwad (1.77 percent), Sinnar (2.98 percent), Igatpuri (1.37 percent) and Niphad (0.95 percent), where agriculture is practiced intensively. (Table No. 3.7). Igatpuri and Kalwan (Kalwan & Deola) talukas belonging to this category

located in the western part of the district, where due to undulating surface, high rainfall and poor soils, the net sown area is less than eastern talukas most of the area of these talukas are covered by forest.

Four talukas report only 3.01 percent to 6.00 percent of the land under this category. They lie by and large in the west part and eastern part of the district. The net sown area of these talukas varies from medium to considerably high category. These taluk**as,** like Nashik [(Nashik & Trimbak) 5.05 percent], Surgana (3.46 percent), Peint (5.57 percent) and Yeola (3.20 percent), lie in this category.

Malegaon and Baglan talukas of the north central and north eastern parts of the district belong to very high category. (Above 9.1 percent). These talukas lie in the category of 50 percent to 60 percentage net sown area of the total geographical area. The western portion of Baglan taluka is hilly and covered by mixed forest. So the area under this category is high.

It is clear from the above discussion that in the reference year 1991 the Culturable waste land of the Nashik district decreases towards the eastern part of the study region except Surgana and Peint talukas from the western part.

Hereafter the spatial analysis of Culturable waste for the reference year 2011 has been attempted in the further study. It reveals the following facts.

Of the total talukas nearly 38.46 percent (5 talukas) are included in the very low category (0.01 percent to 3.00 percent). Peint, Surgan, Kalwan (Kalwan & Deola), Dindori and Baglan talukas of high and medium category in the reference year 1991 have come under low category in the reference year 2011, on the other hand, Chandwad, Igatpuri and Niphad talukas from low category in the reference year 1991 come under high grade in the reference year 2011 as compared to the year 1991. The remaining talukas remains the same as that of the year 1991 except Nashik (Nashik & Trimbak) and Yeola talukas. All talukas lie in the central and eastern part of the district. In Surgana, Peint and Igatpuri talukas, trade of fodder crops has become an important occupation to support the traditional subsistence on agriculture. Further talukas, which lie in the irrigated track of the study region, have net sown area of considerable high grade i.e. Niphad, Baglan and Kalwan talukas (Kalwan & Deola). (Table No. 3.7).

Nearly 23.1 percent talukas of the district belong to medium category (6.01 percent to 9.00 percent). All these talukas are located in the south central and south east parts of the district. (Table No. 3.8).

In general the area under Culturable waste decreased in the reference year 2011 as compared to the reference year 1991. This had the following causes. In year 2011, the attitude of the people was towards the development of agriculture. The Government of Maharashtra provides many facilities to improve farming such as "Sudharit be-biyana", Hybrid Yojana, Supply of Fertilizers and Hybrid seeds at controlled rate. There are shops of fertilizers in big villages. Small gram panchayats grant loans at low rate. The social institutes such as "Vivid Karyakari Sanstha" have developed in the villages.

TEMPORAL ANALYSIS:-

All the talukas of the district are involved in positive or negative changes. (Table No. 3.8) and (Fig. No. 3.3) of these Nine talukas (69.23 percent) are involved in positive changes and 4 talukas (30.76 percent) in negative changes. (Table No. 3.8).

The tendency of talukas towards positive changes:-

The tendency of talukas towards positive change is 69.23 percent. Nearly 46.15 percent belong to very low and low category of increased (1.01 percent to 3.00 percent and 3.00 percent to 6.00 percent), and 23.01 percent belong to considerably high and very high category of increased (6.01 percent to 9.00 percent and 9.01 percent to 12.00 percent). These talukas are spread by and large in the eastern and south central parts of the district respectively. Reasons are the same as explained in the spatial analysis of the year 1991. (Table No. 3.9)

The tendency of talukas towards decrease.

30.76 percent of talukas have undergone negative changes. Out of them, nearly 15.46 percent lie in the very low and low category (0.01 percent to 3.00 percent and 3.01 percent to 6.00 percent) and 15.4 percent lie in the very high category (above 9.1 percent). Baglan and Malegaon belong to very high category located in the central eastern part and eastern parts of the study region. These talukas are located especially in the irrigated zones of the district, except Peint and Surgana talukas in western part. General area under Culturable waste is decreasing towards the east and increasing in the western part due to hilly area and high rainfall (Fig. No. 3.9).

FIG. NO 3.4: % OF AREA UNDER CULTURABLE WASTE TO TOTAL GEOGRAPHICAL AREA

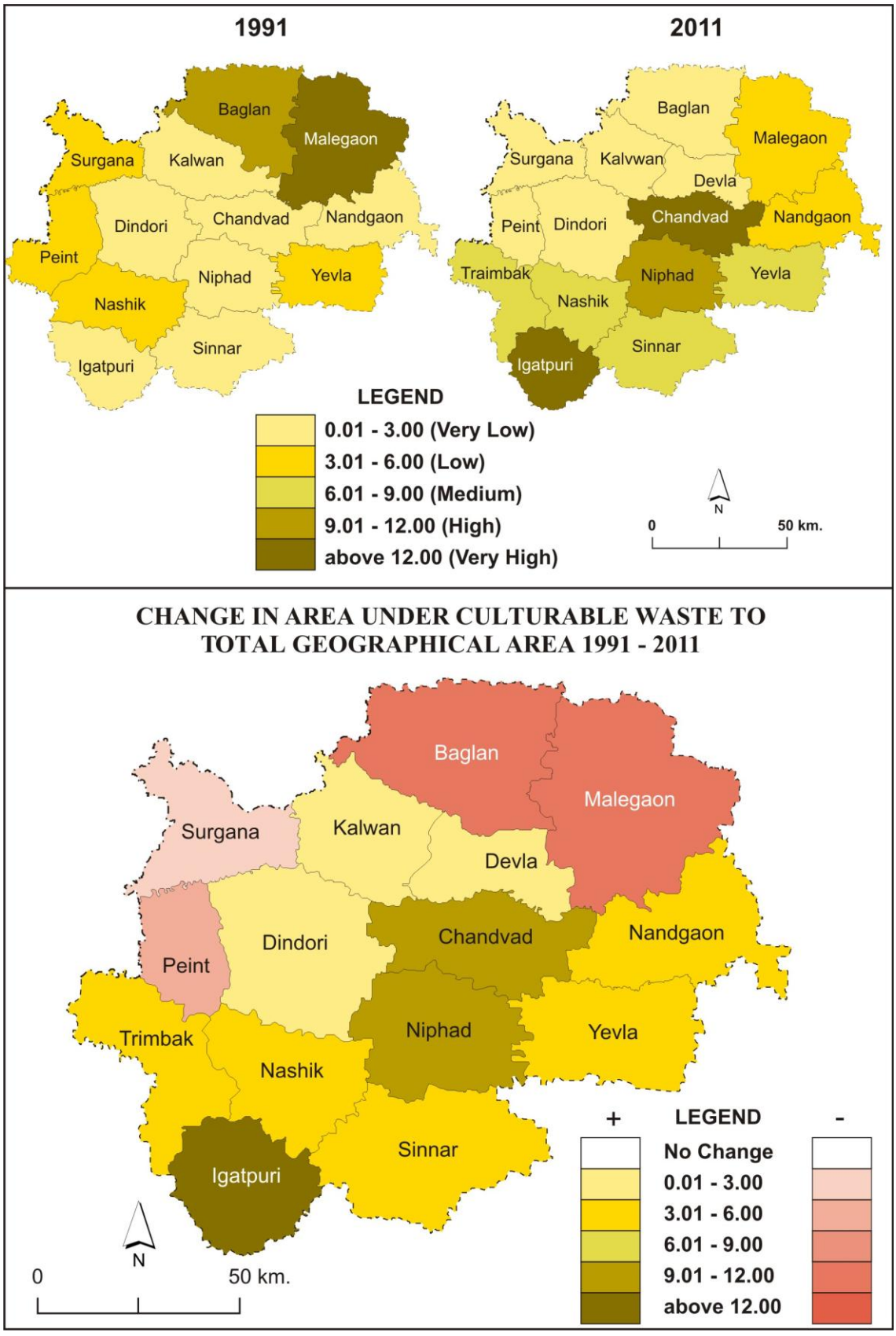


Table No. : 3.7

PERCENTAGE OF AREA UNDER **CULTURABLE WASTE** TO **TOTAL GEOGRAPHICAL AREA**. FOR YEAR 1991 AND 2011 AND CHANGE

(Talukawise)

Sr. No.	**Name of Talukas**	**Percentage 1991**	**Percentage 2011**			**No Change**
1	Nashik	05.05	08.81	03.76		
2	Peint	05.57	00.04		05.53	
3	Dindori	00.23	02.83	02.60		
4	Surgana	03.46	01.09		02.37	
5	Kalvan	00.33	01.18	00.85		
6	Baglan	11.94	01.36		10.58	
7	Malegaon	14.40	04.07		10.33	
8	Chandwad	01.77	12.29	10.52		
9	Nandgaon	01.56	05.71	4.20		
10	Yeola	03.21	0 6.47	03.26		
11	Niphad	00.95	10.44	09.49		
12	Sinnar	02.98	07.68	04.70		
13	Igatpuri	01.33	18.35	17.02		
14	Trimbak					
15	Devla					
Dist.	**Total**	**04.06**	**06.17**			

Table No. : 3.8

SPATIAL ANALYSIS OF TALUKAS ON THE BASIS OF AREA UNDER

CULTURABLE WASTE TO **TOTAL GEOGRAPHICAL AREA**. (1991 -- 2011)

	Category	**Total No. of Talukas (1991)**	**Total No. of Talukas (2011)**	**Percentage of the total No. of talukas (1991)**	**Percentage of the total No. of talukas (2011)**
Very Low	00.01 to 03.00	Dindori, Kavlan, Chandwad, Nandgaon, Niphad, Sinnar, Igatpuri =7	Peint, Dindori, Surgana, Kavlan, Baglan = 5	53.80	38.50
Low	03.01 to 06.00	Nashik, Peint, Surgana, Yeola = 4	Malegaon, Nandgaon = 2	30.80	15.40
Medium	06.01 to 09.00	Nil	Nashik, Yeola, Sinnar = 3	00.00	23.10
High	09.01 to 12.00	Baglan = 1	Niphad=1	07.70	07.70
Very High	Above 12.01	Malegaon = 1	Chandwad, Igatpuri=2	07.70	15.40

Table No. : 3.9

TENDENCY OF TALUKA TOWORDS INCREASES AND DECREASES IN AREA UNDER **CULTURABLE WASTE**.

	Category	**Total No. of Talukas Increases (+ve)**	**Total No. of Talukas Decreases (-ve)**	**Percentage of the total No. of Increase talukas**	**Percentage of the total No. of Decrease talukas**
Very Low	00.01 to 03.00	Dindori, Kavlan= 2	Surgana = 1	15.40	07.70
Low	03.01 to 06.00	Nashik, Nandgaon, Yeola, Sinnar =4	Peint = 1	23.10	15.40
Medium	06.01 to 09.00	Nil	Nil	00.00	00.00
High	09.01 to 12.00	Chandwad, Niphad =2	Baglan, Malegaon = 2	15.40	15.40
Very High	Above 12.01	Igatpuri= 1	Nil	07.60	00.00

3.5) FALLOW LAND:-

The term fallow is applied to lands not under cultivation at the time of reporting, but which were sown in the past. The lands which are fallow come under this category. Fallow lands are divided into two subtypes, i) Current fallows ii) Other fallows. Current fallows are the lands which are kept fallows during the current year. Other fallows include all lands which were taken up for cultivation, but are temporarily out of cultivation for a period not less than one year and not more than five years. Generally the current and other fallows are associated with areas having poor soils and low rainfall characteristics.

Nashik district has a substantial proportion of fallow land with an average of 7.32 percent for the reference year 1991 and it slightly increased in the reference year 2011 (7.66 percent) (Table No. 3.10)

SPATIAL ANALYSIS:-

Spatial analysis of talukas under this head in the reference year 1991 reveals the following aspects.

(38.46 percent) of total talukas belong to very low category (1.01 percent to 05.00 percent). Five talukas have less than 5 percent of the total land area under this category. The fallow lands are mainly located in the north central, central and north eastern parts of the study region. Some talukas of the central and eastern parts lie over the agricultural landscape of the region where the percentage of net the sown area is high above 40.00 percent (Table No. 3.10).

Six talukas account for the second category with 5.1 percent to 10 percent range of the fallow lands as compared to the total geographical area. Out of these talukas Baglan lies in the northern part, Sinnar in the southern part, Yeola lies in the eastern part, Niphad in central, Igatpuri and Peint in the western part of the district. The maximum fallow land percentage of this grade is found in Peint taluka (9.3 percent).

The high category with above 15 percent of the fallow land of total geographical area is made up of two talukas. Out of these, one taluka is located in the central west and one taluka is located in the western part. Nashik (Nashik & Trimbak) and Dindori have the maximum percentage (above 15 percent). Poor soil and high rainfall are the main factors affecting the location of this category. In Nashik taluka (Nashik & Trimbak) pressure of population and industrial development are responsible.

Hereafter spatial analysis of talukas for the reference year 2011 focuses light on the following aspects.

In the reference year 2011, the highest percentage of talukas (46.15 percent) lies in the very low category (1.1 percent to 5 percent). The pattern of distribution of talikas are more or less similar to that of the reference year 1990-91. Surgana taluka is an exceptional case as far as land is concerned. The highest percentage was in the reference year 1991 (17.28 percent) and this percentage has increased by 8.23 percent

during the period under consideration. It has become 25.5 percent in the year 2011. (Table No. 3.11).

TEMPORAL ANALYSIS:-

Seven talukas (53.84 percent) of the district are involved in positive change and six talukas (46.15 percent) in negative change. (Table No. 3.12).

TENDENCY OF TALUKAS TOWARDS INCREASES:-

The tendency of talukas towards positive change is 53.84 percent. Nearly 30.76 percent belong to low category of increase (1.1 percent to 5.00 percent). Kalwan (Kalwan & Deola), Chandwad, Nandgaon and Niphad talukas come under this category. Not a single taluka comes under low and medium category. Yeola taluka belongs to high category (6.01percent to 8.00 percent). It is located in the eastern part of study region. Nashik (Nashik & Trimbak) and Peint talukas from western part of the district have the highest percentage of increase in the area under the fallow land (above 8 percent).

Thus it can be concluded that increase in area under fallow land can be related positively to the degree of accessibility of villages to the surrounding area and density of population as well as uneven distribution of rainfall.

TENDENCY OF TALUKAS TOWARDS DECREASE:-

Area under fallow land has decreased in 46.15 percent talukas (Table No. 3.12). Of these nearly 30.76 percent are included in the very low category and low category (1.01 percent to 2.00 percent & 2.01 percent to 4.00 percent). These talukas lie in the western and central eastern part. Dindori is the only taluka included in the medium category (4.01 percent to 6.00 percent). Sinnar is the only one taluka occurring in the high category of distribution (6.1 percent to 8.00 percent). It lies in the southern part of the district. (Table No. 3.12).

In general, the highest percentage of fallow lands is found in the western part of the district. Here the rainfall is very heavy and relief consists of the steep slopes of the western hills. The soil erosion is also very high and hence the percentage of fallow land is very high. The highest percentage of fallow land is found in Nashik (Nashik & Trimbak), Peint, Dindori and Yeola talukas which are located in the western part and eastern part and the lowest percentage is found in Kalwan (Kalwan & Deola), Nandgaon and Sinnar talukas located in the eastern and western part of the district. (Table No. 3.12) and (Fig. No. 3.4).

Table No. : 3.10

PERCENTAGE OF AREA UNDER **FALLOW LAND** TO **TOTAL GEOGRAPHICAL AREA**. FOR YEAR 1991 AND 2011 AND CHANGE

(Talukawise)

Sr. No.	**Name of Talukas**	**Percentage 1991**	**Percentage 2011**			**No Change**
1	Nashik	17.28	25.51	08.23		
2	Peint	09.31	20.92	11.64		
3	Dindori	16.93	11.92		05.01	
4	Surgana	04.72	02.47		02.25	
5	Kalvan	02.59	02.65	00.05		
6	Baglan	06.37	03.76		02.61	
7	Malegaon	03.15	02.21		00.94	
8	Chandwad	04.28	05.15	00.87		
9	Nandgaon	02.20	03.71	01.51		
10	Yeola	06.13	13.32	07.19		
11	Niphad	09.22	10.54	01.32		
12	Sinnar	07.46	00.98		06.48	
13	Igatpuri	08.42	07.90		00.52	
14	Trimbak					
15	Devla					
Dist.	**Total**	**08.42**	**08.54**			

FIG. NO 3.5: % OF AREA UNDER FALLOW LAND TO TOTAL GEOGRAPHICAL AREA

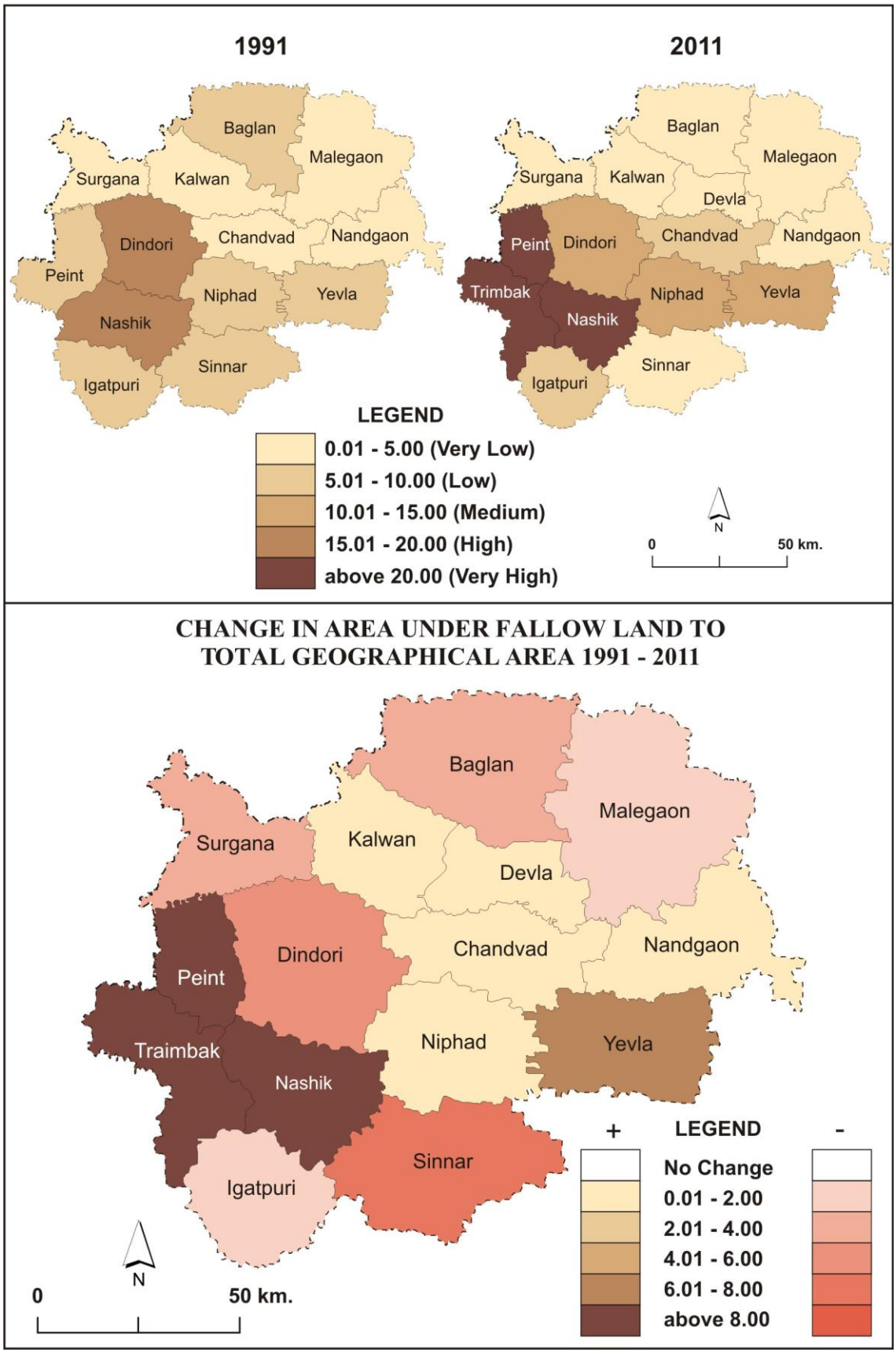


Table No. : 3.11

SPATIAL ANALYSIS OF TALUKAS ON THE BASIS OF AREA UNDER **FALLOW LAND** TO **TOTAL GEOGRAPHICAL AREA**. (1991 -- 2011)

	Category	**Total No. of Talukas (1991)**	**Total No. of Talukas (2011)**	**Percentage of the total No. of talukas (1991)**	**Percentage of the total No. of talukas (2011)**
Very Low	00.01 to 05.00	Surgana, Kalwan, Malegaon, Chandwad, Nandgaon = 05	Surgana, Kalwan, Baglan, Malegaon, Nandgaon, Sinnar = 06	38.50	46.10
Low	05.01 to 10.00	Peint, Baglann, Yeola, Niphad, Sinnar, Igatpuri = 06	Chandwad, Igatpuri = 02	46.10	15.40
Medium	10.01 to 15.00	Nil	Dindori, Yeola, Niphad = 03	00.00	23.10
High	15.01 to 20.00	Nashik, Dindori = 02	Nil	15.40	00.00
Very High	Above 20.01	Nil	Nashik, Peint =02	00.00	15.40

Table No. : 3.12 TENDENCY OF TALUKA TOWORDS INCREASES AND DECREASES IN AREA UNDER **FALLOW LAND**.

	Category	**Total No. of Talukas Increases (+ve)**	**Total No. of Talukas Decreases (-ve)**	**Percentage of the total No. of Increase talukas**	**Percentage of the total No. of Decrease talukas**
Very Low	00.01 to 02.00	Kalvan, Chandwad, Nandgaon, Niphad = 04	Malegaon, Igatpuri = 02	0.76	5.38
Low	02.01 to 04.00	Nil	Surgana, Baglan = 02	0.00	5.38
Medium	04.01 to 06.00	Nil	Dindori=01	0.00	7.69
High	06.01 to 08.00	Yeola =01	Sinnar = 01	7.69	7.69
Very High	Above 08.01	Nashik, Peint =02	Nil	5.38	0.00

3.6) AREA NOT AVAILABLE FOR CULTIVATION:-

The area not available for cultivation has been further divided into (A) Non-agricultural uses, (B) Barren and uncultivable area. This category includes the land occupied by buildings, roads, railways, lands under rivers and canals etc., and other lands put to uses other than agriculture. (Table No. 3.13) (Fig. No. 3.6)

The proportion of this land to total geographical area was 7.32 percent in **the** reference year 1991. It slightly decreased in the year 2011. (6.16 percent) (Table No.3.13)

Spatial analysis of talukas under this category of land-use in the reference year 1990-91 focuses light on the following aspects.

Five talukas (38.46 percent) mostly located in the central and eastern parts, except Igatpuri, Surgana talukas of the western part, have 0.01 percent to 5.00 percent land under this category. Five talukas i.e. Nashik (Nashik & Trimbak), Peint, Dindori, Chandwad and Sinnar lie in low category (5.01 percent to 10.00 percent) and Kalwan (Kalwan & Deola) and Nandgaon lie in middle category. (10.01 percent to 15.00 percent). The area not available for cultivation is not found in high category. Niphad has the highest percentage. (25.47 percent) (Fig. No. 3.13).

Further spatial analysis of the category for the reference year 2010-11 has been attempted in the study area. It reveals the following facts:-

All talukas have some area under this category of the agricultural land-use of these nearly 46.15 percent (6 talukas) have less than 5 percent of land under not available for cultivation. These talukas lie in the western and eastern part.30.76 percent talukas lie in low category (5.01 percent to 10.01 percent). These talukas are located in the eastern and southern part of the study area. Chandwad and Niphad come under medium category (10.01 percent to 15.00 percent).

The maximum area under the category of land not available for cultivation is found only in Igatpuri taluka (18.35 percent), which is locked in the eastern parts due to the mountainous topography and very steep slopes. Not a single taluka has very high percentage (above 20percent). The urban influence and industrial development are the reasons for such a high percentage. (Table No. 3.14).

TEMPORAL ANALYSIS:-

The temporal analysis of the area under not available for cultivation brings out the following facts.

The tendency of talukas towards increases.

Six talukas are involved in the positive change. Of these, nearly 30.8percent talukas are the area under very low category (0.01 percent to 3.00percent). These talukas are in the central and eastern part of the district. Igatpuri and Chandwad talukas from the western and north central part, where there is significant increase in this category has been resulted. Highest percentage increased in Igatpuri taluka (14.92percent).

Some talukas belonging to higher grades lie in the north western and central part because of facilities and electrification.

Tendency of talukas towards decreases:-

The area under this category has decreased in seven talukas. Of these nearly (38.46percent) are included in very low and low category (0.01percent to 3.00 percent and 3.01 percent to 6.01percent). These talukas lie in the western and eastern part except Sinnar from the southern part of the study area. Kalwan [(Kalwan & Deola) 9.45percent] and Niphad (15.5percent) lie in high and very high category (9.01 percent to 12.00 percent and above 12.00 percent).

FIG. NO 3.6: % OF AREA UNDER AREA NOT AVAILABLE FOR CULTIVATION TO TOTAL GEOGRAPHICAL AREA

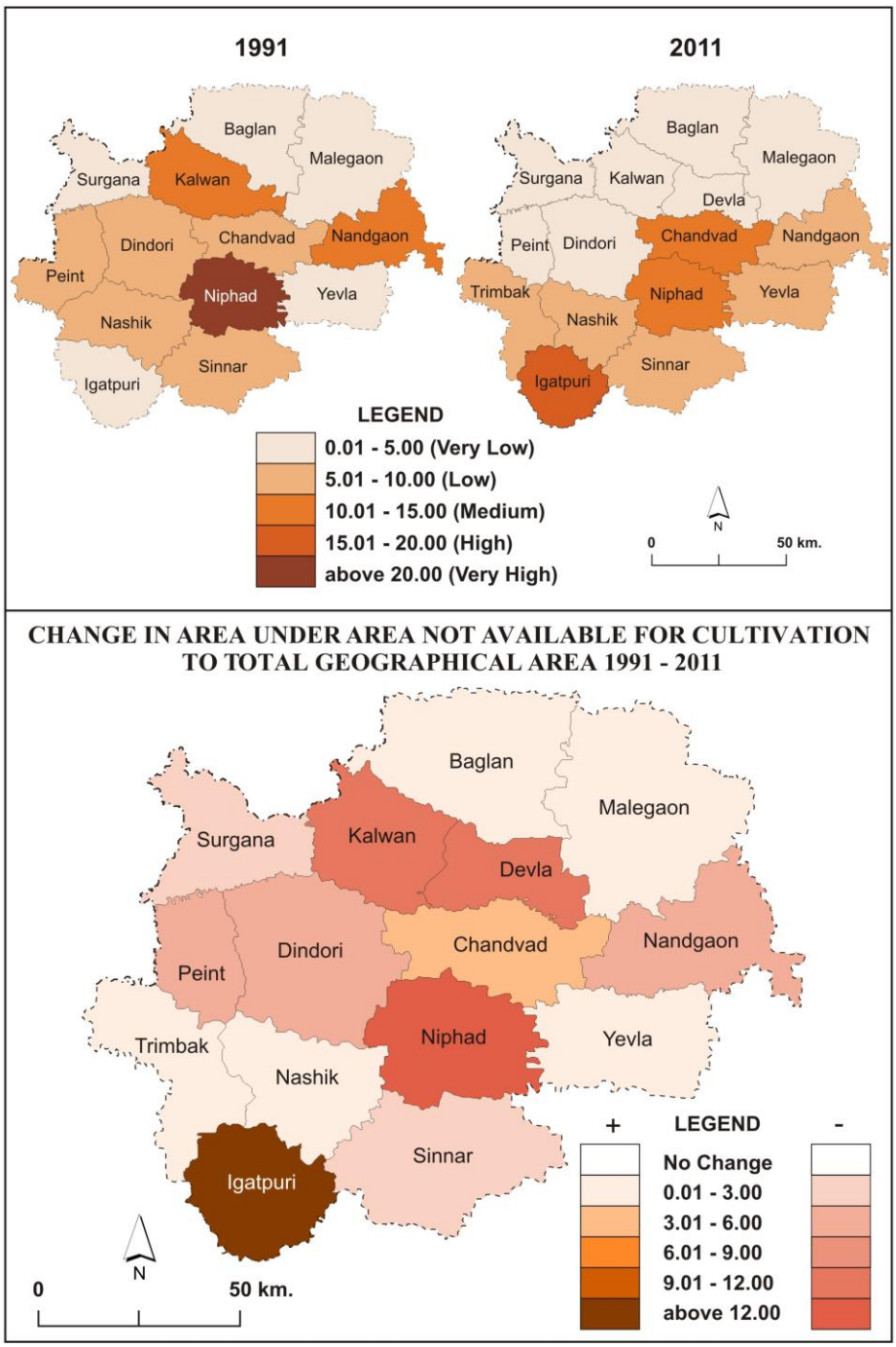


Table No. : 3.13

PERCENTAGE OF AREA UNDER **AREA NOT AVAILABLE FOR CULTIVATION** TO **TOTAL GEOGRAPHICAL AREA**. FOR YEAR 1991 AND 2011 AND CHANGE (Talukawise)

Sr. No.	**Name of Talukas**	**Percentage 1991**	**Percentage 2011**			**No Change**
1	Nashik	07.26	08.81	01.55		
2	Peint	05.57	00.05		05.52	
3	Dindori	08.62	02.83		05.79	
4	Surgana	01.43	01.09		00.34	
5	Kalvan	10.63	01.18		09.45	
6	Baglan	00.37	01.36	00.99		
7	Malegaon	02.94	04.07	01.13		
8	Chandwad	09.08	12.29	03.21		
9	Nandgaon	10.80	05.71		05.09	
10	Yeola	04.43	06.47	02.04		
11	Niphad	25.47	10.44		15.03	
12	Sinnar	09.70	07.68		02.02	
13	Igatpuri	03.43	18.35	14.92		
14	Trimbak					
15	Devla					
Dist.	**Total**	**07.13**	**06.17**			

Table No. : 3.14

SPATIAL ANALYSIS OF TALUKAS ON THE BASIS OF AREA UNDER **AREA NOT AVAILABLE FOR CULTIVATION** TO **TOTAL GEOGRAPHICAL AREA**. (1991 -- 2011)

	Category	**Total No. of Talukas (1991)**	**Total No. of Talukas (2011)**	**Percentage of the total No. of talukas (1991)**	**Percentage of the total No. of talukas (2011)**
Very Low	00.01 to 05.00	Surgana, Baglan, Malegaon, Yeola, Igatpuri =5	Peint, Dindori, Surgana, Kalvan, Baglan, Malegaon= 6	38.50	46.20
Low	05.01 to 10.00	Nashik, Peint, Dindori, Chandwad, Sinnar = 5	Nashik, Nandgaon Yeola, Sinnar = 4	38.50	30.80
Medium	10.01 to 15.00	Kavlan, Nandgaon = 2	Chandwad Niphad= 2	15.40	15.40
High	15.01 to 20.00	Nil	Igatpuri=1	00.00	07.60
Very High	Above 20.01	Niphad = 1	Nil	07.60	00.00

Table No. : 3.15

TENDENCY OF TALUKA TOWORDS INCREASES AND DECREASES IN AREA UNDER **AREA NOT AVAILABLE FOR CULTIVATION**.

	Category	**Total No. of Talukas Increases (+ve)**	**Total No. of Talukas Decreases (-ve)**	**Percentage of the total No. of Increase talukas**	**Percentage of the total No. of Decrease talukas**
Very Low	0.01 to 03.00	ashik, Baglan, Malegaon, Yeola = 4	urgana, Sinnar = 2	8.80	5.40
Low	3.01 to 06.00	handwad = 1	eint, Dindori, Nandgaon = 3	7.60	3.10
Medium	6.01 to 09.00	il	il	0.00	0.00
High	9.01 to 12.00	il	avlan =1	0.00	7.70
Very High	bove 12.01	gatpuri =1	iphad =1	7.70	7.70

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Chapter No. IV

LAND-USEPATTERN OF CROPS

4.1) CROPPING PATTERN:-

Nashik district produced variety of crops and also produced food grains and cash crops. Nashik district is well known for grapes, onion, pomegranates and tomatos production. The district experiences a large variation in soil, precipitation condition and availability of irrigation facilities. The economics of the region revolves round agriculture which is the main occupation of over 70percent of its inhabitants. In fact it has become a tradition, a way of life of many. The present study is mainly directed to the appreciation of variations in agricultural land-use over the area of the district as well as that of changes undergone in the spatial distribution of agricultural land-use over time. The agricultural land-use is the result of the direct application of efforts to usethe available land resources. The quality and quantity of the efforts applied is related to the decisions made by farmers regarding the actual use of land. These decisions are based on the appreciation of the available land resources, response to these resources as conditioned by the knowledge passed from generation to generation and appreciation of the demand for various agricultural commodities in the market. The cumulative effects of the farmer's decisions regarding the choice of crops, the methods of tillage and appreciation of the land resources are reflected in the spatial as well as temporal variations in the agricultural land-use in the study region.

This chapter deals with the analysis of the pattern of crops. The important aspect of crop pattern is distribution. This aspect has been dealt at taluka level. The central objective of such a study is to enhance theunderstanding of the dynamic forces which include changes in the pattern of crop land-use. Hence the approach has been through analysing individual crops in terms of their relative and occupancy strength.

The spatial variations find a direct expression in the cropping pattern in the area, which in turn is related to the crop ecology and tillage of land. In view of these considerations the agricultural land-use is studied in this chapter with reference to the cropping pattern. The spatial distribution of various crops, crop ecology and temporal variations are studied in this chapter. For the spatial distribution of crops, data of hectares has been assumed to be the most usable measure of the farmer's actual intent. Further it is more reliable as an index for the purpose of the study than unsuitable and

often short term variability of each measure as production, influenced so heavily by seasonal variationof yield or value.

The crop data has been prepared as percentages of crops to the net sown area. Percentage point differences between two years are also depicted in the case of individual crop series. The entire agricultural land-use pattern (Crop land-use) in the study of the region can be divided into two fundamental categories. 1) The Kharif and Rabi season cropping and 2) The rain fed and irrigated agriculture.

The spatial variation in the study region in relation to agriculture is the end of the above two categories. Those variations are also the result of new techniques and innovations carried out per se in certain areas. However, traditionally some crops like jowar, bajara and rice are the Kharif season crops and mainly belong to the rain fed category. The Rabi crops includewheat, jowar etc. They mainly depend upon irrigational facilities. Extensive areas under rain-fed agriculture in the Rabi season produce jowar, grams and others. But it must be noted that the variations in rainfall both period-wise and amount-wise and mal-management of land are the major problems dodging the agricultural activities in the study region.

CROP ECOLOGY AND SPATIAL DISTRIBUTION OF CROPS:-

Crops show a marked tendency to adapt themselves to a wide range of environments, but theyalso require a specific set of physiological elements for their optimum growth. The spatial distribution of crops is better understood if correlated with crop ecology. Crop Ecology is the study of physical environmental requirements of crops. The physical environment is represented by the following factors:

i) Physiographic factors: - Relief (Slope and altitude).

ii) Climatic factors: - Temperature, precipitation and light.

iii) Edaphic factors: - Soil characteristics and distribution.

iv) Biotic factors: - association of different plants which may be helpful, natural or harmful.

Spatial variations of crops or crop groups can be appreciated in relation to the spatial differences in various aspects of physical environment as all these physical environmental factors have a bearing upon the growth of crops. Along with the Crop Ecology, the spatial variations in the distributions of crops or crop groups are described here. Table No. 4A shows the significance of individual crops in the district as a whole for the reference year 1991 and also for the year 2011.Bajara ranks first among the crops in the reference year 1991 and 2011inthe net sown area.

