A GEOGRAPHICAL STUDY OF IRRIGATION ON AGRICULTURE LAND USE PATTERN IN SOLAPUR DISTRICT

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Under the Board of Moral and Social Sciences Studies

Submitted By

Mr. B. D. Patil

Under theGuidance of

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CERTIFICATE

*This is to certify that the thesis entitled, **"A GEOGRAPHICAL STUDY OF IRRIGATION ON AGRICULTURE LAND USE PATTERN IN SOLAPUR DISTRICT".** Which is being submitted herewith for the award of the Degree of Vidyavachaspati (Ph. D.) in Geography of Tilak Maharashtra Vidyapeeth, Pune is the result of original research work completed by Mr. Bhupal D. Patil 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.*

Date :

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DECLARATION

*I hereby declare that the thesis entitled "**A GEOGRAPHICAL STUDY OF IRRIGATION ON AGRICULTURE LAND USE PATTERN IN SOLAPUR DISTRICT**" is the original research work carried out by me under the guidance of Dr. S. B. Zodage, Asso. Prof., Department of Geography,Chatrapati Shivaji College, Satara for the award of Ph. D. degree in Geography to the Tilak Maharashtra Vidyapeeth, Pune. This has not been submitted previously for the award of any degree or diploma in any other university.*

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Place: Pune **(Shri B. D. Patil)**
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References

1.1 Introduction

The economic base of the country depends on agriculture. In order to increase the agriculture yield, one should not depend upon rainfall alone. A proper water supply would meet the requirement. Water is an important element for increasing the agricultural production. Natural or artificial application of water to soil for the purpose of moisture and the timely application of water for the growth and production of plants depends largely on the implementation of various irrigation projects .Water is a basic resource on earth for all living organisms including mankind and for development and survival of plant community. Environment process of biosphere is also regulated by water. Normally, groundwater and surface water used for irrigation and when waterisavailable in these sources is taken away artificially by flowing it for supplying water in required quantity to crops, it is called irrigation. Irrigation is a primary input for agricultural production. If an area is facilitated with irrigation water agricultural sector is positively affected. If there is no proper water supply then the use of fertilizer, seeds, pesticides etc. will not be useful for the yield.

India is basically an agriculture oriented country and the role of agriculture is vast as it is the most important enterprise in Indian economy. Agriculture is a broad term encompassing all aspects of crop production, livestock farming, fisheries and forestry. Performance of agriculture plays a major role in the progress of the economy. It helps in achieving the developmental goals of eradication of poverty and modernization of society. Agriculture sector is the back-bone of the country's development and life-line for 70 percent of the population is still dependent on agriculture for their lives. Agriculture provides food to the millions of people and raw material to our industries. The development of agriculture seems to hold the key progress to our economy as a whole. Present day agriculture in India as elsewhere has evolved itself through the ages. The agriculture in India has long been carried out in a traditional manner, hardly using the modern techniques in the developed parts. However, during the last three decades special attention has been paid to modernize the agriculture with adoption of irrigation facilities. India has started marching in this direction particularly, since second five year plan. The new technology was adopted through green revolution, leading to enhancement in food production. Thus, the new culture and its success is linked closely with the development of irrigation.

Irrigation is an artificial supply of water to land for growing crops and to increase the per hector yield. Irrigation is necessary particularly in an uncertain rainfall

area. It is essential an artificial application of water to overcome the deficiencies in rainfall for growing crop (Contor, 1967). Irrigation is one of the indispensable inputs in the transformation of agriculture. However, it is recognized as necessity of cultivators in arid and semi-arid regions for sustaining high productivity of crops and to bring more and more land under cultivation. The need of irrigation is greater in the part, where rainfall is seasonal and un-assured. Moreover, it is life-giving agent to plant hence the artificial supply of water has become most essential. Other inputs such as fertilizers and plant protection measures are hardly effective without supplemental irrigation to mitigate water stress. Therefore, there is need of the development of water resources, creation of irrigation of facilities is, however only the means to end of their effective use for crop production. Irrigation plays a vital role in meeting rising demands of food and fodder, for growing human and livestock population; moreover, it is an age-old practice of ancient civilization design to reduce moisture deficiency. Investment on irrigation leads to multiple benefits, such as it is unable to farmer for harvest two or three crops a year.

Irrigation is a prerequisite for adopting the new technology in the use of cultivable land. Cultivated land is the area regularly ploughed and includes both tillage (net cropped area) and follows land. Irrigation leads to better productive use of cultivated land. To be successful and well developed agriculture requires supply of water at regular interval and required quantities. The transformation partly or fully depends upon the nature and mode of irrigation; hence, it is regarded as an integrated part of sound infrastructure of agriculture.

Irrigation is a major variable to effect on Agriculture. Present research to study the irrigation is affected on agriculture land use in Solapur District, Effect of irrigation on land utilization, cropping pattern and production of crops. The main objective of the study is to find out irrigation effect on agriculture land use pattern in Solapur district. Solapur district is in rain shadow area in western Maharashtra. This region receives overall rainfall in small period, so need of irrigation projects is important for agriculture development and productivity. Therefore, the irrigation facilities are much more important in Solapur District.

1.2 Selection of the Study Region and topic

India is a predominantly agricultural nation and Maharashtra state in India occupiesaimportant position which ranks third in area and second in population. The Solapur district has also a significant position as regards area and population. The Solapur district contributes a considerable share of population and economic production as far as

the state's economy is concerned. The selection of the study region under investigation aims to analyze the geographical study of irrigation on landuse pattern in Solapur district. The study covers irrigation sources and irrigation development in study region. The geographical setting and ecological factors have given boast to it. The region selected for the problem inventory is plateau region in general. It is located in drought prone area of Maharashtra state. That's why irrigation is dominant factor which plays major role in cropping patterns, crop intensity, crop productivity, agriculture transformation, etc.

The choice of the topic under investigation has been analysed by many considerations. For geographical analysis of irrigation, Solapur district is selected as a study region. The researcher is motivated by many factors in selecting the irrigation viz. sources of irrigation, mode of irrigation, crop wise irrigated area and irrigation impact on agriculture. The selected topic for study region has following considerations: -

A. The present study deals with the geographical perspectives of the irrigation in Solapur district. Its latitudinal extent is between 17º05' North latitudes to 18º 32' North latitudes and 74º 42' east to 76º 15' east longitudes. The total geographical area of Solapur district is 14878 Sq. Km. The east-west extension of Solapur district is 153 kms and North-South stretch is 96 Km. The population of the district according to 2011 census is 43,15,527.
B. Agriculture is the most dominant activity in Solapur district. The economy of the district primarily depends on agriculture as supported by the fact that cultivators (595439) and agriculture labourers (500977) together constitute (62.90%) of the total workers in the study region.
C. All eleven tahsils in Solapur district consists dry zone area by Sukhatankarcommittee.
D. The soil, topography, rainfall and climate in Solapur district are in general not vary conductive to agriculture. Resulting in relatively low yields of the important crops in the study area as compared with other district of Maharashtra state.
E. The percentage of net irrigated area to gross cropped area is the study region being only 6.20 percent as compared with 22.09 percent for the state as a whole in 2004-05.
F. The agriculture in the study area is thus largely dependent on monsoon. The investment in irrigation schemes creates favourable impact on production and productivity of crops from the point of view, it is necessary to assess irrigation development and its role in agricultural development.
G. Irrigation has played an important role in transforming the agriculture landscape in general and irrigation in particular, and life of the rural people in the study region.

H. The researcher, who is born and brought up in the study region i.e. Solapur district, is quite aware and well-acquainted with the geographical environment of the area. So, it is helpful in carrying out the field work and required data collection for the purpose of study.

I. The work on the "A Geographical Study of Irrigation on Agriculture Landuse in the Solapur District" has not yet been attempted by any other geographer and such type of work can be useful for preparing and implementing developmental schemes regarding irrigation and agriculture. So the researcher has selected this region and topic for the purpose of geographical investigation.

1.3 Objectives

The objective of this research work is to assess the irrigation impact on Agriculture land use pattern in Solapur district. This study can be carried out by examining following sub-objectives;

i) To examine the physical and socio- economic condition of Solapur district.
ii) To study the level disparities in irrigation and cropping pattern.
iii) To study natural and artificial irrigation sources in study region.
iv) To assess the irrigation and cropping pattern in study area.
v) To propose suggestions for better irrigation planning.

1.4 Databases

Present study mostly relies on the primary data collected through sample survey and personal interviews. Limited use of secondary data is made. For the purpose of survey, systematic purposive sampling method is used as detailed below. The data collected through primary and secondary sources are processed and represented by statistical and cartographic techniques.

1.4.A. Collection of the primary data

This study mainly relies on field work to get necessary primary data from the respondents which is collected by the use of processed schedules. Both schedules and interview techniques are mainly employed for the collection of facts regarding irrigation situation of farmers. The schedules were filled in at the spot survey. The interview and discussion with farmers were attempted during the field visits. Due to this personal discussion clues were provided to the vital issues involved and revealed some of the information which could not be covered in the structural schedules used for the farmers.

1.4.B. Collection of Secondary data

It includes published and unpublished reports and abstracts such as socio-economic review and district statistical abstract. The data for purpose of analysis was collected from various sources published by the government and reports prepared by the Agriculture Department and District Statistical Department of Solapur, Dry Land Farming Research Center Solapur, censes data 1991 and 2001 and Irrigation Dept. of Solapur District. The data was also collected from reference book of eminent authors, published reports of various studies and journals. These sources have been used as additional ones.

The gram panchayat office in village and offices of talaties provided information regarding the distribution of crops, land holding, irrigation wells, general land utilization etc. Data of some irrigation were collected from the engineering department of irrigation, ZillaParishad office at Solapur.

1.5 Methodology

It is a study of a part of Solapur district of Maharashtra. The selection of the region followed two phase. Initially, Solapur district was selected for the study as the agriculture land use is changed during the investigation period (1971-2005) due to the changing of the irrigation of district and the farmers attitude. Out of the various sources of irrigation , well, tube-well, dam, major irrigation project, medium irrigation project, minor irrigation project, percolation tank, K.T.weir dam, canal, lift irrigation are studied in Solapur district are discussed in this study. For these, intensity of irrigation, index intensity of irrigation, etc. are calculated by using statistical techniques to analyse the irrigation development.

In the second phaseirrigation was selected for micro level study. For the present investigation Solapur district is selected as in general and all tahsils in particular. Therefore, tahsil have been aerial unit for regional analysis and village and plot has been chosen for micro level analysis.After conducting the field survey, farmers from each zone were grouped according to various components of irrigation (area, sources of irrigation, mode of irrigation, irrigation period, landuse of farmers etc.) to find out the real situation of irrigation in Solapur district and problem about irrigation.

The primary and secondary sources were processed and represented by statistical and cartographic techniques. The various methods and techniques used are explained in the relevant section in the text. The various internet websites are used for excellent sources of reference. The Map Info, coral draw and windows Microsoft Office 2003 and 2007 software are used for making graphs and figures.

1.6 Review of Literature

The knowledge of research work done in the past relating to the research problem is necessary and helpful to proceed in the right direction. Researcher would be able to make an improvement over the existing studies and also expand horizon of investigation. The review could also help refuting the concepts and statements made in earlier studies as well as supporting the findings of present study following foreign as well as Indian, scholars who have contributed and carried out the study related to fruit farming in India.

GottumuikkalaAnda (2010): He has analyzed micro irrigation technology on yield, salinity, and nitrate quantification in groundwater in Rangareddi district of Andhra Pradesh. He assesses irrigation sources and impact of drip irrigation on crop yield, power supply, fertilizer saving, cost benefit analysis, etc. He also studies advantages and disadvantages of drip irrigation in agriculture development.

K.S. Mony (1995): He has discussed 'economics of irrigation; a case study of Kuttiadi irrigation projects. In his study, he depicted the impact of irrigation on cropping pattern, intensity of cropping and modern technology. He also studied the impact of irrigation on production and employment opportunity. He stated that irrigation impact on cost of inputs and yield structure.

Kadam N. B. (2009): He has studied the role of irrigation in agriculture development in Yavatmal district. He discussed on the mode of irrigation, role of irrigation, agriculture development. He also studied the role of irrigation in socio-economic development.

KhadseNamdeoHiraman (2006): Hehas studied the mapping of slope categories for land use and agriculture in Wasim and Akola districts, Maharashtra. He has also explained many geomorphic, hydrologic and petrologic slopes. He also categories the tahsil wise area coverage of slope classes in Akola and Washim district. Slope divided into level land. Nearly level land ,very gentle sloping land, Gentle sloping land, moderately gentle sloping land, strongly gentle sloping land, moderately steep sloping land, steep sloping land, very steep sloping land and precipitous to vertical sloping land.

M.V. Reddy and N.B.K Reddy (1992): They have discussed the changing pattern of irrigation in Andhra Pradesh. They have also explained irrigation as a decisive factor in Indian agriculture due to high variability and inadequacy of rainfall. Irrigation is imperative for successful agriculture particularly the arid, semi-arid and sub-humid areas which are prone to drought and famine conditions due to partial failure and delayed Arial

or early with drawls of the monsoons. The study area of Andhra Pradesh has substantial area under semi-arid climate; agriculture is a gamble with monsoon.

Mankar Ganesh (2008) has studied agricultural land use pattern in Mulshi tahsil of Pune district. In this research article an attempt has been made to analyze the agricultural land use pattern at micro-level in Mulshi tahsil. He has also calculated the crop ranking, crop combination analysis etc.

Moorthi T.V. and Mellor W.J. (1972) study on 'Cropping Pattern Yields and Income under Different Sources of Irrigation with Special Reference to IADP, Aligarh District, Uttar Pradesh', concluded that farmers with private tube-wellshad better control over water supply in terms of timely availability in adequate quantity. This resulted in higher cropping intensity, yield, higher crop income and cultivation of high yielding crops in such farms. This was attributed to the flexibility factors in quantity and timing available in those farms.

More K.S.(1980): The land use pattern in Kolhapur district is studied by More K.S. According to him, the technological determents largely affects on cropping pattern. He calculated the spatial organization of agriculture in Kolhapur district on the base of six villages in Kolhapur district. He measured the agriculture development in Kolhapur district in his study.

NandaniChattcrjee (1995) has studied irrigated agriculture: a case study of West Bengal; Author has collected official as well as field survey data. The main objectives of the studies were (i) to highlight the basic problems that have made irrigation a necessity, (ii) to assess the physical setting of irrigation by a detailed appraisal of the surface and ground water resources as well as their influence on the types of irrigation in the state, (iii) to assess the impact of irrigation on land use, cropping intensity, cropping pattern as well as on agricultural efficiency by macro and micro level analysis.

Narendra Kumar I. and ChandrasekarRao G. (2007) have analysed in the irrigation reduces the risk and uncertainty inherent in the rain fed cropping. Irrigation has a stabilizing impact on agriculture and generates farm employment through higher levels of cropping intensity adoption of new agricultural strategy, growth of highyielding crops and multiple cropping. Their study pertains to Kurnool district of Andra Pradesh with the objective of Impact of Canal and Bore Wells irrigation sources on the farm output and generation of employment relating to the crops like paddy and cotton.

R.P.Yadhav (2007): He has analyzed very systematically 'Impact of Ground water Depletion on Socio-Economic Conditions in South West Haryana, A case Study. The paper analyses the consequences of ground water depletion in Bhankhri village

(Mahendergarh district) of Haryana. The village is situated in the semi a tract of Haryana having 570 hectares of land where65 per cent people are engaged in agriculture. The study focuses on the socio-economic impact of the rise and fall in the tube well irrigated areas in this semi-land tract of the state.

ShashiBala Singh (2008): He has analyzed the changing pattern of land use, land use efficiency and cropping intensity in SantRavidas Nagar, Uttar Pradesh. He has also explained the changes in land use efficiency and intensity of cropping in SantRavidas Nagar district of Uttar Pradesh. Gyanpur block has highest increase of 160.69% to 133% in 1981. Aurain had the second highest cropping intensity (155.41%) while Suryawan had the third rank (147.71%) during 2001.

T.Pcnchalaish and Y.V.Kamanaiah (1992): They have studied the spatial analysis of rainfall in the drought prone area of Cuddapah district of Andhra Pradesh. In this study, an attempt is made to describe the spatial distribution of rainfall, rainfall intensity, rainfall ratios, rainfall variability and rainfall frequency in Cuddapah district on seasonal and annual basis. Rainfall from 1901 to 1988 was taken for nine rain gauge stations for analysis.title on 'Impact of Irrigation on Employment' on the basis of micro study that

Todkari, G.U. (2009): In his Ph.D thesis entitled "Impact of Environmental Factors on Crop Landuse in Solapur District with Special reference to Grapevine Cultivation" he analyzed the Spatio-temporal variation in grape fruit farming, economy, and marketing of graphs in Solapur district.

1.7 Organization ofthe Work

The present study entitled 'A Geographical Studyof Irrigation on Agriculture LandUse Pattern in Solapur District' is based on the above objectives and methodology. The thesis includes seven chapters. The contents of each chapter have been presented below.

Chapter I:- This chapter under the title '**Introduction'** explains the significance of the theme selected, the objectives, data base , methodology, choice of study region, choice of topic and brief review of relevant literature as well.

Chapter II:- Under the title **'Profile of Study Region'** major characteristics of district are discussed. In this chapter a detailed account of the study area, its location and administrative setup, drainage system, soil and major characteristics of the district is given including the knowledge of physiography and related aspect of natural environment. . In this chapter the population growth, population density, population literacy, land holding

size, agricultural implements, and occupation structure and transport network are discussed.

Chapter III:- Under the title **'Sources of Irrigation'** it deals with approaches to investigation irrigation, and changes there in. In this chapter evolution of irrigation, need of irrigation, presents the source of irrigation, consisting of thespatial distribution of sources of irrigation, presentstatus of irrigation project, and mode of irrigation are discussed.

Chapter IV:- Under the title **'Land-use Pattern'** the chapter is devoted to the analysis of general land-use pattern and agriculture land-use pattern and changes therein. In this chapter, the general land-use is divided into major five major categories and temporal changes therein are observed. For the analysis of agriculture land-use, thirteen major crops were selected and analysed in the form of spatio- temporal variation.

Chapter V:- This chapter under the title **'Irrigation and Agriculture'** deals with the study of index of irrigation, intensity of irrigation, crop ranking, crop combination, crop diversification, Agriculture transformation and impact of irrigation on agriculture are discussed.

Chapter VI:-The name of six chapter is **"A case study of sample villages"**. This chapter is completely based on the field survey data. It includes method of sample selection, physio-cultural status of sample farmers, general landuse of sample farmers, irrigation sources, method of irrigation, and problem of irrigation and agriculture are discussed in this chapter.

Chapter VII:- Under the title **'Conclusion and Suggestions'** precise finding of this work and important suggestion and recommendations at the end of study are given in this chapter. It also highlights some of the important suggestions for irrigation development.

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Chapter - II

PROFILE OF THE STUDY AREA

2.1. Introduction

Agriculture in a way is the result of human efforts applied in the exploitation of land resources towards the satisfaction of one of man's basic needs, food. Broadly speaking, agriculture and its development largely determined by factors of physical and socio-economic environment such as relief, climate, drainage, soils, irrigation, population, transport and communication etc. These factors not only influence the agriculture in many ways but determine the extent of risk and overall development of agriculture. Various aspects of farming systems are also influenced by the socio-economic factors. All factors of physical and socio-economic work together and bring results, or impact on overall growth of agriculture. In the present chapter an attempt has been made to present a physical and socio-economic account of the study area with reference to agricultural land use.

2.2. Historical Background

Historically Solapur is an important city. Solapur is believed to be derived from two words 'sola' means sixteen and 'pur' means villages. The present city of Solapur is spread over sixteen villages i.e. Adilpur, Ahamedpur, Chapaldev, Fethepur, Jamadarwadi, Kalanjapur, Khandarpur, Khanderavkiwadi, Ranapur, Sandalapur, Shaikhpur, Muhammadpur, Solapur, Sonalgi, Sonapur and Vaidkawadi. The area which now forms Solapur district earlier formed a part of Ahmednagar, Pune and Satara district. Solapur district is the conjunction of Maharashtra state and Karnataka state . One of the inspiration found in Solapur fort shows that the town was called *'Sonalapur'* while another inspiration on the well in the fort shows that it was known as *'Sandalapur'*.The word 'Sandal' means sandal wood . It is most probable that during the course of time the name of Solapur is evolved by dropping 'na' from name of the Sonalapur.

Recent research work, however, shows that the the inscriptions of Shiva yogi Shri Siddheshwar of the time of the Kalachuristis of Kalyani, that the town was called `Sonnalage` which came to be pronounced as `Sonnalagi`. A Sanskrit inscription dated Shake 1238(Shalivan Calinder), after the downfall of the Yadavas found at Kamati in Mohol shows that the town was known as Sonalipur. During the Muslim period, the town was known as Sandalpur. Subsequently the British rulers pronounced Solapur as Sholapur and hence the name of the district.

The importance of Solapur is unique in the history of India in the sense that this district enjoyed freedom even before independence. The citizens of Solapur enjoyed independence for three days from 9^{th} to 11^{th} May 1930. The brief history runs like this.

After the arrest of Mahatma Gandhi in May 1930, protests and demonstrations against the British Rule were held throughout India. Large-scale rallies and protests were staged at Solapur also. Many citizens lost their lives in the Police firings. Due to this, the irate mob attacked the Police Stations. Out of fear the Police and other officers ran out of Solapur.

During this period, the responsibility of law, order and security of citizens was on the shoulders of congress party leaders. Then city congress President, Shri. Ramkrishna Jaju, with his other congressmen maintained the law and order for a period of three days from 9^{th} to 11^{th} May 1930. Secondly, the Solapur Municipal Council was the first Municipal Council of India to hoist the National Flag on the Municipal Council building (Now Municipal Corporation) of Solapur in 1930.

2.3. Location:

The district of Solapur is one, of the most important districts of Maharashtra state, both in terms of area and population. It lies entirely in the Bhima basin. The district of Solapur is located between 17^0 10' north to 18^0 32' north latitudes and 74^0 42' east to 76^0 15 ' east longitudes. The east-west length of the district is about 200 kilometer and north-south width is about 150 kilometer. The total geographical area of the Solapur district is about 14895 sq. kilometer with a population of 3855383 according to 2001 census. Within the region under study, Malshiras is the largest tahsil in area and the smallest is North Solapur tahsil. The Solapur district tentatively constitutes 4.84 percent area and 4.51 percent population of the Maharashtra state. In other words, the region under study ranks fourth in terms of area and seventh in term of population among the districts of Maharashtra. The district of Solapur, is well defined to its west as well as to its east by the scarps of Phaltan and Osmanabad plateau respectively. The adjoining districts are Sangali to its Southwest, Satara to its west, Pune to its Northwest, Ahamadnagar to its Northwest and Osmanabad to its North and Northeast, and the Bijapur district lies to its South as well as Gulburga district to its east of Karnataka state.

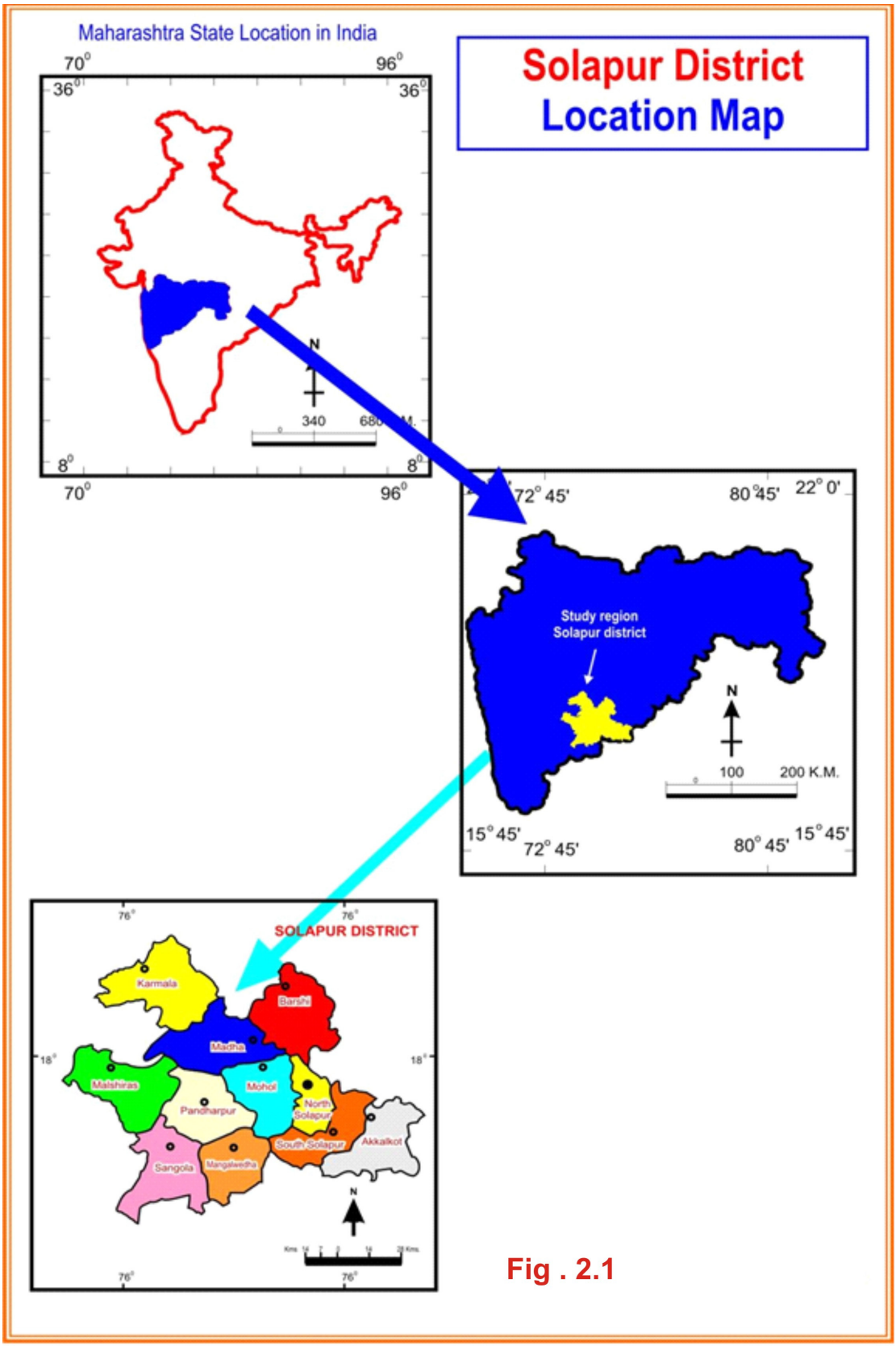

Maharashtra State Location in India
70°
96°
36°
8°
N
340
Solapur District
Location Map
72° 45'
80° 45'
22° 0'
15° 45'
Study region
Solapur district
100
200 K.M.
SOLAPUR DISTRICT
Karmala
Barshi
Madha
Malshiras
Mohol
Pandharpur
North Solapur
South Solapur
Akkalkot
Sangola
Mangalwedha

Fig . 2.1

2.4. Administrative Units

The Solapur district has an irregular shape. The average length of the Solapur district is 180 k.m. and it spread into East Akkalkot taluka to west Malshiras taluka and roughly, squarish width 100 k.m. is spread between Sangola taluka in the South to Karmala taluka in the North. The total geographical area of Solapur district is 14895 square kilometers and it covers 4.84 % area of Maharashtra state.

Table 2.1
Solapur District : Administrative Units

Sr. No.	Tahsils	Area in Hect.	% to total
1	Karmala	159580	10.73
2	Madha	152600	10.26
3	Barshi	152250	10.23
4	N Solapur	68303	04.59
5	Mohol	131689	08.85
6	Pandharpur	129437	08.70
7	Malshiras	160801	10.80
8	Sangola	159431	10.71
9	Mangalwedha	114159	07.67
10	S Solapur	119463	08.02
11	Akkalkot	140130	09.41
	District	1487843	100

Source : Solapur District Socio-economic Abstract in 2005.

According to geographical area, Solapur district is the 5th number district in Maharashtra state .This area is divided into 1.15 percent (170.79 square k. m.) urban area and 98.85 percent (14724 square k.m.) rural area. According to area Malshiras taluka is the largest (160801hect.) taluka and North-Solapur is the smallest tahsil (68303 hect.) in Solapur district.

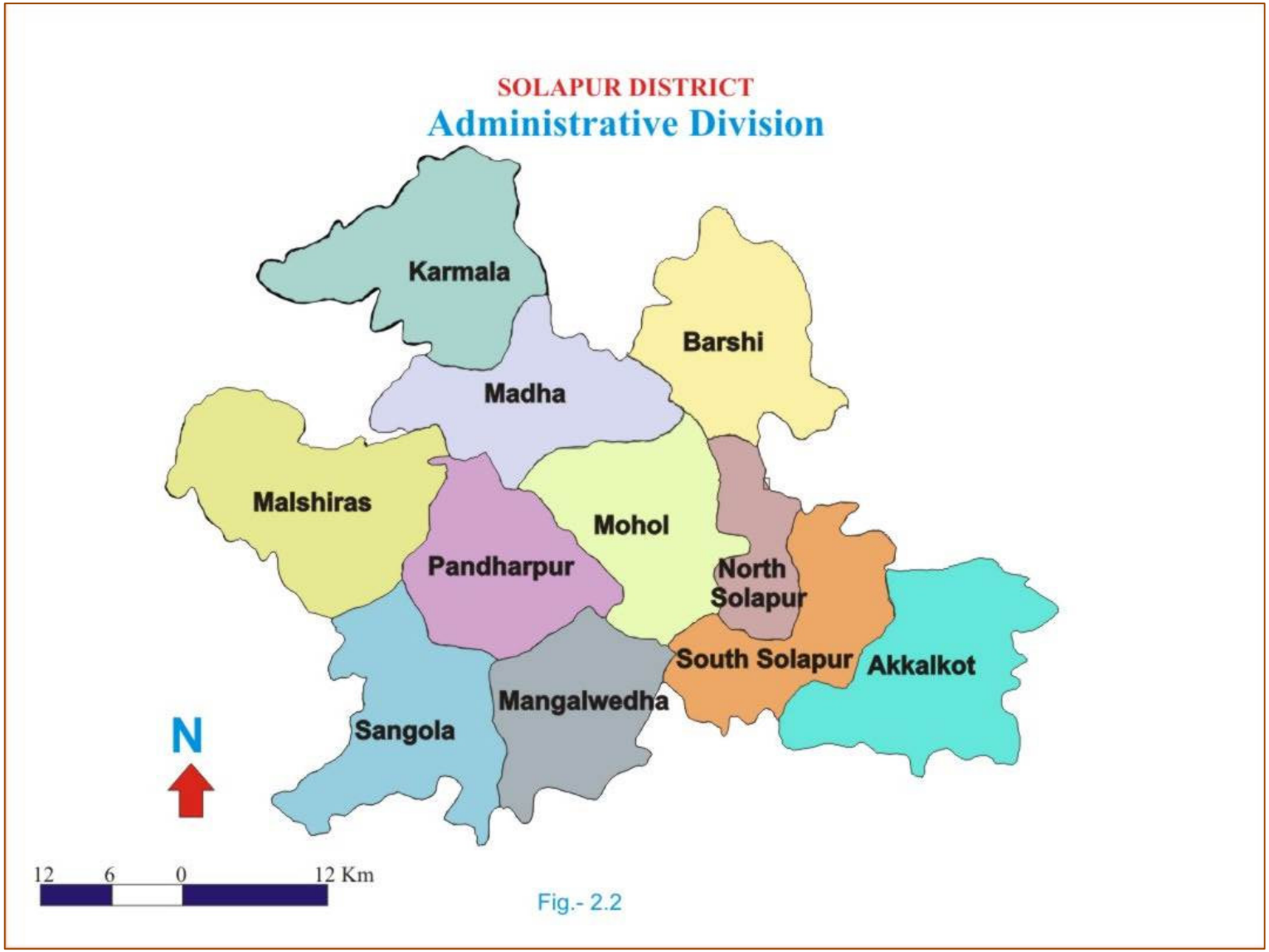

SOLAPUR DISTRICT
Administrative Division
Karmala
Barshi
Madha
Malshiras
Mohol
Pandharpur
North Solapur
South Solapur
Akkalkot
Mangalwedha
Sangola
N
12 6 0 12 Km

Fig.- 2.2

2.5. Physical structure

Physical structure affects agriculture operation in many ways. It directly affects land-use, growth and distribution of crops. It influences land cultivation and farming in a region by affecting the cause of altitudes, so different altitude regions give rise to different crops (Singh, 1974). The study region as whole is monotonously underlain by Deccan trap basaltic lava flows. This lava flows on account of weathering give rise to undulating topography. It is well defined to its west as well as to its east by the inward - looking scarps of Phaltan range and Osmanabad plateau respectively. There are no prominent hilly ranges in the district. The district as whole forms a broad flat or waving basin occupied by the Bhima-river, which flows in the middle in a south easterly direction. The region is characterized by typical Deccan trap geomorphology. On the basis of physical setup, the region is divided into three major relief divisions.

Table. 2.2:
Solapur District- Relief Divisions

Sr. No.	Relief Divisions	Area in Sq. Km.	Percentage to Total Geographical Area of the Region
1.	The Hilly Region	540	3.34
2.	The Plateau Region	11902	80.00
3.	The Lowland Region	2479	16.66
District Total		**1487843**	**100.00**

Source: *Compiled by the Researcher.*

1. The Hilly Region:

The hilly region, in the western and south - western parts occupies its sizable area by Mahadev ranges and Shukracharya ranges which have average height ranging from 600 to 900 meters, and this region also includes the plateau area of the Malshiras, Sangola, Pandharpur and Mangalwedha tahsils of the district. In the north eastern part of the Solapur district along the border of Osmanabad district, there is an important Balaghat range particularly in the Barshi tahsil. The small range of Balaghat range namely Ramling hill lies from north-west to south-east of Barshi tahsil which form the border line between Solapur and Osmanabad districts, which have an altitude between 600 to 750 meters. Most of the small rivers and streams like river the Man, the Korda, the Warai, the Bhogawati, the Nagzeri and Sina, originate from the Balaghat and Mahadev ranges. Some isolated ranges are also found in the various tahsils notably in the central

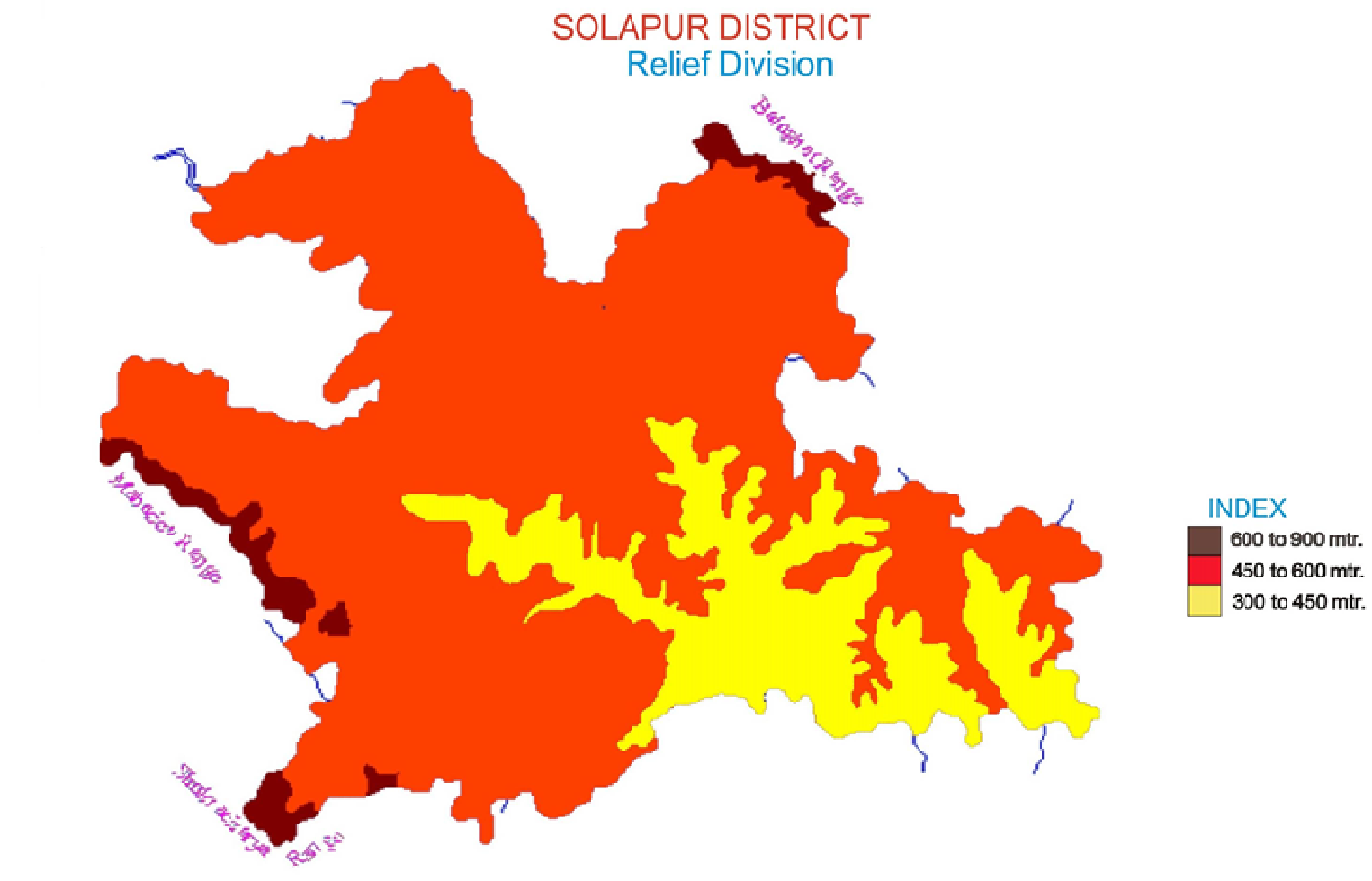

SOLAPUR DISTRICT
Relief Division
INDEX
600 to 900 mtr.
450 to 600 mtr.
300 to 450 mtr.
12 6 0 12 Km

Fig.- 2.3

part of Karmala and Madha tahsils, locally these hills are known as Waghoba and Bodaki respectively. These hilly regions as expected are agriculturally very poor and hence, human settlements are very few. These ranges occupy about 3.34 percent geographical area of the Solapur district. The slope of this study region varies from 3.11^0 to 5.6^0.

2.The Plateau Region:

The plateau covers an area about 11,902 sq. km. (80 percent) of the total geographical area of the region. The average height of the plateau region is ranging from 450 to 600 meters; this region also includes some individual separate hills in different parts of the plateau. This comprises the areas of the Karmala, Madha, Barshi and Akkalkot to the left bank of the river Bhīma and parts of Malshiras, Pandharpur, Sangola and Mangalwedha tahsils are to the right bank of river Bhima. Most of the plateau region in the Solapur district is drained by the river Bhima and its tributaries. The Soils of plateau region are suitable and fertile for the production of various types of fruit crops.