FIG. NO. 4.1: CROP LAND UTILISATION

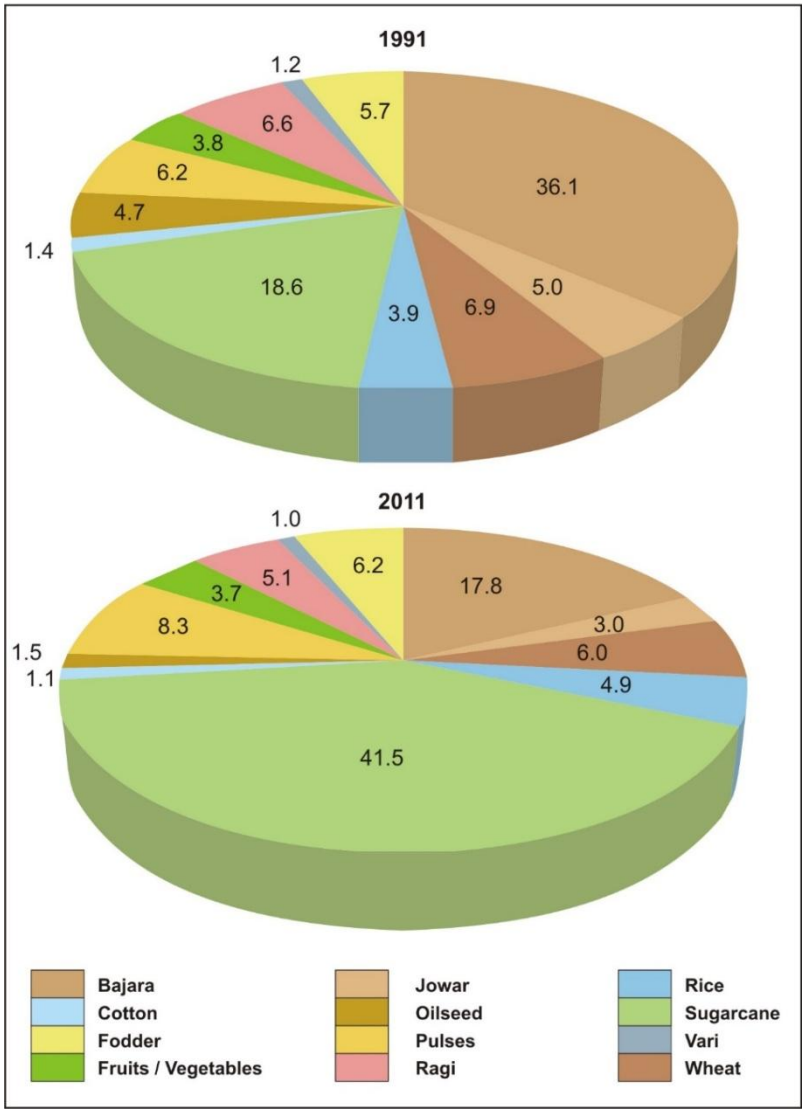


Table No. 4A CROP LAND-USE – Nashik district (1991- 2011).

Sr. No.	Crops	1991	2011
1	Bajara	49.03	35.15
2	Jowar	6.8	5.89
3	Wheat	9.32	11.8
4	Rice	5.26	9.61
5	Sugarcane	25.22	82.03
6	Cotton	1.84	2.2
7	Oildseeds	6.37	2.98
8	Pulses	8.4	16.45
9	Fruits/Vegetables	5.13	7.35
10	Ragi	8.92	10.15
11	Vari	1.63	1.97
12	Fodder	7.76	12.3

FOOD CROPS:-

Food grains play a major role in the cropping of land under tillage in Nashik district. For only under food grains can the land produce enough to sustain the dense population in the study region. Moreover, food grain crops are relatively less demanding and less exacting in their soil moisture requirements than fibber crops. Further it is said that the cropping of some food pulses is unavoidable since it leads to satisfactory rotation. Food grains account for a major proportion in1991 and in year the2011 to thecompared with net sown area in the study region.

4.2) BAJARA (Pennisetumtyphoidenm.):-

Bajara is an important food grain in the study region. It ranks first in the district. It plays a dominant role in the economy of the study region, as a whole. Among the food-grains grown in the district, Bajara occupies an important place covering a large area of 4, 27,624 hectares in 1990-91and 2, 41,110 hectares in 2011. Bajara is the first rank crop in the district accounting for a major proportion and occupying 49.03 percent in1991 and 35.15 percent in 2011 to, the net sown area. It is a staple food of a very large population in the district. It also provides good quality fodder for the livestock.

ECOLOGY:-

Bajara is a typical tropical plant and usually thrives in warm and drier types of climate. It can withstand drought to a great extent and hence is suitable for tracts receiving about 400 mm. to 500 mm. rainfall. It, however, cannot tolerate heavy or even medium rainfall and, therefore, cannot grow in areas where the normal rainfall is more than 900 mm. The ideal temperature range from 25^{o}c to 35^{o}c is suitable. The most important of all the ecological factors is the fact that there should be minimum rainfall of 150 mm. to 200 mm. in the growing period to give very good yields. Bajara thrives in poor to medium soils as well as black cotton soils. Essentially, Bajara is a kharif crop and is sown in June-July. The time of the sowing is so adjusted that the crop gets at least 150 mm. rainfall in the growing season. The crop matures in twelve to fourteen weeks depending on the variety grown. The harvesting is done usually in late September or early October. Bajara is mainlygrown as a Kharif crop. In some areas it is grown more usually as a crop i.e. when the amount of rainfall during Kharif season has not been sufficient for other crops.

FARM OPERATIONS:-

Before the sowing of Bajara, the preparation of land is essential, which includes the operations carried by the cultivators to make it suitable for Bajara cultivation. Land preparation facilitates aeration of soil through ploughing. The preparation of the land is not as thorough as for the seed bed for Jowar. One shallow ploughing, preferably with a mould board plough, is given to the soil up to the depth of 10 to 12 cm. The landis allowed to remain in cloudy conditions during the summer months and two to three crosswise harrowing are given whenever rains are received, if the field has not been ploughed after the harvest of the previous crop.

Bajara is sown from the second week of June to the second week of July. The seeds areeither broadcast or drilled. Usually one hand weeding with a weeding stickle and one or two ploughed with the bullock or light plough are given to grow the crop, the broadcast fields are only hand weeded and hand hoed. Generally Bajara crop is not manured. The crop matures after 12 to 14 weeks. The plants are cut close to ground with stickle and stacked in the field to dry. Sometimes only the matured earheads are removed and carried to the threshing floors.

SPATIAL DISTRIBUTION:-

In Nashik district, Bajara accounts for about 49.03 percent of net sown area as per reference year 1991. During the period of study under consideration, the area decreased by 9 percent. It became 35.15 percent in the reference year 2011. The ecological conditions suitable for the cultivation of this crop are observed in some parts of the district and in most cases the rainfall and edaphic factors influence the spatial distributions of Bajara. Bajara is almost produced in the whole of the study area. Ontheabove background spatial analysis of talukas under Bajara has been attempted for the year 1990-91. It focuses light on the following aspects.

All talukas of the district possessed some area under Bajara in the year 1991. The percentage of area varies from 1.50 percent to 76.90 percent.Nearly 15.40 percent to very low category and 23.10 percent belong to low category occupying condulation terrain of the region. Rainfall is high and soil is poor shallow. Two talukas [Kalwan (Kalwan & Deola) and Niphad] belonging to high category are located in the central and western part of the district. Six talukas have maximum percentage of land under Bajara (above 60.00 percent). These talukas are located in the eastern and south central part of the district. The highest percentage 76.19 percent is found in Yeola. Sinnar and Nandgaon have 75.00 percent and 70.20 percent respectively. These

talukas arelocated mostly in the eastern part of the district where rainfall is less than 500 mm.

Thus due to sturdiness of Bajara it was widely distributed all over region. But during the period under consideration changes have taken place in the crop pattern. Some of them are favourable as Bajara. These areas which lie away from the irrigated tracks have been brought under Bajara. These areas lie in the drier track of the central and eastern part. Soil varies from shallow black to deep black. Bajara does not need day to day attention. Hence with the availability of inadequate labour force within the talukas instead of keeping the cultivable land fallow, it is always brought under Bajara.

But in some talukas the percentage of Bajara has decreased because it has been replaced by other crops such as sugarcane, fruits and vegetables. Keeping this perspective of change in mind further analysis of the area under Bajara forthe year 2011 will show the following aspects. In the year 2011 all talukas had some area under Bajara. The percentage of area under Bajara varied from 02.01 percent to 72.77 percent at taluka level. The percentage of Bajara increased because of hybrid seeds. The highest percentage of talukas 23.10 percent lies in the high category. (45.01 percent to 60.00 percent) and also in very low category 46.40 percent. Two talukas account for very high category with above 60.00 percent range of the area under Bajara. These areas are located in the south-central and the eastern part of the district. (Table No. 4.2)

TEMPORAL ANALYSIS:-

All talukas are involved in some sort of change either positive or negative.

The tendency of talukas towards positive change

Nearly 15.40 percent talukas are involved in positive change, i.e. Nandgaon and Igatpuri. Both talukas belonging to very low category lie in the western and eastern part of the district, and these talukas are associated with the high to low rainfall zone having generally low relief and medium to black soils.

Tendency of talukas towards negative change

Nearly 84.60 percent of the talukas are involved in negative change. Four talukas of negative change belong to very low grade of increase. i. e. Peint, Dindori, Surgana and Chandwad occupy 30.80 percent. These are located in central and western part of the district. Five talukas of low grade occupying 38.40 percent of total

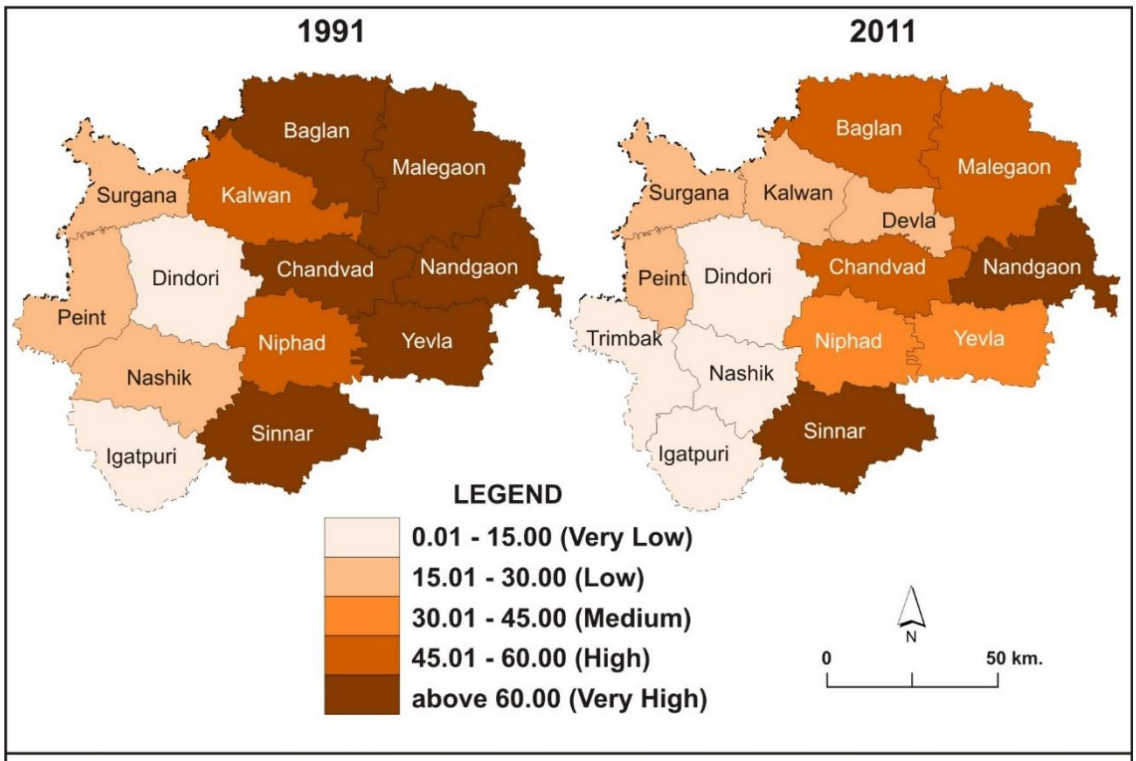
talukas. These talukas are located in western and south central part of the district. Kalwan (Kalwan & Deola) and Yeola lie in medium and high category respectively. The percentage of Bajara is decreased in these talukas because present farmers have replaced Bajara by other crops. Generally the distribution of Bajara shows that there is one major region and one minor region accounting for the crop. The major region consists of nine talukas. All these talukas are contiguous and are located in the central and eastern part of the district. They are associated with the medium to low rainfall zone having generally low relief. The minor region consists of four talukas located in the western part. The percentage ofthe area under Bajara of the net sown area is very low (01.01 percent to 10.00 percent). These talukas are associated with high rainfall (more than 900 mm.), high relief and poor soils. (Table No. 4.3)

Table No. : 4.1 PERCENTAGEOF AREAUNDER**BAJARA**TO**NET SOWN AREA.**

FORYEAR**1991**AND**2011**AND**CHANGE** (Talukawise)

Sr. No.	**Name of Talukas**	**Percentage 1991**	**Percentage 2011**	**+**	**_**	**No Change**
1	Nashik	15.30	05.50		13.43	
2	Peint	20.00	19.50		00.50	
3	Dindori	09.44	04.50		06.95	
4	Surgana	20.25	20.00		00.25	
5	Kalvan	46.75	21.10		25.65	
6	Baglan	62.76	50.15		12.61	
7	Malegaon	70.54	54.68		15.86	
8	Chandwad	64.09	57.44		06.65	
9	Nandgaon	70.20	72.77	02.57		
10	Yeola	76.19	36.79		39.40	
11	Niphad	53.76	35.00		10.26	
12	Sinnar	75.26	65.00		10.26	
13	Igatpuri	01.50	02.00	00.50		
14	Trimbak					
15	Devla					
Dist.	**Total**	**49.03**	**35.15**			

FIG. NO 4.2: % OF AREA UNDER BAJRA TO NET SOWN AREA



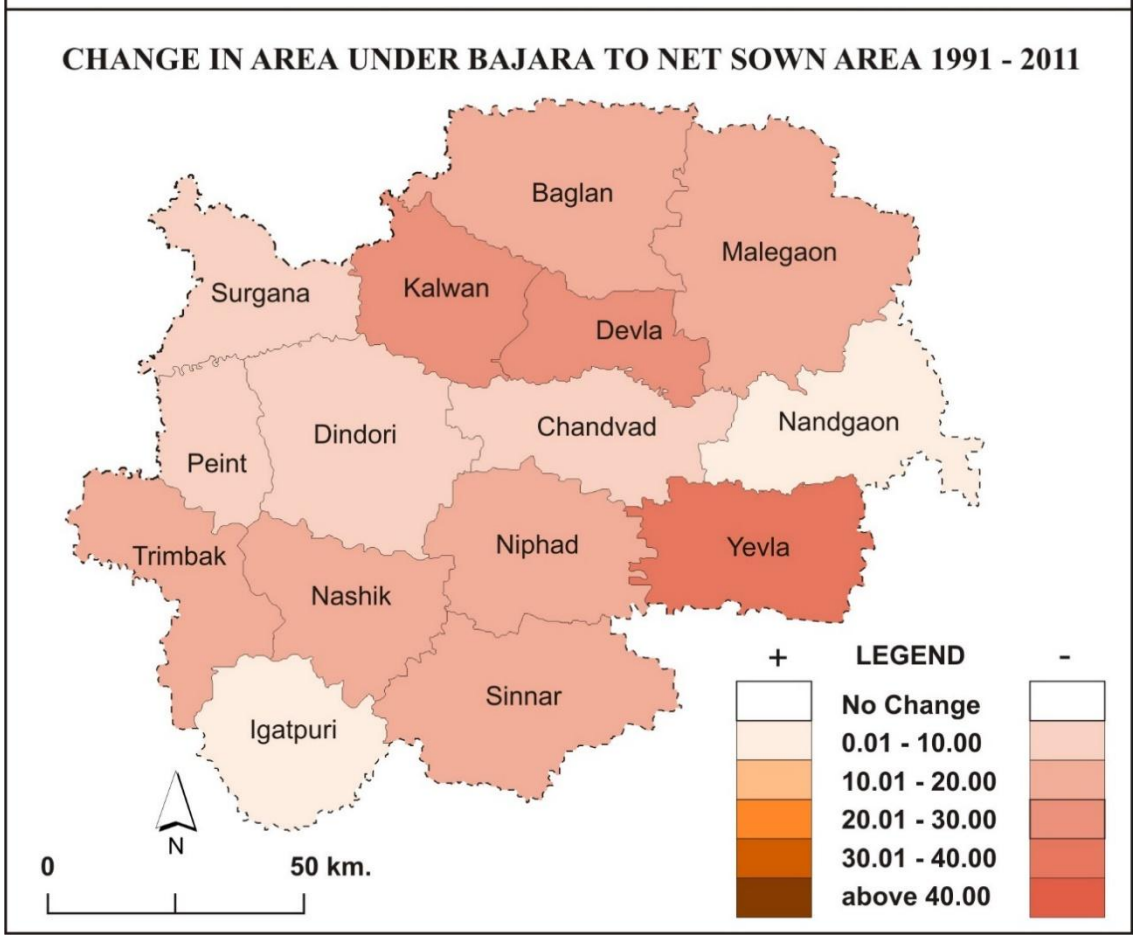


Table No. : 4.2SPATIAL ANALYSISOFTALUKASON THE BASIS OF AREA UNDER**BAJARA**TO**NET SOWN AREA.**(1991 -- 2011)

	Category	**Total No. of Talukas (1991)**	**Total No. of Talukas (2011)**	**Percentage of the total No. of talukas (1991)**	**Percentage of the total No. of talukas (2011)**
Very Low	00.01 to15.00	Dindori, Igatpuri = 2	Nashik, Dindori, Igatpuri = 3	15.40	23.10
Low	15.01 to 30.00	Nashik, Peint, Surgana = 3	Peint, Surgana, Kalvan = 3	23.10	23.10
Medium	30.01 to 45.00	Nil	Yeola, Niphad = 2	00.00	15.40
High	45.01 to 60.00	Kalvan, Niphad = 2	Baglan, Malegaon, Chandwad= 3	15.40	23.10
Very High	Above 60.01	Baglan, Malegaon, Chandwad, Nandgaon, Yeola, Sinnar, = 6	Nandgaon, Sinnar = 2	46.15	15.40

Table No. : 4.3 TENDENCY OF TALUKAS TOWARDS INCREASES AND DECREASES IN AREA UNDER **BAJARA**

	Category	**Total No. of Talukas Increases (+ve)**	**Total No. of Talukas Decreases (-ve)**	**Percentage of the total No. of Increase talukas**	**Percentage of the total No. of Decrease talukas**
Very Low	00.01 to 10.00	Nandgaon, Igatpuri = 2	Peint, Dindori, Surgana, Chandwad =4	15.40	30.80
Low	10.01 to 20.00	Nil	Nashik, Baglan, Malegaon Niphad, Sinnar = 5	00.00	38.46
Medium	20.01 to30.00	Nil	Kalvan =1	00.00	07.70
High	30.01 to 40.00	Nil	Yeola = 1	00.00	07.70
Very High	Above 40.01	Nil	Nil	00.00	00.00

JOWAR: (SORGHUM VULGEARE):-

Jowar is the second in importance as a staple crop in the district. It is one of the important Indian millets. Its botanical name is Sorghum vulgar. Jowar isalso known as great millet. Among all the food grains in the region, it is astaple food crop of the most of the rural population. It isa second ranked crop. Next to Bajara it occupiesthe second largest sown area. It accounted 6.80 percent for in thereference year 1991 and 5.80 percent in the year 2011 of the net sown area in the district. It is a food of poor people. Besides its use as food, it is also used as fodder for livestock. It is commonly known as the great millet due to itslarge size of grain among millets. The height of the plant varies from 70 cm. to 450 cm. A number of improved strains are cultivated in the study region. The hybrid Jowar is becoming increasingly popular and has come to stay, due to high yields.

ECOLOGICAL FACTORS:-

Jowar is a purely tropical crop. The crop thrives well under the conditions of high temperature requiring mean temperature of over 27^0c. It requires temperatures ranging between 26^0c and 32^0c during the growing season. However, many varieties can stand a minimum temperature of 16^0c and a maximum of 40^0c. Generally, the local varieties of Jowar are draught resistant and therefore, it is a very ideal crop in the study region. It is ideally suited to the areas of moderate rainfall i.e. between 350 mm. and 900 mm. Jowar does not tolerate heavy rains as well as very low rains. In the areas where the rainfall is less than 350 mm. the crop requires irrigation.

Jowar is grown on a variety of soils, ranging from heavy and light alluviums to red, medium black to deep back and even sandy soils. The loamy soil is best for this crop. It tolerates saline and alkaline conditions of the soil to some extent. It is mostly cultivated in both seasons, Kharif as well as Rabi. Kharif Jowar is predicted between June and December while Rabi Jowar is produced between September and February. In many talukas Jowar is also taken as an irrigated crop in the summer season for green fodder.

FARM OPERATION:-

The preparation of the land for sowing of Jowar is very important. After the harvesting of theprevious crop, the land is ploughed by aniron plough or bya tractor.

Two or three crosswise harrowing's are given after the commencement of monsoon with a blade harrow. Jowar requires a firm and compact seed-bed for its normal growth.

There are different methods by which Jowar is sown such as broadcasting, drilling, dibbling and transplanting. Of these drilling is a common method. Dibbling is recommended to get higher yields in both Kharif and Rabi. Broadcasting isused only for fodder purpose. Jowar does not require any special care after sowing. The first inter-cultivation is given by hand hoes about a fortnight after sowing and weeds are removed. After 15 days, the subsequent inter-culturings are given with the entire blade hoe. Fertilizers are applied according to the nature of soil. In case of irrigated Jowar, 10-12 tons farmyard manure per hectare may be added to the soil in addition to the fertilizers for getting higher yields. The fully matured plants are either cut close to the ground level or pulled out and allowed to remain in the field for drying. Threshing is an important operation done by cattle, stone roller, tractor or metal disc threshers. After threshing the grain is dried in the sun light and stored or sent to markets.

SPATIAL DISTRIBUTION:-

Jowar is grown as a Kharif crop or Rabi crop in the district. Spatial distribution of Jowar is influenced by rainfall and soil characteristics. Temperature of the district and rainfallare ideal for Jowar cultivation, so they can be considered as influencing factors. In the district it is observed that the proportion of the net sown area under Jowar is insignificant in the western part of the district. Where asina few casesin some parts of some talukas, it is totally absent and in two talukas it occupies only two or three percent of the net sown area.

This proportion generally increases eastwards. In the central and eastern part on an average, the proportion ranges between 02.74 percent to 16.78 percent. Whereasthe area under Jowar was 6.80 percent of the net sown area in thereference year 1990-91, it decreased in thereference year 2011, i.e. 05.80 percent only.

Spatial analysis of thearea of talukas under this crop for thereference year 1991 brings out the following pattern. All talukas of the district possess some area under this crop. The percentage of thearea varies from 02.74 percent to 16.78 percent. Of the total percentage of talukas, nearly 38.50 percent of low category lies in the western and north eastern part of the district i.e. Nashik (Nashik & Trimbak), Peint, Baglan, Malegaon and Igatpuri. It is only because of heavy rainfall, diversified

relief and poor soils. Talukas belonging to medium category 15.40 percent i.e. Kalwan (Kalwan & Deola) and Yeola lie in the western and eastern parts of the district. The highest percentage of Jowar is found in Dindori taluka, (16.78 percent) and Kalwan (Kalwan & Deola 13.25 percent) that lie in the very high category. Not a single taluka lies in very low category.

The spatial analysis of the talukas for thereference year 2011 illustrates the pattern of distribution as follows: All talukas possess some area under this crop. The percentage varies from 0.39 percent to 11.83 percent.

The highest percentage of talukas 69.20 percent (38.50 0f very low and 30.70 0f low category) lie in the very low and low category. Most of the talukas lie in the western, north central and north eastern part of the district, where the rainfall is 500 mm. to 600 mm. except thewestern part. Four talukas of very low category i.e. Surgana, Baglan, Niphad and Igatpuri are located in the western and central part of the district. Peint, Dindori, Malegaon and Chandwad of low category also lie in thewestern and central part of the district. Two talukas i.e. Kalwan and Yeola of medium category occupy 15.40 percent of total talukas. Nashik (Nashik & Trimbak), Nandgaon and Sinnar belong to thevery high category located in the eastern, central and south western part of the district occupying 23.10 percent of total talukas with rainfall zone of 500 mm. and low relief. In some talukas Jowar is grown in both the seasons, Kharif and Rabi.(Table No. 4.5)

TEMPORAL ANALYSIS:-

Temporal analysis of the area under Jowar brings out the following facts. All the talukas of the district are involved in either positive or negative change.

Tendency of talukas towards positive change.

Thearea under Jowar increased in four talukas i.e. 30.80 percent. Of these talukas Malegaon isincluded in very low category, Nandgaon and Sinnar lie in high category, while Nashik taluka lies in very high category. All these talukas lie in the south, eastern and central part of the district. A reason for the increase in the area under Jowar is similar as above.

Tendency of talukas towards negative change

Nearly 69.20 percent of total talukas are involved in negative change. Of these nearly 23.10 percent belong to low category i.e. Baglan, Chandwad and Igatpuri. These talukas lie in thewestern and central part of the district. Two Talukas belong to medium category (04.01 percent to 06.00 percent) i.e. Surgana and Yeola. Dindori and Niphad talukas belong to thehigh category i.e. 07.70 percent. They are mostly located in the North West and central part of the district. Kalwan (Kalwan & Deola) lie inthe high category. The area under Jowar decreases because of irrigation facilities and electrification, farmers replacing the area under Jowar by other crops like sugarcane, fruits, vegetables etc. Generally the distribution of Jowar is closely associated with the relief, rainfall and soil conditions.(Table No. 4.6)

Table No. : 4.4 PERCENTAGE OF AREA UNDER **JOWAR (KHARIF & RABI)**TO**NET SOWN AREA.**FOR YEAR **1991** AND **2011** AND **CHANGE**

(Taluka wise)

Sr. No.	Name of Talukas	Percentage 1991	Percentage 2011	+	-	No Change
1	Nashik	03.54	11.83	08.29		
2	Peint	03.43	03.40		00.03	
3	Dindori	16.78	03.34		13.44	
4	Surgana	06.55	01.69		04.86	
5	Kalvan	13.25	05.87		07.38	
6	Baglan	02.74	00.39		02.35	
7	Malegaon	02.74	03.65	00.91		
8	Chandwad	06.83	03.31		03.52	
9	Nandgaon	04.63	10.85	06.22		
10	Yeola	10.97	05.75		05.22	
11	Niphad	09.18	00.50		08.68	
12	Sinnar	04.17	10.84		02.33	
13	Igatpuri	03.38	00.14		03.24	
14	Trimbak					
15	Devla					
Dist.	**Total**	**06.80**	**05.89**			

FIG. NO 4.3: % OF AREA UNDER JOWAR TO NET SOWN AREA

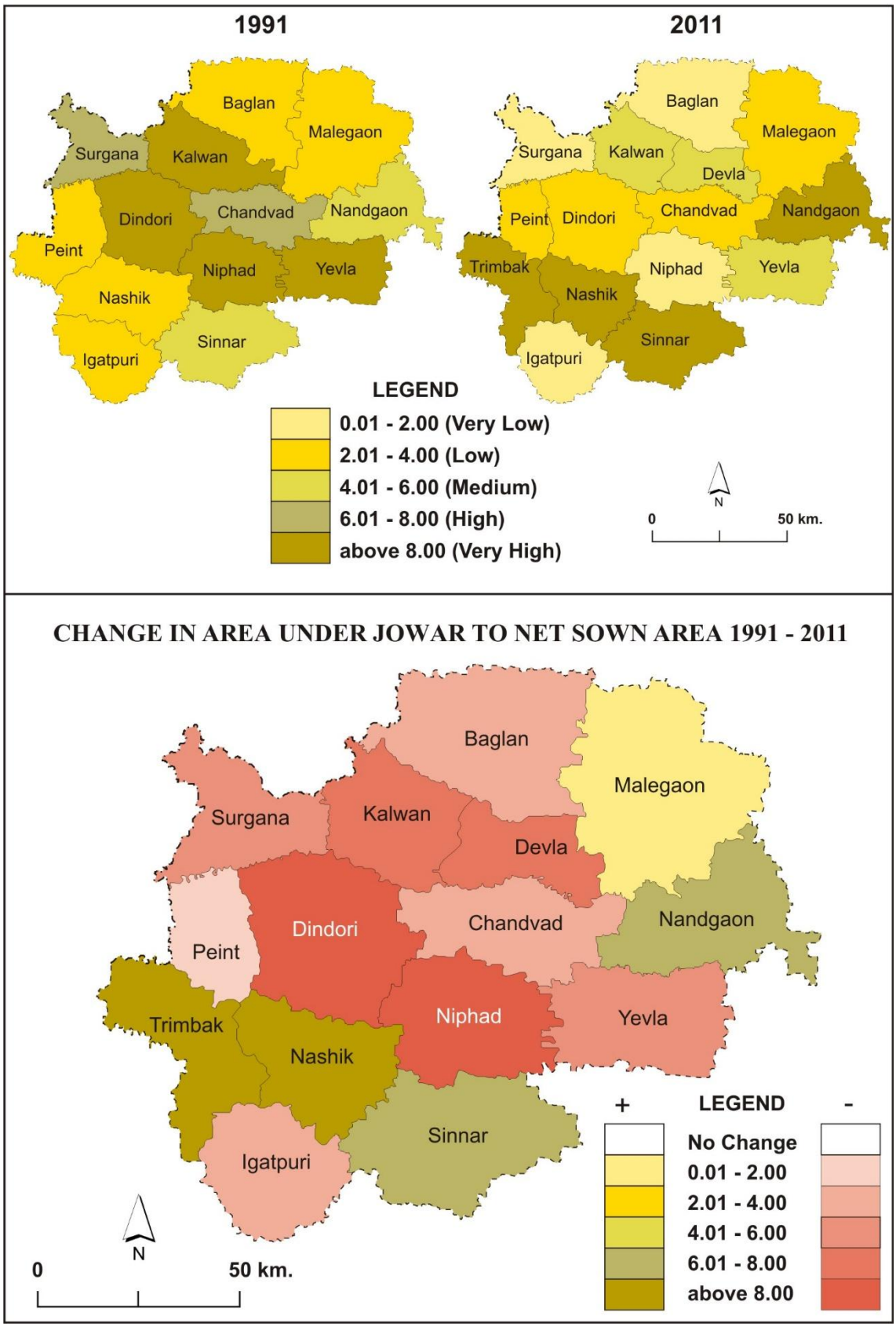


Table No. : 4.5SPATIAL ANALYSIS OF TALUKAS ON THE BASIS OF AREA UNDER **JOWAR (KHARIF & RABI)** TO **NET SOWN AREA.**(1991 -- 2011)

	Category	**Total No. of Talukas (1991)**	**Total No. of Talukas (2011)**	**Percentage of the total No. of talukas (1991)**	**Percentage of the total No. of talukas (2011)**
Very Low	00.01 to 02.00	Nil	Surgana, Baglan, Niphad, Igatpuri = 4	00.00	30.70
Low	02.01 to 04.00	Nashik, Peint, Baglan, Malegaon, Igatpuri = 5	Peint, Dindori, Malegaon, Chandwad 4	38.50	30.70
Medium	04.01 to 06.00	Nandgaon, Sinnar = 2	Kavlan, Yeola, =2	15.40	15.40
High	06.01 to 08.00	Surgana, Chandwad=2	Nil	15.40	00.00
Very High	Above 08.01	Dindori, Kalvan, Yeola, Niphad = 4	Nashik, Nandgaon Sinnar = 03	30.80	23.10

Table No. : 4.6 TENDENCY OF TALUKAS TOWARDS INCREASES AND DECREASES IN AREA UNDER **JOWAR (KHARIF & RABI)**

	Category	**Total No. of Talukas Increases (+ve)**	**Total No. of Talukas Decreases (-ve)**	**Percentage of the total No. of Increase talukas**	**Percentage of the total No. of Decrease talukas**
Very Low	00.01 to 02.00	Malegaon= 1	Peint= 1	07.70	07.70
Low	02.01 to 04.00	Nil	Baglan, Chandwad, Igatpuri = 3	00.00	23.10
Medium	04.01 to 06.00	Nil	Surgana, Yeola = 2	00.00	15.40
High	06.01 to 08.00	Nandgaon, Sinnar = 02	Kavlan = 1	15.40	07.70
Very High	Above 08.01	Nashik= 1	Dindori, Niphad = 2	07.70	15.40

4.4) <u>WHEAT</u>: - (Triticumsatuvum):-

Wheat is the second important food crop in Nashik district. It forms a major part of the staple food in India. The botanical name of wheat is Tricticmsatuvum. Wheat ranks the fourth among the crops grown in the district. It accounted for 4.32 percent in the reference year 1991 and 11.80 percent of the net sown area in the reference year 2011. The area under wheat is decreasing day by day or replaced by other crops like maize.

ECOLOGICAL FACTORS:-

Wheat is mainly a Rabi crop. It is adapted to varying conditions of climate and soil. It grows better in winter temperature between 10^0c and 15 ^{0}c. Rainless days with clear and bright sunshine during the ripening and harvesting period are necessary to have better quality of grains. Areas that are always moist and warm are not suited to this crop. It can be grown in the areas where rain fall is less than 500 mm.with the help of irrigation. As such in the region the monsoon or post monsoon rainfall by itself is not sufficient for optimum production. Ultimately, therefore, it is the extent to which irrigation can be provided to this crop which determines its areal extent and yield capacity. Wheat requires moderate to high rainfall. Frost at flowering time and hail storms when the grain is almost ripe damage the crop. The growth period of the crop is temperature limited. Wheat is produced in the loams and clay soils and also in medium black soil in the district. Generally the period of growth is 12 to 20 weeks.

FARM OPERATIONS:-

A well pulverized but compact seed-bed is required for the wheat crop. This crop depends upon soil and climatic conditions. Preparatory tillage varies with these factors and also whether the crop is to be dry or irrigated, dry crop needs to be taken on heavy clays. For this type of crop the land is kept fallow during monsoon. It is harrowed about 4-5 times with bakhar or vakhar (a blade harrow). The land is ploughed deep with an iron plough once a year. This action is useful for opening the subsurface soil and keeping the annual weeds under partial control. Just before sowing one shallow bakharing is followed by light planking. Sowing is usually started in October and continued till November. Atmospheric temperature is an important

climatic factor for the growth and yield of this crop. Wheat growing in India is a gamble in temperature (Howard). Drilling and broadcasting are the methods of sowing. After the seed has been sown very little is done in the way of hoeing and cultivating. The crop is harvested in February or March. At that time thegrain is dead ripe and the straw is yellow. Plants are usually cut with astickle. The harvested crops are left in the field for one or two days or they are tied in bundles and dried in the field itself for two or three days, and thrashed by thrashing machines or under the feet of bullocks.

SPATIAL ANALYSIS:-

Spatial distribution of wheat is uneven in the region as it is related to the agro-climatic conditions. It means climate plays a dominant role on the cultivation of wheat in the district. Spatial analysis of the area under this crop for the reference year 1991 focuses on the following pattern of distribution. All talukas possess some area under wheat. Of these nearly 30.70 percent talukas lie in the first category i.e. Peint, Malegaon, Chandwad and Nandgaon, 38.50 percent talukas in the second category i.e. Surgana, Kalwan (Kalwan & Deola), Yeola, Sinnar and Igatpuri lie in the western and eastern part of the district. Two talukas i.e. Dindori and Niphad of very high category occupied 15.40 percent of total talukas. Five talukas come under the low category i.e. Surgana, Kalwan (Kalwan & Deola), Yeola, Sinnar and Igatpuri. They lie in the western part of study area except Yeola and Sinnar,where rainfall and soil are as described in the chapter – I. Baglan and Nashik (Nashik & Trimbak) taluka lie in the medium grade and high grade respectively, occurring in the central west part of the district, where rainfall is above 800 mm.Niphad is the only taluka of the highest percentage 09.60 percent of the net sown area under wheat occurring in the form of isolated pocket. This taluka is located in the central part, where irrigation is considerably high and the soil is fertile. During the period under consideration there was a general tendency of decrease in the area under this crop, but total number of talukas increased because of irrigation facilities and electrification.