3 The Lowland Region:

The lowland region covers an area about 2,479 sq. km. (16.66 percent) of the total geographical area of the region. The plain region in the district of Solapur is occupied by Bhima River and its tributaries. The central part of the district lies in the plain region. The plain region naturally is found along both sides of the river Bhima and its tributaries such as the river Sina and the river Man. The soils of the plain region are most fertile due to the deposition of eroded material transported by the river Bhima and its tributaries. The Solapur city, the head quarters of district, is located at the border of plateau and plain region. Surprisingly, there are few hills and isolated uplands found in the plain region, which have the height of more than 550 meter above mean sea level. The average height of the lowland region is ranging between 300 to450 meters.

2.6. Drainage pattern

The drainage pattern in any area is very important for the study of agricultural operations. The rivers like the Bhima, the Sina, the Man, the Nira, the Bhogawati and many other small tributaries drain the district. Among them the Bhima and the Sina are important rivers in this area. These two rivers are tapped for irrigation in drought-prone area of Solapur district (Fig 2.3.).

Bhima River:

The Bhima River drains the central parts of the district comprising greater part of Karmala, Madha, Malshiras, Pandharpur, Mangalwedha, Mohol and Solapur tahsils. The river, one of the main feeders of the Krishna river, rises in 19°4' north

latitude and 73º 34' east longitude close to Bhimashankar in Pune district and runs south-east through Pune, Ahmednagar, Solapur and Bijapur districts before falling into Krishna about 25 km. north of Raichur. It enters the district near the village Jinti in Karmala tahsil and flows in a south-easterly direction, to leave the district and enter into Bijapur near the village Hilli in Akkalkot tahsil. The river has an overall length of 289 km. and within the limits of the district for a winding length is about 110 km. The river flows between high alluvial and tilled banks 200-500 meter apart. In certain places, it is rocky but as a rule, the bed is gravelly or muddy. The river is crossed by nine ferries, three in Pandharpur, at Kuroli, Pandharpur and Brahmapuri and six in Solapur at Ghodeshvar, Kusur, Bhandar-Kavta, Sadepur, Aunj and Takli. The entire valley, 400-600 meter high above the mean sea level, is dotted with isolated but scattered with fragmental quartz which are relics of some intra-trappean formations.

Nira River:

The Nira, the chief right-bank feeder of the Bhima River, rises in the Bhor tahsils of Pune district on one of the spurs of Sahyadri crowned by the Torna fort. It runs southeast and east along the borders of Pune & Satara districts before emptying its drainage into the Bhima River. Of its total length of about 180 km. about 48 km. lies on the borders of Pune and Solapur districts. In this stretch, the river Nira runs northeast forming the northern boundary of Malshiras tahsils and skirting past the village of Akluj, it falls into the Bhima River near Sangam. The banks of the Nira River are steep and rocky and its bed is generally gravelly. It is about 120 meter broad and has a few small pools from which the water is drawn by lifts or budkis to water garden crops.

Man River:

The Man, a right-bank feeder of the Bhima river, rises in the Phaltan range, a spur of the Mahadev range in the Man sub-division of Satara district, west of Dahiwadi and runs through eastern parts of Satara district and flows through Sangola and Pandharpur tahsils of Solapur before joining the Bhima near Sarkoli about 17 km. south-east of Pandharpur. Of its total length exceeding 160 km. about 80 km. lies within the limits of the district. The river flows past the town of Sangola. The banks of the Man River are low and cultivated while its bed is gravelly. The river is notorious for quick rising during the floods. The main feeders of the Man within the district are Belvan, Khurdu, Sanganga and Vankdi, all of which are seasonal.

Sina River:

The river Sina, one of the large left-bank feeders of the Bhima, rises 22 km. west of Torna in Ahmednagar district and runs southeast through Ahmednagar and it enters the Solapur district near Aljapur village in Karmala tahsils and falls into the Bhima near Kudal about 25 km. south of Solapur, on the Maharashtra-Karnataka boundary. It has 180 km. course in Solapur district. About 7 km. north of Mohol, the river receives the Bhogawati River on its left bank.Another small tributary on the left bank is the river Gorda joining the Sina at the east of Madha. The river Sina is about 100-200 meters broad and has steep banks. The bed is generally sandy but occasionally rocky. While upstream of Mohol, the river flows through a narrow valley, downstream it opens out widely to merge into the broad valley of Bhima. Five ferries, one in Madha at Kolgaon, and four in Solapur at Lamboti, Tirhe, Vaddukbal and Vangi cross the Sina.

Bhogawati River*:*

The Bhogawati is a large tributary of the Sina that rises in the south-facing scarps Ramling hills of the Balaghat range in the north-eastern parts of Barshi tahsils and after a south-westerly course of about 65 km. through Barshi and Madha, falls into the river Sina, about 7 km. north of Mohol. It is about 30 meters broad and has a slender stream during the low water. Its main source streams are the Bodki, the Nagsari and the Sira all of which rise in the Balaghat hills and run southeast. All these feeder streams keep the stream running practically throughout the year.

Bhend River*:*

The Bhend is a small tributary of the river Sina on its right bank and it rises near Kem in Karmala and falls into the Sina, a little north of the village Undargaon.

Bori River*:*

The river Bori*,* a minor left-bank feeder of the Bhima, rising on the south facing scarp-lands of the Osmanabad plateau near Tuljapur and flowing south, drains southwards in the eastern part of Akkalkot tahsil. The Harni is its tributary. It has a flow of 50 km. through the district.

Tanks:

There are 40 tank depressions within the district, some of which are used for irrigating farmlands. Most of them lie in Barshi and Sangola tahsils in the foothill slopes at the lower edge of the scarp. Of them, the largest and the most significant are the Ekruk tank in North-Solapur, Budhyal tank in Sangola tahsil and Asti tank in Mohol tahsil.

SOLAPUR DISTRICT

Drainage Pattern

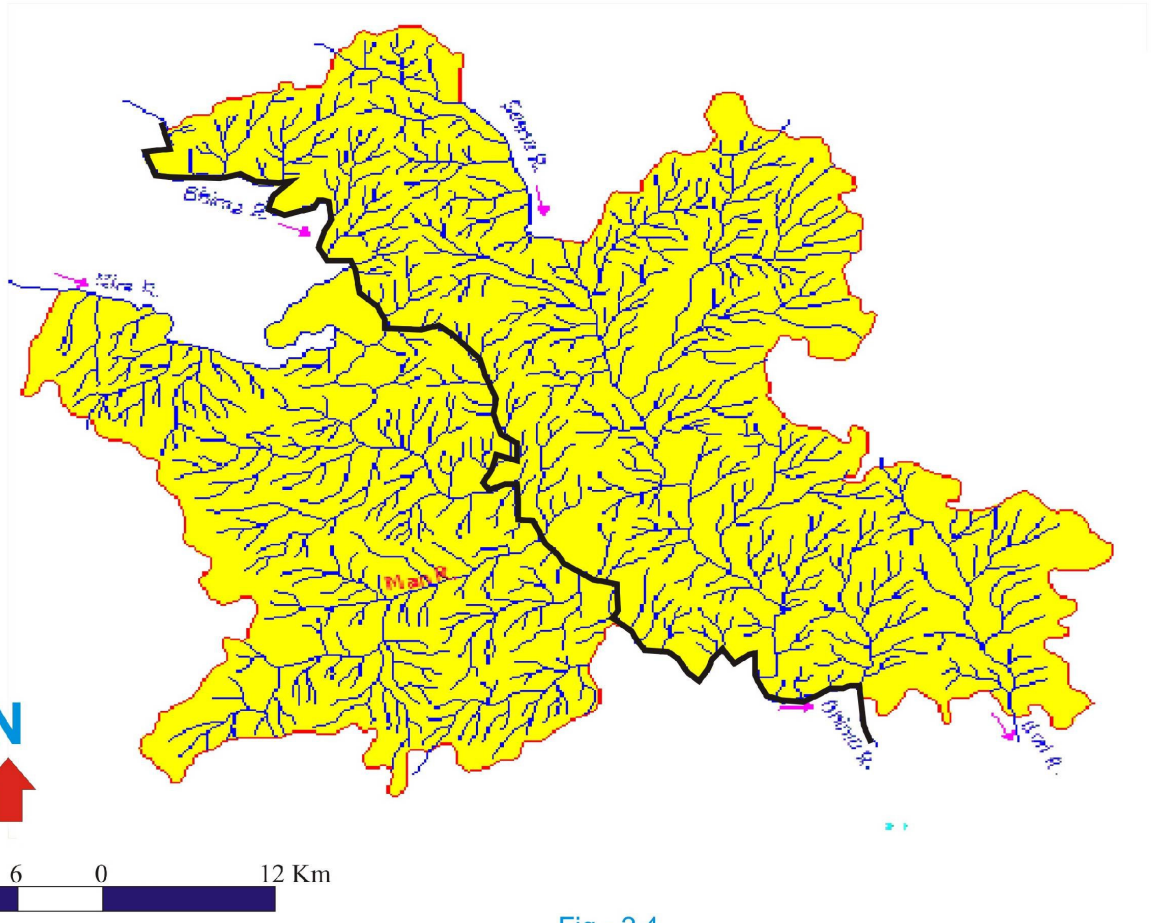


Fig.- 2.4

2.7. Soils:

Any study of farming activity must have reference to the soils. The soil which is the unconsolidated uppermost thin layers of the earth surface has emerged from various weathering processes, relief, parent materials, organisms and time. Soil is a medium of plant growth. Agriculture depends on soil to a great extent. The size of soil particles determines the soil texture and arrangement of soil particles refers to the structure of soil. The land suitability of crops depends largely on these physical characteristics of soil. The physical characteristics are related to the structure, texture, colors of the soil and temperature of the soil. The chemical characteristics are also of great importance and the fertility of the soil to a large extent depends on its chemical structure. The combination of physical, chemical and biological characteristics of soil determine the standard of agriculture and quality of crops raised on them. The soil of the Solapur district is mainly of the Deccan Trap volcanic origin. The soil in the district can be classified in to three main categories on the basis of depth and structure of soil.

Table 2.3
Solapur District- Soil Types

Sr. No.	Soil category	Area in percentage	Depth in cm
1	Shallow Soils	43.05%,	< 23.50
2	Medium Soils	33.99%	23.50 - 45.00
3	Deep Soils	22.96%	> 45.00

Source: - *Kashid P.B. Agriculture land use in Solapur district, Geographical Analysis.*

It is broadly estimated that out of the total cultivated area shallow soils occupies about 43.05 percent, medium soils 33.99 percent and deep soils 22.96 percent of the district.

1. Shallow Soils (Depth Below 23.50 cm.)

The shallow soils occur in southern part of Malshiras tahsil, Sangola and central part of Madha and Karmala tahsils Shallow soils are known as light soils and locally known as Malran. The depth of such soil is up to 23.5 cm. soils are of mixed character varying from light brown to reddish in colour and are not retentive of moisture. Shallow soils are alkaline in character and PH value varies from 7.9to8.6 with the soluble salts less than 0.3 to 0.39 percent. Calcium carbonate content varies from 2.8to20 percent. The nitrogen content is about 0.04 percent, while organic matter varies between 0.32 to 0.90 percent (Table. No.2.3).

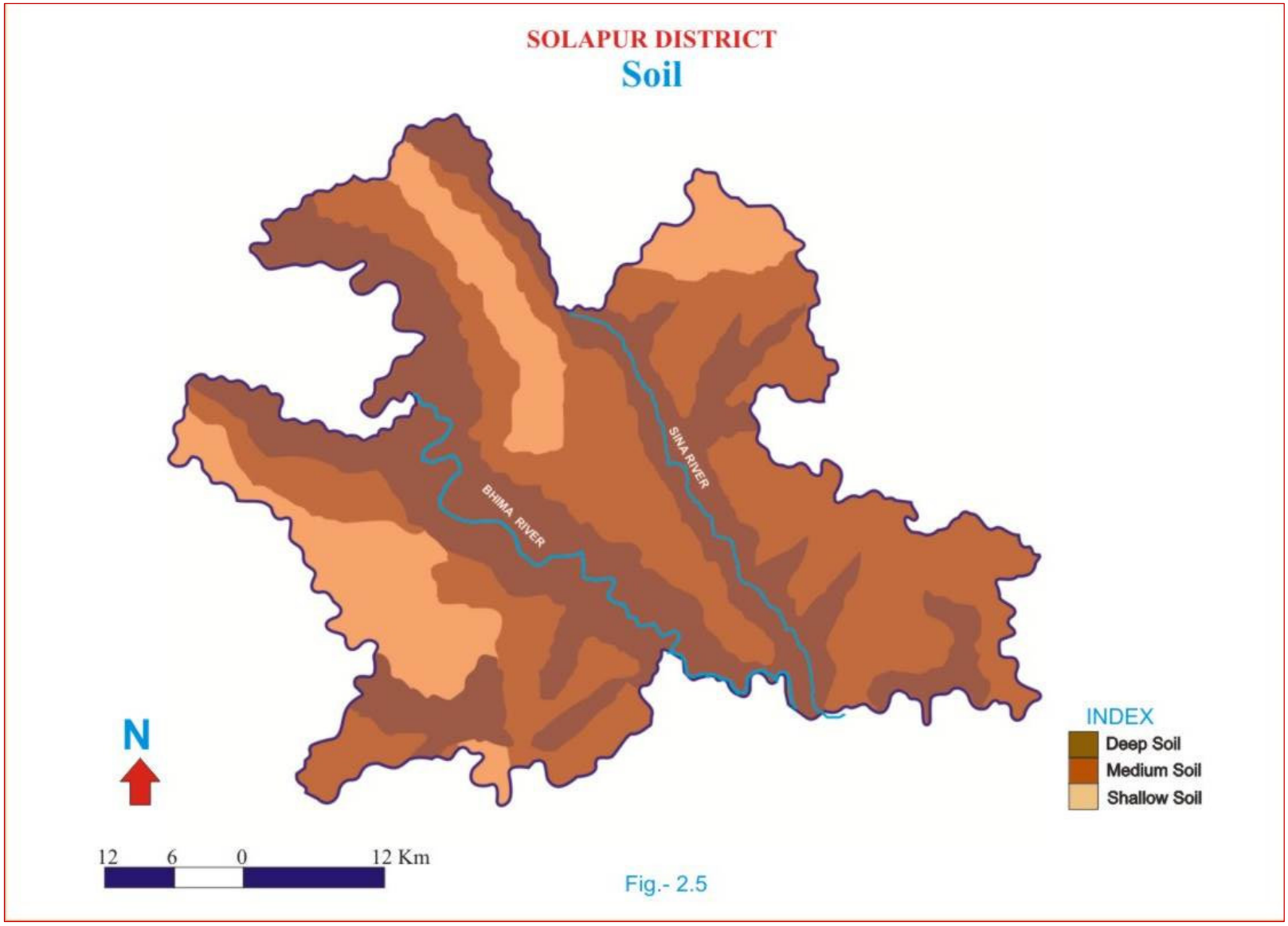

SOLAPUR DISTRICT
Soil
SINA RIVER
BHIMA RIVER
N
INDEX
Deep Soil
Medium Soil
Shallow Soil
12 6 0 12 Km

Fig.- 2.5

2. Medium Soils (Depth 23.50 to 45 cm.)

The medium deep soil is comparatively wide spread in the region. The depth of this soil varies from 23.5 to 45 cm. Medium deep soils are dark brown to black in colour. The texture of this soil off this soil varies from salty loam to clay loam. The pH value ranges from 7.2 to 8.3, with soluble salts 0.2 to 0.51 percent. The content of calcium carbonate and those of organic matter varies between 3.0to 20.0 percent and 0.46 to 1.10 percent respectively. The nitrogen content varies from 0.04 to 0.05 percent and phosphate from 8.20to 12.30 mgm. Percent. Such types of soil occur in central part of the region and eastern part of the Barshi, Mangalwedha and Akkalkot tahsil of the region (Fig. No. 2.5).

3. Deep Soils (Depth more than 45 cm.)

Deep Soils occur along the bank side of the Bhima and its tributaries in Malshiras, Karmala, Pandharpur, South-Solapur, Barshi, Mohol and Akkalkot tahsil of the region. The colour changes from dark gray brown to dark black. These soils are clayey in texture and alkaline in character. pH value varies from 8.5 to 8.9 with soluble salts between 0.4to 2.0 percent. The calcium carbonate content and those of organic matter varies between 6.7 to 15.8 percent and 1.10 to 1.34 percent respectively. The nitrogen content varies between 0.04to 0.06 percent and phosphate between 16.05 to 43.07 mgm. Percent. These soils are fertile and thus give better yields.

2.8. Climate

Climate consists of temperature, rainfall, humidity, sunshine, fog, mist, snow, hailstorm, winds and air pressure. The climate of the Solapur district is on the whole agreeable and is characterized by general dryness except during monsoon season .The year climate is mainly divided into four seasons. The cold season from December to middle of February, followed by the summer season lasting up to the end of May, the South West monsoon season from June to September and the post –monsoon season or retreating monsoon season in October and November .

2.8.A. Rainfall

Rainfall as the primary ecological parameter has created a variety of farming enterprises types or systems of agriculture. It also becomes a climatic hazard to farming when it is characterized with scantiness, concentration, intensity, variability and unreliability. The Solapur district is located in the drought prone area of Maharashtra. The rainfall of Solapur district is very low and uneven. The distribution of rainfall in Solapur district is characterized by three types of rainfall region.

a. High rainfall region [more than 600 mm]

b. Median rainfall region [between 500 -600 mm]

c. Low rainfall region [less than 500 mm]

Table 2.4
Solapur District: Average Annual Rainfall and Change

Sr. No.	Tahsils	Rainfall in mm		
		1971	2005	Change
1	Karmala	697	571	-126
2	Madha	612	631	+19
3	Barshi	933	757	-176
4	N Solapur	786	697	-89
5	Mohol	738	538	-200
6	Pandharpur	429	520	+91
7	Malshiras	469	324	-145
8	Sangola	372	370	-02
9	Mangalwedha	724	656	-68
10	S Solapur	786	698	-88
11	Akkalkot	931	676	-255
	District	732	585	-147

Source: Solapur District Socio-economic abstract 1971 and 2005

The spatial distribution of Solapur district in 2004-05 is following.

a. High Rainfall Region [more than 600 mm] :

The highest rainfall taluka in Solapur district is Barshi and in this tahsil 757 mm rainfall in 2005. North Solapur, South Solapur, Mangalwedha, Akkalkot and Madha are considered in this range of rainfall region .This area is located in the North – East part of Solapur district.

b. Medium Rainfall Region [Rainfall between 500-600 mm]:

The medium rainfall region is bounded between 500 mm and 600 mm rainfall. In this range of rainfall Karamala, Pandharpur and Mohol tahsil are include. This area is located in the central and north –west part of Solapur District. But this area is more irrigated by canal and river.

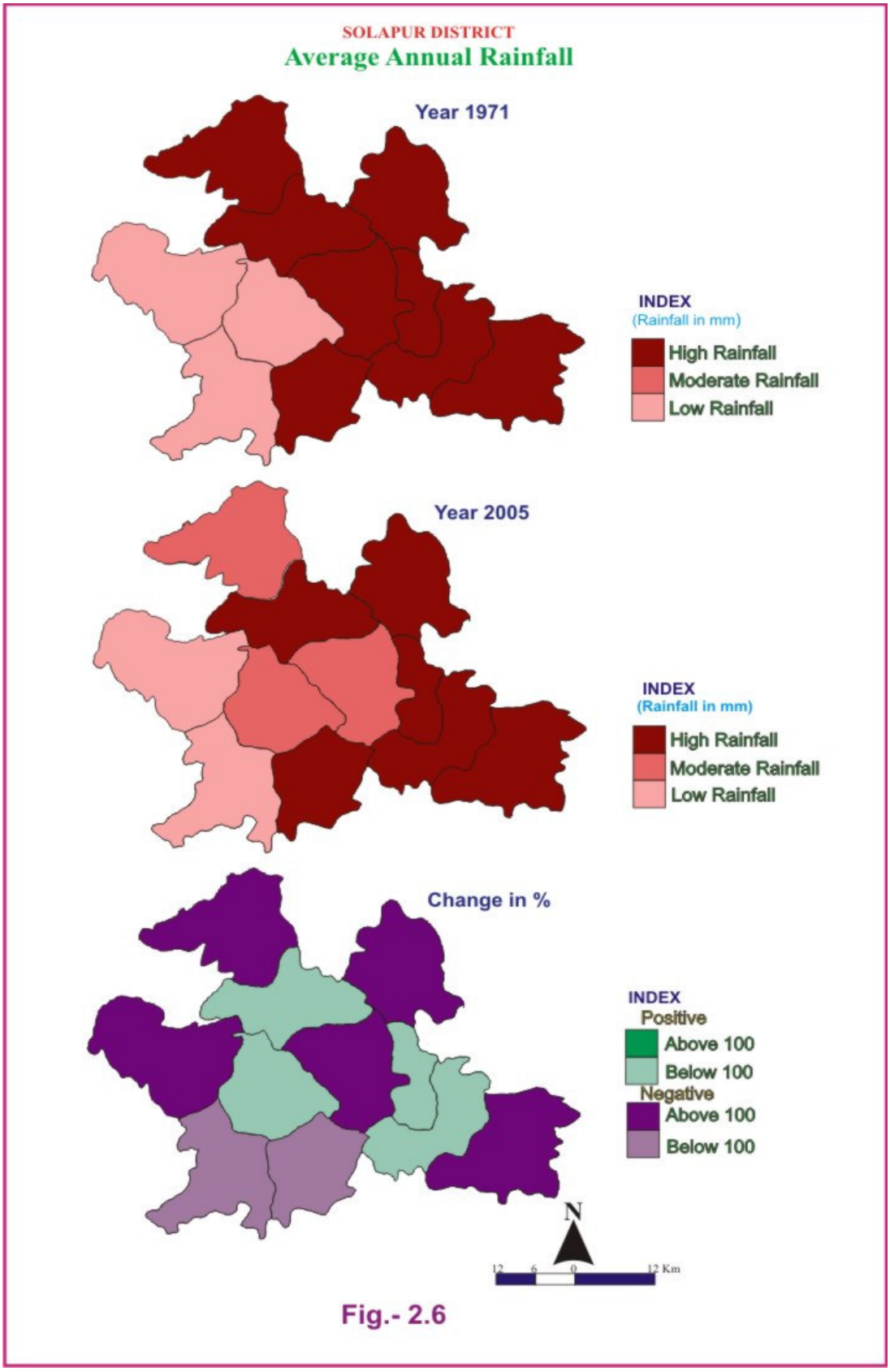

SOLAPUR DISTRICT
Average Annual Rainfall
Year 1971
INDEX
(Rainfall in mm)
High Rainfall
Moderate Rainfall
Low Rainfall
Year 2005
INDEX
(Rainfall in mm)
High Rainfall
Moderate Rainfall
Low Rainfall
Change in %
INDEX
Positive
Above 100
Below 100
Negative
Above 100
Below 100
N
12 6 0 12 Km

Fig.- 2.6

c. Low Rainfall Region [rainfall less than 500 mm] :

The rainfall less than 500 mm is in low rainfall region. The Malshiras taluka is the lowest rainfall tahsil in Solapur district. In this tahsil 324 mm rainfall is recorded. But in this tahsil agriculture is more developed by irrigation of Vir and Bhatgar dam, nira right canal and water available from Bhima river and its tributaries. The Sangola tahsil is also a low rainfall tahsil and in this tahsil 370 mm rainfall is recorded. In this tahsil pomegranate cultivation is more developed by drip irrigation.

The temporal changes during 1970 to 2005 are also depicted in this table 2.4. The table shows that the 147 mm rainfall decreased during the investigation period. The highest decreased observed in Akkalkot tahsil (255 mm) and lowest in Sangola tahsil (2 mm). The average rainfall is increased in only Pandharpur (91 mm) and Madha tahsil (19 mm).

2.8.B. Temperature

Temperature is a very important factor of climate. Solapur district is located in drought prone area and hot tropical region. So the temperature of the district is hot and high. The cold weather commences towards the end of November when temperature begins to decrease rapidly.

Table 2.5
Solapur District: Average Annual Minimum and Maximum Temperature

Sr. No.	Months	1971		2005	
		Mean daily Maximum Temp C°	Mean Daily Minimum Temp C°	Mean daily Maximum Temp C°	Mean Daily Minimum Temp C°
1	Jan	31.2	16.5	30.4	15.3
2	Feb	34.6	18.7	33.2	17.1
3	March	37.9	22.0	36.8	20.8
4	April	39.9	24.8	39.3	24.2
5	May	40.1	25.6	39.9	25.1
6	June	34.3	23.5	34.7	23.3
7	July	32.7	22.3	31.3	22.3
8	Aug	29.9	22.3	31.2	21.8
9	Sept	30.9	21.0	31.1	21.6
10	Oct	33.1	20.5	32.1	20.4
11	Nov	31.2	16.1	30.4	17.2
12	Dec	29.9	12.3	29.9	14.8
District Average		**33.8**	**20.5**	**33.3**	**20.3**

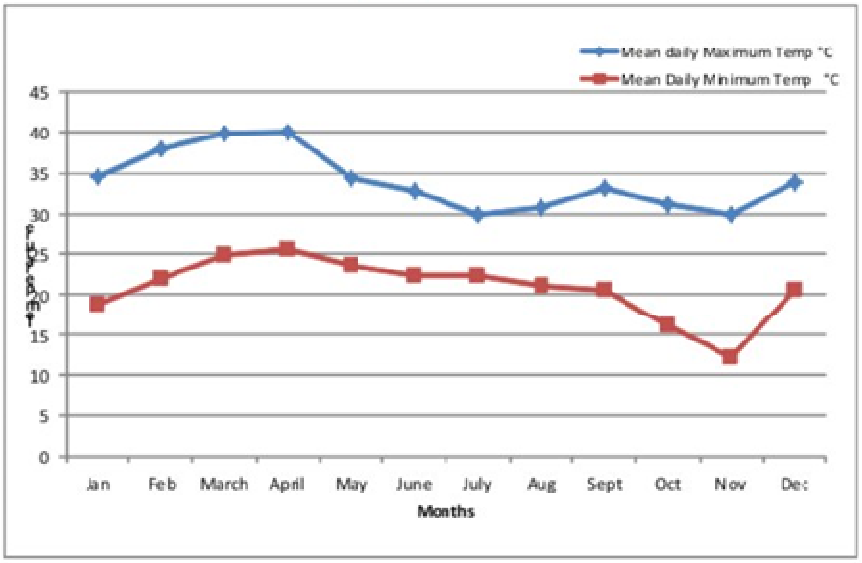
Source : Solapur District Socio-economic abstract 1971 and 2005

December is the coldest month with daily maximum temperature about 29.9ºc and the mean daily minimum temperature at about 14.8ºc. The heat during

Solapur District

Mean Daily Minimum & Maximum Temperature

Year 1971



Year 2005

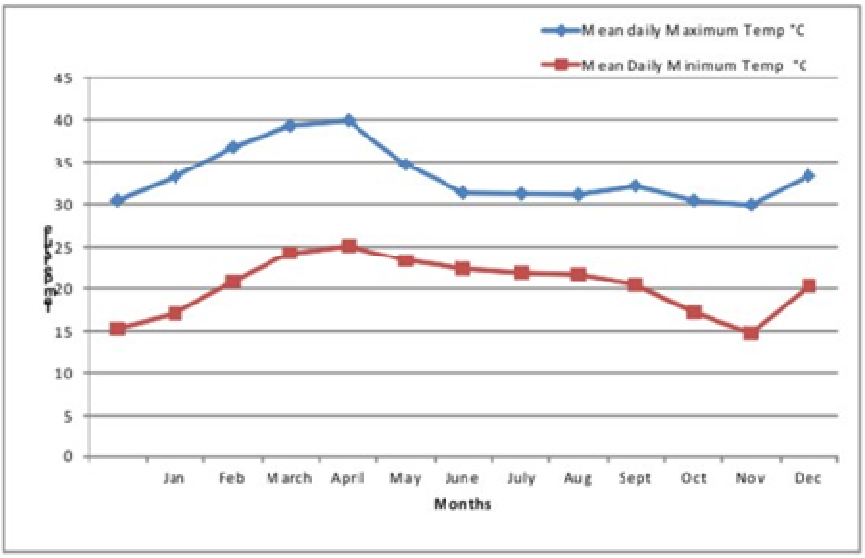


Fig. 2.7

summer [April to May] is intense and maximum temperature sometimes goes up to about 39.9ºc. Afternoon thunder shower which occurs some days during brings welcome relief through temperately with onset of the South East monsoon in the district early in June. There is an approachable drop in temperature with the early withdrawal of the monsoon.

In rainy season monthly maximum temperature for July and August is 31ºc. towards the end of September, temperature again increases slightly (Table No 2.5). In October high increase in the temperature occurs, which is called as "October heat", but temperature of night steadily decreases. In cold season minimum temperature ranges from 17.1ºc to 20.5ºc. December and January are coldest month of the year with minimum temperature of 14.8 ºc and 15.3 ºc.

2.9 Natural Vegetation

All the plants, which grow together in any area of from its vegetation. The vegetation of any region is composed of a collection of number of plants belonging to a few or many different species. The natural vegetation is commonly used to describe the natural plant growth as district from the cultivated plant growth. The natural vegetation consist of three forth division of forest, grassland and desert. In the region under study the forest cover is very poor. The forest of Solapur district occupy 357.9 sq. km. in which 345 sq.km. Forest area and 12 sq. km. is unclassified forest. In other words, 157 sq. km. is under revenue department, 188 sq. km. under forest department, average 12 sq. km. is unclassified reserved and unclaimed forest. Surprisingly, these scattered poor forests constitute only 0.94 percent of the total areas of the district. In the past forest were comparatively dense of predominant of curbs forests on the hill and with growth of babhul and neem, lower drown in the plains. However, at present most of these forests have disappeared, what remain today are poor stunted and malformed trees and scrubs in a scattered patches. Before, the independence of our country the forest areas were under the administration of forest division in Solapur district. But due to the growing pressure of population, some forest lands were converted into agricultural land and some were denuded of vegetation and soil.

At present, forests are mainly observed in patches in Malshiras, Sangola and Barshi tahsils on hills slopes and low lying areas. The local people consume most of the forest produce of the district. In fact, the forest produce fails short of the total demand and the requirements have to be imported from other places of Maharashtra and India. The important collection of forest produce in the district is Barshi and Solapur.


SOLAPUR DISTRICT
Natural Vegetation
KARMALA
BARSHI
MADHA
MALSHIRAS
MOHOL
PANDHARPUR
NORTH SOLAPUR
SOUTH SOLAPUR
AKKALKOT
MANGALWEDHA
SANOGLA
N
12 6 0 12 Km

Fig.- 2.8

2.10. Transport and Communication:

Transport and communication play a significant and pivotal role in the modern agriculture development. The overall development of the region depends upon the transport facilities available in the region. The dimension of agriculture expansion has increased because of the utilization of new inputs and their transport. We are all aware that the availability of transport and communication facilities can certainly develop industry, trade and commerce. In other words it is said that each and every investment in economy, and its success and failure depends at some extent on the transport sector. Transport plays an important role in the growth and distribution of rural and urban settlements as well as in developing the economy and rural- urban interaction. The modes of transport in study region are mainly roads and railways.

2.10.A. Roads:

Road is important means of transportation for the social and economic development in a particular region. Unlike railway, roads provide door to door services. In terms of road transportation, the Solapur district is better off, since it has total length of 14,108 km. out of this, 188 km. (1.33 percent) belongs to the National Highway, 173 km. (2.35 percent) major state highway, while 1332 km. (9.44 percent) state highway. Apart from this, the major district roads have the length of 3039 (21.54 percent) km. while other district roads occupy 2138 km. (15.12 percent). The village roads comparatively have a sizeable length in kilometers and comprise 7238 km. (51.29 percent) length within district connecting all the villages in the district.

Table 2.6
Solapur District - Length of Roads (2004-05)

Types of Road	Length in km.	Length in Percentage
National Highway	188	1.33
Major State Highway	173	2.35
State Highway	1332	9.44
Major District Roads	3039	21.54
District Roads	2138	15.14
Village Roads	7238	51.29
Total Length	14108	100.00

Source: *Compiled by the Author.*

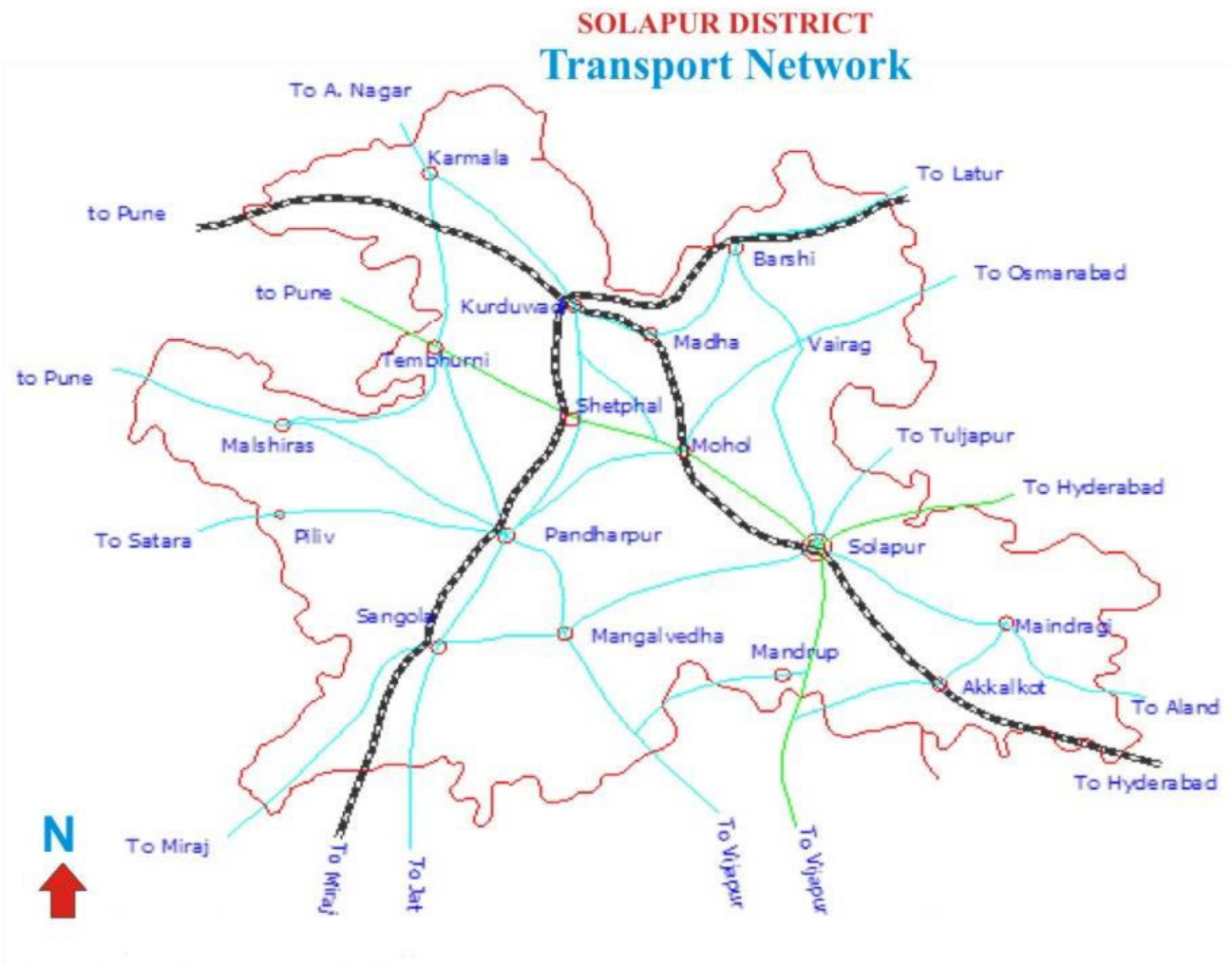

SOLAPUR DISTRICT
Transport Network
To A. Nagar
Karmala
to Pune
to Pune
to Pune
Tembhurni
Kurduwadi
Barshi
To Latur
To Osmanabad
Madha
Vairag
Shetphal
Mohol
Malshiras
To Tuljapur
To Hyderabad
To Satara
Pilv
Pandharpur
Solapur
Sangola
Mangalvedha
Mandrup
Maindragi
Akkalkot
To Aland
To Hyderabad
N
To Miraj
To Miraj
To Jat
To Vijapur
To Vijapur
12 6 0 12 Km

Fig.- 2.9

In order of importance the table concerned reveals the village roads which account more than half of the total length of the district. It is followed by the major district roads which is slightly less than one fourth of the total length of the district. It is further followed by other district roads in order of their importance which is one sixth of the total length of the district roads (Table. No. 2.6).

2.10.B. Railways:

Railway play's a vital role in the transport of freight and passengers. The total length of railway network is 532 km. and it is very low compared to other districts of Maharashtra state. There are three important railway lines passing through the district. These are Mumbai-Chennai, Solapur-Yashvantpur, & Latur-Miraj (Fig.No.2.9). Kurduwdi and Hotgi are the important junction places of the study region. Solapur, Pandharpur, Sangola are some of the railway stations within the limit of study area. Except Malshiras and Mangalwedha tahsils of the district all the remaining tahsils enjoy the facility of rail transport by broad- gauge.

2.11. Demographic situation

2.11.A. Population Distribution

Human resource is the wealth of nation. Man himself is a resource which is the powerful geographical factor on the surface of the Earth. The process of economic development of any region depends upon the quality and quantity of the population. Man plays a dual role in economic activities as a producer and consumer. The growth, distribution, characteristics of population to a certain extent throw light on man-power of the region and it is responsible for its progress also. The attitude of farmer is also an important factor which determines the adoption of innovation in agriculture. That's why in the fruit farming development of study region, man-power is considered as one of the most important elements, because fruit farming responds favorably in the generation of additional employment opportunities for rural masses.

Table No. 2.7
Solapur District - Population Distribution (2001)

Sr. No.	Tahsils	Population (in '000')	Percentage
1	Karmala	233	6.07
2	Madha	292	7.60
3	Barshi	341	8.85
4	North-Solapur	961	24.96
5	Mohol	252	6.56

6	Pandharpur	403	10.46
7	Malshiras	423	10.97
8	Sangola	273	7.06
9	Mangalwedha	170	4.45
10	South-Solapur	211	5.48
11	Akkalkot	290	7.54
Total		3849	100

Source: - *District census hand book, Solapur District- 2001.*

It is noticed from table No. 2.7 that, total population has been observed 3849000 in 2001 in this region. Highest population is observed in North Solapur tahsil 24.96 percent, and very low population is observed 4.45 percent in Mangalwedha tahsil. According to recent 2011 census, the total population of the Solapur is registered 43,16,000 among them, male population is 22,34,000 while female population is 20,82,000.