Total area under this crop increased from 4.32 percent to 11.80 percent during 2011. This is due to the fact that farmers have been encouraged for taking high

production in small areas by using manures, fertilizers, modern seeds and modern farm implements. Because of this, the production of wheat per hectare has increased. On this background spatial analysis of talukas has been attempted for the reference year 2010-11. As compared to the reference year 1990-91, the total percentage of talukas increased in the area under wheat. Reasons are described above. So all the talukas grow wheat. Out of these total talukas nearly 53.90 percent lie in very high grade i.e. Nashik (Nashik & Trimbak), Dindori, Kalwan (Kalwan & Deola), Nandgaon, Yeola, Niphad and Sinnar. These talukas are spread throughout the region. Thesoil type under the crop varies from course shallow to deep black. Peinth and Surgana taluka lie in the very low grade (15.40 percent), while Chandwad, Malegaon, Baglan and Igatpuri lies in the low, medium and high grade respectively. (Table No. 4.8)

TEMPORAL ANALYSIS:-

The temporal analysis for the period under consideration points out the following aspects.

All the talukas of **the**district are involved in the process of change. Of these 92.30 percent are involved in the positive and 7.70 percent in the negative changes.

Tendency of talukas towards positive and negative change.

Peint and Chandwad talukas belong to low grade. Involved in positive change. It is located in the western and central part of the district. Dindori, Baglan and Igatpuri **are**of low category, Malegaon and Niphad of medium category and Nandgaon lies in high category of central and eastern part of **the**district. Nearly 30.80 percent of total talukas increased in very high category i.e. Nashik, Kalwan (Kalwan & Deola), Yeola and Sinnar, where irrigation and electrification are the causes for this positive increase. **Tendency of talukas towards negative change.**

Surgana is the only taluka under negative change. Of the total talukas nearly 7.70 percent talukas are involved in the negative change, they are lie in the very low grade. They lie in the western part of the district.

FIG. NO 4.4: % OF AREA UNDER WHEAT TO NET SOWN AREA

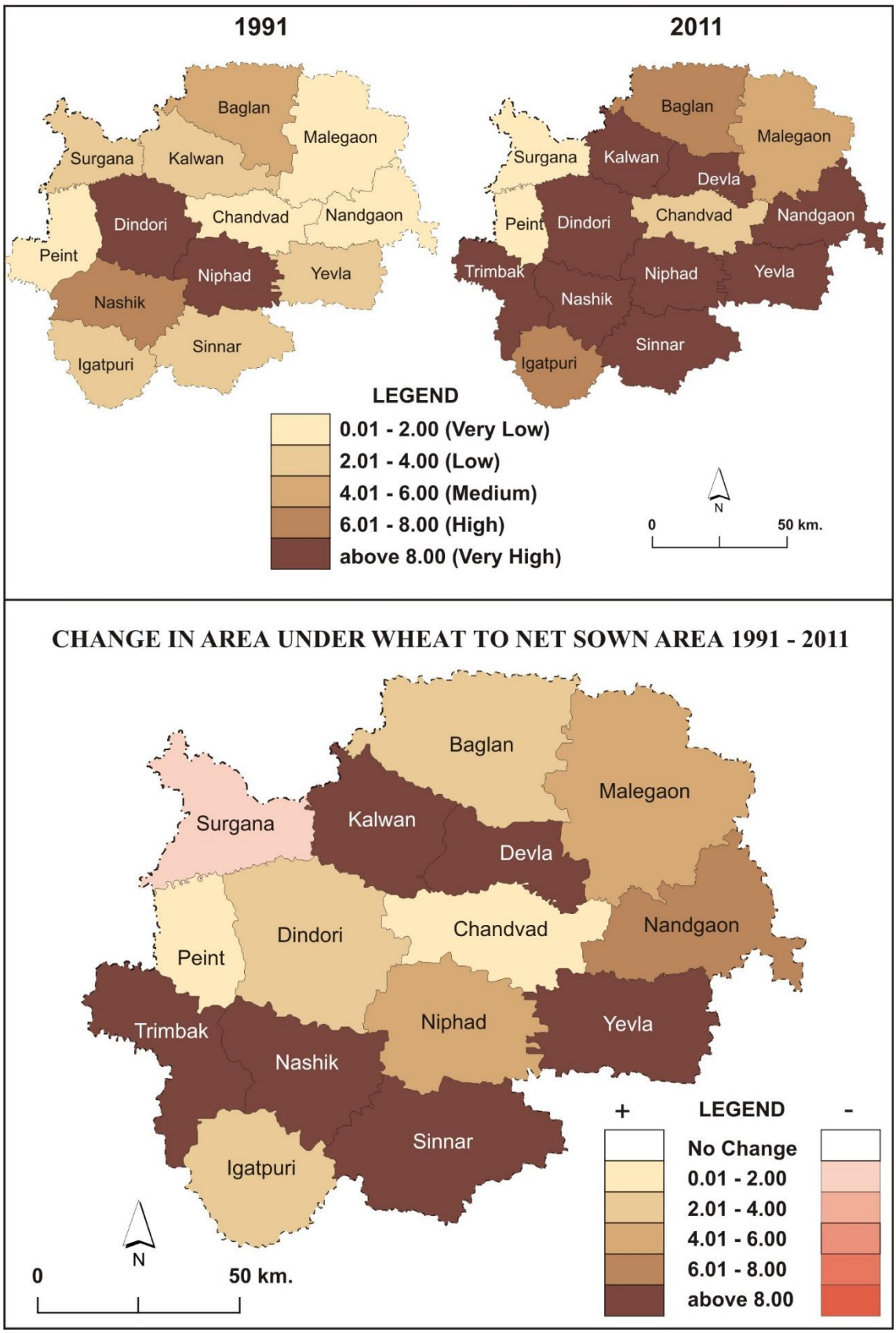


Table No. : 4.7PERCENTAGE OF AREA UNDER **WHEAT**TO**NET SOWN AREA.**

FOR YEAR **1991** AND **2011** AND **CHANGE** (Taluka wise)

Sr. No.	Name of Talukas	Percentage 1991	Percentage 2011	+	_	No Change
1	Nashik	06.47	33.20	26.73		
2	Peint	00.82	01.15	00.33		
3	Dindori	12.34	15.24	02.90		
4	Surgana	02.42	00.74		00.68	
5	Kalvan	03.00	14.59	11.59		
6	Baglan	04.60	07.85	03.25		
7	Malegaon	01.65	05.66	04.01		
8	Chandwad	01.27	02.52	01.25		
9	Nandgaon	01.91	08.92	07.01		
10	Yeola	02.64	13.07	10.43		
11	Niphad	09.60	15.43	05.83		
12	Sinnar	03.52	20.62	17.10		
13	Igatpuri	02.87	06.67	02.80		
14	Trimbak					
15	Devla					
Dist.	**Total**	**09.32**	**11.80**			

Table No. : 4.8 SPATIAL ANALYSIS OF TALUKAS ON THE BASIS OF AREA UNDER **WHEAT** TO **NET SOWN AREA.**(1991 -- 2011)

	Category	Total No. of Talukas (1991)	Total No. of Talukas (2011)	Percentage of the total No. of talukas (1991)	Percentage of the total No. of talukas (2011)
Very Low	00.01 to 02.00	Peint, Malegaon, Chandwad, Nandgaon =4	Peint, Surgana = 2	30.70	15.40
Low	02.01 to 04.00	Surgana, Kavlan, Yeola, Sinnar, Igatpuri = 5	Chandwad 1	38.50	07.10
Mediu m	04.01 to 06.00	Baglan = 1	Malegaon=1	07.70	07.10
High	06.01 to 08.00	Nashik = 1	Baglan, Igatpuri = 2	07.70	15.40
Very High	Above 08.01	Dindori, Niphad = 2	Nashik, Dindori, Kavlan, , Nandgaon, Yeola, Niphad, Sinnar, = 7	15.38	53.90

Table No. : 4.9 TENDENCY OF TALUKAS TOWARDS INCREASES AND DECREASES IN AREA UNDER **WHEAT**

	Category	**Total No. of Talukas Increases (+ve)**	**Total No. of Talukas Decreases (-ve)**	**Percentage of the total No. of Increase talukas**	**Percentage of the total No. of Decrease talukas**
Very Low	00.01 to 02.00	Peint, Chandwad=2	Surgana = 1	15.40	07.70
Low	02.01 to 04.00	Dindori, Baglan, Igatpuri = 3	Nil	23.10	00.00
Medium	04.01 to 06.00	Malegaon, Niphad = 2	Nil	15.40	00.00
High	06.01 to 08.00	Nandgaon =1	--	07.70	00.00
Very High	Above 08.01	Nashik, Kalvan, Yeola, Sinnar= 4	--	30.80	00.00

4.5)<u>RICE</u> (Oriza Sativa):-

Rice is most commonly known as paddy Bhat. It is the most important crop in the tropics. The botanical name of rice is Oriza sativa. Rice is predominantly a rain-fed crop. Now a days to certain extent it is also taken under irrigation. Rice ranks the 7^{th} among the crops grown in the district and accounts for a relatively smaller area coverage. Rice covered an area of 45968 hectares (5.26 percent) in the reference year 1990-91. It slightly increased in 2011and has covered an area of 74652 hectares (9.61 percent) of the net sown area in the district.

ECOLOGICAL FACTORS:-

Rice is a tropical monsoon crop requiring high temperature and high and high rainfall. The distribution and cultivation of rice depend on agro-climatic conditions. The climate of the area plays a more important role in the rice distribution than the soils. The temperature range for rice cultivation is between 20^0c and 35^0c. Beyond these limits it is dangerous to crop. It can be grown in all types of soil. The production of rice increases in the lateritic soils, loamy soils and alluvial soils. Rice requires heavy rainfall through the growing period and hence in the study region it is grown during the southwest monsoon period. The crop matures in 14 to 16 weeks. It is sown

in the month of June or July and is harvested in September or October. There are three cropping seasons observed in India i.e. Early (aus), rainy season (amman) and spring or summer (Dulua or Boro). Rainy season (Kharif) variety is most important in the study region.

FARM OPERATIONS:-

In the study region, rice entirely depends upon rain. In some parts it is grown under irrigation. In the rain fed and irrigated systems the basic cultivation consists of summer ploughing with light ploughs.When rains are received and repeated harrowing's for obtaining good tilth. Compost is added at one of the pre-sowing cultivation operations well in advance of sowing. For transplant crops seedlings are grown either in the dry or wet nurseries. The nursery is kept free of weeds. In the western part the 'rab' system of preparing seed for nursery still prevails. This practice consists of spreading cow dung and available organic refuse or brush wood in a suitable patch in the paddy field itself and allowing it to burn slowly. This helps in destroying harmful organisms and the seeds of grass that may be present in the nursery area and results in better growth of seeding.

The seeding is transplanted after a growth up to 3 to 4 weeks. The total growth period determines approximate number of days after which seeding should be transplanted. Three weeks after transplanting, the crop is inter-cultured and weeded. This operation also helps in stirring the soil and aeration of roots. Inter-culturing is repeated two or four times. It is stopped about one month before harvesting. Rice crop responds well to manuring and there is almost a linear response up to very high dose of nitrogen. (Vaidya, Sahasrabuddhe and Khupse, 1972.). Soils of the study region are generally deficient in nitrogen. It is necessary to add all the three major nutrients N.P.K. to the soil in order to ensure balanced utilization.

The crop is ready for harvest when nearly ripe and the straws are still slightly green. If the harvesting is delayed till the crop is dead ripe, there is a danger in production, grain shedding and affecting the milling quality. The crop is generally cut with a stickle by manual labour and harvested stalks are left in the field for one or two days and tied in bundles and dried in the field itself. They are then brought to the threshing floor and threshed by sticks.

SPATIAL ANALYSIS:-

Among the ecological factors influencing the distribution of rice, temperature and rainfall are very important. In the district the temperature conditions are suitable for the growth of rice. So there is large extent of rice distribution. It is controlled by

the availability of water. The western part, most heavy rainfall areas of the district,are most favourable for the rice cultivation and occupy large areas than the eastern part. The area under rice is decreasing in the eastern part of the district because ofdecreasing precipitation amount. In dry regions rice is grown only with irrigation. Maximum concentration of rice is observed in the western part receiving the rainfall above 1500 mm.

Spatial analysis of the area of talukas for rice in the reference year 1991.

Rice is grown in more or less amount in all talukas of the district. Of these the highest percentage of talukas belong to a very low grade i.e. 00.01 percent to 05.00 percent. By and large these talukas occur in the central and eastern parts of the district such as Kalwan (Kalwan & Deola), Baglan, Malegaon, Chandwad, Nandgaon, Yeola, Niphad and Sinnar, which lie in the rainfall zone of about 500 mm. to 900 mm. The area under rice out of the net sown area in Dindori (6.16 percent), Nashik [(Nashik & Trimbak)10.08percent]and Surgana taluka (18.18 percent) lie in low to high category. Peint and Igatpuri lie in very high category of above 20.01 percent (Table no. 4.11). All these talukas lie in the western part. The reasons are stated above.

S**patial analysis of the area of talukas for rice in the reference year 2011.**

During the period under consideration a very little change has taken place so far as rice is concerned, due to the expansion of irrigation facilities and availability of electricity. In general the area under rice is increased in all talukas except Peint, Malegaon and Niphad. On this background spatial analysis of the area of talukas for rice has been attempted for the reference year 2011. Highest percentage of talukas 46.10 percent belong to very low grade i.e. Baglan, Malegaon, Chandwad, Nandgaon, Yeola and Niphad lie in semi western zone, central and eastern part of study area. The well irrigation is important factor for increasing rice production. Dindori, Kalwan (Kalwan & Deola) and Sinnar come under medium category. Nashik, Peint, Surgana and Igatpuri are talukas which belongs to very high grade (Above 20.00 percent) lies in western high rainfall zone (above 1500 mm.). Surgan and Igatpuri talukas of western high rainfall zone have a maximum percentage of area under rice. Reasons are described as above.

TEMPORAL ANALYSIS:-

Temporal analysis for the period under consideration focuses light on the following aspects. All talukas of the district are involved in the process of change either positive or negative.

Tendency of talukas to Positive and negative change.

Total 10 talukas are involved inapositive change. Nearly 23.10 percent belong to very low grade (00.01 percent to 02.00 percent). Fifteen percent talukas belong to low grade and 7.07 percent come under medium category. Nashik (Nashik & Trimbak), Surgana, Sinnar and Igatpuri belong to very high grade above 8.01 percent. These talukas lie in the western and central part. Peint, Malegaon and Niphad are the talukas of negative change which lie in very low category. (Table No. 4.12)

FIG. NO 4.5: % OF AREA UNDER RICE TO NET SOWN AREA

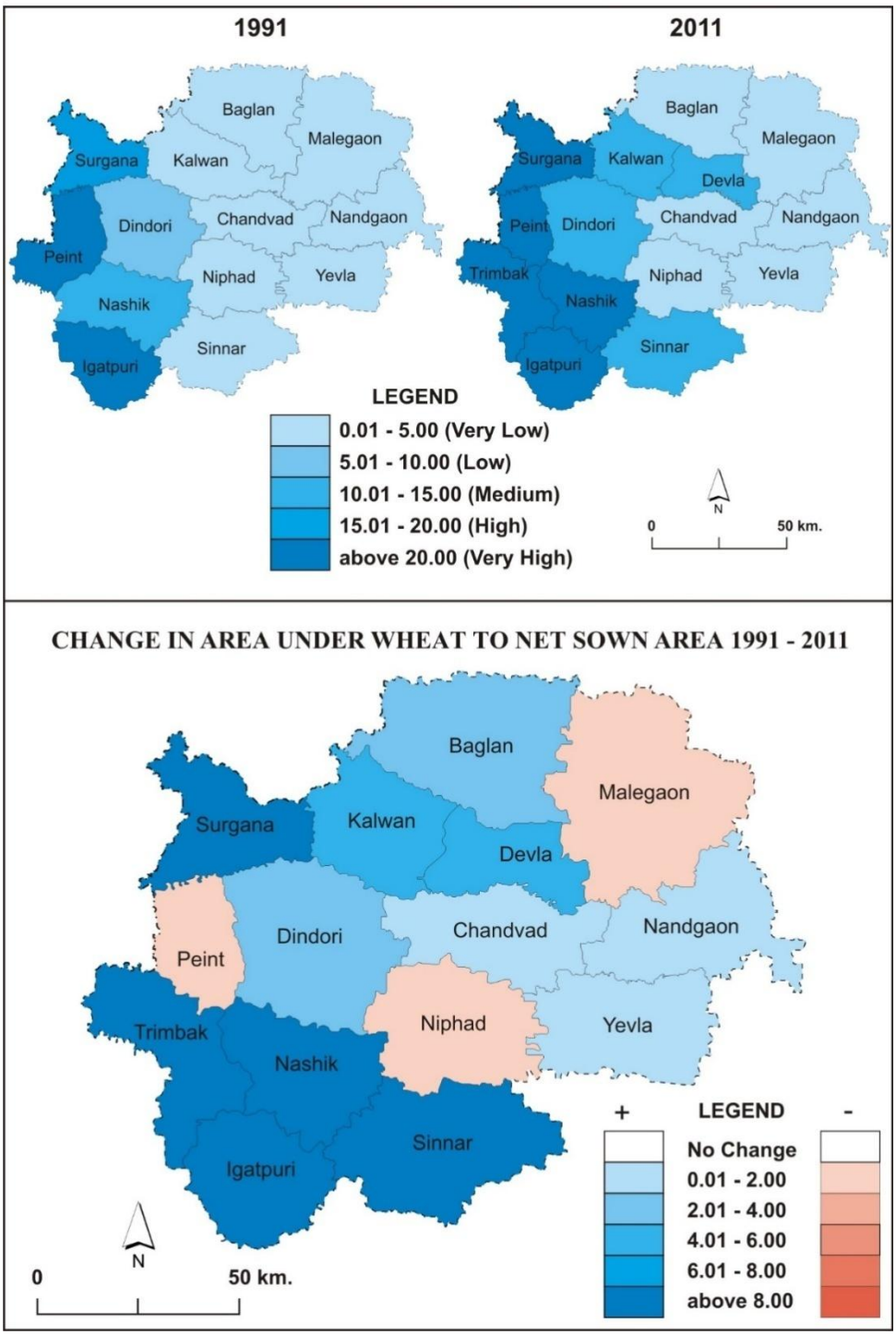


Table No. : 4.10 PERCENTAGE OF AREA UNDER **RICE**TO**NET SOWN AREA.**

FOR YEAR **1991** AND **2011** AND **CHANGE** (Taluka wise)

Sr. No.	Name of Talukas	Percentage 1991	Percentage 2011	+	_	No Change
1	Nashik	10.08	30.47	20.39		
2	Peint	20.51	20.16		00.35	
3	Dindori	06.16	10.08	03.92		
4	Surgana	18.18	32.25	14.07		
5	Kalvan	04.81	10.04	05.23		
6	Baglan	01.40	04.81	03.41		
7	Malegaon	00.18	00.05		00.13	
8	Chandwad	00.33	00.78	00.45		
9	Nandgaon	00.19	00.02	00.01		
10	Yeola	00.02	00.10	00.08		
11	Niphad	01.59	00.29		01.20	
12	Sinnar	01.14	11.75	10.61		
13	Igatpuri	30.82	52.19	21.37		
14	Trimbak					
15	Devla					
Dist.	Total	05.26	09.61			

Table No. : 4.11 SPATIAL ANALYSIS OF TALUKAS ON THE BASIS OF AREA UNDER **RICE** TO **NET SOWN AREA.**(1991 -- 2011)

	Category	Total No. of Talukas (1991)	Total No. of Talukas (2011)	Percentage of the total No. of talukas (1991)	Percentage of the total No. of talukas (2011)
Very Low	00.01 to 05.00	Kavlan, Baglan, Malegaon, Chandwad, Nandgaon, Yeola, Niphad, Sinnar = 8	Baglan, Malegaon, Chandwad, Nandgaon, Yeola, Niphad = 6	64.50	46.10
Low	05.01 to 10.00	Dindori = 1	Nil	07.70	00.00
Medium	10.01 to 15.00	Nashik = 1	Dindori, Kalvan, Sinnar = 3	07.70	23.10
High	15.01 to 20.00	Surgana = 1	Nil	07.70	00.00
Very High	Above 20.01	Peint, Igatpuri = 2	Nashik, Peint, Surgana, Igatpuri = 4	15.38	30.76

Table No. : 4.12

TENDENCY OF TALUKAS TOWARDS INCREASES AND DECREASES IN AREA UNDER **RICE**

	Category	**Total No. of Talukas Increases (+ve)**	**Total No. of Talukas Decreases (-ve)**	**Percentage of the total No. of Increase talukas**	**Percentage of the total No. of Decrease talukas**
Very Low	00.01 to 02.00	Chandwad, Nandgaon, Yeola = 3	Peint, Malegaon, Niphad = 3	23.10	23.10
Low	02.01 to 04.00	Dindori, Baglan = 2	Nil	15.40	00.00
Medium	04.01 to 06.00	Kalvan = 1	Nil	07.70	00.00
High	06.01 to 08.00	Nil	Nil	15.38	00.00
Very High	Above 08.01	Nashik, Surgana, Sinnar, Igatpuri= 4	Nil	30.80	00.00

4.6) <u>SUGARCANE</u> (SaccharumOfficinarum Linn.):-

The sugarcane plant is classified under the genus “Saccharum” (Parthasarthy, 1972). Sugarcane has been known in India from the earliest times and its references are found in Atharva Veda, sometimesabout 3000 to 7000 years ago. According to Barber (1919) the earliest reference to sugarcane is to be found in the ancient Indian literature during the period 1400 to 1000 B.C. The recent botanical and geographical evidences unfold the fact that New Guinea is the early home of Sugarcane. Sugarcane is the main source of sugar in India and it is a premier cash crop. Sugarcane is grown mainly in the irrigated area in the study region. It holds the topmost position in the economy of the district.

ECOLOGICAL FACTORS:-

Sugarcane is supposed to have originated due to complex hybridization with varieties of grasses. Generally sugarcane comprises three main species from which various strains have been developed. Sugarcane grows most successfully in the tropical climate. It means it is cultivated in the regions where there are no temperature extremes. The temperatures ranging between 20^0c to 32^0c are favourable for sugarcane cultivation, but frost often proves fatal. Sugarcane requires a rainfall 0f 700 mm. to 1000 mm. It can also be successfully grown under irrigation. In the relatively high rainfall zone (1200 to 1800 mm. per annum) the crop is grown unirrigated. Hot dry weather affects the crop adversely.

The optimum growth of the crop depends on the soil conditions. It can be grown in a course shallow soils, but it grows best on medium to deep black soils. The alluvial soil and the black cotton or regur soils are most suitable for sugarcane. Water logging or alkalinity make soils unfit for this crop. The period of maturity of the crop varies according to the varieties that are grown. In most places its growing period is from ten to twelve months. But the planning is so adjusted that the sugarcane is ready for harvest in October – November. In general it requires a long growing season.

FARM OPERATION:-

In view of the agro climatic conditions in the study area, the plantation of sugarcane differs. There are three types of planting, in addition to the ratoon crop such as Adsali, pre-seasonal. Before the plantation of Sugarcane, the preparation of land is essential, which includes the operations carried by the cultivators to make land suitable for cane cultivation. Land preparation facilities aeration of soil through ploughing,improves soil structure, removes weeds, drains excess water and prevents pests and diseases. The application of fertilizers and manures along with ploughing or furrowing is also included in land preparation. Since sugarcane is an irrigated crop, land with assured water supply is selected for sugarcane cultivation. The preparatory season starts from November to March. However, for Adsali the work starts from September.

The first ploughing is done in mid-November and land is kept at rest for two or three months, during which it within out and becomes dry. Soils with excess of moisture are not suitable for preparatory work. The second ploughing is done for breaking soil clods and increasing the depth of top soil. Depth of ploughing depends upon the type of plough used and the structure of soils. Depth attained by iron plough,

for instance, with draught power is about 25 cms., whereas it is more than 40 cm. with a tractor. The harrowing is done to crush the clods. In the black soils, the clods are big in size and are usually broken by wooden beam drawn by a tractor or a bullock pair. The harrowing is also done again to crush the remaining clods. The manure of about 40 to 50 carts load per hectares, is spread before the second ploughing by many sugarcane cultivators. After harrowing, residues of previous crops and weeds are collected manually and deposited in the compost bins. Ridges and furrows are simultaneously prepared with the help of a bullock pair. Tractors are also used for this operation wherever they are available.

Inter-culture refers to the operations carried out in the soil from planting right up to harvesting. The region under study has wide variations in the use of implements and source of power used for inter-cultural methods. Wide spacing of furrows is useful for such operations with the help of animal or mechanical power. A week or two weeks after plantation, the loosening of surface soil, locally known as "Nindani" is done by employing hand labour by a small farm implement known as "Khurpe". After 3- 4 months of planting, the replacement of ridges and furrows is made with bullock's power or manually. Tractors are also used provided sufficient spacing is available. A specially designed "Kulav" is used for this purpose.

Harvesting is usually done by cutting with stickles (locally known as Koyata) as close to the ground as possible. The sugarcane, after harvesting, should not be allowed to remain for a long time as there will be reversion of sucrose in juice. The sugarcane should therefore, be crushed within a day of harvesting. When the root – stocks from which the canes have been removed are left in the soil, a new growth of cane, is takes place. This is known as "retoons" (locally known as Khodava) system.

SPATIAL ANALYSIS:-

In Nashik district sugarcane accounts for 25.22 percent of the net sown area as per the reference year 1991. It increased by 82.03 percent during 2011, which is the period under consideration. Spatial analysis of talukas under this crop for the reference year 1991 focuses light on the following facts. More or less all talukas had some area under sugarcane in the reference year 1991.

The percentage varies from 00.05 percent to 11.51 percent. Of these nearly 38.50 percent belong to low grade i.e.00.01 percent to 00.75 percent. These talukas lie in the western and central part of the study region except Nandgaon taluka from the eastern part of the district. Four talukas belong to the low category i.e., Nashik

(Nashik & Trimbak), Dindori, Yeola and Sinnar. Malegaon is the only taluka of medium category, which is in the north eastern part of the study region. Kalwan (Kalwan & Deola), Baglan and Niphad from the North eastern and central part respectively have the highest percentage of area under sugarcane and belong to very high category i.e. above 03.01 percent. Niphad has the highest percentage i.e. 11.51 percent of area under sugarcane.

In the reference year 2011 in most of the talukas sugarcane was cultivated through well irrigation as well as canal irrigation. During the period under consideration drastic changes have taken place so far as sugarcane is concerned. The area under sugarcane increased in the reference year 2011 because of the development of sugar industry in many talukas. Due to electrification in the district the process of well irrigation has accelerated as previously noted. Truck services and labours are supplied to the cultivators. Further sugar factories provide loan, fertilizers and bullock carts to the members and to the cultivators. Uses of Sufala, Urea, Sulphate and Phosphate, and such fertilizers resulted in increase in the production. The tendency of farmers has changed to cash crops, so they have replaced traditional crops (Jowar and Bajara) by sugarcane. All these factors have been responsible for expansion of the area under sugarcane.

On the above background the spatial analysis of talukas has been attempted for the reference year 2011. All talukas have some area under sugarcane Peint, Surgana, Chandwad, Nandgaon and Yeola are talukas which were producing sugarcane in very low category area under sugarcane in the reference year 2011.Reasons are given as above. Of these total talukas nearly 38.50percent lie in very low grade (0.01 percent to 0.75 percent). They are located in the western, central and eastern parts of the district. Not a single taluka lies in the medium and high category. Eight talukas (61.50 percent) of total number of talukas lie in the very high category i.e. above 3.01 percent. All talukas lie all over the study region i.e. central, eastern and western part of the study region. Dindori has the highest percentage under sugarcane (22.06 percent). (Table no. 4.14).

TEMPORAL ANALYSIS:-

Temporal analysis for the period under consideration brings out the following points. All talukas are involved in the process of change either positive or negative. The patterns of distribution of these talukas are the same as described in the reference year 1991 and 2011. Only two talukas Chandwad and Yeola, have undergone negative

change, because the rainfall decreased and water provided from well irrigation was not sufficient to sugarcane. Sugarcane production is profitable. The tendency of the farmers has changed and turned them to other crops i.e. vegetables, fruits and others, which require less water supply. Four taukas belong to the very low grade, of positive change occupying 30.18 percent. Sinnar is the only taluka of low category of positive change. Baglan and Niphad of medium category and Nashik (Nashik & Trimbak), Kalwan (Kalwan & Deola) and Igatpuri come under high category. Dindori is only one taluka coming under very high category (above 8.01 percent). The distribution and reasons of positive talukas are the same as described in the year 2011. In Ravalgaon, Dabhadi, Niphad, Kadava, Vithewadi, Ranwad and Nashik sugar factories play a vital rolein increasing the area under sugarcane. But the position has slightly changed after year the 2011. The farmers replaced sugarcane by fruits and vegetables, so the area under sugarcane has decreased in some talukas.

Fiber crops include cotton (Grossypium species), Jute (Corchorus species), sun hemp (crotalaria) and mesta(Hibiscus sabdriffa). Among all these crops cotton is the only important crop grown in the study region.

Table No. : 4.13 PERCENTAGE OF AREA UNDER **SUGARCANE** TO **NET SOWN AREA.**FOR YEAR **1991** AND **2011** AND **CHANGE** (Taluka wise)

Sr. No.	**Name of Talukas**	**Percentage 1991**	**Percentage 2011**	**+**	**_**	**No Change**
1	Nashik	01.11	08.56	07.45		
2	Peint	00.04	00.51	00.47		
3	Dindori	01.00	22.06	21.06		
4	Surgana	00.05	00.11	00.06		
5	Kalvan	03.36	10.09	06.73		
6	Baglan	03.74	08.76	05.02		
7	Malegaon	01.56	03.04	01.48		
8	Chandwad	00.24	00.07		00.17	
9	Nandgaon	00.57	00.68	00.11		
10	Yeola	00.99	00.10		00.89	
11	Niphad	11.51	16.99	05.48		
12	Sinnar	00.95	03.90	02.94		
13	Igatpuri	00.10	07.16	07.06		
14	Trimbak					
15	Devla					
Dist.	**Total**	**25.22**	**82.03**			

FIG. NO 4.6: % OF AREA UNDER SUGARCANE TO NET SOWN AREA

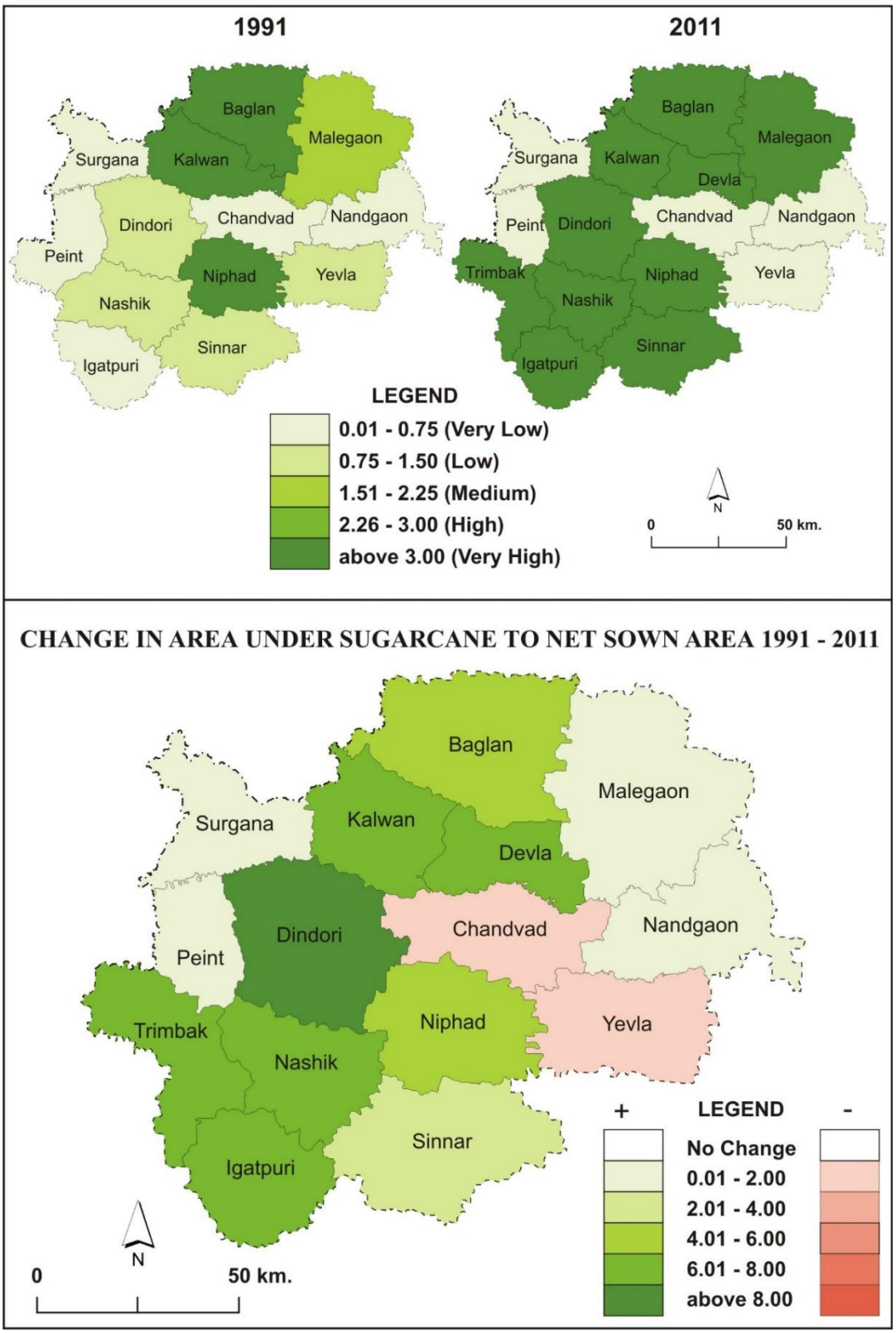


Table No. : 4.14

SPATIAL ANALYSIS OF TALUKAS ON THE BASIS OF AREA UNDER **SUGARCANE** TO **NET SOWN AREA.**(1991 -- 2011)

	Category	**Total No. of Talukas (1991)**	**Total No. of Talukas (2011)**	**Percentage of the total No. of talukas (1991)**	**Percentage of the total No. of talukas (2011)**
Very Low	00.01 to 00.75	Peint, Surgana, Chandwad, Nandgaon, Igatpuri = 5	Peint, Surgana, Chandwad, Nandgaon, Yeola = 5	38.50	38.50
Low	00.76 to 01.50	Nashik, Dindori, Yeola, Sinnar = 4	Nil	30.70	00.00
Medium	01.51 to 02.25	Malegaon = 1	Nil	07.70	00.00
High	02.26 to 03.00	Nil	Nil	00.00	00.00
Very High	Above 03.01	Kalvan; Baglan, Niphad = 3	Nashik, Dindori, Kavlan, Baglan, Malegaon, Niphad, Sinnar, Igatpuri= 8	23.10	61.50

Table No. : 4.15

TENDENCY OF TALUKAS TOWARDS INCREASES AND DECREASES IN AREA UNDER **SUGARCANE**

	Category	**Total No. of Talukas Increases (+ve)**	**Total No. of Talukas Decreases (-ve)**	**Percentage of the total No. of Increase talukas**	**Percentage of the total No. of Decrease talukas**
Very Low	00.01 to 02.00	Peint, Surgana, Malegaon, Nandgaon= 4	Chandwad, Yeola = 2	30.80	15.40
Low	02.01 to 04.00	Sinnar = 1	Nil	07.70	00.00
Medium	04.01 to 06.00	Baglan, Niphad = 2	Nil	15.40	00.00
High	06.01 to 08.00	Nashik, Kalvan, Igatpuri = 3	Nil	23.10	00.00
Very High	Above 08.01	Dindori = 1	Nil	07.70	00.00

4.7) <u>COTTON</u> (Gossypium spp.):-

Cotton is the most important fibre crop and it is grown mainly as a commercial crop in the district. Irrigated cotton is more prominent than the rain fed crop in the study region. Cotton is grown mainly in the central and eastern parts.

ECONOLOGICAL FACTORS:-

Cotton is a sub-tropical crop. It is a very sensitive plant to environmental stimuli, which fact accounts in part for the various types of cotton under cultivation. It requires a rather high and uniform temperature during the early stages of its growth, as this encourages vegetative growth. In the latter stages of its growth the temperature

should be lowered preferably with cool nights. These conditions are useful and encourage fruiting. Heavy irrigation or heavy showers of rain occur, during the fruiting period, the shedding of the flowers and young bolls may result. Weather should be clear at the time of harvesting. It requires temperature between 20^0c to 25^0c and at the time of fruiting and boll development it requires temperature between 25^0c to 30^0c. Forest affects the crop adversely. It can be grown in the area where rainfall is less than 700 mm. It grows in the black cotton soil, red, alluvial and medium black soil. It requires free- draining soil.