2.11.B. Population growth

The growth of population in an area is determined by three basic factors namely births, deaths and migration. The difference between births and deaths is called natural increase in population and with considering births, deaths and migration (in migration or out migration) is called total population growth. For the purpose of analysis total population growth is considered.

Table No. 2.8
Solapur District - Population Growth

Sr.	Tahsils	Population (000)					
		1971	%	2005	%	Change	%
1	Karmala	151	6.70	233	6.07	+ 82	- 0.63
2	Madha	193	8.56	292	7.60	+ 99	-0.96
3	Barshi	263	11.67	341	8.85	+ 78	-2.82
4	N Solapur	487	21.60	961	24.96	+ 474	+3.36
5	Mohol	142	6.30	252	6.56	+ 110	+0.26
6	Pandharpur	108	4.80	403	10.46	+ 295	+5.66
7	Malshiras	226	10.02	423	10.97	+ 197	+0.95
8	Sangola	156	6.92	273	7.06	+ 117	+0.14
9	Mangalwedha	108	4.79	170	4.45	+ 62	-0.34
10	S Solapur	133	5.90	211	5.48	+78	-0.42
11	Akkalkot	207	9.18	290	7.54	+83	-1.46
	District	2254	100	3849	100	+ 1595	-

Source: - District census hand book, Solapur District- 1971 and 2005.

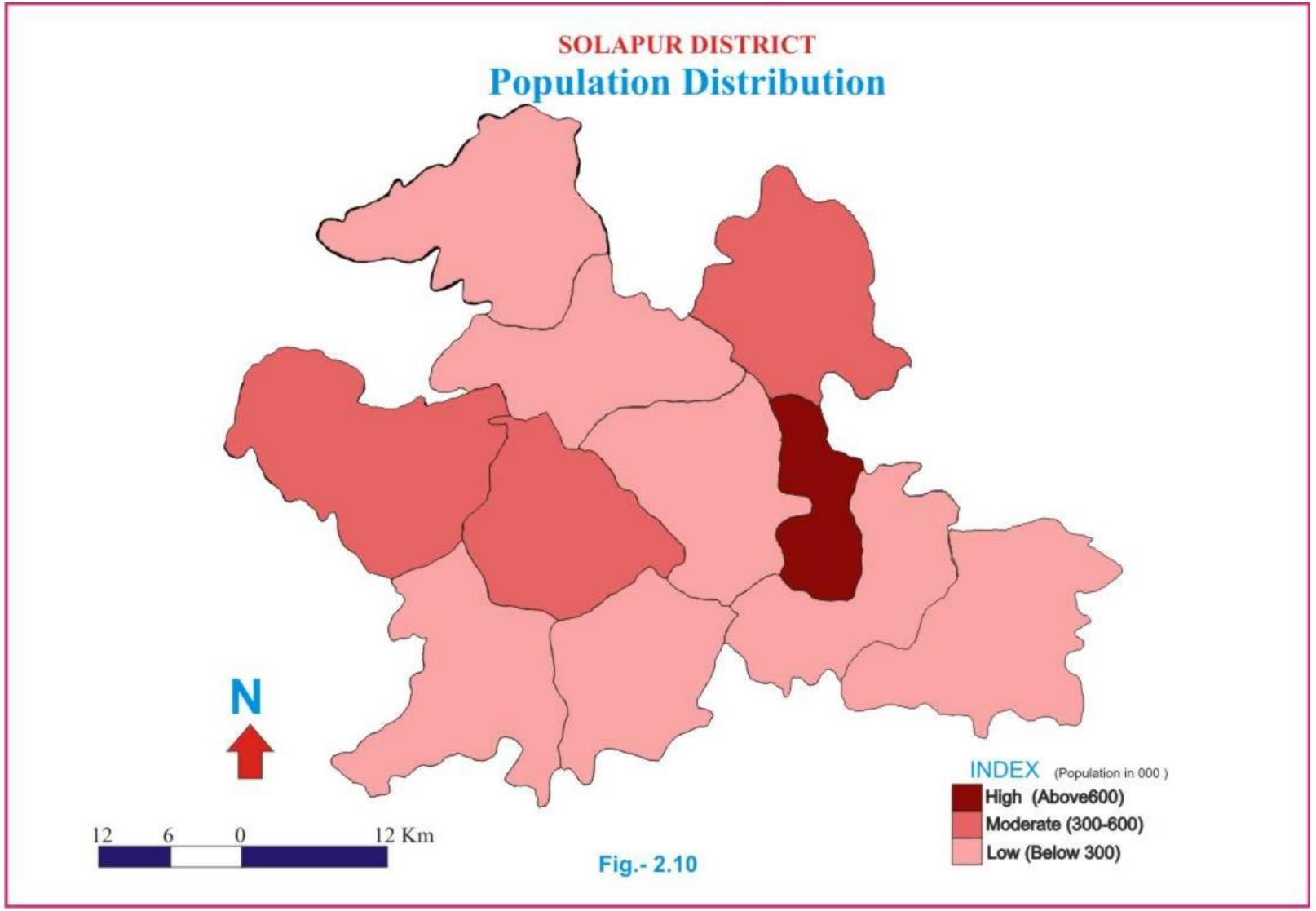

SOLAPUR DISTRICT
Population Distribution
N
12 6 0 12 Km
INDEX (Population in 000)
High (Above600)
Moderate (300-600)
Low (Below 300)

Fig.- 2.10

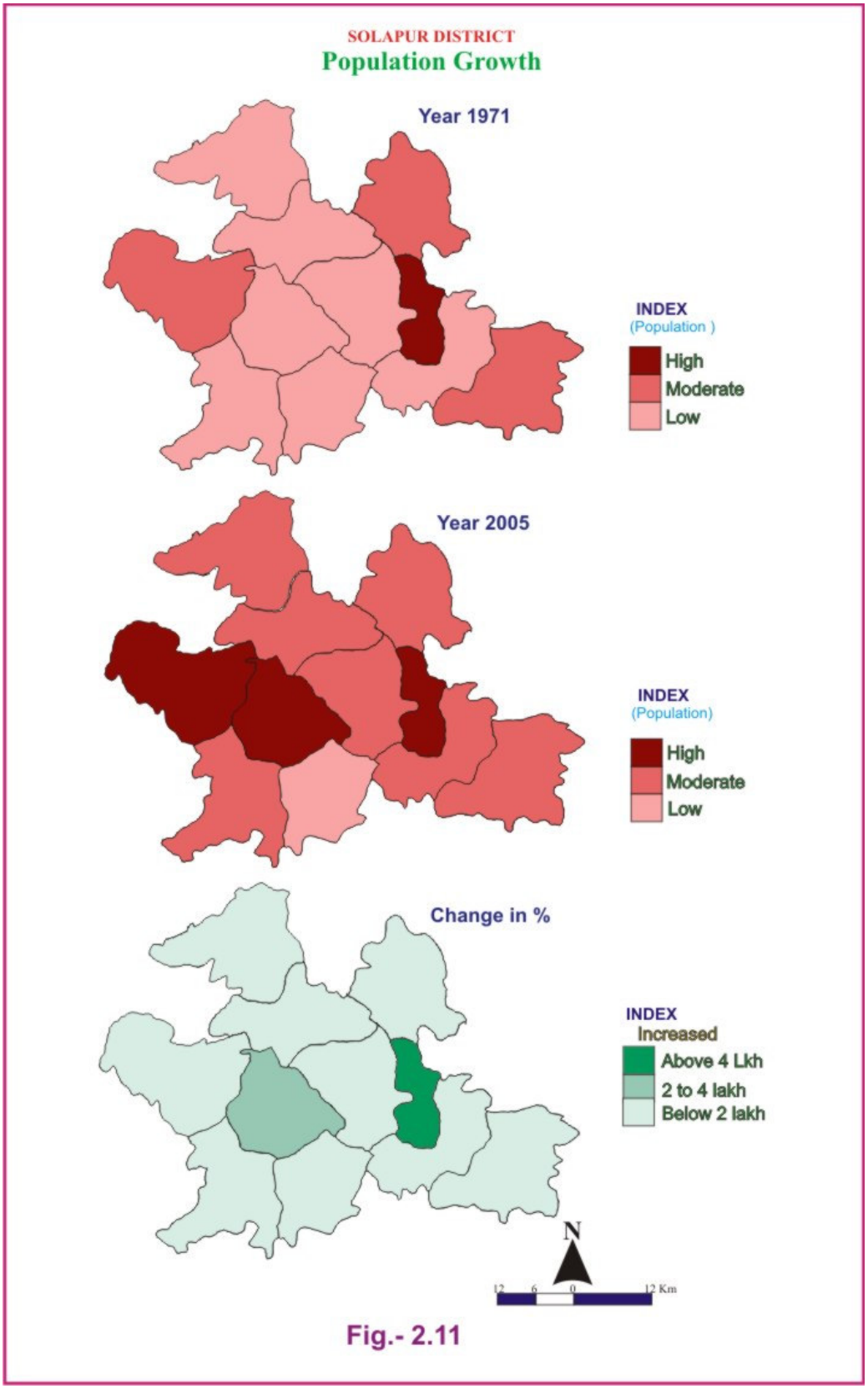

SOLAPUR DISTRICT
Population Growth
Year 1971
INDEX
(Population)
High
Moderate
Low
Year 2005
INDEX
(Population)
High
Moderate
Low
Change in %
INDEX
Increased
Above 4 Lkh
2 to 4 lakh
Below 2 lakh
N
12 6 0 12 Km

Fig.- 2.11

The population of Solapur District is 3.30 percent of the Maharashtra state population . It increased from 1971 to 2005. It was near about 3849000 in 2004- 05. Table 2.7 shows the Population of the district since 1971 - 2005.

In 2005, the growth of population and total population in North Solapur, Pandharpur and Malshiras taluka are very high (above 4,lakh population). Solapur city is included in North Solapur taluka . The district place Solapur provides more job opportunity and transport network like roadways, railways network is more developed. So the growth and total population of Solapur is more. The moderate population (2 lakh to 4 lakh) has been observed in Karamala, Madha, Barshi, South Solapur, Akkalkot, Sangola and Mohol tahsil. The data shows significant growth of population in the Western and North parts of the district because of physical and economic factors are responsible. There are good land, soil fertility, well irrigation, growth of farming product, cotton and sugarcane factories, mill projects, and MIDC. The population in Mangalwedha tahsil is very low (below 2 lakh.)

Then table also shows the population share in total population during study period changed. Compare 1971 censes, the share of North Solapur taluka's population in 2005 is more increased (Above 4 lakh) followed by Pandharpur (2 to 4 lakh). Remaining part of District, the total population growth has been observed low (below 2 lakh.

2.11.C. Population Density

The average density of population is expressed as a number of persons per sq. km. area. The distribution urban and rural population in the study area is uneven and largely influenced by physiographic and socio-economic conditions prevailing in the area. Its density of population determines whether a region or a district is densely or sparsely populated.

According to 2001 census, the population of Solapur district is nearly 38 lakh spread over its area of 14895 square kilometers giving overall density of 272 persons per kilometer. Mainly there is high growth in the western, eastern and middle parts of the district. They are very high population density found in North Solapur that is 1287 persons per kilometer because of Solapur city included in this tahsil. This area is well developed; it is a district place industries with, and good transport network. The high population density is also found in Pandharpur (309 persons) and Malshiras (278 persons) tahsils because of Pandharpur is a religious center and a developed agriculture region. In this region sugarcane cultivation is more developed. Median population

density is in tahsil like Sangola, Barshi, Mohol, Akkalkot, South Solapur and Madha talukas. The population density is 150-300 persons per kilometer in these talukas .Very low population density is spread over in Karamala (145 persons) and Mangalwedha (149 persons) talukas because these talukas are not agriculturally well developed.

Table No. 2.9
Solapur District - Population Growth

Sr	Tahsil	Population Density		
		1971	2005	change
1	Karmala	94	146	+55
2	Madha	125	185	+60
3	Barshi	162	224	+62
4	N Solapur	662	1407	+745
5	Mohol	101	192	+91
6	Pandharpur	144	311	+167
7	Malshiras	149	263	+114
8	Sangola	98	175	+77
9	Mangalwedha	95	150	+55
10	S Solapur	112	176	+64
11	Akkalkot	149	207	+58
	District	150	259	+109

Source: - District census hand book, Solapur district- 1971 and 2005.

A comparative study of the change in population density of Solapur district between 1971to 2005 shows a clear change in tahsil wise population density. There is a large change of population density in North Solapur (+745), Pandharpur (+167), Malshiras (+114) and Sangola (+77) talukas. In these tahsils, the population density increased because of factors like economic situation, cotton mills, industries, fertile land, well irrigation system, developed transport network and trade. In a result the way farmer's economic conditions are good in this region. So the total population density in Solapur district increased by 109 persons per kilometer in 35years between 1971 to 2005.

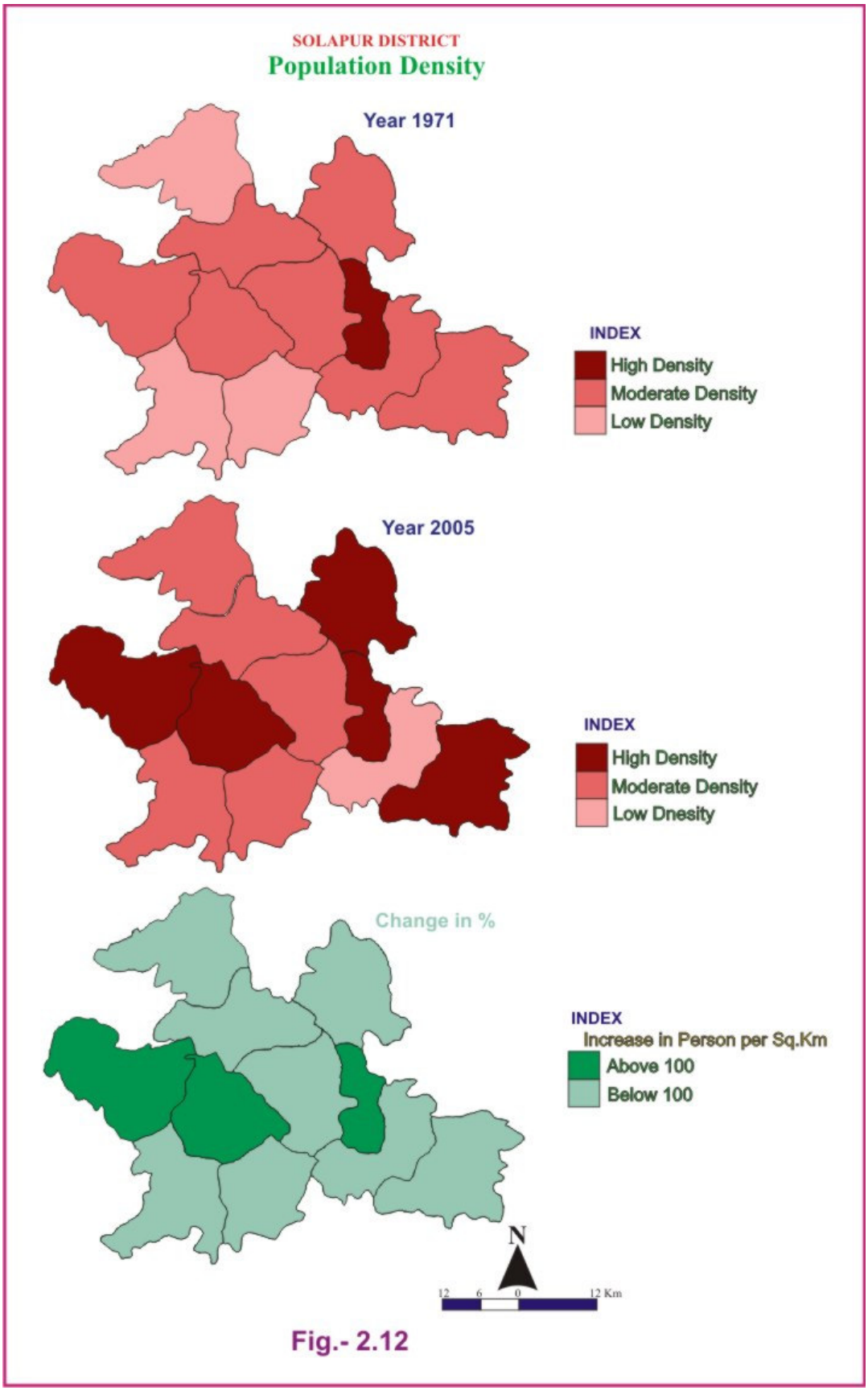

SOLAPUR DISTRICT
Population Density
Year 1971
INDEX
High Density
Moderate Density
Low Density
Year 2005
INDEX
High Density
Moderate Density
Low Dnesity
Change in %
INDEX
Increase in Person per Sq.Km
Above 100
Below 100
N
12 6 0 12 Km

Fig.- 2.12

2.12. Land Holding Size

The size of farm is one of the important factors influencing the farmers decisions regarding agricultural work and determines his income from farming. Land holding is an important aspect of landuse study with the changes in the size of holdings the landuse pattern also changes and the landuse pattern become stagnant as soon as the holdings researches to particular level. In Solapur district the size of the farm varies from 0.5 hectare to above 20 hectares. Table No 2.10 shows the size of operational holdings.

Table 2.10
Agriculture Land Holding Size

Sr	Land Holding Size (Hectors)	Total Holdings							
		Year 1971			Year 2005			Change	
		Number	%	Area	Number	%	Area	Number	Area
1	Below- 0.5	18060	7.40	4400	17416	3.08	25489	-644	+21089
2	0.5- 1.0	17652	7.23	12900	104256	18.43	78738	+ 8660	+65838
3	1.0-2.0	38149	15.63	56500	175693	31.07	261869	+137544	+205369
4	2.0-5.0	78251	32.07	25800	171783	30.38	514506	+93532	+488706
5	5.0 – 10.0	55945	22.93	391400	29936	5.29	206569	-26009	-184831
6	10.0- 20.0	29825	12.22	408300	5608	0.99	78357	-24217	-329943
7	Above 20.0	6065	2.48	173600	697	0.12	25633	-5368	-147967
	Total	243947	100	1305000	565389	100	1191161	+321442	-113839

Ref:- Socio-economic abstract of Solapur district (1970-71 & 2004-05)

In 1971, the total numbers of holding in the study area were 243947. Of these 14.63 percent farmers holding were below 1.0 hectors, 47.70 percent were 1 to 5 hectors, 22.93 percent were 5 to 10 hectors, 12.22 percent's were 10 to 20 hectors and 2.48 percent's were holdings above 20 hectors.

According to 2005, there were 565389 operational holdings of all sizes accounting for 1191161 hectors of operated area. The number of holders as compare to 1971 has increased by 321442. Thus, agriculture holdings have considerable change since 1970-71 in the region. Table No 2.10 shows the details of different size of holdings in Solapur district during two time periods. Over most of the region , 5 to 10 hectors, 10 to 20 hectors and above 20 hectors holdings area and farmers are decreased in study region during the study period.

2.13. Agriculture implements

Agriculture implements play a vital role in enhancing the productivity of land. The irrigation under study has the dominance of traditional implements. The last

three and half decades have however, witnessed substantial increase in the mechanical implements in Solapur District.

Table 2.11
Agriculture Implements

Sr	**Agriculture implements**	1971	2005	Change
1	Ploughs			
	a)Wooden	12300	15037	+2737
	b)Iron	34471	37180	+2709
2	Carts	48972	35485	-13487
3	Agriculture Machinery			
	a) Oil engines	12136	7464	-4672
	b)Electric pumps	918	52366	+51448
	c)Sugarcane crushers	1314	1781	+467
	d)Tractors	229	3747	+3514

Ref:- Socio-economic abstract of Solapur district (1970-71 & 2004-05)

The table 2.11 shows the use agriculture implements in 1971 and 2005. The nature of agriculture depends on the development of agriculture which is highly influenced by rainfall or irrigation situation. The 12300 wooden ploughs and 34471 iron ploughs were used in 1971, however these ploughs quantity are growing in 2005. The use of carts decreased (13487 carts) during the investigation period because of the easily and fast other transport facilities available. In 1971, the Solapur district farmers used 12136 iron pumps, but these are decreased (4672) due to growing price of oils and increasing facilities of electric pumps. The table clearly shows that the number of electric pumps (51448 pumps) increased during the study period. The working capacity of electric pump is more compare to oil engines which increased amount of area under irrigation. The use of sugarcane crushers and tractors are largely increased in Solapur district during the study period.

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Chapter -III

IRRIGATION PATTERN

3.1. Introduction

The present chapter aims to study the evolution of irrigation, need of irrigation, Tahsilwise and crop wise changes in irrigated area. It is also analysed the sources of irrigation in Solapur district during the period of 1971 to 2005. The over all irrigation sources , development of irrigation sources and changes their in are also studied in this chapter.

3.2. Concept and definition of irrigation

Irrigation occupies a place of primary importance in any strategy to increase agricultural production. Nearly about more than a third of its area prone to frequent droughts so, the development of irrigation assumes great importance.

Irrigation is defined as the artificial application of water to soil, for the purpose of supplying water essential to plant growth. This historical allusion emphasizes, the fact that irrigation is human being's effort to substitute for any deficiencies in natural rainfall with the objective of a steady expansion in crop out put. It is the artificial application of water to the land or soil. It is used to assist in the growing of agricultural crops, maintenance of landscapes, and vegetation of disturbed soils in dry areas and during periods of inadequate rainfall. The following are the definitions of the term 'irrigation'.

1. "To supply (dry land) with water by means of ditches, pipes, or streams; water artificially."
2. "The area is assumed to be irrigated for cultivation through such sources as canals (Govt. & Private), tanks, tube-wells, other wells and other sources."
3. Kasinath Singh (2004) : "Irrigation means the application of water by human agency to assist the growth of crops and grass."
4. "Artificial water supply in proper ratio and at proper time for agricultural purposes is called Irrigation."
5. Contor (1967) : "irrigation as the artificial application of water to the soil for crop production. It has been therefore, considered as one of the important technology components of progressive agriculture".
6. Andreae, (1975): "The artificial application of water to land for growing crops is known by the term irrigation. Artificial watering affects the entire organization of the farm increasing production. However, the transformation partly or fully depends on the nature and mode of irrigation. (well, canal, lift and tank) which depends largely on physiographic and climatic condition of a region".

7. Peter wales: “Irrigation is an artificial means of watering the crops or plants or an art of supplying water to the crop.”
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3.3. Evolution of Irrigation

Irrigation is prime process in agriculture development. It is originated when the crops need artificial need of water. The history of irrigation in world, India and Maharashtra as well as study region varied according to time and place.

3.3.A. History of Irrigation Development in World

Archaeological investigation has identified evidence of irrigation in Mesopotamia and Egypt as far back as the 6th millennium BCE, where barley was grown in areas where the natural rainfall was insufficient to support such a crop. In the 'Zana' Valley of the Andes Mountains in Peru, archaeologists found remains of three irrigation canals radiocarbon dated from the 4th millennium BCE, the 3rd millennium BCE and the 9th century CE. These canals are the earliest record of irrigation in the New World.

The Indus Valley Civilization in Pakistan and North India (from 2600 BCE) also had an early canal irrigation system. Large scale agriculture was practiced and an extensive network of canals was used for the purpose of irrigation. Sophisticated irrigation and storage systems were developed, including the reservoirs built at Girnar in 3000 BCE. There is evidence of the ancient Egyptian pharaoh Amenemhet - III in the twelfth dynasty (about 1800 BCE) using the natural lake of the Fayûm as a reservoir to store surpluses of water for use during the dry seasons, as the lake swelled annually as caused by the annual flooding of the Nile.

The Qanats, developed in ancient Persia in about 800 BCE, are among the oldest known irrigation methods still in use today. They are now found in Asia, the Middle East and North Africa. The system comprises a network of vertical wells and gently sloping tunnels driven into the sides of cliffs and steep hills to tap groundwater. The Noria, a water wheel with clay pots around the rim powered by the flow of the stream (or by animals where the water source was still), was first brought into use at about this time,

by Roman settlers in North Africa. By 150 BCE pots were fitted with valves to allow smoother filling as they were forced into the water. The irrigation works of ancient Sri Lanka, the earliest dating from about 300 BCE, in the reign of King Pandukabhaya and under continuous development for the next thousand years, were one of the most complex irrigation systems of the ancient world. In addition to underground canals, the Sinhalese were the first to build completely artificial reservoirs to store water. The system was extensively restored and further extended during the reign of King Parakrama Bahu (1153 – 1186 CE).

In the Szechwan region ancient China the Dujiangyan Irrigation System was built in 250 BCE to irrigate a large area and it still supplies water today. In fifteenth century Korea the world's first water gauge (woo ryang gyae) was discovered in 1441 CE. The inventor was Jang Young Sil, a Korean engineer of the Choson Dynasty, under the active direction of the King, Se Jong. It was installed in irrigation tanks as part of a nationwide system to measure and collect rainfall for agricultural applications. With this instrument, planners and farmers could make better use of the information gathered in the survey.

3.3.B. History of Irrigation Development in India

Ministry of Water Resources (Govt. Of India), on its web site briefly explains the history of irrigation development in India which can be traced back to prehistoric times. Vedas, Ancient Indian writers and ancient Indian scriptures have made references to wells, canals, tanks and dams. These irrigation technologies were in the form of small and minor works, which could be operated by small households to irrigate small patches of land. In the south, perennial irrigation may have begun with construction of the Grand Ancient by the Cholas as early as second century to provide irrigation from the Cauvery River. The entire landscape in the central and southern India is studied with numerous irrigation tanks which have been traced back to many centuries before the beginning of the Christian era. In northern India also there are a number of small canals in the upper valleys of rivers which are very old.

Ghiyasuddin Tughluq (1220-1250) is credited to be the first ruler who encouraged digging canals. Fruz Tughlug (1351-86) is considered to be the greatest canal builder. Irrigation is said to be one of the major reasons for the growth and expansion of

the Vijayanagar Empire in southern India in the fifteenth century. Babur, in his memoirs called 'Baburnamah' gave a different description of prevalent modes of irrigation practices in India at that time. The Gabar Bunds captured and stored annual runoff from surrounding mountains to be made available to tracts under cultivation.

The end of nineteenth century according to sources of irrigation; canals irrigated 45 %, wells 35 %, tanks 15 % and other sources 5 %. Famines of 1897-98 and 1899-1900 necessitated British to appoint first irrigation commission in 1901, especially to report on irrigation as a means of protection against famine in India. As a result of recommendations of first irrigation commission total irrigated area by public and private works increased to 16 Million hectors in 1921. From the beginning of 19th century to 1921 there was no significant increase in tube well irrigated area. During 1910 to 1950 growth rate of irrigation was estimated at 2.0 % per annum for government canal irrigation, 0.54 % per annum for well irrigation and 0.98 % per annum in respect of irrigation from all sources.

At present, with almost one fifth of worlds net irrigated area (57 Million hectors); India has the highest irrigated area in the world today. India's ultimate irrigation potential was estimated at 139.9 Million hectors, comprising of 58.46 Million hectors through major and medium irrigation schemes and 81.43 Million hectors from minor irrigation schemes. Recently some positive steps were also taken to long-awaited inter-basin water transfer, aiming at adding 35 Million hectors to India's irrigated area. The implementation of the inter-basin water transfer link schemes are taken up in a phased manner depending on the priorities of the Government. The links namely (i) Ken-Betwa link (ii)Parbati-Kalisindh-Chambal link (iii) Godavari(Polavaram) – Krishna (Vijayawada) link (iv) Damanganga-Pinjal link and (v) Par-Tapi-Narmada Link have been identified as priority links for consensus building amongst concerned States for taking up preparation of Detailed Project Reports (DPR).

3.3. C. History of Irrigation Development in Maharashtra

The linguistic state of Maharashtra was politically evolved on the 1st of May 1960 as a late consequence of the states reorganization shemes of the Government of India. Commanding a more or less central situation in the Republic of India Maharashtra is one of the largest state both in population and in area. The total geographical area of the state is 307.58 Lakh hectares and net sown area of 179.11 lakh hectare (58.23 percent of

geographical area). The gross cropped area in the state comes to 236.87 Lakh hectares and the percentage of gross irrigated area to gross cropped area is noticed to be 22.23% by the end of the year 2004-05. According to the 2001 population census, the total population of the state stood at 96879000 out of which 57.57% lives in rural areas and remaining 42.43% lives in urban areas. In Maharashtra, there is very limited scope for an increase in cropped area. The agro- climatic conditions of the state are favorable to maximizing yields through irrigation.

The main feature of the state is that agriculture continues to be the major source of income of the state. Maharashtra state is situated in a relatively low rainfall zone and about 33% of its area is the drought prone. The rainfall in the state varies from 800cm to 50cm (mainly in drought prone area). The rainy days are 45 in a year. The lack of adequate rain underline the need of irrigation. Culture and history of irrigation indicates the civilization in the state has developed on the banks of Godavari, the Krishna, the Bhima, the Tapi, the Wainganga, the Painganga etc. like country the agriculture in state is a gamble in monsoon, because monsoon rainfall is uneven, unevenly distributed and 20 about 33 percent of population of Maharashtra state is suffering from scarcity.

During the pre-independence period, British government appointed Famine Commission in 1880 and the commission reported that protective irrigation schemes should be under taken by government. At the same the commission was of the opinion the government should give first priority to irrigation scheme. But due to some problems the irrigation schemes were neglected. In 1901 famine was intolerable, hence government appointed irrigation commission in same year. This commission stated that farmers should dug more wells and when it was not possible then only government should undertake irrigation schemes. For suggesting measures to face the water problem in famine area, Bombay government appointed Shri F.H. Bill. He recommended that government should be gave sanction to Pravara, Bhandardara and Girna irrigation projects.

The efforts for the development of irrigation in state started since the formation of Maharashtra state in 1960. The government of Maharashtra was the appointed state irrigation commission. This commission made a comprehensive study of the irrigation potential in the state and submitted its report to government in 1962. The commission hoped that near about 30 percent area can be irrigated by river water and after completion of all proposed major, medium and minor irrigation projects. On the basis of the first irrigation commission's recommendations a number of new irrigation canals i.e. the Godavari canal and Girna left bank canal etc. and its distribution channels were taken

up. Simultaneously, works were carried out on remodeling, improving and extending the Pravara and Nira canals. Large number of tanks was excavated during the first two decades of century in the Vidharbha region, which tend formed part of eastwhile central province. The Ramtek tank in Nagpur district, the Chandrapur, Khairbhanda, Chol Khamara and Bodulkasa tank in the Chandrapur district were excavated during this period.

3.3. D. History of irrigation in Solapur District

Irrigation development in Solapur district the total irrigated area is 7.47 percent to states irrigated area in 2004/05. This irrigated area is 1.3 lakh hectors in 1960, which is only 10.60 percent to net sown area. In this period, irrigation technology was not satisfactory means electric pump sets or disel engines were absent in well, tank irrigation. The canals and bore-wells were not used for irrigation. After the green revolution, irrigated area increased tremendously i.e. in 1980, irrigation area is 1.8 lakh hectors which contribute 14.71 percent to net sown area. It reached 2.5 lakh hectors in 2000 year and cover 30 percent net sown area. After that the irrigation area and share in net sown area decreased due to the decreasing average rainfall of the region, the more time absence of electricity, continuously going down water surface level and non-planning irrigation use by farmers.

3.4. Need of irrigation

The rainfall of Solapur district is depend on monsoon. Rainfall can control our agriculture. But the Solapur district is said to be 'the gambling of monsoon' as the monsoon rainfall are uneven, uncertain, irregular and uneven or unequal. So irrigation is essential of agriculture in Solapur district. The following are the primary reasons of irrigation in Solapur district.

1. About the 80 percent of the total annual rainfall of Solapur district occurs in four months i.e. from mid-June to mid-October. So it is essential to provide water for production of crops during the rest of eight months.
2. The monsoon is uncertain. So irrigation is necessary to protect crops from drought as a result of uncertain rainfall.
3. It does not rain equally in all parts of the country. So irrigation is necessary for agriculture in less rainfall areas.
4. Soils of the some areas are shallow soil. Shallow soil can not retain water like alluvial and black soil. That is why irrigation is essential for farming in areas having shallow and medium soil.

5. The rainfall flow down way quickly along the slope. So irrigation is essential to grow crops in such areas.
6. India is an agricultural and populous country. About the 80 percent of total people depends on agriculture in order to grow food crops and agricultural products in large quantities to feed the growing millions, intensive farming and rotation of crops are essential. Extensive irrigation is therefore necessary for more production.

Need of Irrigation in Solapur District

Irrigation is essential for successful agriculture particularly in the area, where rainfall is inadequate uncertain, and unpredictable. Irrigation is necessary in traditional agriculture to overcome droughts scarcity of rainfall. It constitutes one of the most effective technical means of the raising agricultural production in the developing countries. Where there irrigation by gravity is possible, much work of installing facilities can be carried out by manual labour, through there is an obvious economic advantages even in countries with very low wage level are using technical aids in the constructional and earth moving works where the water necessary. The force of gravity can be brought to the land to be irrigated slowly, it is necessary use pumping installation. Mechanical source of power has considerably increased the efficiency of water pumping and have extended the use of irrigation by making. It possible to use ground water located at considerable depth and with the aid of sprinkling arrangement, to brings irrigation to areas that, could otherwise not have been brought under cultivation except at uneconomically high cost. There is still a very large potential field for development by means of this system. It is identified as a decisive factor in Indian agriculture due to high variability and inadequacy of rainfall.

Irrigation has played an important role in transforming the crop cultivation and better yield. There are various any other type of irrigation such as in their well irrigation, rivers, tanks and canal etc. But there are additional factors such as their location, their topography, geological aspect and height, hilled area depending on various elements. In the region under study mainly two types of irrigation are practised namely well and canal irrigation. For the present investigation, District is selected as in general and tahsils in particular. More K. S. and Mustafa R. R. (1984) suggested simple statistical method which is used to compute the need of irrigation in Solapur District in present study. In order to assess the need of irrigation, the following formula has been adopted.

$$\text{Need of irrigation} = \frac{Pr \times Ar}{R}$$

Where_ Pr = Percentage of rural population in a areal unit
Ar = Percentage of cultivated area in a areal unit
R = Average annual rainfall

$$\text{Need of Irrigation} = \frac{Pr \times Ac}{R}$$

There are imbalances in need of irrigation in Solapur district. The need of irrigation in Solapur district is 8.46. The highest need of irrigation is observed in Malshiras tahsil (13.88) and lowest in North Solapur tahsil (01.10). This coefficient of need irrigation is divided into three groups.

Table – 3.1
Solapur District: Irrigation Coefficient

Sr. No	Taluka	Percentage of Rural Population	Percentage of Cultivated Area	Average Annual Rainfall (mm)	Coefficient
1	Karmala	90.60	74.24	503	13.37
2	Madha	92.21	71.23	519	12.65
3	Barshi	69.25	80.82	595	9.40
4	N Solapur	9.19	74.23	617	1.10
5	Mohol	100	69.17	574	12.05
6	Pandharpur	77.30	82.14	523	12.14
7	Malshiras	100	58.58	422	13.88
8	Sangola	89.66	40.40	462	7.84
9	Mangalwedha	87.32	58.75	520	9.86
10	S Solapur	100	76.71	617	12.43
11	Akkalkot	78.58	64.81	643	7.92
	District	68.17	67.65	545	8.46

Source: 1. Socio-economic abstract of Solapur District 2004-05.
2. Compiled by Researcher

Table-3.2
Solapur District: Need of Irrigation

Need of irrigation	Number of tahsil	Name of tahsil
High (above 10)	06	Karmala, Madha, Mohol, Pandharpur, Malshiras, South Solapur
Moderate (05 to 10)	04	Barshi, Sangola, Akkalkot, Mangalwedha
Low (below 05)	01	North Solapur

Source: Compiled by Researcher

1. **High need of irrigation:** The value of tahsil above 10 is called high need of irrigation in study region. The seven tahsils of study region are required high need of irrigation. These tahsils are Karamala, Madha, Mohol, Pandharpur, Malshiras and South Solapur.

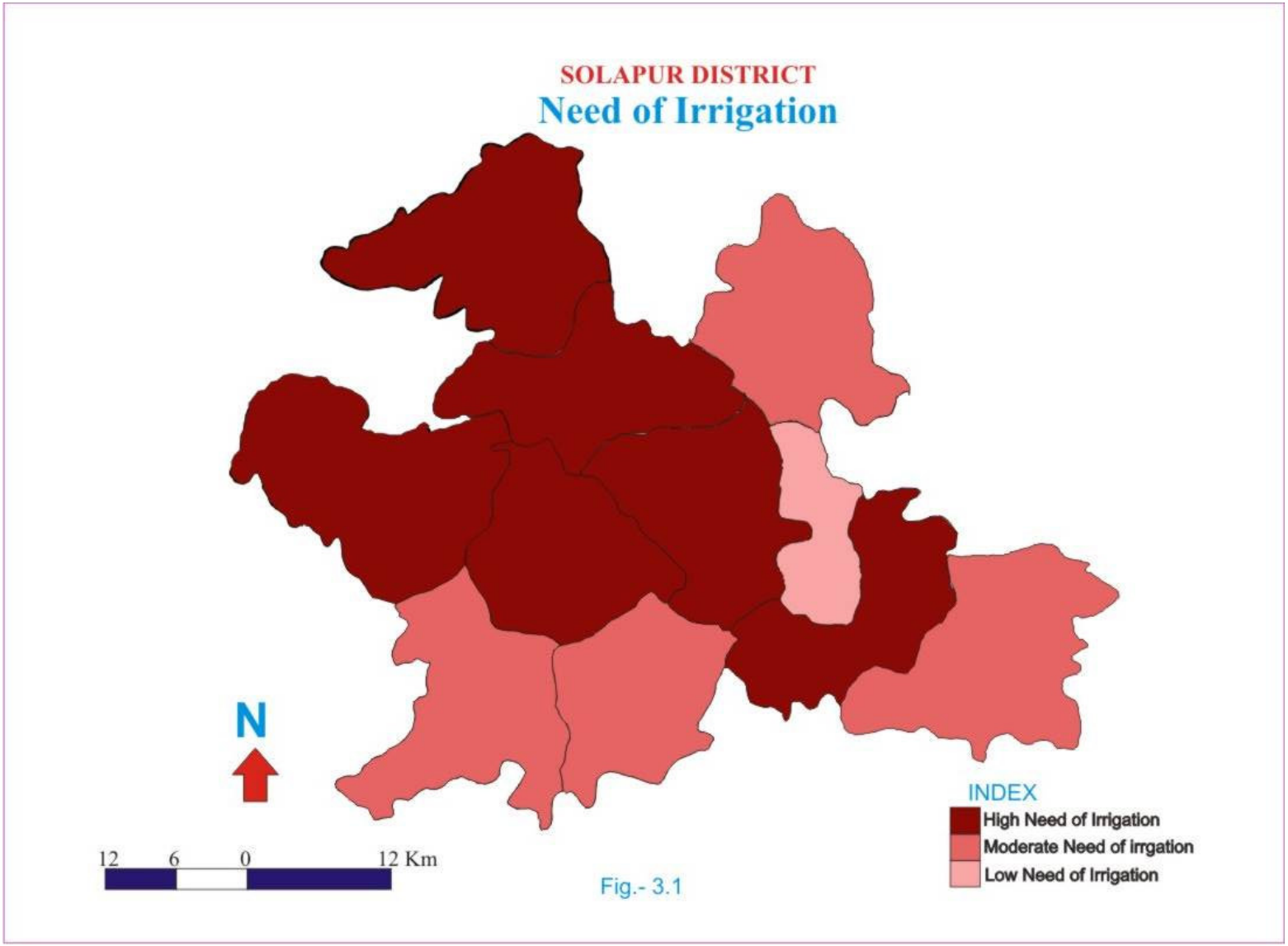
SOLAPUR DISTRICT
Need of Irrigation
N
12 6 0 12 Km
INDEX
High Need of Irrigation
Moderate Need of irrgation
Low Need of Irrigation

Fig.- 3.1

It is suggested that the natural environment are unfavorable for agriculture which means that it is essential to provide irrigation facilities for better agriculture.