FARM OPERATIONS:-

Fine and firm seedbed is useful for cotton. Deep ploughing is not necessary for rain-fed crop every year, but the land is harrowed three or four times. The land for irrigated cotton is turned into ridges and furrows after the initial ploughing and a few cross harrowing's. The longer the growing season of a variety, it is sown earlier. Cotton varieties grown under irrigation are usually sown earlier. The rain-fed crop sowing is usually done with the commencement of monsoon (15^{th} June to 15^{th} July). Longer growing season of a variety are usually sown early. In the Nashik district, two methods of sowing are used.

i) Hand dibbling or broad casting. ii) Drilling Method.

Weeding is an important operation for cotton. One hand weeding is done within three or four weeks after sowing and is followed by two to three inter-culturing operations with bladed hoe at an interval of 15 to 20 days with one hand hoeing. Cotton is harvested in three or four pickings as the bills mature. Cotton is removed from the bolls in the field itself. In the case of closed bolls cotton, partially open bolls are collected from the plant in the field and seed – cotton is separated from the bolls later. The harvesting period is not uniform. It varies with the variety. It usually starts in October. Harvesting goes on from October to December.

SPATIAL ANALYSIS:-

Spatial analysis of the talukas under this crop for the reference year 1991indicates the following aspects. Cotton is grown more or less in ten talukas. Three talukas have no production of cotton i.e. Peint, Surgana and Igatpuri which lie in heavy rainfall zone. Percentage of area varies from 0.1 percent to 0.60 percent. The highest percentage is found in Nandgaon taluka and the lowest percentage is in

Nashik taluka(Nashik & Trimbak). Nearly in 23.10 percent talukas of the western part, cotton is totally absent or negligible in production i.e. Peint, Surgana and Igatpuri.During the period under consideration very few changes have taken place so far as cotton is concerned. Due to a variety of cotton, irrigation facilities, electrification and availability of marketthe area under cotton has also increased in some talukas. Malegaon, Satana, Lasalgaon and Nashik are the local markets for agricultural production.

On this background a spatial analysis of the area of the talukas for cotton has been attempted for the reference year 1991.The total production of the district is only 0.5 percent. Nearly 69.23 percent of the total talukas possess some area under cotton. The highest percentage of talukas (53.80 percent) belongs to low grade and 0.11 percent to 0.20 percent occur in the central and eastern parts of the district. Nandgaon is the only taluka which belongs to the very high grade i.e. above 0.41 percent, and occurs in the east part of the study region.

Spatial analysis of the talukas under cotton for the reference year 2011 indicates that similar to the reference year 1991 cotton is absent in three talukas because of very high rainfall. More or less production is taken in ten talukas. Percentage of area varies from 0.05 percent to 0.50 percent. Total percentage of the district is 1.10 percent in the reference year 2011.

TEMPORAL ANALYSIS:-

Temporal analysis for the period under consideration focuses light on the following aspects. All talukas of the district are involved in the process of change except Peint, Surgana and Igatpuri because of no production. Total seven talukas (53.84 percent) are involved in positive change. All the talukas belong to low grade except Nandgaon which belongs to very high grade.

Tendency of talukas to the negative change:-

Three talukas are involved in the negative change. These talukas lie in the eastern part and belong to the very low grade. Mostly the western part of the study region does not grow cotton because of high rainfall (above 1000 mm.) and poor soils. Nowadays the tendency of farmers has changed and they have replaced cotton by other remunerative crops such as grapes, pomegranates and others fruits, vegetables, sugarcane and maize.

FIG. NO 4.7: % OF AREA UNDER COTTON TO NET SOWN AREA

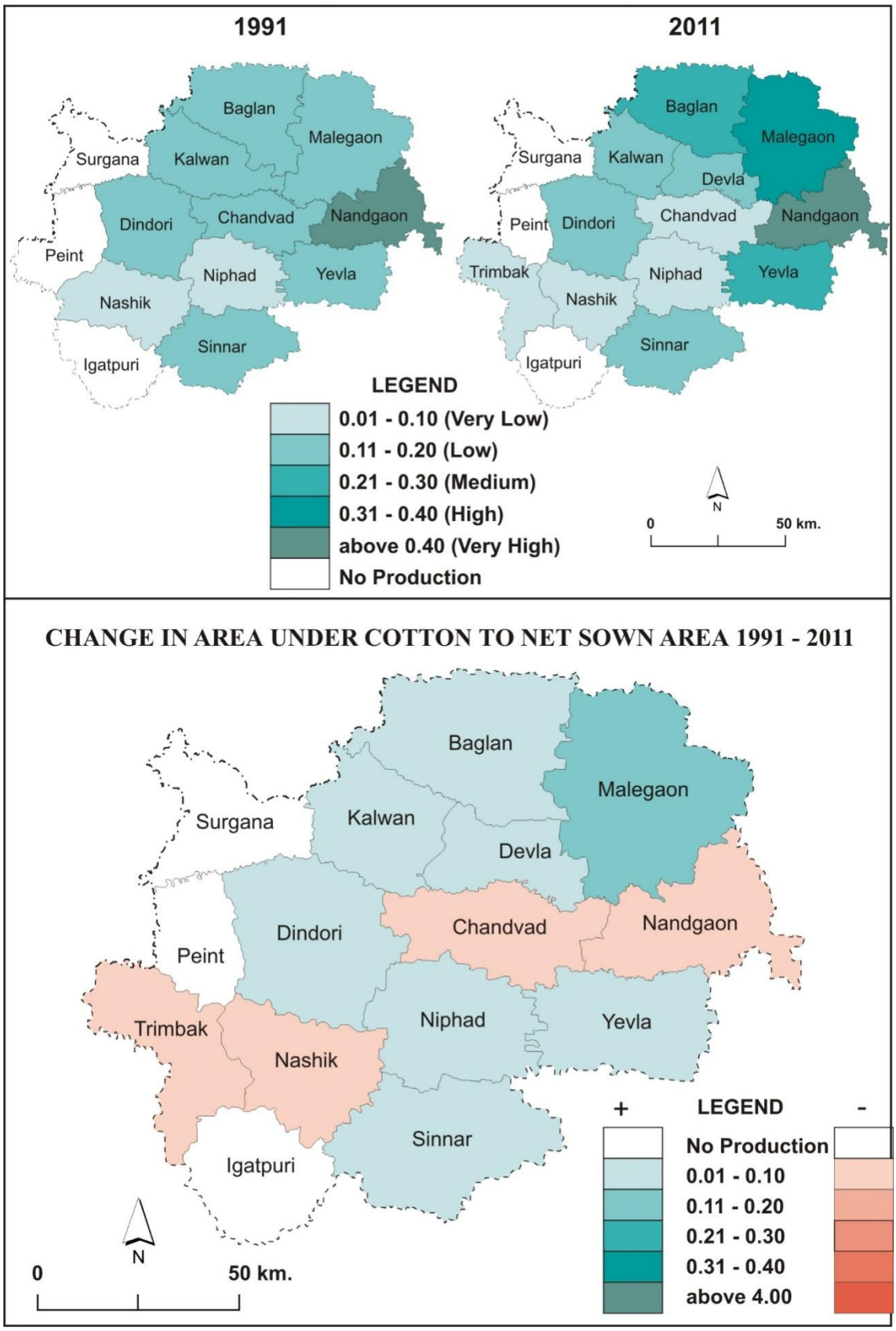


Table No. : 4.16PERCENTAGE OF AREA UNDER **COTTON** to **NET SOWN AREA.**

FOR YEAR **1991** AND **2011** AND **CHANGE** (Taluka wise)

Sr. No.	Name of Talukas	Percentage 1991	Percentage 2011	+	-	No Change
1	Nashik	0.10	0.05		0.05	
2	Peint	N.P.	N.P.	N.P.	N.P.	
3	Dindori	0.11	0.15	0.04		
4	Surgana	N.P.	N.P.	N.P.	N.P.	
5	Kalvan	0.15	0.20	0.05		
6	Baglan	0.17	0.25	0.08		
7	Malegaon	0.20	0.40	0.20		
8	Chandwad	0.11	0.05		0.06	
9	Nandgaon	0.60	0.50		0.10	
10	Yeola	0.20	0.30	0.10		
11	Niphad	0.05	0.10	0.05		
12	Sinnar	0.15	0.20	0.05		
13	Igatpuri	N.P.	N.P.	N.P.	N.P.	
14	Trimbak					
15	Devla					
Dist.	**Total**	**1.84**	**2.20**			

Note: - Three talukas have No Production (N.P.) i.e. Peint, Surgana, Igatpuri.

Table No. : 4.17 SPATIAL ANALYSIS OF TALUKAS ON THE BASIS OF AREA UNDER **COTTON** TO **NET SOWN AREA.**(1991 -- 2011)

	Category	Total No. of Talukas (1991)	Total No. of Talukas (2011)	Percentage of the total No. of talukas (1991)	Percentage of the total No. of talukas (2011)
Very Low	00.01 to 00.10	Nashik, Niphad=2	Nashik, , Chandwad, Niphad, = 3	15.40	23.10
Low	00.11 to 00.20	Dindori, Kalwan, Baglan, Malegaon, Chandwad, Sinnar, Yeola= 7	Dindori, Kalwan, Sinnar = 3	53.80	23.10
Medium	00.21 to 00.30	Nil	Baglan, Yeola = 2	0.00	15.40
High	00.31 to 00.40	Nil	Malegaon = 1	00.00	07.70
Very High	Above 00.41	Nandgaon=1	Nandgaon=1	07.70	07.70
No Productio.		Peint, Surgana, Igatpuri=3	Peint, Surgana, Igatpuri=3	23.10	23.10

Note: - Three talukas have No Production (N.P.) i.e. Peint, Surgana, Igatpuri.

Table No. : 4.18 TENDENCY OF TALUKAS TOWARDS INCREASES AND DECREASES IN AREA UNDER **COTTON**

	Category	**Total No. of Talukas Increases (+ve)**	**Total No. of Talukas Decreases (-ve)**	**Percentage of the total No. of Increase talukas**	**Percentage of the total No. of Decrease talukas**
Very Low	00.01 to 00.10	Dindori, Kalwan, Baglan, Sinnar, Yeola, Niphad= 6	Nashik, , Chandwad, Nandgaon= 3	46.20	23.10
Low	00.11 to 00.20	Malegaon =1	Nil	07.70	00.00
Medium	00.21 to 00.30	Nil	Nil	00.00	00.00
High	00.31 to 00.40	Nil	Nil	00.00	00.00
Very High	Above 00.41	Nil	Nil	00.00	00.00

Note: - Three talukas have No Production (N.P.) i.e. Peint, Surgana, Igatpuri.

4.8) <u>OILSEEDS</u>:-

Oilseeds play a significant role in Maharashtra's agriculture as well as agricultural economy of the study region for several reasons. Ground nut, Til, Seasamun, Niger (Karale), Lineseed and sunflower are important constituents of this group of crops. Oilseeds rank 4thin the district occupying 6.37 percent area under these crops in the reference year 1991 and it decreased up to 2.98 percent out of the net sown area in the reference year 2011.

ECOLOGICAL FACTORS:-

Oilseeds include edible and non-edible ones. Edible oilseeds include ground nut, til (sesame), karale and kardai. Non edible oilseeds are erandale and others. Of all these oilseeds, groundnut is an important crop in the study region. Generally groundnut is grown in the Kharif season. It requires warm conditions with temperature between 20^{0}c and 30^{0}c. It is grown mostly in thecentral and eastern part

in the study region receiving rainfall about 500 mm. to 900 mm. They take 12 to 16 weeks to ripen. They can be grown on a variety of soils. Oilseeds are sown in the month of June or July and harvested between September and October.

SPATIAL ANALYSIS:-

Rainfall amount and temperature conditions play an important role in the distribution of Oilseeds during specific stages in growth. Soil is not so important as compared to rainfall and temperature. Groundnut is spread all over the district and itsproportion to the net sown area varies from 01.44 percent to 10.91 percent.

Spatial analysis of the area of the talukas under this crop for reference year 1991brings out the following aspects.

All talukas of the study area possess some area under this crop. Of these 00.01 percent to 04.00 percent lies in low and very low grade. Yeola is the only taluka in very low category. Four talukas belong to the low grade i.e.30.80 percent and lie in the western and central part of the district. Peint and Kalwan (Kalwan & Deola) come under medium category. Nashik (Nashik & Trimbak) and Igatpuri from the extreme west part of the district belong to high grade.

Four talukas belong to the very high grade i.e. Dindori, Nandgaon, Baglan and Malegaon located in the western, central and eastern parts of the district occupying30.80 percent. All talukas lie in the medium rainfall zone producing oilseeds in the study area where the soil is medium black to deep black.

Now thespatial analysis of talukas in thereference year 2011illuminates the pattern of distribution as follows.

Similar to the base year all talukas possess some area under these crops. But the percentage of the area under oilseeds has decreased. Of the total talukas maximum tahsils come under low grade (2.01 percent to 4.00 percent) occupying 61.50 percent. Nashik (Nashik & Trimbak), Peint, Surgana, Kalwan (Kalwan & Deola), Yeola, Chandwad, Nandgaon and Niphad come under this category are distributed throughout the district. Four talukas belong to medium category occupying 30.80 percent. The highest percentage above 8.01 percent of area under oilseeds is found in the Dindori taluka which lies in west part where the soil is medium black.

TEMPORAL ANALYSIS:-

All talukas are involved in some sort of change, positive or negative. Tendencies of the talukas towards the negative change are as follows. Nearly 23.10 percent of the total talukas belong to negative change. All talukas distributed in low and medium grades lie in the central and eastern part of the district. The highest percentage of negative change is found in Yeola and Sinnar talukas. The lowest percentage is found in Chandwad taluka, where the area under oilseeds is replaced by other more remunerative crops i.e. sugarcane, wheat, fruits and vegetables.

Tendency of talukas towards positive change.

Ten talukas of the total talukas show the positive change Except Chandwad, Yeola and Sinnar increase in area under oilseeds varies between very low to very high category. The highest percentage of positive change occurs in four talukas i.e. Nashik (Nashik & Trimbak), Baglan, Malegaon and Nandgaon, which lie in the central and eastern parts of the study region.

Table No. : 4.19 PERCENTAGE OF AREA UNDER **OIL SEEDS** TO **NET SOWN AREA.**FOR YEAR **1991** AND **2011** AND **CHANGE** (Taluka wise)

Sr. No.	Name of Talukas	Percentage 1991	Percentage 2011	+	–	No Change
1	Nashik	6.37	3.30		4.07	
2	Peint	4.91	3.50		2.41	
3	Dindori	9.58	8.72		1.86	
4	Surgana	3.73	2.50		2.23	
5	Kalvan	5.90	3.25		3.65	
6	Baglan	10.55	5.50		6.50	
7	Malegaon	10.91	4.60		7.31	
8	Chandwad	2.97	3.15	1.18		
9	Nandgaon	8.50	2.27		7.23	
10	Yeola	1.44	2.84	2.40		
11	Niphad	3.95	3.15		1.80	
12	Sinnar	2.54	4.33	2.79		
13	Igatpuri	7.44	4.98		3.46	
14	Trimbak					
15	Devla					
Dist.	**Total**	**6.37**	**2.98**			

FIG. NO 4.8: % OF AREA UNDER OILSEEDS TO NET SOWN AREA

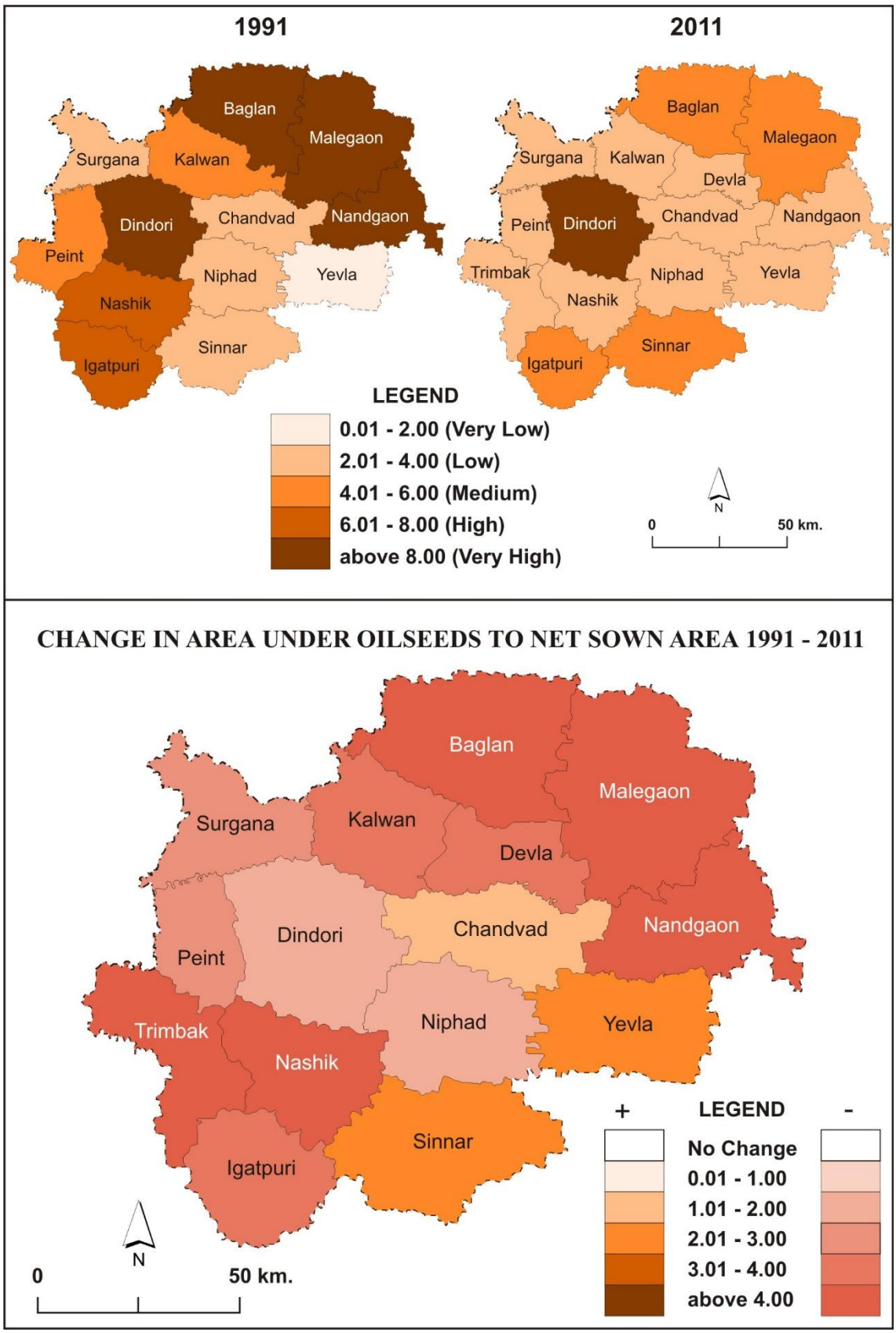


Table No. : 4.20SPATIAL ANALYSIS OF TALUKAS ON THE BASIS OF AREA UNDER **OIL SEEDS** TO **NET SOWN AREA.**(1991 -- 2011)

	Category	**Total No. of Talukas (1991)**	**Total No. of Talukas (2011)**	**Percentage of the total No. of talukas (1991)**	**Percentage of the total No. of talukas (2011)**
Very Low	00.01 to 02.00	Yeola = 1	Nil	07.70	00.00
Low	02.01 to 04.00	Chandwad, Sinnar, Surgana, Niphad = 4	Nashik, Peint, Kavlan, Chandwad, Niphad, Surgana, Nandgaon, Yeola = 8	30.80	61.50
Medium	04.01 to 06.00	Peint, Kavlan = 2	Baglan, Malegaon, Sinnar, Igatpuri = 4	15.40	30.80
High	06.01 to 08.00	Nashik, Igatpuri = 2	Nil	15.40	00.00
Very High	Above 08.01	Dindori, Baglan, Malegaon, Nandgaon = 4	Dindori = 1	30.80	07.70

Table No. : 4.21 TENDENCY OF TALUKAS TOWARDS INCREASES AND DECREASES IN AREA UNDER **OIL SEEDS**

	Category	**Total No. of Talukas Increases (+ve)**	**Total No. of Talukas Decreases (-ve)**	**Percentage of the total No. of Increase talukas**	**Percentage of the total No. of Decrease talukas**
Very Low	00.01 to 01.00	Nil	Nil	00.00	00.00
Low	01.01 to 02.00	Chandwad =1	Dindori, Niphad = 2	07.70	15.40
Medium	02.01 to 03.00	Yeola, Sinnar = 2	Peint, Surgana = 2	15.40	15.40
High	03.01 to 04.00	Nil	Kavlan, Igatpuri = 2	00.00	15.40
Very High	Above 04.01	Nil	Nashik Baglan, Malegaon, Nandgaon= 4	00.00	30.80

4.9) PULSES CROPS:-

The pulses in the region are grown in both, Kharif and Rabi seasons. The region produces a variety of pulses. However, principal pulses are gram (cicerarietion), urid (phaseolusradialus), moong, math, arhar, val, tur etc. They are mainly practiced as internal croppings and are largely rain-fed. Pulse crops perform two main functions, first they are a source of proteins for the vegetarian population and secondly, pulses replenish the soil by fixing nitrogen. Pulse crops together occupied the second rank in the reference year 1991 and the third rank in the reference year 2011among the crops grown in the study region. The actual area under pulses was 83,042 hectares in 1990 and 1, 12,819 hectares in 2011. It accounted for 9.51 percent of the net sown area in the reference year 1991. The area slightly increased and it was 16.45 percent in the reference year 2011. Generally pulses crops are taken along with major crops like Bajara, Jowar, Cotton, wheat etc. (Table No .4.24).

SPATIAL ANALYSIS:-

The individual crops like Tur, Moong, Math etc. are mostly grown in rotation with other crops or occasionally as an independent crop in the district. They are cultivated in all talukas of the district.

Spatial analysis of the talukas under these crops for the reference year 1991 focuses light in the followingfacts.

All talukas possess some area under pulses. The percentage varies from 05.51 percent to 24.02 percent. Sinnar, Malegaon and Yeola belong to low grade and medium grade. Four talukas have 8.10 percent to 10.00 percent area under these crops and lie in the western and central part of the study area. The highest percentage was found in Peint, Dindori, Surgana, Kalwan (Kalwan & Deola) and Nandgaon lying in the western part of the district except Nandgaon.

Spatial analysis of the talukas for the reference year 2011 illuminates the pattern of distribution as follows. Nandgaon and Niphad talukas are included in the low grade i.e. 4.01 percent to 6.00 percent. Remaining all talukas belong to the very high grade. They occupy 84.60 percent and lie in the western and central part of the district except Yeola. (Table No. 4.23 and Fig No. 4.8).

TEMPORAL ANALYSIS:-

Temporal analysis for the period under consideration brings out the following points.

Tendency of talukas to positive change.

All talukas are involved in the process of change. Nearly 76 .90 percent of such talukas are involved in the positive change. Three talukas lie in very low, and very high category. Igatpuri belongs from tothe medium category, and Sinnar is the only taluka which belongs to high category. (Fig.No.4.8).

Tendency of talukas to negative change.

Nearly 23.10 percent talukas are involved in the negative change. Total 15.40 percent belong to low grade and 7.07 percent belong to medium grade. The highest percentage is found in Nandgaon taluka lying in the eastern part of the district. Peint and Niphad talukas belong to low grade and lie in west and central part of the district. (Table No. 4.24& Fig. No. 4.8)

Table No. : 4.22

PERCENTAGE OF AREA UNDER **PULSES**TO**NET SOWN AREA.**

FOR YEAR **1991** AND **2011** AND **CHANGE** (Taluka wise)

Sr. No.	**Name of Talukas**	**Percentage 1991**	**Percentage 2011**	+	_	**No Change**
1	Nashik	09.34	22.74	13.40		
2	Peint	16.92	12.85		04.18	
3	Dindori	14.60	12.61	01.99		
4	Surgana	11.73	16.71	04.98		
5	Kalvan	11.42	24.02	12.60		
6	Baglan	09.07	10.95	01.88		
7	Malegaon	06.80	10.10	03.30		
8	Chandwad	09.73	10.08	00.35		
9	Nandgaon	11.20	04.65		06.55	
10	Yeola	07.76	20.31	13.55		
11	Niphad	08.58	04.76		03.82	
12	Sinnar	05.51	14.28	08.77		
13	Igatpuri	08.40	14.86	06.46		
14	Trimbak					
15	Devla					
Dist.	**Total**	**08.40**	**16.45**			

FIG. NO 4.9: % OF AREA UNDER PULSES TO NET SOWN AREA

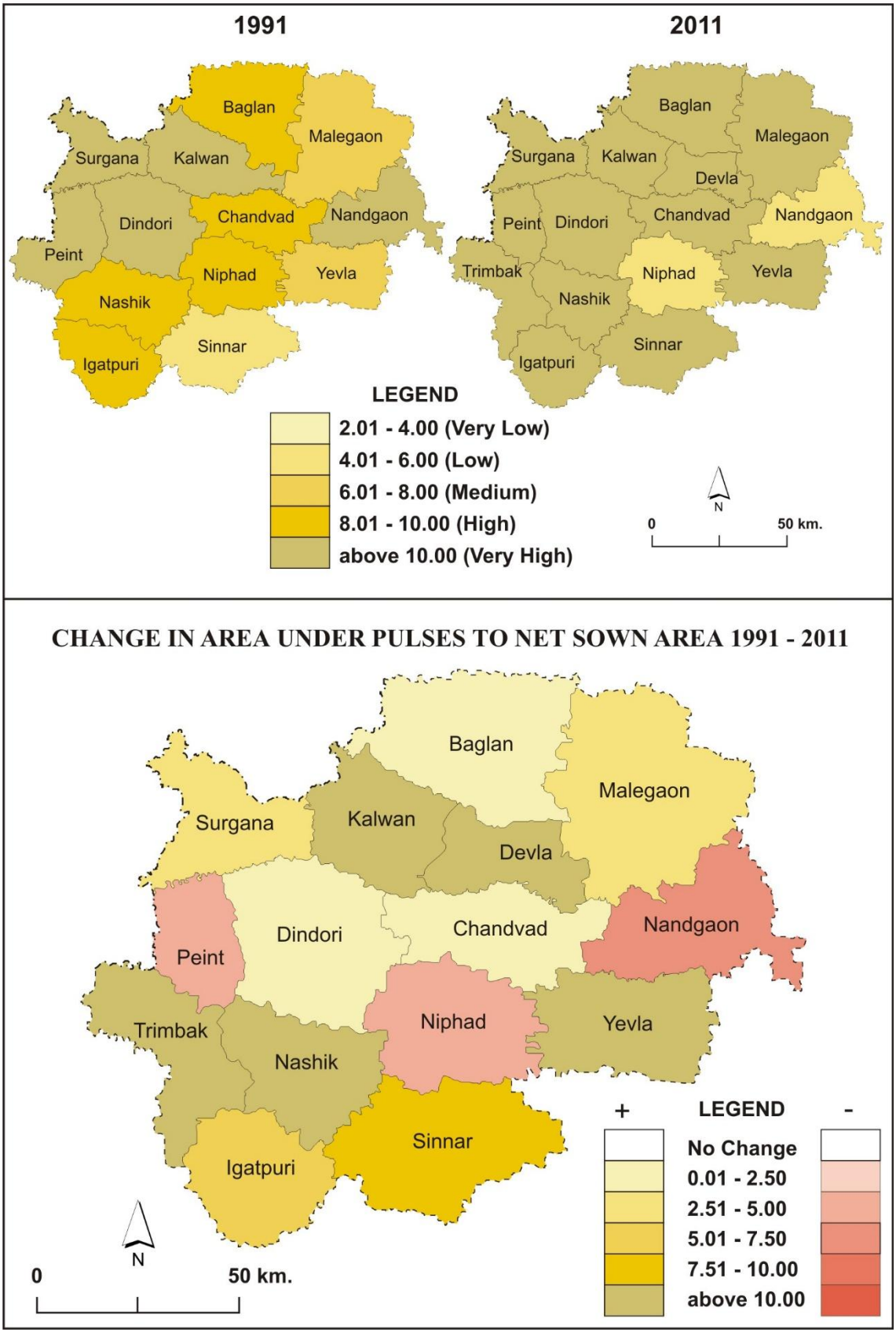


Table No. : 4.23

SPATIAL ANALYSIS OF TALUKAS ON THE BASIS OF AREA UNDER **PULSES** TO **NET SOWN AREA.**(1991 -- 2011)

	Category	**Total No. of Talukas (1991)**	**Total No. of Talukas (2011)**	**Percentage of the total No. of talukas (1991)**	**Percentage of the total No. of talukas (2011)**
Very Low	02.01 to 04.00	Nil	Nil	00.00	00.00
Low	04.01 to 06.00	Sinnar = 1	Nandgaon, Niphad = 2	07.70	15.40
Medium	06.01 to 08.00	Malegaon, Yeola = 2	Nil	15.40	00.00
High	08.01 to 10.00	Nashik, Baglan, Chandwad, Niphad, Igatpuri = 5	Nil	38.40	00.00
Very High	Above 10.01	Peint, Dindori, Surgana, Kavlan, Nandgaon = 5	Nashik, Dindori, Surgana, Kavlan, Baglan, Malegaon, Chandwad, Yeola, Niphad, Sinnar, Igatpuri= 11	38.50	84.60

Table No. : 4.24

TENDENCY OF TALUKAS TOWARDS INCREASES AND DECREASES IN AREA UNDER **PULSES**

	Category	**Total No. of Talukas Increases (+ve)**	**Total No. of Talukas Decreases (-ve)**	**Percentage of the total No. of Increase talukas**	**Percentage of the total No. of Decrease talukas**
Very Low	00.01 to 02.50	Dindori, Baglan, Chandwad = 3	Nil	23.10	00.00
Low	02.51 to 05.00	Surgana, Malegaon = 2	Peint, Niphad = 2	15.40	15.40
Medium	05.01 to 07.50	Igatpuri = 1	Nandgaon =1	07.70	07.70
High	07.51 to 10.00	Sinnar = 1	Nil	07.70	00.00
Very High	Above 10.01	Nashik, Kalvan, Yeola= 3	Nil	23.10	00.00

4.10) FRUITS AND VEGETABLES:-

In the present investigation horticultural crops are treated separately, primarily because their distribution is more localized in terms of both area and the number of holdings on which they are grown, than that of the most farm crops studied previously. Flowers, fruits and vegetables are generally considered separately from other crops under the heading of horticulture (COPPOK, 1971), the most distinctive feature of which is its variety. Other characteristics of horticulture may be stated as under.

Horticultural production comprises a large range of crops which differ in their perishability, seasonality and value, and also in their soil and climatic requirements. Horticultural crops being usually associated with a high standard of living, in a subsistence economy their significance. Most of the fruit crops are produced by intensive methods. Fruits have undoubtedly been man's oldest food, but the development of fruit growing on commercial lines has taken place relatively recently in Maharashtra, which happens to be the "fruit bowl of India" (Department of agriculture, M.S. Pune, Bulletin No.397). The other two fruit-growing areas of India are the sub mountain Himalayan region and the Hyderabad area of Andhara Pradesh

(Singh, 1969). Varieties of fruits and vegetables are grown in the region, which share insignificant 5.13 percent land under these crops out of the net sown area in the reference year 1991. The percentage has increased by 2.22 percent during the period of 10 years (the period under consideration). Thus it became 7.35 percent in the reference year 2011.

SPATIAL ANALYSIS:-

Spatial analysis of the talukas under these crops for the reference year 1991 focuses light on the following facts.

All talukas possess some area under fruits and vegetables. This percentage varies from 0.50 percent to 25.30 percent. Of these nearly 38.50 percent talukas belong to very low grade i.e. Peint, Surgana, Kalwan (Kalwan & Deola), Nandgaon and Igatpuri. These talukas lie in eastern and western part of study region. Five talukas belong to the low grade i.e. Baglan, Malegaon, Chandwad, Yeola and Sinnar lying in central and east part of the study region. Nashik (Nashik & Trimbak) is the only taluka coming under medium category. The highest percentage under these crops is found in Dindori and Niphad talukas lying in the western and central part.

During the period under consideration drastic changes have taken place so far as fruits and vegetables are concerned. The land under these crops increased in the year 2010-11 because of the rainfall amount decreasing day by day and ground water level also decreasing. So the tendency of farmers changed. Demand and market rates are higher than other traditional crops i.e. Jowar, Bajara etc. Sugarcane, Wheat and other crops require more water than these crops. The labour problem is rising day by day in the district. These crops are grown twice a year, because they need short growing period than others. So the tendency of farmers changed. They replaced the traditional crops by fruits and vegetables.

On this background a spatial analysis of talukas has been attempted for the year 2011.

The area under these crops has increased near the urban areas. All talukas have some area under these crops. Peint is only one tehsil coming under very low category. Nearly 30.80 percent talukas belong to low grade i.e. Surgana, Kalwan (Kalwan & Deola), Nandgaon and Igatpuri lying in the western part except Nandgaon lying in the east part. 30.80 percent talukas belong to medium category i.e. Malegaon, Yeola and Sinnar. Nashik (Nashik & Trimbak) is the only taluka in high grade. Dindori,

Chandwad and Niphad have maximum percentage under these crops. They are in very high category (Above 8.01 percent).

TEMPORAL ANALYSIS:-

Temporal analysis for the period under consideration points out the following aspects. **All talukas are involved in positive change.**

Of the total talukas, nearly 100 percent are involved in positive change and increase in the area under these crops ranges from 1.50 percent to 35.50 percent. Nearly 61.50 percent of positively changed talukas lie in very low grade. These talukas are more or less the same as that of the year 1991. Two talukas belonging to low grade and one taluka i.e. Nashik (Nashik & Trimbak) belongs to medium category. Dindori and Niphad have maximum percentage of these crops. They belong to very high grade. The significance of these crops has considerably increased in all talukas. Reasons for this are given above.