2. **Moderate need of irrigation:** The moderate need of irrigation is observed in four tahsil i.e. Sangola, Mangalwedha ,Barshi and Akkalkot. The average rainfall in Sangola and Akkalkot is low but the agriculture area is low due to huge fallow land compare to other tahsil of district.
3. **Low need of irrigation:** The low need of irrigation is observed in North Solapur. It is happen due to the very few population lived in rural area. The district head quarter Solapur is located in this tahsil, that's why the need of irrigation is low according to this formula.

3.5. Tahsilwise Changes in Irrigated Area

Tahsilwise changes in area under irrigation are shown in table no 3.3 and fig. no3.2 of Solapur district for the period 1971 to 2005. The tahsilwise changes in percentage of irrigated land to total agriculture land are also calculated. Over all in Solapur district the area under irrigation has increased 145974 hectors (15.71 percent to Agri. Land) during the period of 1971 to 2005. The tahsilwise spatio-temporal changes in irrigated area are uneven.

Table 3-3

Solapur District: Tahsilwise changes in irrigated area (area in Hect.)

Sr No	Tahsil	1971		2005		Change	
		Irrigated Area	% to Agri. Land	Irrigated Area	% to Agri. Land	Irrigated Area	% to Agri. .Land
1	Karamala	8059	6.73	25506	21.52	+17447	+14.79
2	Madha	12544	9.36	28020	25.77	+15476	+16.41
3	Barshi	12319	11.43	35193	28.58	+22874	+17.15
4	N Solapur	5444	10.04	13476	26.58	+8032	+16.54
5	Mohol	11023	10.27	15777	17.32	+4754	+7.05
6	Pandharpur	13254	13.83	26654	25.07	+1300	+11.24
7	Malshiras	34274	36.81	31527	33.46	-2747	-3.35
8	Sangola	14369	15.07	31253	48.52	+16884	+33.45
9	Mangalwedha	8235	9.13	32281	48.10	+24046	+38.97
10	S Solapur	9870	10.46	21277	23.22	+11407	+12.76
11	Akkalkot	10609	8.90	25029	27.56	+14420	+18.66
	District	140000	12.70	285974	28.41	+145974	+ 15.71
Source : Socio-economic Abstract of Solapur District 1971 & 2005							

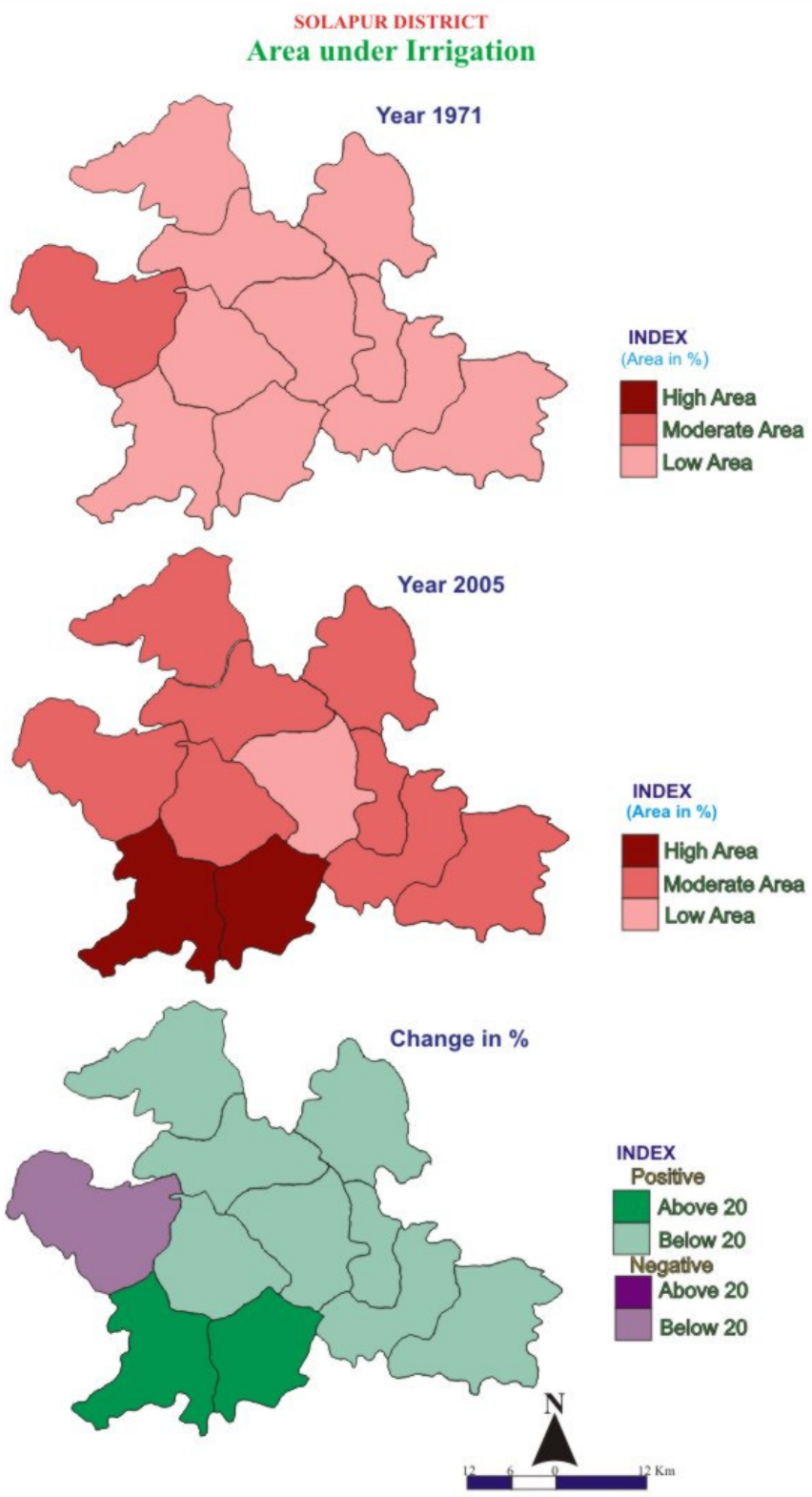
SOLAPUR DISTRICT
Area under Irrigation
Year 1971
INDEX
(Area in %)
High Area
Moderate Area
Low Area
Year 2005
INDEX
(Area in %)
High Area
Moderate Area
Low Area
Change in %
INDEX
Positive
Above 20
Below 20
Negative
Above 20
Below 20
N
12 6 0 12 Km

Fig.- 3.2

1. **Karamala Tahsil**

This tahsil is situated in Northern side of Solapur district. The area under irrigation is 8059 hectors which is 6.73 percent to agriculture land in 1971. After the thirty-five years, the area under irrigation increased (17447 hect.) tremendously due to increase of tube well, Sina Kolegaon dam, Mangi dam, Ujani back water and Kukadi project 25506 hectors which constitutes 21.52 percent to agriculture land.

2. **Madha Tahsil**

Madha is located north side of Pandharpur tahsil. The topography of this tahsil is uneven and unfavorable for irrigation facilities. The total irrigated area of Madha tahsil was 12544 hectors (9.36 %) in 1971. After the development of Ujani dam, Bhima Sina joint canal, K.T. Weir on Sina rivers, C.C.T. (*Bandhare)*, minor projects and percolation tanks etc. are responsible for increasing the irrigated area. However, in 2005 the area under irrigation has reached near about 28020 hectors (25.77 %). Especially the irrigation area increase during the last fifteen years.

3. **Barshi Tahsil**

Barshi tahsil is situated in North eastern part of Solapur district. The Hingani dam, Jawalgaon dam, Pimpalgaon medium irrigation projects are provided water for irrigation in Barshi district. The only three minor irrigation projects are available in 1971, however in 2005; the 18 minor irrigation projects available for irrigation. The large quantity of percolation tanks, KT weir on Bhogawati River and tube-wells are major sources of irrigation in Barshi tahsil. The irrigated area is 12319 hectors (11.43 % to Agriculture land) which has been reached on 35193 hectors (28.58 % to Agriculture land) in Barshi tahsil during the study period.

4. **North Solapur Tahsil**

The area under irrigation is 5440 hectors in 1971 which has reached in 13476 hectors in 2005. This happened due to the increase of tube-well, Percolation tanks, Sina River, Ujani dam canal etc. After the construction of Sina-Bhima joint canal, the area under irrigation has rapidly increased. Ekrukh dam, an Earth fill dam on Adela river within the north Solapur tahsil are provide water for irrigation.

5. **Mohol Tahsil**

Mohol is located in central part of Solapur district. Astti medium project, Ujani Left canal and Sina river are the major source of irrigation in Mohol tahsil. The maximum (331) percolation tanks are constructed in Mohol tahsil. The 10 K.T. weir are built on Sina

River which provides water for irrigation. That's why the area under irrigation increased 4754 hectors during the period study.

6. Pandharpur Tahsil

Pandharpur is well developed irrigated tahsil in Solapur district because of Bhima river flows in this tahsil. The area under irrigation is13254 hectors (13.82 % to Agriculture land) in 1971 which has rapidly increased in 2005 i.e. 26654 hectors (25.07 % to Agriculture land). This growth happen due to the construction of K.T. weir on Bhima river, Ujani right bank canal, Nira right bank canal, increasing no of tube wells etc.

7. Malshiras Tahsil

Malshiras tahsil is located in Western part of Solapur district. The area under irrigation in Malshiras tahsil is 34274 hectors in 1971 and 31527 hectors in 2005. The highest area irrigated by this tahsils in Solapur district by various sources of irrigation. Among them Nira Right bank canal, 20 K.T. weir, Uajani right bank canal, abundant digging of wells and tube wells. However the area under irrigation decreased near about 2747 hectors. The main reason of decreasing area under irrigation is the land captured by industries and settlement and second reason is the land of Maharashtra State Agricultural Developmental Corporation is fallow from last 10 years.

8. Sangola Tahsil

Sangola tahsil is situated in Southwestern part of Solapur district and it is also known as most dry zone tahsil of Maharashtra state. The area under irrigation is 14369 hectors in 1971 (15.07 % to Agriculture land) which growing in 2005 and i.e. 31253 hectors (48.52 % to agriculture land). The seasonable river of Man, Belwan, Korada and Apruka flows in this tahsil. In last two decades the area under irrigation highly increased due to the growing land under fruit crops which is more use of drip irrigation system. This system requires minimum water for plants and that's why growing area under irrigation. The no of wells and tube wells, Bhudhyal medium irrigation project, small percolation tanks are sources of irrigation in this tahsil. The new farm water storage tanks also helpful for irrigation.

9. Mangalwedha Tahsil

Mangalwedha tahsil is located in Middle Southern part of Solapur district. The eastern part of this tahsil is plain black soil and Bhima River flows in this side. Due to this the irrigated area is more near the bank of Bhima River. The western part of this tahsil is uneven topographically and totally dry. The area under irrigation is 8235 hectors in 1971 which share 9.13 percent to total agriculture land. After the thirty five years, the irrigated

area highly increased (32281hectors) and it share 48.10 percent to total agriculture land. It is happen due to K.T. weir on Bhima and Man River, Ujani Right Bank canal, individual farmers lift irrigation on Bhima River, etc.

10. South Solapur Tahsil

The area under irrigation in South Solapur is 9870 hectors (10.46 % to Agriculture land) in 1971. However, the area under irrigated in 2005 is 21277 hectors which capture 23.22 percent to total agriculture land. The Sina river, Bhima River and 11 K.T. weir, tube wells, 79 percolation tanks are the major sources of irrigation.

11. Akkalkot Tahsil

Akkalkot tahsil is located in eastern part of Solapur district. It is well known tahsil of tank in Solapur district. The irrigated area in 1971 is 10609 hectors (8.90 % to Agriculture land) which has increased near about 25029 hectors in 2005 which constitute 27.56 percent to agriculture land. The major sources of irrigation in Akkalkot tahsil are bori river, bori dam, 13 K.T. weir, 16 minor projects and 67 percolation tanks, many tube wells and wells.

3.6. Cropwise Irrigated Area

Irrigation has played a vital role in cropping pattern in drought prone area. After the development of irrigation, agriculture transformation has been happened. After the 1971, the irrigation has been continuously increased. However the crop wise area under irrigation is uneven. It depends upon of crop type, market of crop production, required climatic condition of crop, farmers' attitude towards agriculture, etc.

1. **Jawar**

Jawar is grown mostly in October-March season on the moister retentive deep black soil of Solapur district. It is grown on clay to clay loams the irrigation requirement is low and on lighter soils, irrigation requirement is higher. The area under irrigation was 53300 hectors (8.48 percent) in 1971, which has been increased in 2005, i.e. 60500 hectors (8.98 percent). The highest area under irrigation is 7800 hectors in Malshiras taluka in 2005 and the lowest irrigated area in Mohol tahsil (3200 hectors). The area under irrigation increased in seven tahsils and decreased in three tahsil. The high irrigated area increased in Karamala (4300 hectors) and high decreased in Malshiras tahsil (3400 hectors).

2. **Bajara**

Bajara is mostly grown as a rainy season crop under rainfed condition. Bajara is preferred when the rainfall is inadequate, however bajara responds well to the application of supplemental irrigations. The area under irrigated of bajara crop was

6500 hectors (4.88 percent) which has been decreased in 2005, i.e. 3600 hectors (14.49 percent). Now in 2005, the area under irrigated is near about 400 hectors in seven tahsils of Solapur District. During the investigation period, the irrigated area has been increased in Madha, Barshi, Mangalwedha, Akkalkot, South Solapur and North Solapur on a small scale and the remaining part of Solapur district it has been decreased especially in Malshiras tahsil; it has been decreased 3200 hectors (12.95 percent).

Table -3.4
Solapur District: Cropwise Area under Irrigation (area in 00 Hect.)

S.	Crops / Name of Tahsil		Jawar		Bajara		Maize		Wheat		Tur	
			Area	%	Area	%	Area	%	Area	%	Area	%
1	Karmala	1970-71	29	4.04	08	5.47	12	85.71	13	40.62	16	34.04
		2004-05	72	8.44	04	12.50	10	24.62	29	100	00	0.00
		Change	+43	+4.40	-04	+7.03	-02	-61.09	+16	+59.38	-16	-34.04
2	Madha	1970-71	54	6.81	-	-	17	94.44	18	66.66	12	25.00
		2004-05	60	7.58	04	16.68	02	11.28	46	65.72	00	0.00
		Change	+06	+0.77	+04	+16.68	-15	-83.16	+28	-0.94	-12	-25.00
3	Barshi	1970-71	84	12.40	-	-	01	12.50	13	48.14	08	12.30
		2004-05	67	7.91	04	33.04	09	35.52	20	43.19	00	0.00
		Change	-17	-4.49	+04	+33.04	+8	+23.02	+07	-4.95	-08	-12.30
4	North Solapur	1970-71	21	7.26	-	-	02	50.00	05	41.66	07	9.21
		2004-05	37	10.24	01	10.52	02	12.00	29	95.66	00	0.00
		Change	+16	+2.98	+01	+10.52	00	-38.00	+24	+54.00	-07	-9.21
5	Mohol	1970-71	31	4.74	00	0.00	06	24.00	17	68.00	04	5.55
		2004-05	32	4.85	01	17.02	03	12.24	43	85.14	00	0.00
		Change	+01	+0.11	+01	+17.02	-03	-11.76	+26	+17.14	-04	-5.55
6	Pandharpur	1970-71	39	5.84	06	6.45	08	80.00	16	84.21	03	33.33
		2004-05	58	8.88	04	33.57	18	46.30	60	79.37	00	0.00
		Change	+19	+3.04	-02	+27.12	+10	-33.70	+44	-4.94	-03	-33.33
7	Malshiras	1970-71	112	22	36	21.95	06	85.71	30	93.75	03	27.27
		2004-05	78	14.74	04	9.00	08	36.95	46	74.24	00	0.00
		Change	-34	-7.26	-32	-12.95	+02	-48.76	+16	-19.51	-03	-27.27
8	Sangola	1970-71	71	13.37	14	4.02	06	85.71	17	100	01	20.00
		2004-05	42	11.78	04	9.73	15	15.26	13	67.42	00	0.00
		Change	-21	-1.59	-10	+5.71	+09	-70.45	-04	-32.58	-01	-20.00
9	Mangalwedha	1970-71	13	2.90	01	0.38	02	40.00	11	47.82	02	25.00
		2004-05	38	10.39	04	8.80	15	48.16	14	58.71	00	0.00
		Change	+25	+7.49	+03	+8.42	+13	-8.16	+03	+10.89	-02	-25.00
10	South Solapur	1970-71	-	7.64	-	-	01	16.66	05	20.83	08	14.81
		2004-05	61	9.04	02	26.75	02	17.0	41	71.87	00	0.00
		Change	37	+2.90	+02	+26.75	+01	+0.41	+36	+51.04	-08	-14.81
11	Akkalkot	1970-71	42	8.15	-	-	01	20.00	09	27.27	26	18.43
		2004-05	60	9.35	04	29.96	02	14.48	20	95.31	00	0.00
		Change	+18	+1.20	+04	+29.96	+01	-5.52	+11	+68.04	-26	-18.43
	District	1970-71	533	8.48	65	4.88	62	56.88	154	57.89	90	16.69
		2004-05	605	8.98	36	14.49	86	31.87	361	75.57	00	0.00
		Change	+72	+0.50	-29	-9.61	+24	-25.01	+207	+17.68	-90	-16.69

Tables continue. ….