Table No. : 4.25 PERCENTAGE OF AREA UNDER **FRUIT AND VEGETABLE** TO **NET SOWN AREA.**FOR YEAR **1991** AND **2011** AND **CHANGE** (Taluka wise)

Sr. No.	**Name of Talukas**	**Percentage 1991**	**Percentage 2011**	**+**	**-**	**No Change**
1	Nashik	4.50	6.68	2.18		
2	Peint	0.50	1.50	1.00		
3	Dindori	25.30	35.15	9.85		
4	Surgana	1.10	2.25	1.15		
5	Kalvan	1.65	3.60	1.95		
6	Baglan	2.25	5.50	3.25		
7	Malegaon	3.50	4.50	1.00		
8	Chandwad	3.30	8.86	5.56		
9	Nandgaon	1.10	2.15	1.05		
10	Yeola	2.25	4.10	1.85		
11	Niphad	15.50	35.50	20.00		
12	Sinnar	3.50	5.50	02.00		
13	Igatpuri	1.10	2.35	1.25		
14	Trimbak					
15	Devla					
Dist.	**Total**	**05.13**	**07.35**	**2.22**		

FIG. NO 4.10: % OF AREA UNDER FRUITS AND VEGETABLES TO NET SOWN AREA

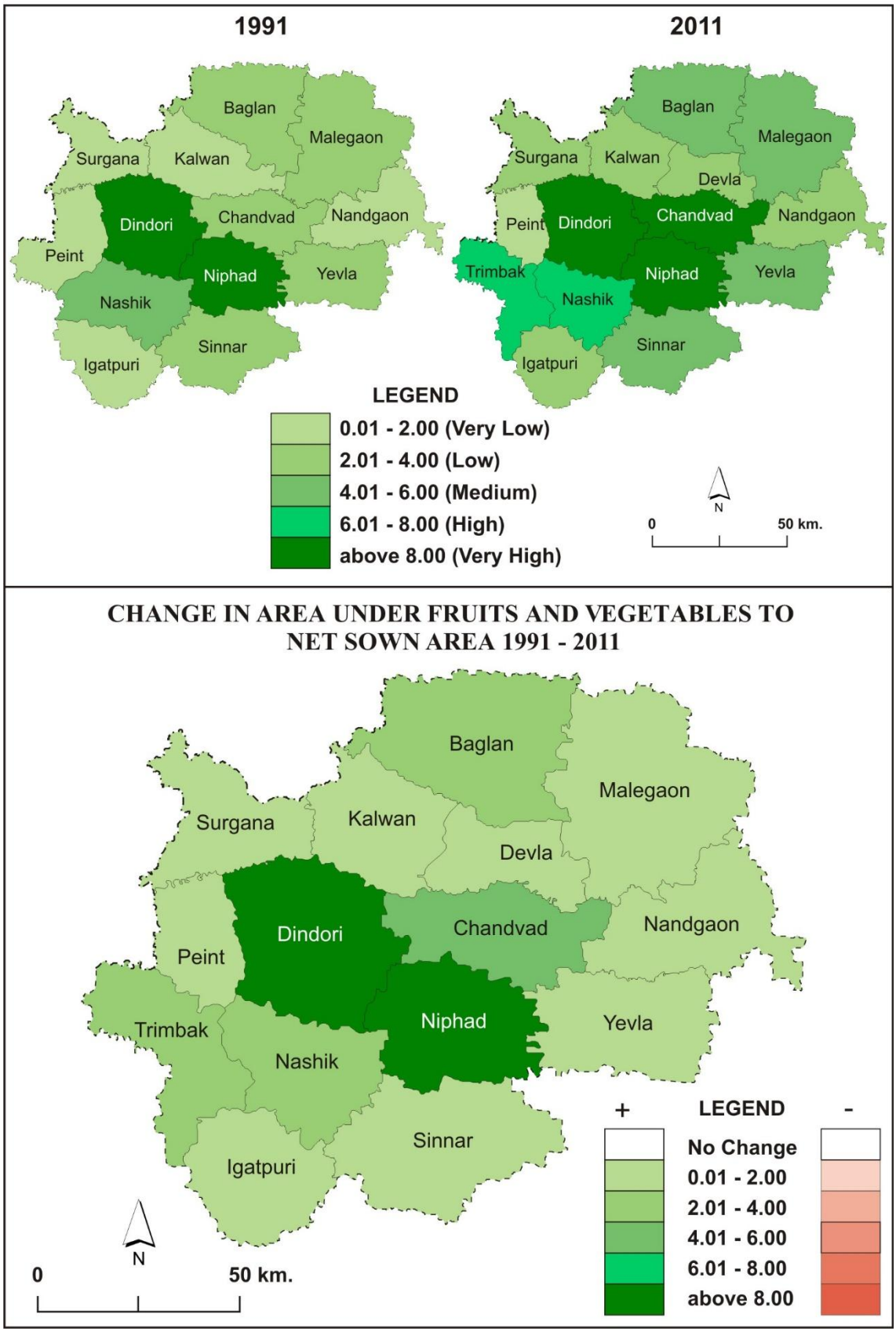


Table No. : 4.26

SPATIAL ANALYSIS OF TALUKAS ON THE BASIS OF AREA UNDER **FRUIT AND VEGETABLE** TO **NET SOWN AREA.**(1991 -- 2011)

	Category	**Total No. of Talukas (1991)**	**Total No. of Talukas (2011)**	**Percentage of the total No. of talukas (1991)**	**Percentage of the total No. of talukas (2011)**
Very Low	00.01 to 02.00	Peint, Surgana, Kavlan, Nandgaon, Igatpuri = 5	Peint= 1	38.50	07.70
Low	02.01 to 04.00	Baglan, Malegaon, Chandwad, Yeola, Sinnar = 5	Surgana, Kavlan, Nandgaon, Igatpuri = 4	38.50	30.80
Medium	04.01 to 06.00	Nashik = 1	Baglan, Malegaon, Yeola, Sinnar = 4	07.70	30.80
High	06.01 to 08.00	Nil	Nashik = 1	00.00	07.70
Very High	Above 08.01	Dindori, Niphad =2	Dindori, Chandwad, Niphad =3	15.40	23.10

Table No. : 4.27

TENDENCY OF TALUKAS TOWARDS INCREASES AND DECREASES IN AREA UNDER **FRUIT AND VEGETABLE**

	Category	**Total No. of Talukas Increases (+ve)**	**Total No. of Talukas Decreases (-ve)**	**Percentage of the total No. of Increase talukas**	**Percentage of the total No. of Decrease talukas**
Very Low	00.01 to 02.00	Peint, Surgana, Kavlan, Malegaon, Yeola, Sinnar, Nandgaon, Igatpuri = 8	Nil	61.50	00.00
Low	02.01 to 04.00	Nashik, Baglan = 2	Nil	15.40	00.00
Medium	04.01 to 06.00	Chandwad = 1	Nil	07.70	00.00
High	06.01 to 08.00	Nil	Nil	00.00	00.00
Very High	Above 08.01	Dindori, Niphad =2	Nil	15.40	00.00

4.11) <u>RAGI</u> (Eleusine Cororocana):-

This is an important hill-millet produced in Nashik district, especially in thewestern part of study region. Mostly this crop is grown in the hilly area. Sloping land is favourable for such hill-millets.

Ragi is mainly produced in monsoon season so this crop is Kharif food grain. Next to rice this crop is important in the western zone of study area. This crop is locally known as Nachani or Nagli. It is also known as Buck wheat crop or finger millets. Ragi is a short duration crop and permits intercultural with other kharif crops that do not require much soil moisture. The plant and the grain both remain free from pets and disease. The plant is hard and can withstand droughts that would destroy most other crops. The grain has a great nutritive value and is very suitable for those doing hard physical labour. It is kept quite dry. It can be stored for many years

without damage. The straw is good for both working and milk cattle. The grain flour is used for making gruel, porridge and rotis. The grain is hand pounded either into course (for making porridge) or fine flour to convert into rotis (Gananathan, 1970).

It is usually grown on lighter, hilly soils which are unsuitable to grow anything else. Varkas land of Konkan hill slopes or poorer upland soils provide the ideal setting for Ragi cultivation. Although Ragi is in some respects a better food than rice, with a remarkable high calcium content (0.33 percent), "it is often regarded as a food suitable for poor and ignorant villagers and also as the food of prisoners in the jails". (Stamp and Learmonth, 1967).

SPATIAL ANALYSIS:-

Ragi occupied about 8.92 percent area of the total net sown area in the year 1991 and 10.15 percent area in 2011 (Table No. 4.28). Differences in the regional distribution are striking and the proportion varies from negligible to over 44 percent in the year 1990-91 and over 48 percent in some area in the year 2011. Higher percentage of area under Ragi is noticeable in Peint taluka (44 % - 1991 and 48 % - 2011). (Table No. 4.29)

The following important points are brought out in thespatial analysis of the area of the talukas under this crop for the reference year 1991.

Nearly 70 percent of the total talukas possess some area under this crop. The percentage varies 01.00 percent to 44 percent. Of these nearly 15.40 percent talukas belong to very low grade. Kalwan (Kalwan & Deola) and Baglan talukas belong to low grade (1.00 percent to 2.00 percent). Not a single taluka falls in medium and high grade. The highest percentage is found in Peint taluka and Surgana taluka i.e. above 30 percent. They lie in the western part of the district. 30.20% talukas have no production i.e. Malegaon, Niphad, Nandgaon and Yeola.

Spatial analysis of talukas for the reference year 2011.

Kalwan (Kalwan & Deola) talukas belong to very low grade, and Baglan, Chandwad and Sinnar talukas belong to low grade (23.10 percent). Similar to the reference year 1990-91 four talukas each belong to very high grade and have no production. i. e. 38.50 percent and 30.20 percent respectively. (Table No. 4.29)

TEMPORAL ANALYSIS:-

The following changes are brought by the temporal analysis for the period under consideration. Ten talukas have either the tendency towards either positive or negative change. Of the total 46.15 percent talukas indicate the positive change and 23.07 percent taluka show the negative change. 30.76 percent talukas have no production. Reasons and distribution of the talukas are the same as explained for the reference years 1991 and 2011. Mostly Ragi is produced in the western part, especially in Peint, Surgana and Igatpuri talukas of the study region.

Table No. : 4.28 PERCENTAGE OF AREA UNDER **RAGI**TO**NET SOWN AREA.** FOR YEAR **1991** AND **2011** AND **CHANGE** (Taluka wise)

Sr. No.	**Name of Talukas**	**Percentage 1991**	**Percentage 2011**	**+**	**_**	**No Change**
1	Nashik	11.00	15.50	04.50		
2	Peint	44.00	48.00	04.00		
3	Dindori	10.50	12.00	01.50		
4	Surgana	31.50	41.00	09.50		
5	Kalvan	02.00	01.00		01.00	
6	Baglan	02.00	01.50		00.50	
7	Malegaon	N.P.	N.P.	N.P.	N.P.	
8	Chandwad	01.00	02.00	01.00		
9	Nandgaon	N.P.	N.P.	N.P.	N.P.	
10	Yeola	N.P.	N.P.	N.P.	N.P.	
11	Niphad	N.P.	N.P.	N.P.	N.P.	
12	Sinnar	01.00	02.00	O1.00		
13	Igatpuri	13.00	09.00		04.00	
14	Trimbak					
15	Devla					
Dist.	**Total**	**08.92**	**10.15**			

Note: - Four talukas have No Production (N.P.) i.e. Malegaon, Nandgaon, Yeola, Niphad.

FIG. NO 4.11: % OF AREA UNDER RAGI TO NET SOWN AREA

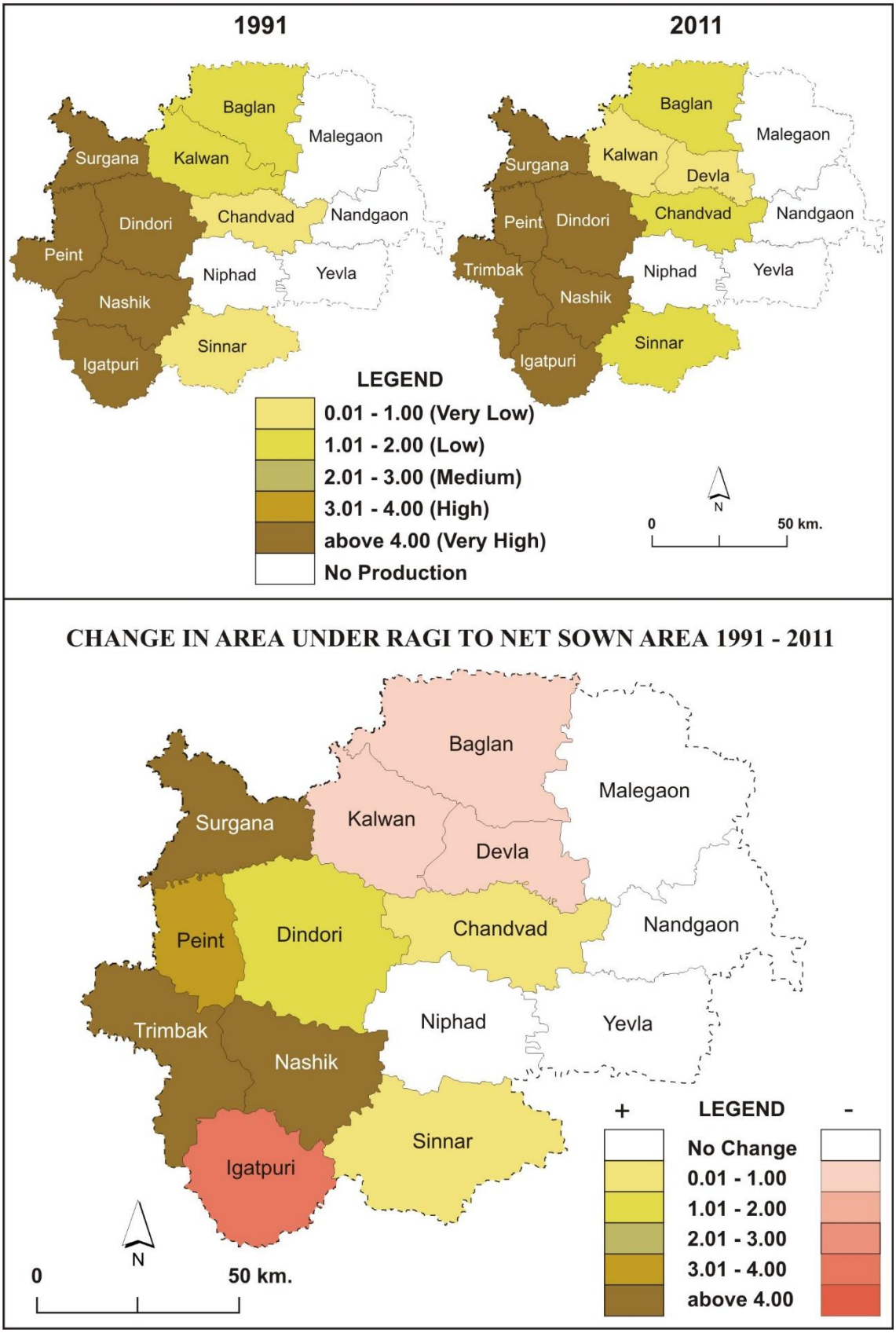


Table No. : 4.29 SPATIAL ANALYSIS OF TALUKAS ON THE BASIS OF AREA UNDER **RAGI** TO **NET SOWN AREA.**(1991 -- 2011)

	Category	**Total No. of Talukas (1991)**	**Total No. of Talukas (2011)**	**Percentage of the total No. of talukas (1991)**	**Percentage of the total No. of talukas (2011)**
Very Low	00.01 to 01.00	Chandwad, Sinnar = 2	Kavlan - 1	15.40	07.70
Low	01.01 to 02.00	Kalwan, Baglan = 2	Baglan, Chandwad, Sinnar, = 3	15.40	23.10
Medium	02.01 to 03.00	Nil	Nil	00.00	00.00
High	03.01 to 04.00	Nil	Nil	00.00	00.00
Very High	Above 04.01	Nashik, Peint, Igatpuri Dindori, Surgana = 5	Nashik, Peint, Igatpuri Dindori, Surgana = 5	38.50	38.50
No Producti.		Malegaon, Nandgaon, Yeola, Niphad= 4	Malegaon, Nandgaon, Yeola, Niphad= 4	30.80	30.80

Note: - Four talukas have No Production (N.P.) i.e. Malegaon, Nandgaon, Yeola, Niphad.

Table No. : 4.30 TENDENCY OF TALUKAS TOWARDS INCREASES AND DECREASES IN AREA UNDER **RAGI**

	Category	**Total No. of Talukas Increases (+ve)**	**Total No. of Talukas Decreases (-ve)**	**Percentage of the total No. of Increase talukas**	**Percentage of the total No. of Decrease talukas**
Very Low	00.01 to 01.00	Chandwad, Sinnar =2	Kalwan, Baglan = 2	15.40	15.40
Low	01.01 to 02.00	Dindori = 1	Nil	07.70	00.00
Medium	02.01 to 03.00	Nil	Nil	00.00	00.00
High	03.01 to 04.00	Peint = 1	Igatpuri = 1	07.70	07.70
Very High	Above 04.01	Nashik, Surgana = 2	Nil	15.40	00.00

Note: - Four talukas have no production i.e. Malegaon, Nandgaon, Yeola, Niphad.

4.12) Vari (Panicum miliacenum):-

Next to Ragi another important hill-millets is Vari. It occupies the secondary place in the western part of the study region. Vari is also known as varai. It is a common hill millet holding the third place in the food grains produced in the study region. Vari is a poor food crop with worthless fodder and is taken on varkas soils or hilly land usually after ragi. Agricultural operations are nearly similar to those of ragi cultivation.

Vari is grown mostly in the western part particularly on the hills slopes. Average yields per hectare are by and large lower and there is poor margin to cultivators in its production as compared to rice or even ragi. Still poor farmers use it as a substitute for rice and cook it like rice. Sometimes it is ground into flour and converted into bread and used for burning the land as rap material and for thatching. The variety vari-10 has been evolved and released which gives 41 percent more yield than the local varieties. (K.K.V., 1978).

In Nashik District Vari accounts for 2.92percent of the net sown area as per the reference year 1991. It has increased by 0.38 percent during the period under consideration. It has become 3.30 percent of the net sown area in the reference year 2010-11. There is a slight increase in area under this crop (Table No. 4.31).

SPATIAL DISTRIBUTION:-

Following important points focus light on this crop in the spatial analysis of the reference year 1991.

Total ten talukas (7.69 percent) possess some area under Vari. This percentage varies from 0.50 percent to 16.50 percent (1991) and 0.50 percent to 21.50 percent as per the reference year 2011 of the study region. (Table No. 4.32)

Nearly 15.40 percent of the total talukas belong to very low grade (0.01 percent to 0.50 percent). i.e. Baglan and Nandgaon lie in the central and eastern part of taluks respectively. Three talukas belong to low grade. Igatpuri is the only taluka of the study region which belongs to high grade and lies in the west part. Maximum percentage (16.50 percent) is found in Surgana taluka belonging to very high grade.

Four talukas Nashik (Nashik & Trimbak), Peint, Dindori and Surgana belong to very high grade (above 2.00 percent). They are in heavy rain fall zone of the west part. Three talukas have no Vari production.

Spatial analysis of talukas for the reference year 2011 illuminate the pattern of distribution as follows.

Total ten talukas possess some area under thin crop. Nashik (Nashik & Trimbak), Peint, Surgana and Sinnar talukas, which belong to very high grade (above 2.01 percent). Chandwad and Igatpuri are the only taluka which belongs to very low grade and low grade respectively. Dindori and Baglan are talukas which belongs to high grade (1.51 percent to 2.00 percent). The highest percentage (21.50 percent) is found in Surgana taluka, similar to the year 1991. Three talukas have no area under Vari. The pattern of distribution of talukas and reasons are the same as described for the year 1991. (Table No. 4.32).

TEMPORAL ANALYSIS:-

Tendency of talukas towards positive change.

The temporal analysis for the period under consideration brings out the following points. Of the total, ten talukas are involved in the process of change. (Table No. 4.33). Nearly 46.15 percent belong to positive change, of these talukas Nashikis of very low grade, Kalwan (Kalwan & Deola), Nandgaon are of low grade, and Baglan, Sinnar belong to medium grade. Surgana is the only taluka belonging to high grade of positive change. (Table No. 4.33).

Tendency of talukas towards negative change.

Nearly 30.76 percent talukas are involved in negative change. Nearly 15.40 percent of these negative change taluka belong to very low grade (0.01 percent to 0.50 percent). One talukais from low category and lies in the western part. The highest percentage (above 2.1 percent) of negative change is found in Peint taluka. These talukas are more or less the same as that of the year 1991. (Table No. 4.33).

FIG. NO 4.12: % OF AREA UNDER VARI TO NET SOWN AREA

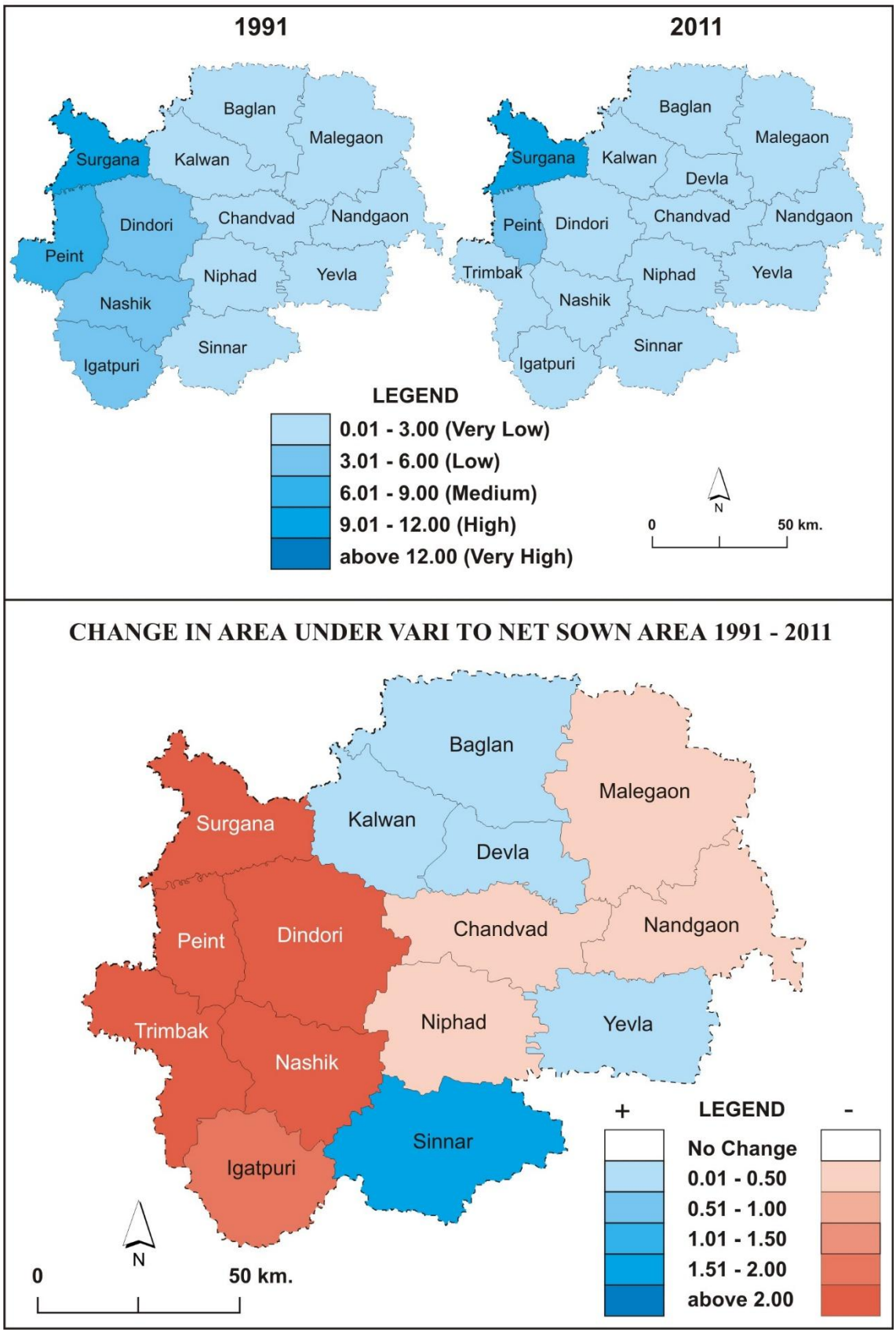


Table No. : 4.31PERCENTAGE OF AREA UNDER **VARI**TO**NET SOWN AREA.**

FOR YEAR **1991** AND **2011** AND **CHANGE** (Taluka wise)

Sr. No.	Name of Talukas	Percentage 1991	Percentage 2011	+	-	No Change
1	Nashik	03.04	00.53		02.51	
2	Peint	07.48	04.22		03.26	
3	Dindori	04.18	01.78		02.40	
4	Surgana	14.11	11.05		02.96	
5	Kalvan	00.05	00.21	00.16		
6	Baglan	00.08	00.15	00.07		
7	Malegaon	00.10	00.05		00.05	
8	Chandwad	00.50	00.20		00.30	
9	Nandgaon	00.75	00.50		00.25	
10	Yeola	00.50	00.75	00.25		
11	Niphad	00.75	00.70		00.05	
12	Sinnar	0.009	01.84	01.83		
13	Igatpuri	04.15	02.39		01.76	
14	Trimbak					
15	Devla					
Dist.	**Total**	**01.63**	**01.97**			

Table No. : 4.32 SPATIAL ANALYSIS OF TALUKAS ON THE BASIS OF AREA UNDER **VARI** TO **NET SOWN AREA.**(1991 -- 2011)

	Category	Total No. of Talukas (1991)	Total No. of Talukas (2011)	Percentage of the total No. of talukas (1991)	Percentage of the total No. of talukas (2011)
Very Low	00.01 to 03.00	Kalvan, Baglan, Malegaon, Chandwad, Nandgaon, Yeola, Niphad, Sinnar, = 8	Nashik, Dindori, Kalvan, Baglan, Malegaon, Chandwad, Nandgaon, Yeola, Niphad, Sinnar, Igatpuri = 11	61.50	84.60
Low	03.01 to 06.00	Nashik, Dindori, Igatpuri = 3	Peint = 1	23.10	07.70
Medium	06.01 to 09.00	Peint = 1	Nil	07.70	00.00
High	09.01 to 12.00	Surgana = 1	Surgana = 1	07.70	07.70
Very High	Above 12.01	Nil	Nil	00.00	00.00

Table No. : 4.33 TENDENCY OF TALUKAS TOWARDS INCREASES AND DECREASES IN AREA UNDER **VARI**

	Category	**Total No. of Talukas Increases (+ve)**	**Total No. of Talukas Decreases (-ve)**	**Percentage of the total No. of Increase talukas**	**Percentage of the total No. of Decrease talukas**
Very Low	00.01 to 00.50	Kavlan, Baglan, Yeola = 3	Malegaon, Chandwad, Nandgaon, Niphad = 4	23.10	30.80
Low	00.51 to 01.00	Nil	Nil	00.00	00.00
Medium	01.01 to 01.50	Nil	Nil	00.00	00.00
High	01.51 to 02.00	Sinnar = 1	Igatpuri = 1	07.70	07.70
Very High	Above 02.01	Nil	Nashik, Peint, Dindori, Surgana = 4	00.00	30.80

4.13) <u>FODDER</u>:-

Fodder is an important non-food crop in the study region. Fodder means the food derived by livestock from crops after the extraction of the ripe grain (Singh, 1974). Besides the leaves, stalks and residue of food grains, the grasses are other important dry and green fodder. The pastures are maintained in hilly and high rainfall areas for the same purpose. Chari, Bajara, Kadwal, khonde, (irrigated summer Jowar purely grown as aFodder). Gajar (a root crop), Ghas (green grass), Shevari, are also largely used as a Fodder in the region.

The most striking and significant change in the use of the cropped land in the study region, particularly during the last three decades, has been the remarkable uplift in the growing of the fodder crops. In Nashik district, fodder occupies about 7.76 percent of the net sown area. It has increased by 4.54 percent during the period under consideration. It has become 12.30 percent of the net sown area in the year of 2011. (Table No. 4.34).

SAPTIAL ANALYSIS:-

Spatial analysis of the talukas under this crop for the reference year 1991 focuses on some area under fodder. (Table No. 4.34). This percentage varies from 1.50 percent to 28.50 percent. Of these nearly 15.40 percent belong to very low grade (1.01 percent to 2.00 percent) i.e. Kalwan (Kalwan & Deola) and Yeola. (Fig. No. 4.34). Malegaon is the only taluka which belongs to the medium grade (4.01 percent to 6.00 percent). Three talukas (23.10 percent) belong to low grade (02.01 percent to 4.00 percent) and lie in the irrigated area except Peint. Highest percentage is found in Nashik (Nashik & Trimbak) and Igatpuri talukas (above 25 percent), due to different reasons. The Igatpuri taluka comes under high rainfall and hilly zone, further it has undulating topography. Nashik (Nashik & Trimbak) taluka has high percentage because of the urban influence. Farmers produce fodder and sell it in Nashik city or around the area.

During the period under consideration drastic changes have taken place. The land under fodder increased in 2011, the pattern of distribution is illuminated as follows. Of the total talukas, nearly 23.10 percent talukas are included in very low grade (0.01 percent to 2.00 percent). Baglan and Niphad talukas belong to low grade. (2.01 percent to 4.00 percent). Malegaon is the only talukas belonging to medium grade. Maximum percentage is found in Igatpuri taluka (31.50 percent). 53.80 percent talukas belong to very high grade, similar to the reference year 1991. The **re**asons are described above. (Table No. 4.35)

TEMPORAL ANALYSIS:-

Temporal analysis for the period under consideration brings out the following point. All talukas are involved in the process of change.

Tendency of talukas towards positive change.

Of the total talukas nearly 53.84 percent (7 talukas) are involved in the positive change. Nearly 15.40 percent talukas lie in very low grade, Dindori belongs to low grade, Nandgaon and Igatpuri belong to medium grade and Nashik (Nashik & Trimbak) and Sinnar belong to high grade. Igatpuri, Nashik and Dindori belong to very high grade (above 4.01 percent) and lie in the western part of the district (Fig. No. 4.36).

Tendency of talukas towards negative change.

Of the total talukas nearly 46.15 percent (6 talukas) are involved in the negative change. Nearly 15.40 percent talukas lie in very low grade i.e. Kalwan (Kalwan & Deola) and Yeola. 23.10 percent belong to low grade i.e. Peint, Chandwad

and Niphad lying in west and central part. Surgana is the only taluka belonging to medium grade. (2.01 percent to 3.00 percent). Not a single taluka belongs to high and very high grade.

FIG. NO 4.13: % OF AREA UNDER FODDER TO NET SOWN AREA

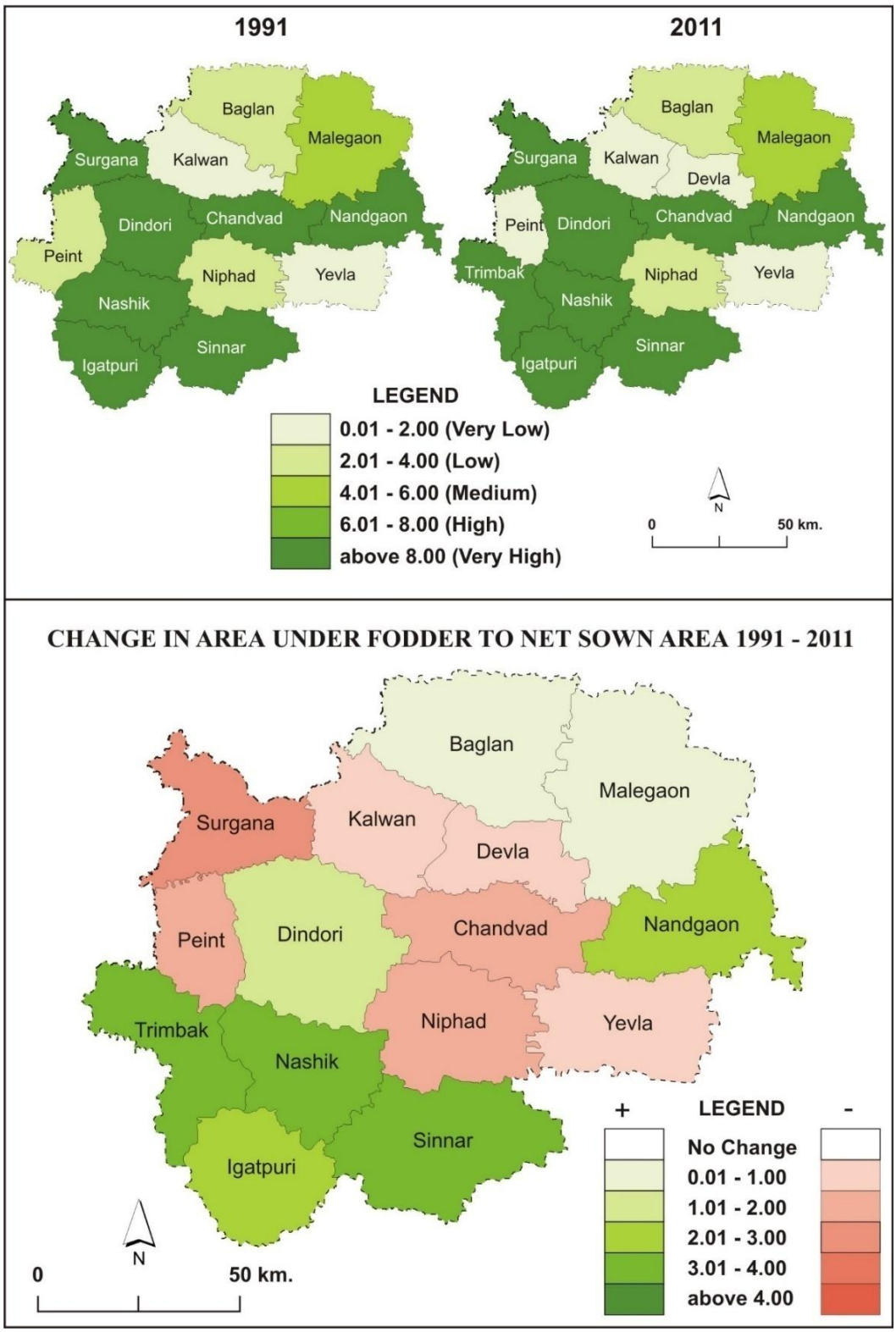


Table No. : 4.34 PERCENTAGE OF AREA UNDER **FODDER**TO**NET SOWN AREA.**

FOR YEAR **1991** AND **2011** AND **CHANGE** (Taluka wise)

Sr. No.	**Name of Talukas**	**Percentage 1991**	**Percentage 2011**	+	-	**No Change**
1	Nashik	26.00	29.50	03.50		
2	Peint	03.00	01.50		01.50	
3	Dindori	25.50	27.50	02.00		
4	Surgana	12.50	09.50		03.00	
5	Kalvan	01.50	01.00		00.50	
6	Baglan	02.50	03.50	01.00		
7	Malegaon	04.50	05.00	00.50		
8	Chandwad	11.00	09.00		02.00	
9	Nandgaon	16.50	19.50	03.00		
10	Yeola	01.50	01.00		00.50	
11	Niphad	04.00	02.50		01.50	
12	Sinnar	15.00	19.00	04.00		
13	Igatpuri	28.50	31.50	03.00		
14	Trimbak					
15	Devla					
Dist.	**Total**	**07.76**	**12.30**			

Table No. : 4.35

SPATIAL ANALYSIS OF TALUKAS ON THE BASIS OF AREA UNDER **FODDER** TO **NET SOWN AREA.**(1991 -- 2011)

	Category	**Total No. of Talukas (1991)**	**Total No. of Talukas (2011)**	**Percentage of the total No. of talukas (1991)**	**Percentage of the total No. of talukas (2011)**
Very Low	00.01 to 02.00	Kalwan, Yeola = 2	Peint, Kavlan, Yeola = 3	15.40	23.10
Low	02.01 to 04.00	Peint, Baglan, Niphad = 3	Baglan, Niphad = 2	23.10	15.40
Medium	04.01 to 06.00	Malegaon = 1	Malegaon =1	07.70	07.70
High	06.01 to 08.00	Nil	Nil	00.00	00.00
Very High	Above 08.01	Dindori, Nashik, Surgana, Chandwad, Nandgaon, Sinnar, Igatpuri = 7	Dindori, Nashik, Surgana, Chandwad, Nandgaon, Sinnar, Igatpuri = 7	53.80	53.80

Table No. : 4.36

TENDENCY OF TALUKAS TOWARDS INCREASES AND DECREASES IN AREA UNDER **FODDER**

	Category	**Total No. of Talukas Increases (+ve)**	**Total No. of Talukas Decreases (-ve)**	**Percentage of the total No. of Increase talukas**	**Percentage of the total No. of Decrease talukas**
Very Low	00.01 to 01.00	Baglan, Malegaon =2	Kavlan, Yeola = 2	15.40	15.40
Low	01.01 to 02.00	Dindori = 1	Peint, Chandwad, Niphad = 3	07.70	23.10
Medium	02.01 to 03.00	Nandgaon, Igatpuri =2	Surgana = 1	15.40	07.70
High	03.01 to 04.00	Nashik, Sinnar = 2	Nil	15.40	00.00
Very High	Above 04.01	Nil	Nil	00.00	00.00

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CHAPTER No.- V

REGIONLISATION OF AGRICULTURE

In the previous chapters the description of the agricultural geography of Nashik district was based upon a review of the estimates relating to agricultural attributes and controls, computed at taluka level, which have been analyzed in their various aspects. It now remains to synthesis these facts for formulating agricultural regions having variable agronomic, economic and demographic problems and differential farming features and potentials. For regionalization is probably the most effective form of description of real differences. Moreover, agricultural regions are used as basis for planning and they have been accepted as suitable devices for planning improvements in underdeveloped territories (Grigg, 1969).

5.1) BASIS OF REGIONALISATION:-

For dividing an area into agricultural regions a number of criteria could be adopted like physical, economic, cultural etc. However, the agricultural regions, according to Morgan and Munton, should be defined in agricultural terms, that is by crops, livestock and enterprise association data or by measurements of farming processes or of farming organizations. Most systems of agricultural regions devised by geographers are based largely crops and livestock combinations, farming methods and sometimes institutional features i.e. farm sizes, and tenures. However, agriculture penetrates in so many aspects of life in much of the worid that to base a system of regions solely upon these largely economic attributes is to miss the essence of regional differentiation of agriculture. Thus for any given area there can be a number of possible sets of agricultural regions depending on the selected criteria.

TECHNIQUES ADOPTED IN THE PRESENT STUDY:-

The basis of classification sought in the present study is objective and quantitative, based on statistical examination of cropped land occupancy by different crops. Crop ranking, crop combination, diversification of crops and agricultural location model are used for the Regionalization of Agriculture.

Agricultural regionalization has attracted the attention of many scholars in the field. Every geographer has been interested in the overall agricultural region, although they by no mean completely agree on its definition or the importance of its study in agricultural geography. Agricultural geographers have commonly used physical and cultural attributes to define an agricultural region singly or in combination.

Engalbrecht (1883) constructed an individual distribution map of major crops and animals for the U.S.A. and later in 1930 for other countries. Finally he summarized his findings in the world map of "Agricultural Zones" (Landbauzonen). Multiple feature regions then attracted many a geographer. Buchanan (1959) thinks that the definition must be in agricultural terms a crop, a crop association, a crop and livestock association, a system of organizations of farm processes etc. Baker's (1926) definition typifies the physical emphasis. For him the region was "An area of land characterized by homogeneity of agricultural conditions, especially crops grown". Further, it was "usually determined principally by climatic conditions.

Subdivisions of study region were the results of differences in land relief, or in slope and soils, "which might cause variations in the proportion of land used for crops, pasture or forest, or in the relative importance of the crops. Hartshorne and Dickens (1935) classified the agricultural regions of North America and Europe using statistics for the measurement. A cultural concept of the agricultural regions was espoused by Waibel (1933), Cholley (1946), and Carol (1952). The worldwide classification of agricultural systems was worked out by Whittlesey (1936) and Hahn (1892). In the late 1930 British geographers used statistical data for delimitation of agricultural regions. Weaver (1954) used the standard deviation to measure the deviation of actual occurrences against the theoretical curve. The Weaver approach to determine multifactor crop combination regions can be regarded as a vital step forward in the integration of a number of variables for regional delimitation. Thomas (1963), modified the Weaver approach making use of all the data available for the calculation of variance for each crop combination. Johnson (1956) used a simple scale of gradation baon averages, for crop association region of Bangladesh.

In India several studies have been made in which the concept of crop combination regions found its application in a sophisticated way both in quantitative techniques and cartographic designing. Indian geographers delimited agricultural regions based techniques like crop-association, cropping pattern, crop concentration, crop diversification and agricultural efficiency. Most of these works are the modifications and applications of the ideas of Weaver. The geographers like Kenda (1939), Pownall (1953), Nelson (1965) Doi (1957), Rao (1954), Rafiullah (1956), Shafi (1960), Bhat (1960,1964,1965), Athawale (1966), Ahmad and Siddiqui (1967), Sinha (1968), Sen Gupta (1968), Ayyar (1969), Sharma (1972), Husa (1972) and Dikshit (1973) have introduced the techniques that have contributed to the various aspects of agricultural regionalization in India. In the last two decades, more advanced techniques have been tested like a linear programming type of model (Henderson, 1957) and Chi-square analysis (Zobler, 1957).

5.2) RANKING OF CROPS:-

Ranking of crops is an insight into the geographical reality of a cropping structure. The percentage of gross cropped land and of the areal strength of a particular crop reveals the agricultural operations involved, period of, peak of labor demand and the opportunities of employments to the farmer's family as well as to the labor dependent on him. Ranking of crops also indicates the nature of economic i.e. whether the farmers of a particular areal unit are traditional subsistent farmers, commercial market-oriented or partly subsistent and partly market oriented.

The relative positions of strength among crops were ascertained by simply ranking them for each taluka in the order of percentage of total cropped land occupied by each crop. The crops ranking first and second were been mapped talukawise for the reference year 1991 and 2011(Fig. No. 5.1 & 5.2) 3^{rd} rank to 10^{th} rank were also mapped talukawise for the years 1991 and 2011. (Fig. no. 5.3 & 5.4). It is evident from the map that the distributional pattern of crops in the basin is more diversified owing to subsistence agriculture.

Table No. 5.1 (1991& 2011)

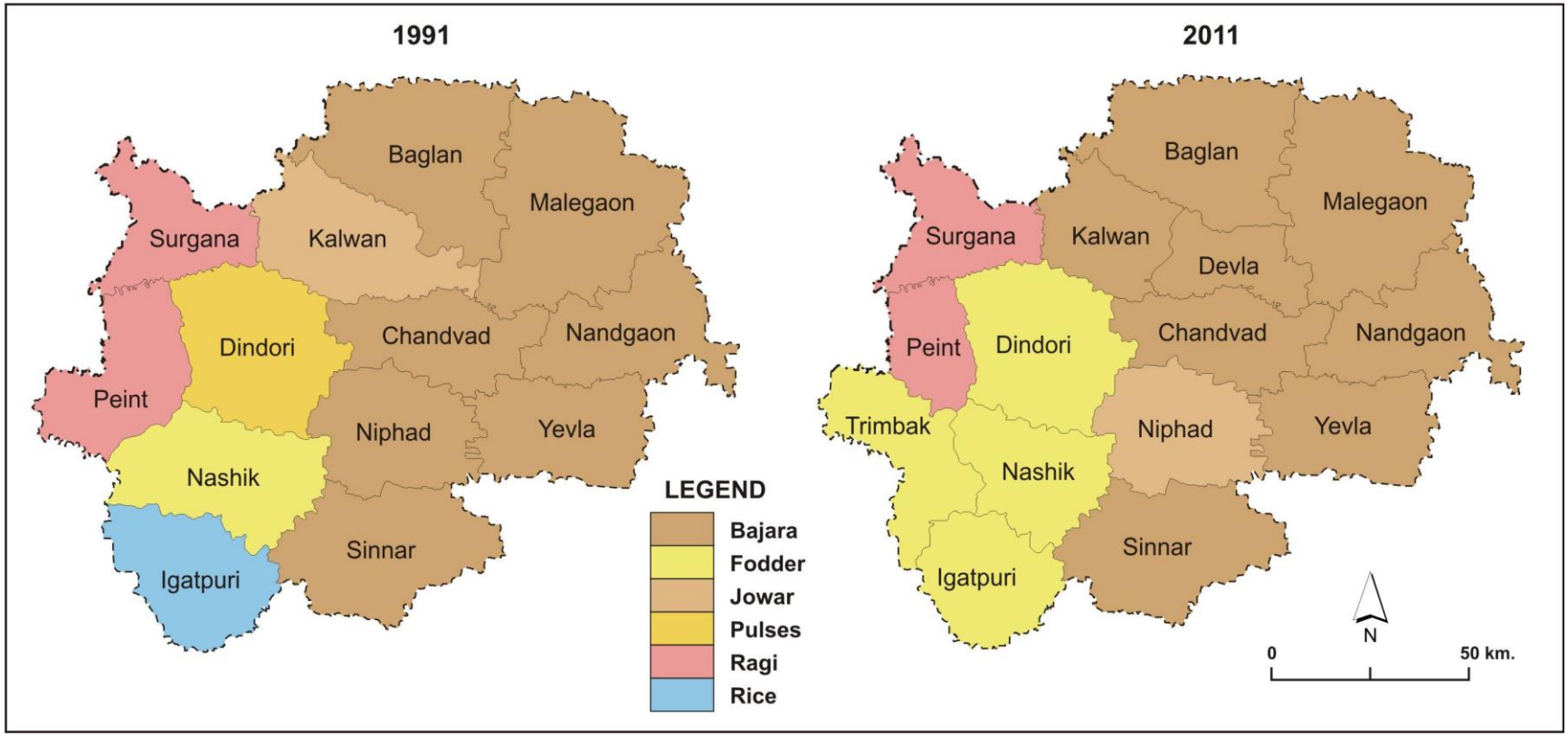
Distribution of talukas on the basis of crop ranks. 1991 and **2011.**

1991	**2011**
First Rank (Six crops)	First Rank (Four crops)
1. Bajara: - Baglan, Malegaon, Nandgaon, Chandwad, Niphad, Yeola, Sinnar. 2. Ragi: - Peint, Surgana. 3. Pulses :- Dindori 4. Rice:- Igatpuri 5. Jowar:- Kalwan 6. Fodder:- Nashik (Nashik & Trimbak)	1. Bajara:- Kalwan, Baglan, Malegaon, Chandwad, Nandgaon, Yeola, Sinnar 2. Fodder:- Dindori, Nashik (Nashik & Trimbak), Igatpuri 3. Ragi: - Peint, Surgana. 4. Jowar:- Niphad
Second Rank (Eight crop)	Second Rank (Seven crop)
1. Oilseed: - Surgana, Baglan, Malegaon. 2. Bajara: - Kalwan, Nashik. 3. Wheat:- Dindori, Niphad 4. Pulsees: - Nandgaon, Sinnar. 5. Rice:- Peint 6. Fodder: - Chandwad. 7. Jowar :- Yeola 8. Ragi: - Igatpuri.	1. Oilseed: - Malegaon. 2. Rice: - Surgana, Peint, Igatpuri. 3. Jowar: - Dindori, Yeola. 4. Bajar: - Niphad, Nashik. 5. Fodder: - Chandwad, Nandgaon, Sinnar. 6. Pulses: - Kalwan. 7. Wheat: - Baglan.
Third Rank (Five crops)	Third Rank (Eight crops)
1. Fodder: - Surgana, Dindori, Niphad, Sinnar, Igatpuri. 2. Oilseed: - Nandgaon, Kalwan. 3. Jowar: - Malegaon, Chandwad. 4. Pulses: - Baglan, Yeola, Peint,. 5. Wheat: - Nashik.	1. Pulses: - Surgana, Kalwan, Nandgaon, Yeola. 2. Jowar: - Niphad, Malegaon. 3. Rice: - Igatpuri. 4. Fruit & Vegetables: - Nashik. 5. Wheat: - Dindori. 6. Oilseed: - Sinnar, Baglan. 7. Surgarcane: - Chandwad. 8. Ragi: - Peint.
Fourth Rank (Seven crops)	Fourth Rank(Seven crops)
1. Pulses: - Surgana, Kalwan, Niphad, Igatpuri. 2. Jowar: - Baglan, Nandgaon. 3. Wheat: - Chandwad, Yeola. 4. Rice: - Nashik. 5. Vari: - Peint. 6. Bajara: - Dindori. 7. Fodder: - Maalegaon.	1. Pulses: - Baglan, Malegaon, Dindori, Sinnar. 2. Wheat: - Niphad, Yeola. 3. Jowar: - Chandwad, Nandgaon. 4. Ragi: - Surgana, Kalwan. 5. Vari; - Igatpuri. 6. F/V: - Nashik. 7. Oilseed: - Peint.

Fifth Rank (Six crops)	Fifth Rank (Eight crops)
1. Wheat: - Kalwan, Baglan, Malegaon, Sinnar, Nandgaon. 2. Oilseed: - Chandwad, Yeola, Niphad, Igatpuri. 3. Rice: - Dindori. 4. Vari: - Surgana. 5. Fodder: - Peint. 6. F/V: - Nashik	1. F/V: - Sinnar, Peint, Chandwad. 2. Surgane: - Yeola, Nandgaon. 3. Jowar: - Surgana, Baglan. 4. Fodder: - Malegaon, Niphad. 5. Oilseed: - Dindori 6. Wheat: - Igatpuri. 7. Maize: - Kalwan. 8. Pulses: - Nashik.
Sixth Rank (Eight crop)	Sixth Rank (Six crop)
1. Sugarcane: - Baglan, Malegaon, Chandwad, Yeola. 2. Jowar: - Peint, Niphad. 3. Ragi: - Nashik, Kalwan. 4. Oilseed: - Dindori. 5. Cotton: - Nandgaon. 6. Wheat: - Igatpuri. 7. Rice: - Surgana. 8. F/V: - Sinnar.	1. Oilseed: - Surgana, Kalwan, Nashik, Sinnar, Chandwad. 2. F/V: - Malegaon, Dindori, Yeola. 3. Jowar: - Igatpuri, Peint. 4. Wheat: - Nandgaon. 5. Rice: - Baglan. 6. Pulses: - Niphad.
Seventh Rank (Nine crops)	Seventh Rank (Seven crops)
1. Rice: - Kalwn, Nandgaon. 2. F/V: - Chandwad, Niphad. 3. Pulses: - Nashik, Malegaon. 4. Oilseed: - Igatpuri, Peint. 5. Jowar: - Dindori. 6. Wheat: - Surgana. 7. Ragi: - Baglan. 8. Fodder: - Sinnar. 9. Vari: - Yeola.	1. Wheat: - Baglan, Surgana, Peint. 2. F/V: - Kalwan, Malegaon, Yeola. 3. Rice: - Niphad, Chandwad. 4. Jowar: - Nashik, Sinnar. 5. Ragi: - Igatpuri. 6. Bajara: - Dindori. 7. Sugarcane: - Nandgaon

Eighth Rank (Eight crops)	Eighth Rank (Eight crops)
1. Rice: - Baglan, Dindori, Yeola, Niphad. 2. Jowar: - Surgana, Igatpuri. 3. Surgarcane: - Nandgaon. 4. Vari: - Nashik. 5. Fodder: - Kalwan. 6. F/V: - Malegaon. 7. Pulses: - Chandwad. 8. Ragi: - Sinnar. 9. No Rank: - Peint.	1. Wheat: - Kalwan, Chandwad, Malegaon. 2. Rice: - Peint, Dindori, Sinnar. 3. Pulses: - Surgana, Igatpuri. 4. F/V: - Baglan. 5. Oilseed: - Niphad. 6. Sugarcane: - Nandgaon. 7. Vari: - Nashik. 8. Fodder: - Yeola.
Nineth Rank (Six crops)	Nineth Rank (Six crops)
1. F/V: - Nandgaon, Yeola, Sinnar, Dindori. 2. Maize: - Nashik, Baglan, Kalwan. 3. Cotton: - Malegaon, Chandwad. 4. Bajara: - Igatpuri, Surgana. 5. Fodder: - Niphad, 6. Sugarcane: - Peint.	1. F/V: - Baglan, Nandgaon, Dindori, Surgana. 2. Cotton: - Malegaon, Kalwan, Yeola. 3. Maize: - Nashik, Niphad, Chandwad. 4. Rice: - Sinnar. 5. Sugarcane: - Peint. 6. Bajara: - Igatpuri.
Tenth Rank (Eight crops)	Tenth rank (Nineth crops)
1. F/V: - Igatpuri, Kalwan, Nadgaon. 2. Sugarcane: - Sinnar, Yeola, Surgana. 3. Jowar: - Niphad, Nashik. 4. Wheat: - Peint. 5. Pulses: - Chandwad. 6. Rice: - Malegaon. 7. Vari: - Dindori. 8. Fodder: - Baglan.	1. Pulses: - Chandwad, Niphad. 2. Sugarcane: - Sinnar, Nashik. 3. Vari: - Dindori, Kalwan. 4. Rice: - Malegaon. 5. F/V: - Igatpuri 6. Fodder: - Baglan. 7. Jowar: - Yeola. 8. Wheat: - Nandgaon. 9. No Ranks: - Surgana, Peint.

FIG. NO.5.1: DISTRIBUTION OF FIRST RANKED CROPS



FIRST RANKING CROPS:-

Out of fifteen talukas (Two new talukas) seven talukas have Bajara as their first ranking crop. This comes to account for 54 percent of the total number of talukas i.e. Bagalan, Malegoan, Nandgaon, Chandwad, Niphad, Yeola and Sinnar. In general, it appears to be well distributed everywhere, except the western talukas of the district. This is because of low relief and gentle slope in the river basins. Two talukas have ragi as their first ranking crop, i.e. Peint and Surgana. Pulses hold the first rank in Dindori taluka, rice ranks first in Igatpuri taluka, whereas Jowar ranks first in Kalvan (Kalvan & Deola) taluka and Fodder ranks first in Nashik (Nashik and Trimbak) in the reference year 1991.

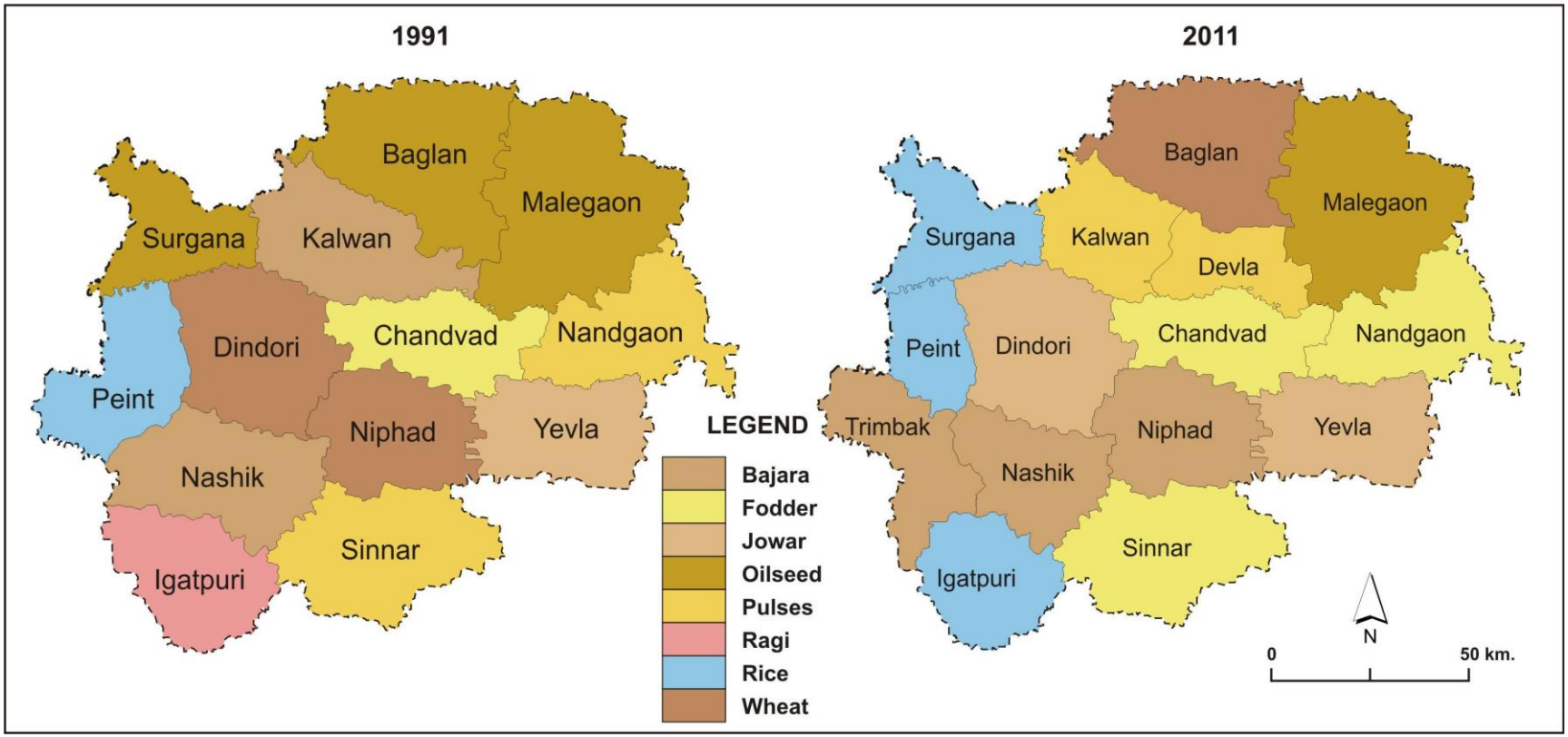
As per reference year 2011 the district has only four crops involved as first ranking crops. Out of the 15th talukas, 7 talukas have Bajara i.e. Kalvan (Kalvan & Deola), Baglan, Malegaon, Chandwad, Nandgaon, Yeola and Sinnar talukas have high percentage under Bajara because of black medium soil, suitable climate and moderate rainfall. 3 have Fodder Two have Ragi and one has Jowar as their first ranking crop. Jowar has first rank in Niphad taluka because of irrigation facilities. Ragi ranks first in Peint and Surgana talukas, where rainfall is heavy and there is high relief. Fodder occupies comparatively more hectare and ranks as the first important crop in Nashik (Nashik and Trimbak), Dindori and Igatpuri talukas. (Fig. no. 5.1)

SECOND RANKING CROPS:-

The Second rank is significant because it brings out the second preference of farmers in the determination of the crop pattern. Further analysis of the second rank focuses light on the pattern of distribution and changes which have taken place in giving preference for this rank. These changes reflect the development of crop land-use in the area. Expansion of irrigational facilities and electricity have supported certain crops like sugarcane, fruits and vegetable, wheat etc.; which need regular supply of water.

On this background spatial distribution of the second ranked crops has been viewed for the year 1991as follows

FIG. NO.5.2: DISTRIBUTION OF SECOND RANKED CROPS



It is evident from the map (Fig. no. 5.2) that the first ranking crops in some talukas comes in second ranking crops in the rest of the talukas. Eight crops, i.e. Bajara, Rice, Wheat, Oilseeds, Fodder, Pulses, Jowar and Ragi are the second ranking crops. It can be seen that oilseeds are the second ranking crop in 3 talukas i.e. Surgana, Baglan and Malegaon. It is 23 percent of the total talukas. These talukas lie in the western, north western and north eastern part of the district. Bajara is preferred as the Second ranked crop in nearly 15 percent of the total talukas i.e Kalvan (Kalvan & Deola) and Nashik (Nashik and Trimbak). Wheat ranks second in Two talukas of the total talukas i.e. Dindori and Niphad. Pulses also rank second in two talukas i.e. Nandgaon and Sinnar, irrigation and black soil are responsible for it. Rice in Peint taluka, Fodder in Chandwad taluka, Jowar in Yeola taluka and Ragi in Igatpuri taluka come under the second ranking crops. Requirements of environmental factors for these crops are as previously described in the first ranked crops.

Further spatial distribution for the year 2011considers changes which have taken place during the period under study. It reveals the following aspects. Seven crops come to the second ranking crops in the district. Wheat and Ragi are replaced by other crops. As regards oilseeds remain only in Malegaon. Rice in Surgana, Peint and Igatpuri, Jowar in Dindori and Yeola talukas respectively. Both the crops rank second in 15 percent talukas of the total talukas. Bajara is the second ranking crop in Niphad and Nashik (Nashik and Trimbak) talukas. Fodder ranks second in three talukas i.e. Chandwad, Nandgaon and Sinnar. Pulses and Wheat have one taluka each i.e. Baglan, Kalvan (Kalvan & Deola).

THIRD RANKING CROPS:-

The distribution pattern of the third ranking crops is fragmented and diversified (Fig. No. 5.3). Five crops in the reference year 1991, and eight crops in the reference year 2011 come under the third ranking crops in the districts. Fodder, oilseeds, jowar, pulse, wheat (1991). pulses, jowar, rice, fruits and vegetable, Oilseeds, wheat, sugarcan, and ragi in the year 2011.

As per reference year 1991, out of total talukas, Fodder has Five i.e. Surgana, Dindori, Niphad, Sinnar and Igatpuri, Oilseeds have two talukas such as Nandgoan and Kalvan (Kalvan & Deola), Jowar in Malegaon and Chandwad, Pulses come under three talukas i.e. Peint, Yeola & Baglan, wheat has one taluka which is Nashik (Nashik and Trimbak) as their third rank crops. As per reference year 2011, eight crops in the district are under the third ranking crops. Out of total talukas, Pulses have four talukas i.e. Surgana, Kalwan, Nandgaon and Yeola, Jawor in Niphad and Malegaon talukas comes under this rank. Oilseed also in two talukas i.e. Sinnar and Baglan. Rice, fruits and vegetable, wheat, sugarcane, and ragi have one taluka each as their third raking crop. As compared to 1991 reference year, a changed picture of ranking of crops is seen during the reference year 2011. Number of talukas under Pulses are increased. Fodder is replaced by Vegetable and fruits, rice and sugarcane in the reference year 2011, because the tendency of farmers changed as well as irrigation facilities and electrification were available. (Table No. 5.1and 5.2).

FOURTH RANKING CROPS:-

Both the reference years have seven crops as their fourth ranking crops in the district. But little change is seen in the position of their ranks in various talukas. As per reference year 1991 Pulses have four talukas Surgana, Kalvan (Kalvan & Deola), Niphad and Igatpuri, Jowar has two talukas i.e. Baglan and Nandgaon, wheat has two talukas i.e. Chandwad and Yeola, and Rice [Nashik- (Nashik and Trimbak)], Vari (Peint), Bajara (Dindori), Fodder (Malegaon) have one taluka each as their fourth ranking crop. But as per reference year 2011 wheat in Niphad and Yeola, pulses come in four talukas i.e. Baglan, Malegaon, Dindori and Sinnar, Jowar in Chandwad and Nandgaon talukas and Ragi in Surgana and Kalvan (Kalvan & Deola), Vari in Igatpuri, Fruits and Vegetables in Nashik (Nashik and Trimbak) taluka, Oilseeds in Peint taluka each as their fourth ranking crop. (Table no. Table No. 5.1& 5.2), (Fig no. 5.3)

FIG. NO 5.3: CROP RANKING

FIFTH RANKING CROPS:-

As per 1991reference year six crops and as per reference year 2011, eight crops in the district are fifth ranked crops. As per 1991reference year out of fifteen talukas, wheat has five talukas, which are Kalvan (Kalvan & Deola), Baglan, Malegaon, Sinnar and Nandagaon Oilseeds have four talukas i.e. Chandwad, Yeola, Niphad and Igatpuri, Rice (Dindori), Vari (Surgana), Fodder (Peint), Fruits and Vegetable Nashik (Nashik and Trimbak) have one taluka each as their fifth ranking crops. But as per the reference year 2011, out of 13 taluka, 8 crops are regarded as fifth ranking crops. Fruits and Vegetables have three talukas i.e. Sinnar, Peint and Chandwad, Sugarcane has 2 talukas i.e. Yeola and Nandgaon, Jawor in Surgana and Baglan talukas and Fodder has also two talukas i.e. Malegaon and Niphad. Wheat (Igatpuri), Maize (Kalvan (Kalvan & Deola), Pulses Nashik (Nashik and Trimbak) and Oilseeds (Dindori) in one taluka each are their Fifth ranking crops. (Table No. 5.1& 5.2), (Fig No. 5.3)

SIX RANKING CROPS:-

Sixth ranking crops show different positions in different talukas. It can be seen that sugarcane is the sixth ranking crop in four taukas i.e. 31 percent talukas out of the total talukas sugarcane is produced in Baglan, Malegoan, Chandwad and Yeola. Jowar (Peint & Niphad), Ragi (Nashik (Nashik and Trimbak) and Kalvan (Kalvan & Deola)) have 2 talukas each and oilseeds (Dindori), cotton (Nandgaon), wheat (Igatpuri), rice (Surgana), and fruits and vegetables (Sinnar) have one taluka each as their Sixth ranking crops during 1991reference year. As per reference year 2011 Oilseeds have five talukas i.e. Surgana, Kalwan, Nashik, Sinnar and Chandwad taluka. fruit and vegetables have three talukas i.e. Malegaon, Dindori and Yeola. Jowar is observed as ranking in Igatpuri and Peint taluka. Wheat in Nandgaon, Rice in Baglan, and Pulses in Niphad have as their Sixth ranking crops. Environmental factors are the same as described in the First ranking crops. (Table No. 5.1& 5.2).

SEVENTH RANKING CROPS:-

As per reference year 1991 in the Nashik district nine crops come under this rank. Rice has two talukas i.e. Kalwan and Nandgaon., Fruits and Vegetables are produced in Chandwad and Niphad taluka, Pulses have two talukas i.e. Nashik and

Malegaon, Oilseeds have also two talukas i.e. Igatpuri and Peint taluka come in this rank. Jowar (Dindori), Wheat (Surgana), Ragi (Baglan), Fodder (Sinnar), and Vari in Yeola taluka. But as per year 2011 seven crops are considered as seventh ranking crops. During this year wheat has three talukas i.e. Baglan, Surgana and Peint, Fruit /Vegetables have three talukas i.e. Kalwan, Malegaon, Yeola. Rice and Jowar have two talukas each i.e. Niphad, Chandwad and Nashik, Sinnar respectively. Ragi (Igatpuri), Bajara in Dindori taluka and Sugarcane (Nandgaon), are their seventh ranking crops. (Table No. 5.1 and 5.2).

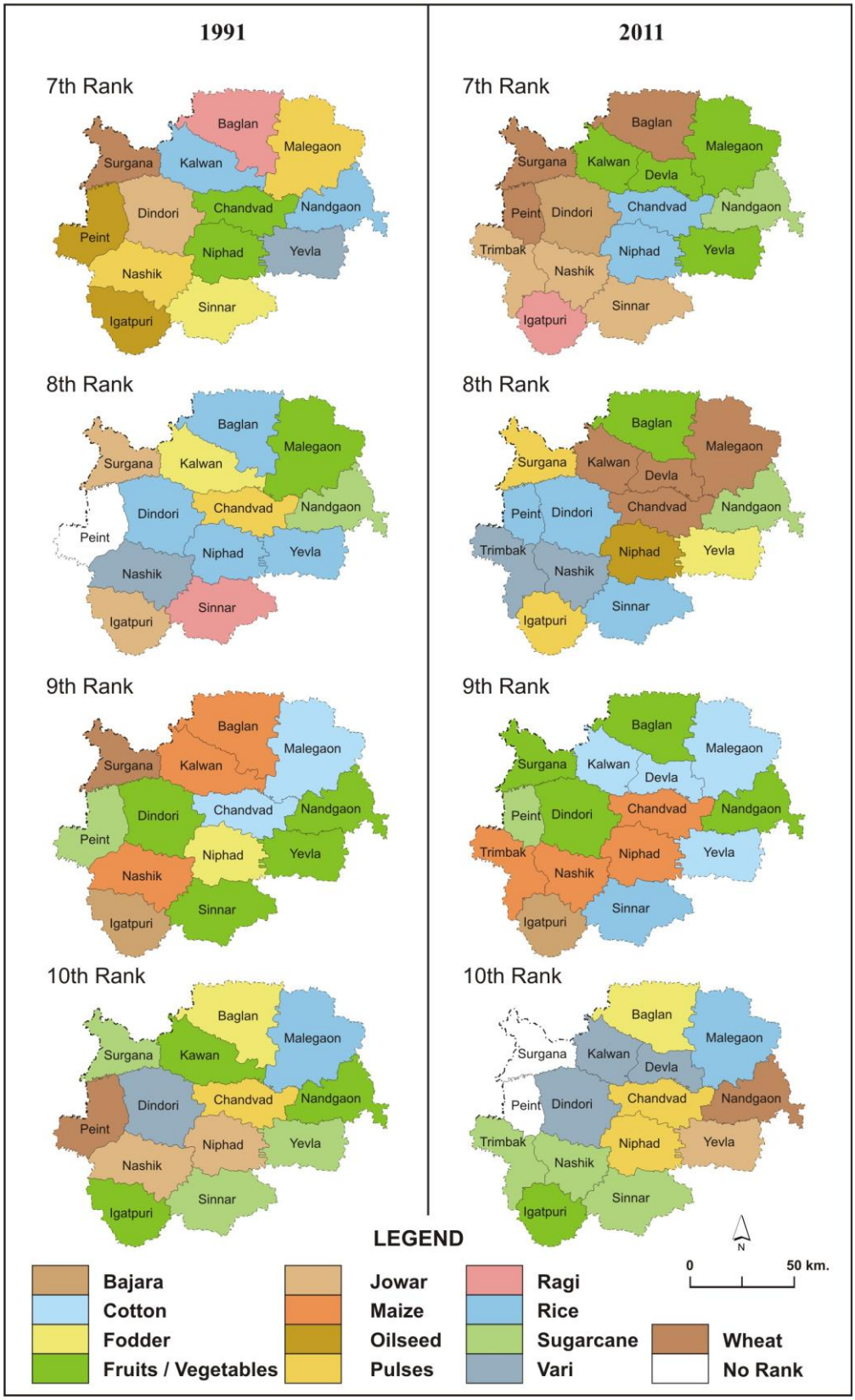
EIGHTH RANKING CROPS:-

According to 1991and 2011reference years, eight crops are considered as 8^{th} ranking crops. During the reference 1991 year Rice has 4 talukas i.e. Baglan, Dindori, Yeola and Niphad, Jowar has 2 talukas (Surgana & Igatpuri). Sugarcane (Nandgaon), Vari (Nashik), Fodder Kalvan (Kalvan & Deola), Fruits & Vegetables (Malegaon), Pulses (Chandwad) and Ragi (Sinnar) have one taluka each as their eight ranking crops and Peint has no rank. As per reference year 2011 wheat has three talukas i.e. Kalwan, Chandwad and Malegaon, Rice has also three talukas i.e. Peint, Dindori and Sinnar, Pulses have 2 talukas i.e. Surgana and Igatpuri. Fruits and Vegetable (Baglan), Oilseeds in Niphad, Sugarcane (Nandgaon), Vari (Nashik) and Fodder (Yeola) have 1 taluka each as their 8^{th} ranking crops. (Table No. 5.1& 5.2).

NINTH RANKING CROPS:-

As per reference years 1991, and in 2011 six crops are considered as 9^{th} ranking crops. During 1991years, Fruits and Vegetable have four talukas i.e. Nandgaon, Yeola, Sinnar and Dindori. Maize has three talukas i.e. Nashik, Baglan and Kalwan taluka, Cotton has two i.e. Malegaon and Chandwad, Bajara has also two talukas i.e. Igatpuri and Surgana. Fodder in Niphad and Sugarcane in Peint Taluka are their Nineth ranking crops. But during 2011 reference year the pattern is changed. Out of 13 talukas, Fruit and Vegetables have four, i.e. Baglan, Nandgaon, Dindori and Surgana. Cotton has three talukas i.e. Malegaon, Kalwan and Yeola, Maize has also three talukas i.e. Nashik, Niphad and Chandwad come under this rank. Rice has one i.e. Sinnar, Sugarcane in Peint, and Bajara in Igatpuri taluka. (Table No. 5.1& 5.2).

FIG. NO 5.4: CROP RANKING



TENTH RANKING CROPS:-

As per reference years 1991 eight crops and 2011 nine crops are considered as Tenth rankig crops. During the 1991 year Fruits Vegetable have three i.e. Igatpuri, Kalwan, and Nandgaon, Sugarcene in Sinnar, Yeola and Surgana. Jowar in Niphad and Nashik, Wheat Pulses, Rice, Vari, Fodder have one taluka each i.e.Peint, Chandwad, Malegaon, Dindori, Baglan respectively as their tenth ranking crop. But during 2011 years, Pulses (Chandwad, Niphad), Sugarcane (Sinnar, Nashik) and Vari (Dindori and Kalwan) i.e. two talukas each come under this rank. Fruits and Vegetables in Igatpuri, rice in Malegaon, fodder in Baglan, jowar in Yeola and wheat in Nandgaon are one taluka each as their tenth ranking crops. This crop ranking is absent in Surgana and Peint taluka (No Rank). (Table Nos. 5.1& 5.2).

CROP COMBINATION:-

5.3) CROP COMBINATION:-

The variations in climate, irrigation facilities, temperatures and other environmental factors have resulted in multiple cropping patterns. The concept of crop combination is a scientific means to study the existing spatial relationship of crops in association with each other in agricultural geography and land utilization. Such a study is necessary in order to have a more complex structure of agricultural regions. The measures and the area dominance of crops are closely related and occur together in varying strength. Any study of crops on the regional scale must take into consideration the combinational analysis and the relative position of the crops. The study of combinational analysis will ultimately minimize the chance of over simplified generalizations.

Crop combination regions may be used to evaluate if a particular combination would lead to dietary adequacy or Inadequacy in the essentially agricultural land scape. In any proposed research work, an attempt can also be made to study the crop-association regions with a view to (I) testing the procedure of combinational analysis in an essentially agricultural region with vast agricultural potentialities and diversity

of crops, and (II) evaluating the consistency or otherwise of crop-association regions that structure in a meaningful way. Geographers have contributed a lot of agricultural planning by studying both micro and macro regions. The work done by them on crop combinations provides not only a good help to regionalization, but also opens up a further line of analysis and action for agricultural planners, that is to focus attention on weaker parts and enrich crop rotations. Crops are the principal index of agricultural typology in an area, so much that agricultural regions are commonly known after the dominant crops, i.e. the bajara region, jowar region or wheat region. Crop combination aims at eliminating certain less important crops from the crop complex and is essentially a process of elimination.

In order to determine some sharp cut-off points for the delineation of crop combinations, the geographers have applied different statistical techniques to demarcate the set of elements that play significant roles in any particular system. The present study does not introduce a new method of forming such elements combinations, but it is only an attempt to review some of the methods already worked out and to assess their accuracy and usefulness. The purpose of the present study has been two fold.

(I) To democrate sets of those crops which play a dominant role in each taluka, and

(II) To find out areas where crop cultivation is more specialized, and where it is not.

So crop combination regions are delineated here on the basis of the methods advocated by Weaver J.C (1954) and Doi K. (1959). The most important and more popular approach was presented by Prof. J.C. Weaver for delineating the complex structure of agricultural regions of Middle West in the U.S.A. in 1954. In this study he has taken into account the percentages of crop areas out of the total cropped area and has calculated deviations of real percentages for all the possible combinations in the component areal units against a theoretical standard. The theoretical standard is 100 percent of the gross cropped area for monoculture, 50 percent for two crop combinations and 33.33 percent for three crop combinations and so on. For the

determination of the minimum deviation for each of the components areal units standard deviation method was applied by using the formula.

$$S.D. = \sum d^2 / n$$

However, as Weaver has pointed out, since the relative rank of the amount of deviation among the several possible combinations was desired, and not the actual magnitude of deviation, the square root was not extracted in accordance with standard deviation formula. The specially used variant procedure could therefore, be expressed as

$$S.D. = \sum (d)^2 / n$$

In the above formula "d" is the difference between the actual crop percentage in a given country and the appropriate percentage in the theoretical curve, and "n" is the number of crops in a given combination. As a result of statistical processing by Weaver's deviation method, 10 crop combination regions are identified in Nashik district from 14 main crops. i.e. bajara, jowar, rice, cotton, oilseeds, wheat, sugarcane, fruits and vegetables, pulses, fodder, grapes, maize, ragi and vari.

5.4) CROP COMBINATION ACCORDING TO J.C.WEAVER:-

As a result of the application of the Weaver's method, ten crop combination regions emerge out in Nashik district. The talukas falling into different combinations are given in (Table Nos. 5.5 and 5.6) and plotted in (Fig No. 5.5)

$$S.D. = \sum d/n$$

The Weaver's method has been accepted for the delineation of crop combination regions as its application result is a suitable and accurate combination. The method, however, gives most unwieldy combinations for the units of high crop specification. As per year 1991, in 3 talukas (Nashik (Nashik and Trimbak), Nandgaon and Sinnar) of the total talukas decrease in variance was gradual. (Table No. 5.5), where every crop occupying as much as 1% of the gross cropped area was included in the combination to find out the lowest variance. In the year 2011, in 5 talukas (Baglan, Malegaon, Chandwad, Nandgaon and Sinnar) decrease in variance was gradual. (Table No. 5.6).

Table No. 5.2

CROP COMBINATION BASED ON WEAVER'S METHOD 1991.

No.of crops	No. Of talukas	Name of talukas	crops
Mono	--	--	--
2	1	Kalwan	JB
3	1	Malegaon	BOJ
4	1	Baglan	BOPJ
5	3	Peinth Dindori Yeola	ROVFJ PWFBR BJPWO
6	3	Surgana Chandwad Niphad	OFPVRW BFJWOS BWFPOJ
7	--	--	--
8	1	Igatpuri	RFPOWVJB
9	--	--	--
10	3	Nashik Nandgaon Sinnar	FBWRF/VVOMG BPOJWCRSF/VM BPFJWF/VORSV

FIG. NO.5.5: CROP COMBINATION BY WEAVER

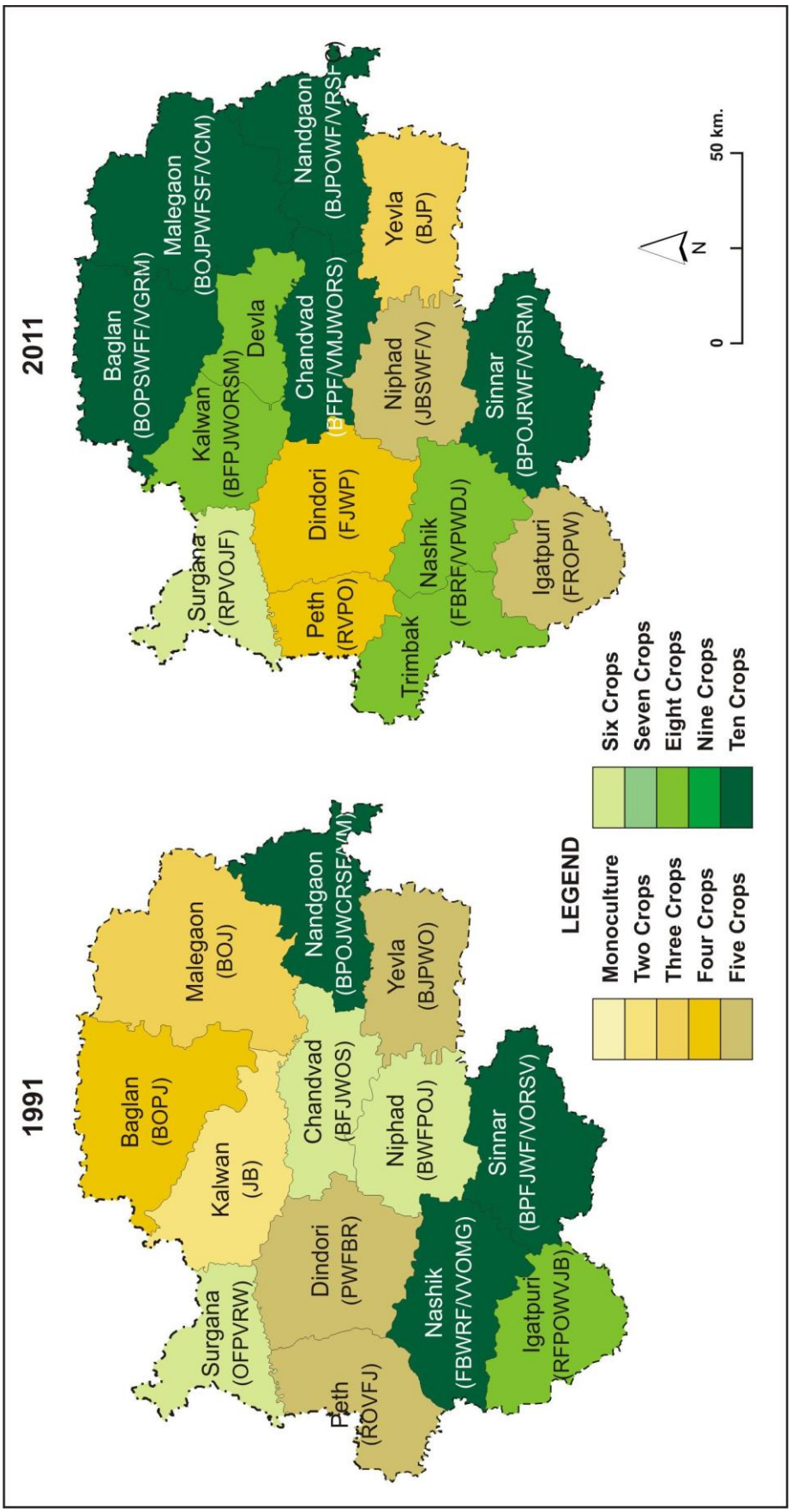


Table No. 5.3

CROP COMBINATION BASED ON WEAVER'S METHOD 2011.

No.of crops	No. Of talukas	Name of talukas	crops
Mono	--	--	--
2	--	--	--
3	1	Yeola	BJP
4	2	Peint Dindori	RVPO FJWP
5	2	Niphad Igatpuri	JBSWF/V FROPW
6	1	Surgana	RPVOJF
7	--	--	--
8	2	Nashik Sinnar	FBRF/VPWOJ BFPJWORSM
9	--	--	--
10	5	Baglan Malegaon Chandwad Nandgaon Kalwan	BOPSWFF/VGRM BOJPWFSF/VCM BFPF/VMJWORS BJPOWF/VRSFC BPOJRWF/VSRM

In the remaining talukas the variance value does not show gradual decline. In these talukas the variance decreases up to a few places from where it increases and then decreases again so as to surpass even the former decrease. It is also observed from the crop combination map of Weaver, that those areas which have irrigation facilities grow crops like sugarcane, wheat and cotton. In fact, all the crop combination regions have been derived from 12 major crops. The striking feature of these regions is the absence of monoculture combination in both the reference years.

TWO CROP COMBINATION:-

The Two crop-association of Jowar and Bajara is confined only to Kalwan (Kalwan & Deola) talukas in 1991, where soils vary from deep black to light red. Rainfall is below 1600 m. m. In the talukas Jowar and Bajara occupying more area in the net sown area. These are the dominating crops; Kalwan (Kalwan & Deola) taluka lies in the north western part of the district and has a small percentage of net irrigated area out of the net sown area. So there is no chance for diversified crop cultivations. The main feature of these study regions is the absence of monoculture and two crop combination regions in the years 1991and 2011 (Table Nos. 5.5 and 5.6).

THREE CROP COMBINATION:-

Malegaon taluka in 1991and Yeola taluka in 2011 present the pattern of three crop combination. Bajara, Oilseeds and Jowar were important crops in Malegaon taluka in the year 1991, but in Yeola taluka Bajara, Jowar and Pulses were dominant crops in the year 2011. Both talukas lie in the eastern part, where rainfall is below 700 m. m. Scanty rainfall and black to medium black soil result in the cultivation of these crops. Black soil is found in Malegaon taluka and black, red brown and medium soil is found in Yeola taluka. Some parts of Malegaon taluka are supplied with canal irrigation facilities. Bajara and jowar crops depend upon natural rainfall in both the talukas. (Table Nos. 5.5 and 5.6).

FOUR CROP COMBINATION:-

Four crop combination is in Baglan taluka in the year 1991 and two talukas i.e. Peint and Dindori include in the reference year 2011. The patterns of Four crop combination are absent in the year 2011 in Baglan taluka. It lies in the north western part of the district, where rainfall varies from 450 m. m. to above 1600 m. m. The soil

is deep black to course shallow. Baglan taluka was marked as designed with Bajara, Oilseeds, Pulses and Jowar during the reference year 1991. Peint taluka had with rice, vari, pulses and oilseeds, and Dindori had fodder, jowar, wheat and pulses in the year 2011. Both of these talukas lie in the western part, where rainfall is 950 m. m. to above 1900 m. m.. The soil is medium black to course shallow. Due to rough and hilly nature and medium to poor soil as well as more rainfall in Peint and Dindori talukas Rice and Fodder are dominant crops respectively. (Table Nos. 5.5 and 5.6).

FIVE CROP COMBINATION:-

This crop combination is observed in Peint, Dindori and Yeola talukas as per 1991 year, because of medium to poor soil with moderate to high rainfall. Rice, Oilseeds, Vari, Fodder, Jowar, Bajara were the dominating crops in the year 1991 in the above talukas. As per 2011 reference year Niphad and Igatpuri taluka had five crop combination because of black soil with irrigation facilities and hot climate. Sugarcane, Fruits and Vegetable have shown better percentage in Niphad taluka. As compared to other talukas Igatpuri taluka receives high amount of rainfall, so fodder, rice and pulses are dominating crops.

SIX CROP COMBINATION:-

This crop combination is observed in Chandwad and Niphad talukas as per year 1991 and Surgana taluka is observed with this crop combination in both the reference years. They are situated in the western part of the district. Chandwad and Niphad lie in the central part. These talukas had Bajara, Fodder, Jowar, Pulses, Vari, Wheat and Oilseeds during the year 1991. In 2011 Surgana taluka was the only taluka with rice, pulses, vari, oilseeds, jowar and fodder combination. Due to hilly area, poor soils and high rainfall in Surgana taluka rice is the dominant crop. (Table Nos. 5.5 and 5.6).

SEVEN CROP COMBINATION:-

There is not a single taluka that comes under the seven crop combination as per years 1991and 2011. So seven crop combination is not found in any talukas of the study region.

EIGHT CROP COMBINATION:-

Igatpuri is the only taluka as per year 1991 included in the eight crop combination, and Nashik (Nashik & Trimbak) and Kalvan (Kalvan & Deola) talukas as per reference year 2011 have come under same crop combination. Because of medium to high rainfall in Igatpuri and Kalvan (Kalvan & Deola) taluka rice, fodder, pulses, oilseeds, wheat, vari, jowar and bajara were dominating crops in the above taluka. But in Nashik (Nashik and Trimbak) taluka because of urban influences, irrigation facilities and medium rainfall, Fruits and Vegetable crops are included in this crop combination. These talukas come under medium to black soils zone and lie in the western part of the district. (Table Nos. 5.5 and 5.6). (Fig No. 5.5).

NINE CROP COMBINATION:-

Nine crop combination is absent in both the reference years. i.e. 1991and 2011. (Table Nos. 5.5 and 5.6). (Fig No. 5.5).

TEN CROP COMBINATION:-

As per 1991 year there are three talukas i.e. Nashik (Nashik and Trimbak), Nandgaon and Sinnar that come under this combination, and according to 2011 reference year five talukas show ten crop combination. These talukas are Baglan, Malegaon, Chandwad, Nandgaon, Kalvan (Kalvan & Deola) which belong to the central and eastern part of the district where rainfall is medium and the soil varies from black to course shallow. They have also the same area under well irrigation. Main crops are bajara, jowar, oilseed, pulses, sugarcane, fruits and vegetables, rice and maize these are crops considered for combination. All the above crops are affected by environmental factors, so there is diversification in combination and distribution pattern of crops. (Table Nos. 5.5 and 5.6).

From the above evidence it is clear that bajara and jowar are leading crops in the central and east part. On the other hand rice, vari are dominat in the western part. Surgarcane, fruits and vegetable, especially Promogranites and Grapes dominat in Niphad, Baglan, Kalwan and Malegaon tehsils.

5.5) DIVERSIFICATION OF CROP:-

Cropping pattern means the proportion of the area under different crops at a point of time. A change in cropping pattern implies a change in the proportion of area under different crops. Because of changing environmental factors some crops are replaced by other crops. In the study area diversification of crops is found. The concept of diversification, in quantitative measurement refers to uniform share of any phenomena in the socio-economic sphere. Diversification according to Fukuda (1976) denotes the combining of farming horticulture, livestock raising or fishery together. Diversification, for the present investigation, is limited to cropping pattern, in other words, it refers to raising a variety of crops involving high competition amongst field crops for arable land. Dhabai (1979) in his study states that the process of convergence and divergence in crop diversification is cyclic one. Generally, in the initial stage of development the farmer grows all subsistence crops .As a result, diversification occurs. In the second stage, after getting inputs like irrigation, H.B. seeds, fertilizers etc. the farmers concentrate on one or two major crops. In the third stage, again they diversify their agriculture to strengthen the existing level of development. In fact, a large number of factors influence the choice of cropping systems such as physical, socio-economic and techno-organizational. On the other hand crop-specialization or monoculture system leads to progressive reduction in yield or to the yield falling below a profitable level (Singh, 1978).

The techniques of measuring diversification have been developed initially in the field of manufacturing by various scholars such as, Clenn (1930), Tress (1935), Plorene (1942) and Rainwald (1949), wherein they have tried to find out the degree of diversification and concentration of leading industries in their respective countries. Recently Gibbs Martin (1974) developed an index to measure the diversification of employment in industries, which seems to be suitable for other sectors also.

The diversification was also attempted by Bhatia (1965). In his formula the sum total percentages of cultivated area under the crop occupy more than 10 percent

of the cultivated area was taken as the numerator and the number of those crops as denominator. Lower limits of percentage of individual crop to out total a cultivated area are not mentioned. His contention was that the lower the value of index, the higher the diversification and vice-versa.

In 1976, Jasbir Singh in his study modified the technique of Bhatia. The modified technique has been used to show the magnitude of crop diversification in the region under study .The higher the value of the index, the lower the degree of crop diversification and vice-versa. The value cannot be less than 5% The crops which occupy individually less than 5% area are not considered. The modified formula is developed by Jasbir Singh. To find out the spatial pattern of crop diversification in the Nashik District, Jasbir Singh's formula has been applied. The modified formula is as follows.

$$\text{Index of Crop Diversification} = \frac{\%\text{of total harvested area under "n" crop}}{\text{Number of "N" crops.}}$$

The "n" crops are those which occupy individually 5% or more in

The total harvested area in the given area unit. The indices thus, obtained with this formula are shown in Nashik District (Fig. No. 5.6) in 1991 and 2011 reference years.

From the map "pattern of crop combination", we can say that in Nashik district, three parts of crop diversification, i.e. (1) High crop diversification (2) Moderate crop diversification and (3) Low diversification of crops exist.

In the reference year 1991, Kalwan, Baglan, Malegaon and Nandgaon talukas. and Yeola, Malegaon and Nandgaon talukas during the reference year 2011 have high diversification class.(above 21 index value). It means these talukas have low diversification of crops. For there were limited irrigation facilities, as well as these received very scanty rainfall. That's why these talukas grow mainly food grains. (Fig. No. 5.6)

The moderate crop diversification is seen in Peint, Yeola and Sinnar talukas during 1991 reference year, and Baglan, Chandwad, Niphad, Sinnar and Igatpuri talukas during 2011 (17 to 20 index value) reference year. The hectares under Sugarcane, Rice, and Fodder have increased their percentage in the above talukas. (Table No 5.6).

The low crop diversification class (13 to 16 index value) was Confined to the central and western part (Surgana, Dindori, Niphad and Chandwad) during 1991 reference year ; and Nashik, Peint, Surgana and Kalwan talukas during 2011 reference year . This diversification is observed because the rainfall is high, soil is medium in Surgana, Dindori and Igatpuri, 50 cultivators of these taluka have shifted their attention from traditional crops to vegetables and fruits, fodder crops. In Niphad taluka this diversification is observed because of irrigation facilities (wetland canal). So the cultivators of this taluka have changed their attention from food grains to non-food grains and cash crops such as sugarcane, fruits and vegetable, oilseeds, and wheat. (Fig. 5.6)

Very low diversification is observed only in Nashik and Igatpuri taluka during 1991 reference year and Dindori was the only taluka under this diversification during 2011 reference year.

Pattern of Diversification and Changes therein:-

The Pattern which thus emerged for the years 1991 and 2011 (Fig. No. 5.6) reveals that the region can broadly be divided agriculturally in to three zones, which are similar to their climatic divisions of wet in the west and dry in the east. The central zone is developed with water resources. The western part of the study area is characterized by very low and low level of diversification, whereas the central and eastern parts of the region are characterized by moderate to high level (17 to 21 index value) of diversification (Fig 5.6).

5.6) AGRICULTURAL LOCATION MODEL:-

The variation in agricultural production intensity and crop combinations is related predominantly to the variations in the different aspects of the environment (physical and socio-economic) viz. relief, soil, rainfall, irrigation and transportation have already been noted in the preceding chapters. The significance of the effect

factors of physical environment on agricultural patterns in developing economies cannot be overemphasized. Appreciating the observations made in the preceding chapters, an attempt is made here to build a schematic model to bring out the correlation between the spatial variations in relief, rainfall, soil, irrigation and accessibility on the one hand and the variations in agricultural patterns depicted by land use zones on the other. These land use zones are presumed to be resulting from the interactions of the said variables in the study region. The schematic model is mainly based on rainfall distribution and relief, to which are added one by one the remaining variables.

An attempt to offer a theory which could explain the location of different types of agriculture according to economic principles was made by Johan Heomrocj Von Thunen in the first half of the 19th century .Von Thunen approached the problem of agricultural locations introducing the concept of locational rent, illustrating the manner in which the rent mechanism produced a land use pattern under conditions prevailing at that time. The analysis of agricultural location problem has been made explicit by Dunn (1954), Hoover (1937), Losch (1954) and Isard (1956).In developing countries like India, where agricultural is still the main occupation of the rural masses, the changes in agriculture are very slow due to the scarcity of agricultural inputs, less developed infrastructure, illiteracy and poverty of the average Indian farmer. This leads to the dependence of a farmer upon physical factors while making decisions regarding the choice of agricultural enterprises.

THE PROPOSED MODEL:-

The model presented proposes three variables, a combination of which results in different crop associations. The resources (water, soil, etc.) are fixed in location .The other variables are as follows.

1] PHYSICAL ENVIRONMENT:-

The spatial distribution of agricultural land-use is influenced by physical environment directly or indirectly .Relief, soil and rainfall are important physical variables considered here.

I] RELIEF:-

The area of Nashik district is not plain without isotropic surface .The western boundary of the district runs along the Steep slopes in the western part, moderate relief, moderate slopes or small with small hills in transitional zone, and low divides, plains and plateaus with gentle slopes in the eastern part. The rivers originate in the western part and flow from west to east. (Chapter No. – I, Fig No. 1.3)

II) SOIL:-

Soils are an important environmental factor influencing cultural land-use. They also influence the availability of land for cultivation and choice of crops. Poor soils of steep slope areas are unfit for crops .The deep black soils are used for important crops i.e. jowar, wheat and cash crops .The poor soils are used for hill-millets and bajara.

III) RAINFALL:-

The rainfall in study area received the amount of rainfall varies from 500 m. m. (in the east) to above 2500 m. m. (in the west). The study area is divided into three rainfall zones (a) western high rain-fall zone. (b) Medium rainfall zone and (c) drier zones

(Chapter No. -I and fig. No. 1.6)

2) ACCESSIBILITY:-

There are two major routes, joining most of the central places. Small villages and small market places are connected to each other by kachcha roads, most of which cease to work in the monsoon period and thus many villages are totally cut off during the monsoon season .Bullock cart is the main mode of transportation in the study area.

3) IRRIGATION:-

Irrigation facilities are important for crops. The supply of water is the main requirement for successful cultivation of crops in the medium rainfall zone and drier zone. Irrigation projects are constructed in heavy rainfall and high relief regions storing water to be used for agriculture by constructing canals .Well irrigation is also practiced in the central and eastern parts of the study region.

The study area is divided in the following land-use zones based upon these assumptions. Agricultural land-use of each zone results from the interaction of environmental factors i.e. rainfall, relief, accessibility and water supply.

THE FIRST ZONE:-

It is characterized by very high rainfall (above 2500 mm.) and rugged, hilly topography with steep slopes .Because of this very limited land is available for cultivation .Irrigation facilities are not available .Transportation is extremely poor. A major portion of the geographical area is covered by either grass or forests. vari, sawa, nachani and rice are the main crops of this zone. Agriculturally this zone is less significant, but has high potentials for development of forestry. This zone occupies 4.5 percent of the total model area. (Table No. 5.14)

SECOND ZONE:-

This zone has a similar physical environment as that of the 1st zone except the rainfall amount received is between 1500 mm. and 2000 mm. Rice is the main crop of this zone. This zone also has a significant proportion of its total geographical area under grass and forestry .The land available for cultivation is more than the 1st zone. Transportation is poor but slightly better than the first zone. Most of the rough roads are useless in monsoon. Physiographic conditions in this zone are favorable for the construction of water reservoirs. Five schemes are located in this zone. This zone occupies 4.65 percent area (Table No. 5.14)

THIRD ZONE:-

This zone is found between wet areas and scarcity areas. Rainfall here varies from 600 mm. to 1500 mm. Moderate slope, flat topped divides and wide valley bottom are the main physical characters of this zone .The area under cultivation increases the main crops of this zone are jowar, bajra, pulses, oilseeds, rice, cash crops, wheat and cotton. Bajra is the main crop of this zone. The agricultural pattern in this zone is influenced by Bombay Agra Road and railway routes. The influences of city markets and the improved connectivity are reflected in the vegetable fruits crops(grapes) , grown specially for the city markets .The availability of irrigation water from the schemes on major rivers in zone I and II has introduced a diversified

cropping pattern, including double cropping and cash crops like sugarcane, vegetables and fruits. Well irrigation is also practiced. The total area of this zone is 34.25 percent of the model area. (Table No. 5.14).

FOURTH ZONE:-

This is a semi –arid zone marked by low relief, low divides, broad open valleys and gentle slopes .The area under cultivation is increased because of these physiographic conditions. Grass and forested area are insignificant. The amount of rainfall received is between 500 mm. and 600 mm. This zone occupies 26.30 percent of the model area. The land use is modified by transport route joining a few central markets and the area under canal irrigation. (Table No. 5.14).

FIFTH ZONE:-

This zone occupies the eastern part of the study region. This zone is marked by low plateaus, gentle slopes, broad valleys and rolling plains. The land available for cultivation is maximum. Rainfall received is less than 500 mm. bajara is the main crop of this zone. The accessibility and availability of water has changed the crop pattern, introducing sugarcane, cotton, jowar, fruits and vegetables. This scarcity zone occupies 20.65 percent of the model area. (Table No. 5.14).

The growth of transportation network, exploitation of available irrigation potential, agricultural innovations, market potential, and small socio-economic changes are responsible for further modification of land-use patterns. This zone is divided into (i) Problem region (zones IV and V) and (ii) Potential region (zones I and II). The first and second zone provide the problem area with surplus of fodder for animal husbandry. Besides this, high rainfall zones would provide water to the scarcity areas solving a part of the major problem of scarcity zones. The model of agriculture land-use presented here is applicable to the whole of the western part of Maharashtra, where the environmental factors are more or less similar to Nashik district.

ASSOCIATION BETWEEN AGRICULTURAL LAND –USE AND PHYSICO –CULTURAL ENVIRONMENT

5.7) ASSOCIATION BETWEEN AGRICULTURAL LAND –USE:-

The form of agricultural activities and farm economy as a whole are influenced to a large measure by environmental and cultural factors. Relief, Soil and climate are important environmental factors which play a dominant role in agricultural activities. In the earlier chapter different elements of physical and cultural environment, their spatial distribution and their impact on agricultural land-use were discussed. In this chapter these relationships are further studied and analyzed applying quantitative techniques like simple correlation and multiple regression. It would have been impossible to handle a large volume of data consisting of 14 variables and 100 observations without the help Computer unit, Package of ICL 1900 statistical analysis XDS 3/26 were used for the above analysis. In order to investigate the association between land-use types on the one hand and environmental elements (Physical–cultural) on the other the following fourteen variables – X1 to X6 dependent and X7 to X14 independent Variables were carefully selected from the set of available variables.

X-1 - Net Sown area (NSA) (Percentage to out of total geographical area)
X-2 – Grass (Percentage to out of total geographical area)
X-3 – Rice (Percentage to out of net sown area)
X-4 – Jowar (Percentage to out of net sown area)
X-5- Bajara (Percentage to out of net sown area)
X-6- Cash crops (Percentage to out of net sown area)
X-7 – Irrigated land (Percentage to out of net sown area)
X-8 – Accessibility.
X-9 – Owner cultivators (Percentage to out of total agricultural workers)
X-10 – Density of population.
X-11 –Slope less than 3 degree.
X-12 – Slope higher than 20 degree.
X-13 – Distance from crest.
X-14 – Distance from major streams.
X-15 – Agricultural Density.

Among the independent variables, distance from crest indirectly independent represents the variations

In the rainfall distribution it is assumed that the amount of rainfall decreases as the distance from the crest increases. This is backed by the fact that all the ohytes are almost parallel to the crest line. Thus this variable in fact represents the rainfall pattern. Secondly increasing the distance from the crest also means changes of relief from hilly, rugged areas to broad open valleys, low divides and low plateaus .It therefore, reflects the variations in climate as well as in relief. Another variable, distance from the major stream (of order 5^{th} and above) is defined in order to bring out the variation in the land use with changes in the slope characteristics and soils across the river valleys. Two more variables of slope types represent the "relief "factor. The amount of slope in degrees was obtained from the available one inch topographic maps. Initially relative relief was measured using 1000 Y ds x 1000 Y ds grid .Then taking the radius of the grid area as the horizontal equivalent and relative relief as the vertical interval, tan 0 was calculated and a map showing different categories of slope was prepared. The variables irrigated area and accessibility in terms of route length per taluka are included to estimate the relation between these two economic elements and the agricultural land-use. Density of population and proportion of owner cultivators may focus light on the impact of social factors upon the land-use.

5.8) CORRELATION ANALYSIS:-

"Person's product moment correlation coefficient" method was calculated by using the 100 x 15 data matrix. Students "t" test was applied to determine significant "r" values at 0.05 and 0.01 levels of significance. The results obtained reveal a certain significant association between the selected variables, which are summarized as follows. (Table No.5.15).

NET SOWN AREA – 1) PHYSICAL AND CULTURAL ENVIRNOMENT:

"The area under net sown area is strongly influenced by the physical environment". It has a positive correlation with slope (r=0.79). It is obvious that the gently sloping lands and rolling plains would offer maximum scope for cultivation and in the hilly terrain with steep slopes (slope 20°), there is very small proportion of total area available for cultivation(r = -0.67).The net sown area also increases with the distance from the crest (r=0.79) as the terrain changes from hilly tracts with steep slopes to broad open valleys and low divides with gentle slope. Distance from the major stream has no significant correlation with net sown area indicating that net sown area is independent of locations in the valleys or on the divides. The economic factors like irrigation (r=0.46) and accessibility (r=0.27) have significant positive correlations with net sown area meaning thereby that increase in irrigation and accessibility would offer a scope for bringing more area under cultivation as expected .Lastly, the increase in net sown area is associated with increase in population density (r=0.28), but the proportion of owner cultivators to total agricultural workers decreases with the increase in the net sown area. This perhaps can be explained by the fact that with the increases in the size of holding the proportion of laborers increases and relatively the proportion of owner cultivators decreases.

2) GRASS –ENVIRNOMENTAL FACTORS:

There is high positive correlation between grass and slope >20° (r=0.53), and a high negative correlation with slope <3° (r=0.64).

It means the distribution of grass is strongly affected by the nature of terrain. (Table No. 5.15). It is observed that the lands unsuitable for cultivation are given to grass, a fact which explains why its high positive correlation with slope is 20° and negative correlation with slope <3°. Grass is not affected by distance from stream which is indicated by a negative correlation with distance from stream (r=-0.09). The area under grass decreases in more accessible, and irrigated areas (r=0.41 and r=-0.31 respectively). The density of population is low in the grass areas, though there is higher proportion of owner cultivators, which is indicated by negative correlation (r=-0.19). (Table No. 5.15).

3) RICE- ENVIRNOMENTAL (PHYSICAL AND CULTURAL) FACTORS:

The distribution of rice is strongly affected by the rainfall. The impact of rainfall on the distribution of rice is revealed by a high negative correlation (r=-0.60) between the distance from the crest and rice. (Table No. 5.15). The amount of rainfall received decreases with increasing distance from the crest and so does the proportion of rice in the net sown area.

The concentration of rice in the western hilly area of the study region is indicated by its correlation with slope >20° (r=0.66) and distance from the crest (r=0.60). Irrigation and accessibility both have a negative correlation (r=-0.39 and r=-0.21 respectively) with rice suggesting that due to heavy rainfall rice does not need irrigation and accessibility in the hilly tracts is poor. The correlation of rice with density of population is weak (r=-0.25) , the negative sign indicating that for the study region as a whole rice is grown in the areas of low density of population.

This is only because of the distribution pattern of rainfall, which is higher in the western hilly tract which has lower accessibility and hence low population density. The proportion of owner cultivators is higher in the rice growing areas indicated by high positive correlation (r=0.44). Significant negative correlation of rice with Jowar (r=-0.57), Bajara (r=0.53) and Cash crops (r=-0.51) indicates that rice is not significantly grown in association with these crops. (Table No. 5.15).

4) JOWAR – ENVIRNOMENTAL FACTORS (Physical and Cultural):

A positive correlation of Jowar with the distance from the crest (r=0.74) indicates that the area under Jowar increases with the increasing distance from the crest. This correlation suggests that Jowar is concentrated in low rainfall zone (less than 600mm). Jowar is grown on gently sloping lands below 3° of slope (r=0.70). There is a positive correlation between Jowar and irrigation, accessibility (r=0.27 and r=0.20 respectively). The proportion of owner cultivators decreases (r=-0.42) as the size of holding becomes larger away from the crest. A positive correlation is found between Jowar and cash crops, (r=0.15) but the correlation of Jowar with grass is negative. Jowar and Bajara do not show any significant relation. (Table No. 5.15)

5) BAJARA - ENVIRONMENTAL FACTORS (Physical and Cultural):

The correlation of Bajara with physical elements (slopes), irrigation, accessibility, cultivators and density of population, has similar relationship as that of Jowar. The distance from the crest does not influence the spatial distribution of Bajara significantly. The location of Bajara on plateaus and low divides, instead of on the better land near the streams, is reflected in a positive correlation between Bajara and distance from the stream (r=0.13). Bajara is indicated positively while crash crops (0.41) negatively (-0.53) with rice and grass. (Table No. 5.15).

6) CASH CROPS- ENVIRONMENT FACTORS:

Irrigation is a very important factor strongly influencing the spatial distribution of cash crops(r=0.70). With respect to relief factor, the area under cash crops increases with the increase in area with gentle slope below 3^0 (r=0.41) and increasing distance from the crest (r=0.25).It decreases in the steeply sloping hilly area (r=0.44) for slope $>20^0$. Improved accessibility also has some bearing on the increase in the proportion of cash crops (r=0.21). The proportion of owner cultivators is less in the areas where cash crops are important (r=-0.46), a fact which indicates that with the intensification and commercialization of agriculture input in the form of agricultural labor increases. The cash crops are positively related to the density of population, again indicating the significance of labor inputs.

The correlation analysis provides a basic structure which can be used for identification of useful quantitative techniques to be used for a more precise explanation of the spatial variation in land-use. The above analysis brings out clearly the importance of physical environment like slope and distance from the crest (rainfall) and economic factors like irrigation and accessibility as major factors influencing the land-use patterns The increasing proportion of cultivators in the hilly tracts with the low net sown area and the decreasing proportion of owner cultivator in the irrigated areas with the cash crops is clearly brought out. However, the distance from the major streams which differentiates between valley locations and divide locations does not show any significant relationship with the land-use variables except Bajara (Table No. 5.15).

MULTIPLE REGRESSION:-

"Regression model" is a very valuable technique in geographical research which helps to understand the functional relationship between variables. One variable is considered to be dependent upon one or several other variables. Here, multiple regression model is used to obtain the degree of association between agricultural land-use variables i.e. the net sown area, Grass, Rice, Jowar, Bajara and Cash crops (dependent) and the environmental variables i.e. irrigation, accessibility, owner cultivators, population density, slope less than 3 degrees, slope higher than 20 degrees, distance from the crest, distance from major streams, (independent), which were mentioned in the correlation analysis. The multiple regression model used is-

$$Y = a+b1x1+b2x2+b3x3.....+ bmxm +e$$

Where Y=dependent variables

X1.....x m= independent variables

a = constant or Y intercept

b ,.....b m = regression coefficients

The following (six) multiple regression equations were derived in order to estimate the influence of environment variables on the agricultural land-use in 100 observations of the district defined earlier. The partial correlation coefficients derived indicate the inter correlation of one independent variable, the dependent variables with all other independent variables held constant. Thus, these coefficients indicate the relative importance of each independent variable in explaining the total variance The significance of the individual multiple regression coefficients was tested at 0.01 and 0.05 levels of significance .Lastly the level of "explained variation" indicated by "R" was calculated. The results of the analysis are summarized as follows.

Table No. 5.4

1) **NET SOWN AREA (**X1=DEPENDENT VARIABLE**) - INDEPENDENT VARIABLES (**X7 TO X15**):**

Variables	Regression Coefficient	Part Correlation	T Stat	Significant
x10	b10 = 0.10	0.21	2.25	Yes
x 11	b ll = 0.25	0.24	3.05	Yes
x 12	b 12 = -0.09	-0.13	1.51	No
x 13	b 13 = 0.46	0.48	6.10	Yes
X14	B14 = 0.04	0.10	1.10	No

R=0.77 a=10.65

R=0.59

Among the variables included in the regression set the distance from the crest appears to be very important (0.46), followed by the slope<3^0 (0.25) and population density (0.10). The coefficient is negative for the variable slope>20^0 (-0.09). The distance from the stream and slope above 20^0 are not significant, though they are included in the regression set. About 60 percent of the variation is explained by the five above mentioned variables. Though the correlation analysis reveals significant relationship of the net sown area with all variables (except distance from streams) only five variables were included in the regression set and only three were observed to be significant in explaining the occurrence of the net sown area. However, the economic factors having significant positive correlation with the net sown area as revealed by correlation analysis do not occur in the regression set.

Table No. 5.5

2) GRASS (X2= DEPENDENT VARIABLE**) - INDEPENDENT VARIABLES (**X7 TO X15**)**

Variables	Regression Coefficient	Part Correlation	T Stat	Significant
x 11	b ll = -0.23	-0.16	1.18	Yes at 0.05 level
x 12	b 12 = 0.10	-0.09	1.10	No
x 13	b 13 =- 0.36	-0 .28	3.05	Yes
X14	B14 = 0.10	-0.16	1.25	No

R=0.65 a=45.10

R=0.42

The distance from the crest and slope N3 influenced on grass. Regression coefficients for both are negative (-0.23 and -0.36respectively). The factors distance from stream and slope 20^0 are not important as compared to slope 3^0 and the distance from the crest. These four variables account for about forty three percent of the total variation. Like net sown area and grass also have significant correlation ("r" values) with all the remaining variables except distance from stream. But only four variables are considered important enough to be included in the regression set. Though grass has strong positive correlation (0.09) with slope >20, in the regression analysis the effect of slope > 20^0 upon grass is not that much significant. The economic factors which have significant negative correlations with grass do not occur in the regression set.

Table No. 5.6

3) RICE (X3= DEPENDENT VARIABLE**) - INDEPENDENT VARIABLES (**X7 TO X15**)**

Variables	Regression Coefficient	Part Correlation	T Stat	Significant
x 7	b 7	-0.06	0.75	No
x 9	b 9	0.10	1.10	No
x 11	b 11	-0.17	2.00	Yes (at 0.05 level)
x 12	b 12	0.27	3.10	No
x 13	b 13	-0 .07	1.01	No
X14	b14	-0.20	2.10	Yes

R=0.73 a=24.10

R=0.53

The occurrence of rice is explained by independent variables i.e. irrigation(x7), cultivators(x9), slope<3 (x11), slope 20^0 (x12), distance from the crest (x13) and distance from stream (x14). Of these variables "b" co-efficient for three i.e. slope >20^0, distance from stream and slope <3^0 are important variables .For the rest of variables, the regression coefficients are not significant and thus, the contribution of the variables owner cultivator, distance from the crest and irrigated area to the total variation is not so important. The total variation explained by six variables is about fifty three percent. The correlation analysis reveals that distance from the crest has a strong negative (-0.07) correlation and distance from stream does not have a significant relation with rice. However, in the regression analysis distance from stream, explaining the location of rice confined to valleys, appears to be more important than the distance from the crest.

Table No. 5.7

4) JOWAR (X4= DEPENDENT VARIABLE**) – INDEPENDENT VARAIABLES (**X7 TO X15**)**

Variables	Regression Coefficient	Part Correlation	T Stat	Significant
x7	b7 = -0.07	-0.11	1.15	No
x11	bll = 0.17	0.13	1.20	No
x12	b12 = -0.11	-0.11	1.10	No
x13	b13 0.52	0 .45	6.01	Yes

R = 0.75 a = -1.05

R = 0.56.1 s2

The occurrence of Jowar is explained by four independent variables. Distance from the crest is the only variable which contributes significantly to the total variation. The regression coefficients for the remaining variables. i.e. slopes $<3^0$, Irrigated area and slope $> 20^0$ are not significant indicating their lesser importance. About fifty six percent of the total variation is explained by these four variables. Slope 3^0, which has a very strong positive correlation (0.13) with Jowar does not appear significant in this regression analysis. Another interesting relationship is between irrigation and Jowar, which is positive in correlation analysis, but because of the combined effect of other variables it has become negative in the multiple regression analysis, (-0.11).

Table No. 5.8

5) BAJARA (X5= DEPENDENT VARIABLE**) – INDEPENDENT VARIABLES (**X7 TO X15**)**

Variables	Regression Coefficient	Part Correlation	T Stat	Significant
x10	b10 = -0.07	-0.08	1.01	No
x 11	b ll = 0.19	0.10	1.05	No
x 12	b 12 = -0.39	-0.26	3.10	No
x 13	b 13 =- 0.30	-0 .18	2.15	Yes(at 0.05 level)
X14	B14 = 0.19	0.21	2.30	Yes

R = 0.41 a = 21.15

R = 0.17

The distance from the crest, distance from stream and slope >20 are more or less equally important in explaining the occurrence of Bajara as indicated by the respective partial correlation coefficient values. Other variable like slope < 30 and population density are less important. The total variation explained is rather low at seventeen percent. Bajara does not have very strong correlation with other variables as indicated in the correlation analysis, though some important relationships are singled out in the regression analysis. Bajara has a positive correlation with distance from the crest as revealed by the correlation analysis, but the regression coefficient slopes negatively.

Table No. 5.9

6) CASH CROPS (X6= DEPENDENT VARIABLE**) – INDEPENDENT (**X7 TO X15**)**

Variables	Regression Coefficient	Part Correlation	T Stat	Significant
x10	b7= -0.46	-0.51	6.75	Yes
x 11	b 9 = - 0.10	-0.15	2.01	Yes (at o.051 level)
x 12	b 10 = -0.25	-0.31	3.75	Yes
x 13	b 12 =- 0.22	-0 .28	3.10	Yes
x 14	b 13 = -0.17	0.21	2.158	Yes
	b 14 = 0.03	0.09	1.01	No

R= 0.75 a= 21.18

R = 0.56

The regression coefficients are significant for five variables in the case of cash crops, but distance from stream "b" is not significant. The contribution of the variable irrigated area is most important explaining the occurrence of cash crops followed by population density, slope > 20^0, distance from the crest and owner cultivators. The total variation explained is about fifty six percent. The correlation coefficients for distance from the crest and accessibility are nearly equal, but has not been included in the regression accessibility. Besides, the correlation coefficient is positive for distance from the crest and negative for distance from stream, but the regression coefficients are negative (-0.17) and positive (0.03) respectively.

The application of multiple regression model to explain the influence of various environmental factors upon agricultural land-use reveals that among the set of selected independent variables. by and large, the variables related to physical environment like slope $< 3^0$, slope $>20^0$ the distance from the crest and the distance from major stream appear to be more important than the factors chosen to represent the socio- economic environment like irrigation accessibility, proportion of owner cultivators in the total agricultural workers and population density. Only in the case of cash crops, irrigation is the only important variable contributing to the total explained variation. Density of population and owner cultivators, are also important for cash crops.

Out of six equations, in five the "b" coefficient for distance from the crest is significant and the partial correlation coefficient also indicates its importance as an explanatory variable. The variables like slope $< 3^0$ and slope $> 20^0$ have significant "b" coefficient in three cases each, whereas the distance from stream appears to be a less important explanatory variable with significant "b" coefficients in only two equations.

CONCLUSION:

Simple correlation and multiple regression are different methods used to find out the correlation between land use and environmental factors in the study region. The results of these analyses indicate a very strong influence of the factors of physical environment on the spatial variation in agricultural land-use. The entire analysis was based on the division of the whole area into units of observations based on the consideration of relief. The Second important aspect of physical environment used for the development of the basic regional frame was the spatial variation in the amount of rainfall. The result of the correlation analysis and multiple regression bringing out the importance of these factors of physical environment can be considered as validating the earlier finding.

Table No. 5.10 CORRELATION MATRIKES

(Correlation between Agricultural land-use and Physical-Cultural-Environmental.)

Variables	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15
X1	1.00	0.76	0.72	0.66	0.41	0.46	0.46	0.27	-0.48	0.28	0.79	0.67	0.79	0.02	-0.15
X2		1.00	-0.41	-0.55	-0.41	-0.43	-0.41	-0.32	0.42	-0.19	-0.63	0.58	-0.64	-0.01	-0.11
X3			1.00	-0.58	-0.52	-0.52	-0.39	-0.23	0.44	-0.25	-0.69	0.66	-0.61	-0.01	0.12
X4				1.00	-0.61	0.15	0.31	0.21	-0.42	0.12	0.74	-0.59	0.74	0.28	0.05
X5					1.00	0.41	0.14	0.17	-0.11	0.19	0.29	-0.39	0.11	0.13	0.75
X6						1.00	0.71	0.26	-0.49	0.63	0.42	-0.44	0.25	-0.01	0.11
X7							1.00	0.10	-0.51	0.52	0.45	-0.34	0.41	-0.01	0.15
X8								1.00	-0.21	0.29	0.29	-0.29	0.19	0.04	0.05
X9									1.00	-0.34	-0.51	-0.39	-0.49	0.01	0.85
X10										1.00	0.27	-0.33	0.10	-0.01	0.95
X11											1.00	-0.76	0.77	-0.01	0.18
X12												1.00	0.58	0.01	-0.12
X13													1.00	0.01	0.05
X14														1.0	0.075
X15															1.0

Where, x1 = N.S.A X2 = Fodder (Grass) X3 = Rice

X4 = Jowar X5 = Bajara X6 = Cash Crops (Sugarcane)

X7 = Irrigation X8 = ACCESSIBILITY X9 = Owner Cultivators

X10 = DENSITY OF POPULATION X11 = Slope < 3° X12 = SLOPE > 20°

X13 = DISTANCE CREST X14 = DISTANCE Major STREAM X15 = Agricultural Density

Source: Author

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CHAPTER VI

PROBLEMS AND SUGGETIONS

6.APROBLEMS:-

The study region is presently facing several problems, some of which are common to the rest of India as well as Maharashtra. The problems confronting the farmers of Nashik district in general and the agricultural land-use in particular may be considered as follows:

6A.1) ENVIRONMENTAL PROBLEMS:-

i)Physical Environmental Problems

ii) Soil Erosion

iii) Uncertainty of Climate

i)PHYSICAL ENVIRONMENTAL PROBLEMS:-

The first problem of the study region is physical difficulties arising from natural environmental setting of Nashik district.

Soil depletion is a major physical problem particularly in the western part of the district. It has been settled and farmed for so long a period that the soil cover has been subjected to modification. Grassland and deficiencies of vegetal cover have agricultural implications. In many parts of the district, the lack of forest cover reduces the infiltration of moisture leading to increasing run-off and thus giving rise to soil erosion. Although the extent of the soil erosion is not yet determined, the western part of the district is a victim of this scourge.

ii) SOIL EOROSION:-

Soil erosion is also a main problem of agricultural development in the district, particularly in the western talukas (Igatpuri, Surgana, Peint and the west part of Kalwan and BaglanTalukas). It is hilly and in the steeply sloping area receiving very high rainfall (above 2500 mm) soil is very poor and thin. So the physical erosion has resulted in heavy loss of fertile soil cover. Particularly in the western talukas (Peint, Surgana and Igatpuri) underproductive soil is very little. Cultivation takes place even on gentle slopes. Especially gully erosion is more rapid, so it is necessary to conserve the soil by using all measures of soil conservation.

The department of soil conservation has adopted many measures to control soil erosion. Soil loss is heavy, but efforts are poor. To stop soil erosion, Nalabunding, counter bunding, terraces, percolation tanks, afforestation and pasture land development should be implemented.

iii) UNCERTAINTY OF CLIMATE:-

Overall uncertainty of climate is also a major problem of the study region. The all- too- familiar climatic uncertainty often expressed in the commonly held view that "Agriculture in India is a gamble against the monsoon is the most outstanding problem in the category. The monsoonal rains, in Nashik district, generally show considerable variation in their time of arrival, amount and duration. Such variations are clearly brought out in the first chapter and represented in Fig. No.1.8. The results of such erratic behaviour of the monsoon are clearly visible in the yield and output of the main crops in Nashik district.

Shortage of arable land is also a major problem in the study region particularly in the western part of the district.

All these physical problems though not insurmountable, have certainly hampered the growth of agriculture especially when it is remembered that majority of farmers in Nashik district lack financial resources. It is only since the beginning of the planning era that the government has made some efforts to overcome some of the physical problems through soil conservation schemes,construction of the medium and minor irrigation works etc. However, these efforts, being relatively recent, their impact on agricultural development in the region is yet to be felt and assessed.

6A.2) <u>CULTURAL ENVIRONMENTAL PROBLEMS</u>:-

The socio-economic pattern of development in Nashik district bears the influence of physical characteristics. The spread of civilisation and modernisation has been checked by the hill ranges and plateaus, particularly in the western part and north eastern as well as southern part (Sinnartaluka). This barrier has been so formidable that cultural patterns have remained distinct from those of the changing cultural patterns of the rest of Maharashtra state.

Rural inefficiency resulting from farm fragmentations is a serious problem in Nashik district. Quite a lot of time and efforts are needlessly spent in travelling to and from the scattered plots and in lifting heavy ploughs and scarifiers over the bunds when moving from one small field to the next field. Scarce and valuable land is also wasted in the bunds separating the numerous tiny plots, and in the extra irrigation channels needed to supply them water at several places. Moreover, many plots are too small to allow any degree of mechanisation at all.

Literacy is also a problem facing the farmers of the district. Low levels of literacy in the country side also inhibit agricultural programmes by restricting the use of written material and necessitating direct contact between the limited number of agricultural extension workers and farmers of the district living in the isolated rural areas.Other problems are of cultural nature some religious beliefsingrained conservatism of majority of the peasant farmers and lack of capital economic.

6A.3) PROBLEM OF IRRIGATION:-

The farmers of the district are facing this problem. It is a very serious problem because day by day the rainfall is decreasing. So it is a major problem, particularly in the western part. Irrigation facilities are very limited and are found only in the eastern and central parts. Because of lack of irrigation facilities agriculture is poorly developed. The agriculture of some talukas of the district depends on the monsoon rainfall. Thus only one crop is taken in a year. Now some measures are being taken by authorities. There is implementation of some new schemes like digging common well, lift irrigation, pipelines etc. in the drier part and western part resulting in the development of agriculture.

AVAILABILITY OF MARKETS:-

It is also a very serious problem and farmers of Nashik district face this problem for agriculture products. There is not a big market in the district for marketing agricultural products. Nashik,Malegaon,Lasalgaon are the only markets for agricultural products. These market centres are far away from the rural area, so it is difficult for farmers to send their agricultural products to markets.

AGRO-BASED INDUSTRIES:-

The farm produce does not fetch good prices.There are very few agro-based industries. Thengoda (Baglantaluka) has the only cotton industry in the district. In Nashik district no other agro based industries are established except sugar factories.

AGRICULTURE PRICE STRUCTURE:-

Fluctuation in agricultural prices is also a major problem of farmers in the study area, which is common in Indian agriculture. According to Sir Roger Thomas "Next to rain, price changes have been the greatest enemy of the farmer". Agriculture produces foodstuffs and row materials, the demand for which in the aggregate relatively fluctuates widely from year to year, and from one part of the year to another, on account of the variations in the yields, due to weather conditions, variations due to supplies being more abundant in certain months of the year and changing marketing conditions. These fluctuating supplies constitute the most important factors responsible for the wide fluctuation in agricultural prices. So most of the farmers of the district cannot ordinarily adjust in response to the changes in the price level.

6A.4) PROBLEM OF DRY FARMING:-

Dry land farming in the western part of the district is much handicapped as compared to irrigated farming of the central and eastern parts of the district, in the matter of full exploitation of land and other available resources. In the western talukas of dry land, multiple cropping is not possible. Because of dry farming the level of fertilisers input is extremely low, consequently productivity per unit of land, labour, power and other capital resources remains low. In other words, uncertainty as well as instability of production and low yields are hallmarks of dry land in the study area.

MAGNITUDE OF LOSSES DUE TO PLANT PESTS AND DISEASES:-

It is also a serious problem of agriculture in the study region. In Nashik district crops are damaged not only by insect's pests and diseases of crops, but also by small and wild animals and natural calamities. The crops suffer from insects, nematodes, fungi, bacteria, viruses, parasites, weeds, rodents and other animals like snakes, snails and snugs.

Besides, rodents also cause an enormous loss during pre and post-harvest periods when the crop is still in the field. Beside animals, pest and animals like monkeys, birds like crow's, sparrows stray cattle, Flying Foxes, Rabbits, Parquets, Parrots, Sparrow's,Goats and Sheep also damage standing crops to a large extent.

6A.5) PROBLEM OF LOW YIELDS:-

The position of Nashik district is not very satisfactory in so far as the yield of crops per hectare is concerned. The productivity of agriculture in the district is very low. So the farmers cannot get sufficient returns.

AVAILABILITY OF LOAN FACILITIES:-

Loan facilities are not sufficient to the farmers of the Nashik district. The procedure of sanctioning the loan of co-operative banks or commercial banks is time consuming and complicated. The rate of interest is also high. So farmers are not ready to take a loan. Officers of that particular department are not ready to give co-operation to farmers. Because of this situation of the institutional finance, the farmers prefer to take a loan from local money lenders and landlords. The rate of interest of these sources is very high. Because of high rate of interest farmers cannot return the loan in stipulated time. So the indebtedness of the farmers is increasing day by day.

6A.6) OTHER PROBLEMS:-

Besides these, there are many other problems like low land holdings, low use of agriculture inputs and technology, rural electrification, low use of manures and fertilizers, lack of improved seeds, draughts, floods, lack of modern implements and mechanization, labour charges, agricultural taxes, lack of agro-based industries etc.

6.B SUGGESTIONS:-

Considering the effects of the environmental factors on agricultural land use the following important suggestions can be made for the development of agriculture in Nashik district

1) Crop yields are important for farmer's economy. But except some most crops are attacked by ad diseases. The natural calamities ruin all the crops. Hence, it is suggested that crops insurance against natural calamities should be made available to

farmers. At present, New India Assurance Company has come forward for this purpose. But its efforts are found inadequate. Some private Sanghas (Maharashtra RajyaDrakshaBagaitdarSangh) give some amount only for grapes. Hence it is suggested that the government of Maharashtra should formulate a general policy in this regard.

2) Ware Houses and Cold storage facilities be made available for small as well big farmers.

3) Day by day there may be shortage of water sources. Hence, the need for economic use of water is felt. As such, it is suggested that farmers should start drip irrigation instead of flood irrigation for fruit crops.

4) The produce of the small and medium farmers be purchased by organizations like marketing federation or such other institution so that they get higher prices.

5) Loans be made available at low interest to the farmers to buy farm implements.

6) Maharashtra government should make transport available at cheap rate for the farmers to take their agricultural products to the markets.

7) Hundred percent loan should be given to the farmers to buy various farm implements by co-operative or commercial banks.

8) High yielding varieties of seeds should be discovered and provided to the farmers at the cheapest possible rate.

9) Steel, cement etc. should be made available at subsidized rate for growing grapes.

10) Maharashtra government should fix well in advance the base prices of food grains like Jowar, Bajara, Wheat in proportion to cost of production.

11) Rates of electricity fair be reduced for farmers.

12) In case of natural calamities if farmers do not get good harvest, the loans taken by the farmers or at least the interest should be wair.

13) The Maharashtra government should get all the crop insured on behalf of farmers.

14) During the field work and survey of the selected villages, it has been observed that there is common practice among the rural community to encroach upon the fertile land for construction of residential houses and also for keeping livestock. It is suggested that this practice should be checked. The social workers and the village level workers should convince the villagers not to do so.

15) For irrigation Problems it is very imported thing use traditional systems. For proper irrigation farmer must use Sprinkle, Thibak and Drips.

16) A better integrated rural development programme should be initiated, wherever the population is very dense. New planned colonies should be developed on the uncultivable lands. Efforts should be made to minimize the distance of farms from settlements. In order to achieve this goal, it is suggested that co-operative farm houses should be constructed on the outer margins so that neglected and poor land may be utilized properly, yielding better returns to the farmers.

17) The important point which needs implementation relates to a range in the attitude of villagers towards agricultural land practices, for such a change will surely help farmers to adopt those practices which may insure better returns to them. For bringing about a change in attitude, social workers and village level workerscan play an important role.

18) Loan at minimum interest rate should be provided for Drip Irrigation, Pipeline, Sprinkals, Net Steel roads(ThibakSinchan set) etc for vegetables and fruits and flowers.

19) 24 hour electric supply is essential for farmers so the government of Maharashtra should provide 24 hours electric supply.

20) The government of Maharashtra should provide loans for purchasing modern implements of farming.

21) The union government and State government should fix the base price for all agricultural products and also insure all agricultural products on behalf of farmers.

22) Labour is very difficult problem for agriculture so the government must look into it or give subsidy for labour cost.

23) Migration from rural to urban zone is a serious problems in the study area. The government should make all facilities available to farmers.

24) Weekly markets or dairy market facilities are essential for the rural area.

25) For bringing about a change in attitude of the social workers and agricultural workers in rural area**.**

26) Landless labourers and other agricultural labourers need work through the year, small farmers require labourers for some time in a year so the government should make provisionlike RojgarYojana scheme to farmers in peak seasons.

27) Small farmers require capital for investment in land, lack of capital prevents small farmers from experimenting. They require capital for purchase of better seeds, fertilizers and farm appliances.So the government should provide loan at in low rate interest.

28) Excessive water has created some problems in some talukas of the eastern central part the of study area, good agricultural lands are affected by salt efflorescence. These lands are not suited for cash crops, so crop rotation is important. Give proper guidance to farmers through proper government agencies.

29) Environment is changed. Rainfall depends on nature. Nowadays rainfall is very uncertain.So farmers face the problems of changes in climate and rainfall and for this problem farmers must change their mentality of irrigation and use modern techniques like drip irrigation and other modern techniques.

30) There are various other socio-economic problems of irrigation and labourers. The number of total agricultural workers is very high. Cultivators are relatively small in number. Many labourers migrate to the urban area. If work is provided to labours throughout the area,an atomatically migration of labours will stop.

31) Development of dairy farming, poultry, piggery pisci culture and sericulture will go a long way in improving the lot of the farmer of the study area.So gold should provide loans to farmers.

CHAPATER VII

SUMMARY AND CONCLUSION

The spatial analysis of agricultural land use in Nashik district of western Maharashtra and the role of environmental factors on the agricultural land use is the study that we are related with. It is not simple to offer an explanation on the large scale, but some approaches are made in that direction and some findings together with the perspective on the dynamics of agricultural land use are summed up here. Below is given a summary of observations, analyses and findings of the previous chapters.

For the present topic, the areal unit study has to be pressed on some aspects of environment. There is a general variation in agricultural land use over the study area, taking into account this fact, relief, rainfall and soil were chosen as the most important factors of the physical environment for the identification of basic units in this study. The method followed for the identification of such units resulted in 100 units. This procedure again provided a basic frame work for further analysis. So this can be accounted as a vital step in the present investigation of spatial patterns of agricultural location.

It is also necessary to understand that there are some vital factors of cultural environment which influence land use pattern of the Nashik district. It is equally important to understand the characteristics of these factors of cultural environment.

A study of population shows some variations of population characteristics in the district. The region selected for the study shows that there has been consistent growth of population from the beginning of the 20^{th} century. In the district as a whole (40.77percent) working population is engaged in the agriculture field. This lower percentage is due to urbanization and industrialization. However, in the rural area agriculture is the main occupation of people. Their livelihood depends only on agriculture. More than 85 percent workers are engaged in agriculture in the western hilly part of the district. At other places more than 75 percent people are working in this field. The number of owner cultivators in the total farm workers is more in the western part, while and the number of agricultural labor is more in the eastern part.

There is no equality in the agricultural income of the people due to unequal distribution of land. The average size of holdings in the district was 5.2 hectares in 1991 and 4.1 hectares in the year 2011. This average further decreased up to 3.6 hectares in year 1988. An increase in the use of modern equipment's and implements by farmers was found. This is confined to only big land holders and those owning irrigated land. But this also shows the progress in agriculture made by some regions, especially by the irrigated areas.

Irrigation is an important environmental factor influencing the productivity as well as the progress from subsistence to commercial level of agricultural economy. The district has a relatively higher proportion of net irrigated area (3.6percent-1951 and 15.68percent-1981) as compared to Maharashtra in general. The central and eastern parts of the district have larger irrigated areas as compared to the western parts. An analysis of temporal variations in the irrigated areas under different crops reveals spectacular increasing cases of cotton, Sugarcane, Wheat, Rice and Groundnut within the given set up of environment factors, indicating that the future of agricultural development mainly lies in the optimum utilization of available water resources.

Accessibility is another important economic factor linked with the extension of road system in the study region. In the central and eastern parts of irrigated tracts an increase in the number and size of weekly markets is noted. The accessibility of this area is high and purchasing power of the farmers is also high. The physiographic and high rainfall amount of western part are the factors influencing the accessibility of the district. Many villages of these hilly areas are partly or totally cut/off in the monsoons. In the western hilly area of the district, market centers are absent or less frequent on account of low marketable surplus, poor accessibility and low purchasing power of the farmers.

The temporal analysis of general land-use indicates clearly that on the whole the land-use pattern has remained more or less the same since the reference year 1950-51. Land under net sown area, forests and area not available for cultivation occupy a major portion of the total area and these categories do not display fluctuations. The significant changes observed in case of the area under culturable waste, grazing land, fallow land, and areas sown more than once can be attributed to

the variations in the human response to the various aspects of land. The changes in the land-use are associated with variability of rainfall. The drought years display increase in areas under fallow, culturable waste and grazing lands. The net sown area, however shows a marked decrease during the periods of drought.

Environment of the district influences the spatial analysis of land-use. Certain physical and cultural environmental factors, particularly relief, influence the spatial variations in land utilization in the district. The variations in the net sown area indicate a strong influence of relief and slopes. The proportion of the net sown area is very high in central and eastern parts of the district because of low divides and rolling plains. On the other hand, the proportion is very small in the western hilly parts, with steep slopes it increases. The spatial distribution of culturable waste forest and fallow land exhibit a concentration in the western hilly tracts and decreasing proportion in the central and eastern parts. The area not available for cultivation shows less variation in the different parts of the district.

The temporal analysis of agricultural land-use for the period under consideration point out the following aspects. The Cereals have experienced a slight decline in the volume of change in the last two decades. Bajara and Jowar both have lost some afeal strength. Rice and wheat have some positive changes in the volume. Pulses show fluctuating trends, but sugarcane, fruits and vegetables show a highly positive volume of change. Total oilseeds show a moderate increase in the period under consideration. This temporal variation clearly indicate that farmers shift from traditional crops to the increase in important cash crops i.e. sugarcane, fruits and vegetables.

The crop ecology of each crop helps to understand the spatial distribution of crops. The distribution of Bajara is largely governed by the seasonal distribution of rainfall and soil types i.e. moisture retaining capacity of the soil. Heavy rainfall is not useful for Bajara and Jowar. So both are not found in the western part. The distribution of oilseeds and pulses is strongly influenced by rainfall and temperature conditions during the growth period. Both are spread over large areas in the central and eastern parts. Pulse crops like mung, math, tur are grown along with jowar and bajara. Like physical environment the economic condition of farmers and irrigation are the main factors which determine the rice distribution. Wheat is grown in cool, dry

and clear climate. Rice and wheat also are grown in low rainfall zones with irrigation. The hill millets like nachani, sawa and vari are concentrated in the western high rainfall and poor soil zone. Generally they are grown on sloping land. Thus the spatial distribution of crops shows a strong influence of environmental factors. Cash crops like sugarcane are exceptional cases with a strong association with irrigation.

Multiple regression and simple correlation helps in further analysis of agricultural land-use. All variables explained in chapter No. VII were included in the analysis. Net sown area, grass, rice, jowar, bajara and cash crops were treated as dependent variables. Irrigation, accessibility, owner cultivators, population density, slope N3 and i20, distance from the crest and distance from stream were the independent variables. The simple correlations are useful in the initial stages of locational analysis. These correlations give a clear idea of relationships. They brings out the importance of physical factors like slope and distance from the crest and economic factors like irrigation and accessibility. It is clearly found that the higher proportion of cultivators is in the western hilly area and the higher proportion of agricultural labor in the irrigated area.

The multiple regression model brings out the functional relationship between the variables.

$$Y= a+b1x1+b2x2+----------+bmxm+e$$

Total six regression equations were derived for six land-use types. Spatial correlation coefficients derived indicate the relative importance of each independent variable in explaining the total variance. It shows that among the set of selected independent variables those related to physical environment like slopes, distance from the crest and stream appear to be more important than the factors chosen to represent the socio-economic environment like irrigation, accessibility, owner cultivators and population density, except Sugarcane. Accessibility does not appear in any of the regression equations. The total variation explained (R^2) is maximum (59percent) in case of the net sown area. For rice, Jowar and cash crops it is between 60 percent to 70 percent minimum percent is in case of bajara (17percent).

Generally, in the period under consideration the overall trends in the yield rate and output turn of crops indicate a significant increase in most of the crops. The yield production of bajara, jowar, rice, ragi and groundnuts have registered a significant rise per unit area but a decline in the yield of pulse crops. The yield of all crops is reflected lower during drought years.

The relative positions of strength among the crops were ascertained by simply ranking them for each taluka in order of the percentage of total net sown area occupied by each crop. The ranking method reveals dominance of Ragi and Rice in the western part of the district. Bajara dominates in the central and eastern parts of the district. Jowar is an important crop only in the Kalwan taluka. These crops are first rank crops. Rice and other hill millets are found to be associated with each other in the western part. Jowar and bajara in the central and eastern parts, cash crops and fruits and vegetables in the irrigated area and oilseeds and jowar in some isolated talukas. Wheat, oilseeds, pulses and fodder are important as third rank crops.

Crop combination by J.C. Weaver using the study area. The combinational analysis by J.C. Weaver shows that not a single taluka is identified as monocultural. One taluka each identified two, three and four crop combination with each other. Three talukas have five crop combinations, rice, vari, oilseeds, jowar and fodder appear in this combination. All crops have appeared in various combinations. The spatial variation in the number of crops in combination reflects their relationship with environmental factors.

The relationship between environmental factors and land-use patterns is the core of is research. Appreciating the observations made in the earlier chapters a schematic model is constructed to show the location of agricultural land-use as resulting from the interaction between some selected environmental variables like relief, rainfall, soil, irrigation and accessibility. Five land-use zones are marked. The first zone is characterized by high rainfall and hilly topography with hill millets as main crops. The second zone receives adequate rainfall, has moderate slope and rice as the main crop. The third zone is of moderate rainfall with a variety of crops like bajara, jowar, wheat etc. The forth zone is also known as drier zone with gentle sloping. The fifth zone of scare rainfall and gentle sloping has bajara as its main crop. The model represents existing land-use pattern, but further modifications are also visualized with the growth of transportation network and exploitation of irrigation and

market potentials. The model can be used as a basic frame for planning agricultural development.

To understand the association between environment and land-use at micro level, sample villages were selected from each one of the model zones. Some characteristics of the sample villages are common, but in other aspects they differ from one village to the other. There is not much scope for further expansion of the area under cultivation in sample villages. The economic conditions of farmers is not equal. Some farmers are very poor. They do not possess all the implements needed for agriculture. Medium and high class farmers are economically sound. So they possess all implements. Some farmers owns oil engines, electric motors and tractors. The proportion of owner cultivators is very high in the villages where agriculture is for subsistence. Land holding is not equal in all villages. In the western hilly area the average size of holding is small. Generally the proportion of the areas under various categories increases from lower size category of land holding to higher size categories. A large number of small holders operate on a very small proportion of the total area. The number of fragments generally increased with larger sizes of holdings, but in irrigated areas the number of fragments is more in the case of small holdings and less in the case of larger holdings.

The attitude of farmers of the western part and drier zone of the district is changed since last decades. The farmers are by and large conservative in their attitudes towards adoption of new techniques. The small farmers of irrigated area are progressive in their attitudes. In general the landless labor and small farmers prefer jobs as their first priority, whereas the big farmers needed capital for various agricultural operations.

The observations and results of the analysis summed up above indicate that the objective with which the research project was taken up has been fulfilled. The author believes that the procedure followed for the identification of physical units has proved to be a very useful technique for developing a regional frame for the purpose of agricultural development and planning at the district level, particularly in a region with varied environmental factors.

Thus from the previous spatial temporal analyses of agricultural land-use in Nashik district, the following general trends are noticed.

1) The general land-use pattern has not changed significantly in the period under consideration.
2) No significant changes have taken place in the area under forests.
3) The area under fallow land decreased up to reference year 1981, it slightly increased in the year 1988.
4) The net sown area slightly decreased in the reference year 1981. This change in the net sown area is in proportion to that of culturable waste.
5) The area under culturable waste is decreased but the area not available for cultivation is increased.
6) The area under remunerative crops such has sugarcane, vegetable and fruits and fodder has increased because the traditional crops like bajara, jowar etc. were replaced by them.
7) This type of increase in the area under cash crops is higher in proportion to the higher proportion of under irrigation area in the district.
8) Increase in area under Bajara and rice is observed in some talukas in which it is rotated with sugarcane to maintain the fertility of the soil.
9) Increase in area under rice, sugarcane, fruits and vegetable has taken place in some talukas, where there has been slight increase in the area under irrigation.
10) The establishment of new sugar factories at Vithewadi, Ranwad and Materwadi has encouraged farmers to grow more sugarcane because of the facilities such as loan, truck service, labor and the establishment of market committees started in every tehsil. They are responsible for getting proper rate of agricultural production.
11) The spatial variation in land utilization brings to surface the strong influence of environmental factors. This is reflected in the farmer's decision leaving not much room for the choice of crops .The process of commercialization has begun but is mainly confined to the irrigated area. The farmers working in unirrigated lands are still at subsistence level and are likely to remain as subsistence farmers unless a break-through in the methods of cultivation brings about any significant change. The quantitative techniques like simple correlation and multiple regression used here throw further light on the strong influence of environment factors upon agricultural land-use.

The quantitative analysis has helped to find out the contribution of each independent variable in the explanation for locational variation in agricultural land-use, and it is of great value as is it has validated the regionalization based on simple technique of consideration of relief and climate as basic factors of environment for the purpose of differentiation. This is important in view of the paucity of data for regional analysis in the developing regions of the world.

12) Analysis of comparative yield data brings out two important features. One agricultural productivity is miserably low in the district, in nearly all crops. Secondly, over the last few years' average productivity per acre has been increasing, due to increasing use of hybrid seeds, high yielding varieties of seeds, greater application of chemical fertilizers, launching of land improvement programs and increasing availability of irrigation facilities, followed by scientific methods of farming and cultivation.
13) In conclusion it can be stated that the present study brings out clearly the relationship between factors of physical environment and the spatial variations in the agricultural land-use, as well as temporal changes with variations in socio-economic conditions. The initial hypothesis of strong influence of physical environment on agricultural patterns which formed the basis of regionalization using climate and relief as the major factors has been validated by the quantitative analysis of these variations.

GRAIN CROPS

Photo 1

Bajara

Photo 2

Jowar

Photo 3

Wheat

Photo 4

Rice

Photo 5

Ragi

Photo 6

Vari

CASH CROPS

Photo 7

Sugarcane

Photo 8

Cotton

Photo 9

Oil Seeds

VEGITABLE CROPS

Photo 10

Lady's Finger

Photo 11

Brinjal

Photo 12

Tomato

Photo 13

Cabbage

Photo 14

Onion

Photo 15

French bean

FRUITS CROPS

Photo 16

Graphs

Photo 17

Promogranate

Photo 18

Mango

GENERAL LAND USE

Photo 19

Forest

Photo 20

Fallow Land

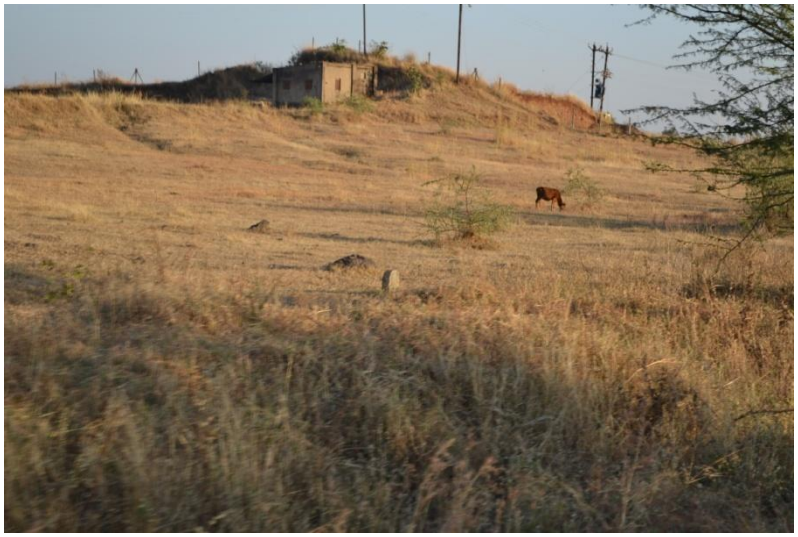

Photo 21

Net son Area

IRRIGATION SYSTEM

Photo 22

Pipe Line

Photo 23

Sprinkler

Photo 24

Fish Water Tank

PULSES CROPS

Photo 25

Gramme

Photo 26

Moog

Photo 27

Matar

WORKERS AND CULTIVATORS

Photo 28

Tractor

Photo 29

Cultivator

Photo 30

Labor

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