S	Crops / Name of Tahsil		Gram		Moog		Sugarcane		Fruit		Groundnut		Safflowers	
			Area	%	Area	%	Area	%	Area	%	Area	%	Area	%
		1970-71	-	-	07	35.00	03	100	02	100	01	3.22	22	15.94
		2004-05	07	28.65	00	0.00	41	89.13	44	86.27	06	60.00	06	17.14
1	Karmala	Change	+07	+28.65	-07	-35.00	+38	-10.87	+42	-13.73	+05	+56.78	-16	+1.20
		1970-71	-	-	04	44.44	06	75	04	66.66	02	4.00	15	15.15
		2004-05	08	24.45	00	0.00	39	88.63	46	97.87	06	85.71	16	64.00
2	Madha	Change	+08	+24.45	-04	-44.44	+33	+13.63	+42	+31.21	+04	+81.71	+01	+48.85
		1970-71	-	-	05	27.77	07	100	05	71.42	-	-	08	42.10
		2004-05	31	64.43	00	0.00	63	80.76	49	96.07	07	87.50	26	55.31
3	Barshi	Change	+31	+64.43	-05	-27.77	+59	-19.24	+44	24.65	+07	+87.50	+18	+13.21
		1970-71	00	-	01	50.00	10	100	06	66.66	02	3.92	06	60.00
	North Solapur	2004-05	01	6.33	00	0.00	18	64.28	19	54.28	01	20.00	03	30.00
		Change	+01	+6.33	-01	-50.00	+08	-35.72	+13	-12.38	-01	+16.08	-03	-30.00
		1970-71	05	22.72	01	50.00	07	100	17	89.47	02	5.55	07	17.07
5	Mohol	2004-05	02	8.25	00	0.00	22	44.89	20	66.66	01	25.00	04	19.04
		Change	-03	-14.47	-01	-50.00	+15	-55.11	+03	-22.81	-01	+19.45	-03	+1.97
		1970-71	06	19.35	01	100	12	100	06	100	18	94.73	08	17.39
6	Pandhar	2004-05	09	22.06	00	0.00	46	55.42	45	83.33	02	66.66	01	3.57
		Change	+03	+2.71	-01	-100	+34	-44.58	+39	-16.67	-16	-28.07	-07	-13.82
		1970-71	13	68.42	02	50.00	67	100	06	85.71	17	89.47	04	17.39
7	Malshiras	2004-05	12	33.55	00	0.00	49	49.00	63	86.30	05	71.42	01	2.63
		Change	-01	-34.87	-02	-50.00	-18	-51.00	+57	+0.59	-12	-18.05	-03	-14.76
		1970-71	02	28.57	01	100	04	100	01	100	05	100	01	100
		2004-05	01	3.18	00	0.00	34	91.89	34	39.06	04	66.66	01	3.12
8	Sangola	Change	-01	-25.39	-01	-100	+30	-8.11	+33	-60.94	-01	-33.34	00	-96.88
		1970-71	07	24.13	01	100	03	100	03	100	05	31.25	03	10.00
9	Mangal	2004-05	03	16.23	00	0.00	61	100	34	77.27	01	33.33	10	26.31
		Change	-04	-7.90	-01	-100	+58	0.00	+31	-22.73	-04	+2.08	+07	+16.31
		1970-71	-	-	01	16.66	04	50	05	100	02	1.71	02	8.00
10	South Solapur	2004-05	09	35.29	00	0.00	29	80.55	13	32.50	02	100	18	50.00
		Change	+09	+35.29	-01	-16.66	+25	+30.55	+08	-67.50	00	+98.29	+16	+42.00
		1970-71	-	-	01	20.00	14	100	16	84.21	01	0.38	02	7.40
11	Akkalkot	2004-05	19	71.12	00	0.00	87	91.57	21	95.45	01	25.00	18	48.64
		Change	+19	+71.12	-01	-20.00	+73	-8.43	+05	+11.24	00	+24.62	+16	+41.24
		1970-71	33	13.04	25	36.23	139	97.20	71	85.52	55	7.21	78	16.99
	District	2004-05	102	31.96	00	0.00	493	75.03	388	79.18	36	61.01	104	29.97
		Change	+69	+18.92	-25	-36.23	+354	-22.17	+317	-6.34	-19	+53.80	+26	+12.98

Source : Socio-economic abstract of Solapur District 1971 & 2005

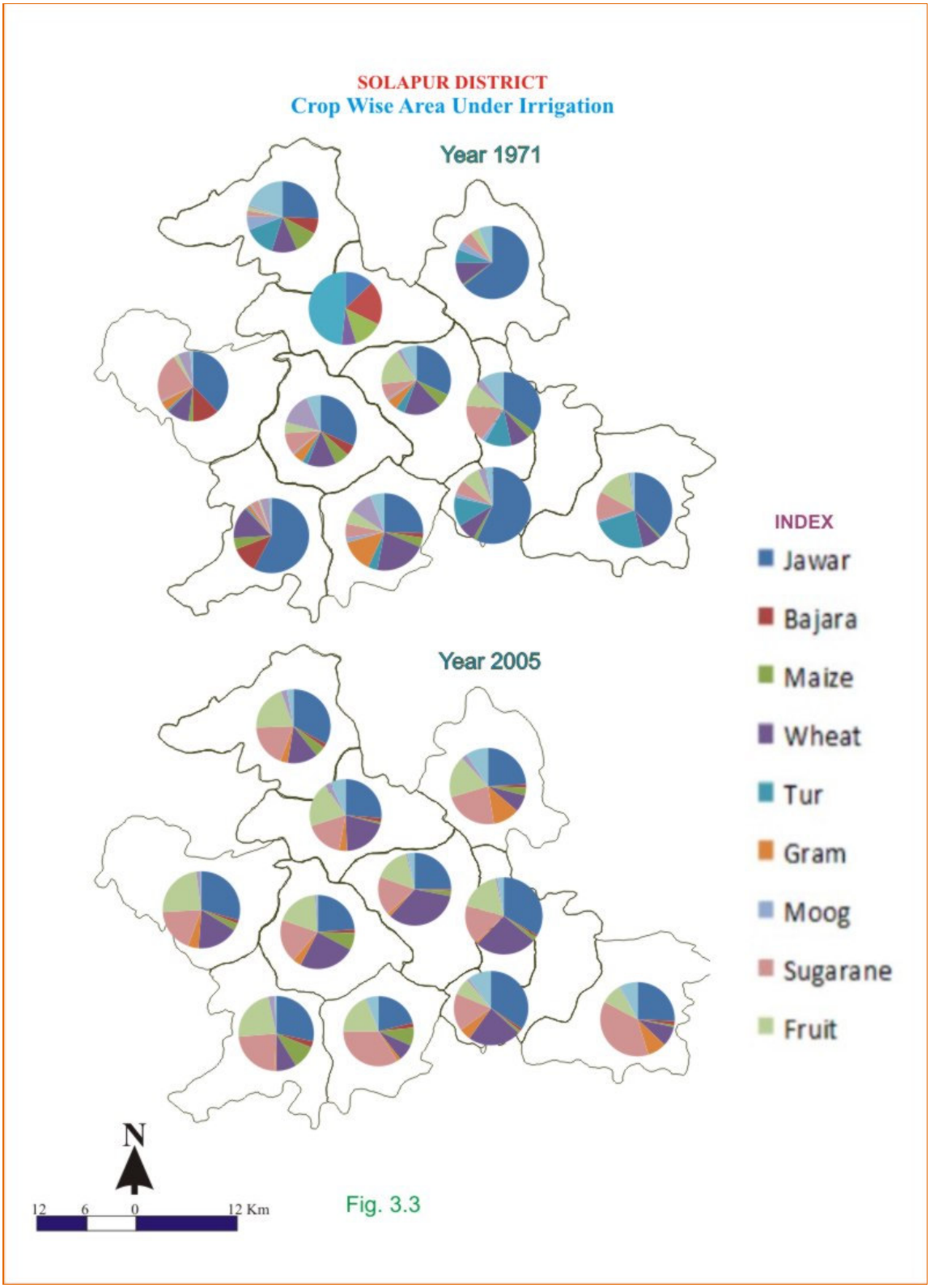
SOLAPUR DISTRICT
Crop Wise Area Under Irrigation
Year 1971
Year 2005
INDEX
Jawar
Bajara
Maize
Wheat
Tur
Gram
Moog
Sugarane
Fruit
N
12 6 0 12 Km

Fig. 3.3

3. **Maize**

The irrigation requirements of maize crops vary with the type of soil and the season which they are grown, depending upon the rainfall received. Maize is mostly grown during in monsoon period as rainfed or irrigated and smaller scale in summer season under irrigation in Solapur District.

The area under irrigation of Maize crop is 6200 hectors (56.88 percent) in 1971; however it is 8600 hectors (31.87 percent) in 2005. The highest area under irrigated of maize crop is 1800 hectors in Pandharpur in 2005 and lowest (below 2 percent) is in Madha, North Solapur, South Solapur and Akkalkot tahsil. In seven tahsil of district the irrigated area under maize increased and remaining tahsils, it has decreased.

4. **Wheat**

Wheat is grown as an irrigated crop or rainfed crop, depending on the occurrence of rains during the growing period. In many temperate regions it is grown as a rainfed crop. The need of pre-sowing irrigation depends on the adequacy of soil moisture for germination of the wheat seed.

The area under irrigation of wheat crop was 15400 hectors in 1971, which is been become 36100 hectors in 2005. The highest area under irrigation of wheat crop is 6000 hectors in Pandharpur tahsil and lowest is in 1300 hectors in Sangola tahsil in 2005. The irrigated area has been increased in all district except Sangola tahsil. The highest increase in area under irrigation observed is in Pandharpur tahsil.

6. **Tur**

Tur is cultivated in kharif season in Solapur district. The total irrigated area under tur crop is 9000 hectors in 1971, which is not available in 2005. The highest irrigated area under tur crop is 1900 hectors in Akkalkot and 1600 hectors in Karamala tahsil in 1970-71 and lowest is in Mangalwedha and Sangola tahsil.

7. **Gram**

Gram is best situated for low rainfall areas. However, it has been found to respond to irrigation in the absence of winter rains, especially on the lighter soils of northern India. The crop generally requires only one or two time irrigations when grown in rabbi season.

The total irrigated area under gram crop is 3300 hectors in 1971, which is 10200 hectors in 2005. The highest irrigated area under gram crop is 3100 hectors in Barshi tahsil in 2005 and lowest is North Solapur and Sangola tahsil. The irrigated area under gram crop decreased in Mohol, Malshiras, Sangola and Mangalwedha tahsil,

however the area under irrigation of gram crop increased in all remaining tahsils of Solapur district.

8. **Moog**

Moog is best situated for low rainfall areas. However, it has been found to in lighter soils of northern India. It is cultivated only on rainfall water. The total irrigated area under gram crop is 2500 hectors in 1971, which is not available in 2005. The high irrigated area under moog crop is 700 hectors in Karamala tahsil, 500 hectors in Barshi and 400 hectors in Madha tahsil in 2005 and below 200 hectors area under moog crop in remaining tahsils of Solapur district.

9. **Sugarcane**

Sugarcane usually occupies the land for period about 10 to 18 months and thus necessitates adequate irrigation for realizing its potential yields. The frequency and depth of irrigation vary with the growth periods of the crop. Sugarcane requires irrigation in every stage of plant growth.

The area under irrigation by sugarcane is 13900 hectors in 1971 and it is 49300 hectors in 2005. It is clearly shows that after the development of irrigation facilities the irrigated area under this crop increased tremendously in Solapur district. The highest irrigated area under sugarcane crop is observed in 8700 hectors in Akkalkot tahsil and lowest is in 1800 hectors in North Solapur in the year of 2005. The irrigated area under sugarcane crop is increased in all tahsils of Solapur district except of Malshiras tahsil because sugarcane replaced by cash crop like fruit crop.

10. **Fruit**

The fruit crops like grape, pomegranate. Mango, ber, custard apple, lemon, etc. are cultivated in Solapur district. All fruit crops require adequate water after plnation and before harvesting. The total irrigated area under fruit crops is 7100 hectors in 1971, which is 38800 hectors in 2005. The highest irrigated area under fruit crop is observed 6300 hectors in Malshiras tahsil in 2005 and lowest is 1300 hectors in South Solapur tahsil. The irrigated area under Fruit crop increased in all tahsil of district.

11. **Groundnut**

Groundnut is best suited for low rainfall areas. However, it has been found to respond to irrigation in the absence of rains. The total irrigated area under groundnut crop is 5500 hectors in 1971, which is 3600 hectors in 2005. The highest irrigated area under groundnut crop is 700 hectors in Barshi tahsil in 2005 and lowest is North Solapur, Mohol, Mangalwedha and Akkalkot tahsil. The irrigated area under groundnut crop decreased in

Pandharpur, Malshiras and Sangola tahsil; however the area under irrigation of groundnut crop increased in all remaining tahsils of Solapur district.

12. **Safflower**

Safflower is important oil seed crop in Solapur district. It has draught resistant deep rooted crop. It requires low water. The total irrigated area under safflower crop is 7800 hectors in 1971, which is 10400 hectors in 2005. The highest irrigated area under safflower crop is 2600 hectors in Barshi tahsil in 2005 and lowest is in Pandharpur, Malshiras and Sangola tahsil. The irrigated area under safflower crop increased in Madha, Barshi, Mangalwedha, South Solapur and Akkalkot tahsils; however the area under irrigation of safflower crop increased in all remaining tahsils of Solapur district.

3.7. SOURCES OF IRRIGATION

There are imbalances in irrigation development in Solapur district. They are natural as well as created imbalance. The natural imbalances are caused due to the relative advantages and disadvantages of regions with respect to irrigation sources. These natural differences in regions can described as regional disparities. The sources of irrigation Solapur district is influenced by physical features such as geology, water, soil, presence of ground water, terrain, etc. The major sources of irrigation are the following.

I. Ground Water Irrigation sources - a) Wells, b) Tube wells.

II. Surface Water Irrigation sources - a) Rivers, b) Lakes.

III. Man-made Irrigation Sources - a) Project b) Canal c) Lift irrigation

3.7. I. Ground water irrigation sources

Ground water is annually replenished primarily through the rainfall and subsequently by surface water bodies such as rivers, lakes and tanks etc. It is called as underground water, which occurs below the surface of the Earth. Water table is defined as the upper surface of ground water. There is close relationship with water table, with increasing rainfall the water table rises. It is used for different purpose in the form of well, tube- well, springs, etc. these are followings. Its occurrence and distribution is controlled by rock type, altitude of rock, joint pattern and drainage pattern etc. in the region.

a. Well irrigation

Well irrigation is traditional source of irrigation to agriculture since long time. The main sources of irrigation in the districts are Lake, tanks, river, canal and wells. The distribution of wells is different according to the tahsils. The depth of well is 40 feets in

period of 1970, they give sufficient water for irrigation. For the irrigation, the bullock or oil engine was used. After the 1990, the mode of irrigation changed and bullock, oil engine replaced by electric motor which discharges the water capacity is 200 liter per minute. That's why, the ground water table came down and many well become dry. This situation of wells become dried continuously since.

Table – 3.5
Solapur District: Tahsilwise No. of wells and change

Sr No	Tahsil	1971		2005		Change
		Wells	%	Wells	%	Wells
1	Karmala	4781	5.5	3901	5.70	-880
2	Madha	8971	10.4	6566	9.60	-2405
3	Barshi	8598	10.0	7002	10.00	-1596
4	N Solapur	3282	3.80	1726	2.50	-1856
5	Mohol	8243	9.60	3820	5.60	-4423
6	Pandharpur	7618	8.80	12220	17.80	+4602
7	Malshiras	14643	17.00	3302	4.80	-11341
8	Sangola	10059	11.65	8510	12.40	-1549
9	Mangalwedha	4826	5.60	6458	9.40	+1632
10	S Solapur	8010	9.30	5875	8.60	-2135
11	Akkalkot	7241	8.40	9170	13.40	+1929
	District	86272	100	68550	100	-17722

Source: Socio-economic abstract of Solapur District 1971 and 2004-05.

The spatial distributions of wells are uneven in 2004-05. The Pandharpur tahsil have highest no. of wells followed by Akkalkot and Sangola talukas having high (above 8000 wells) no. of wells. The moderate wells (5000 to 8000 wells) are found in Madha, Barshi, South Solapur, and Mangalwedha tahsils. The low (below 5000 wells) well irrigation has located in Karamala, Mohol, and North Solapur and Malshiras tahsils.

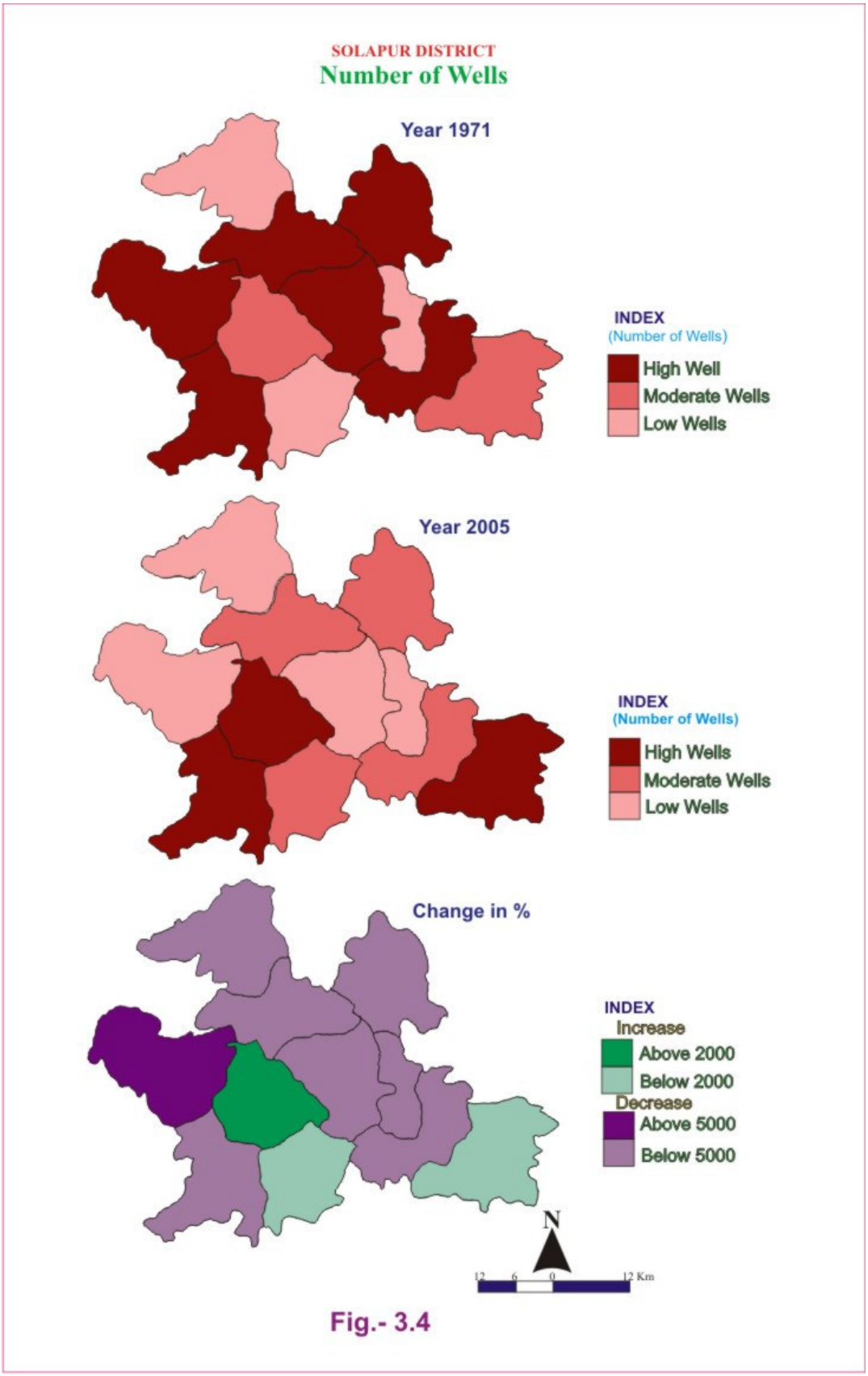
SOLAPUR DISTRICT
Number of Wells
Year 1971
INDEX
(Number of Wells)
High Well
Moderate Wells
Low Wells
Year 2005
INDEX
(Number of Wells)
High Wells
Moderate Wells
Low Wells
Change in %
INDEX
Increase
Above 2000
Below 2000
Decrease
Above 5000
Below 5000
N
12 6 0 12 Km

Fig.- 3.4

During study period, the quantity of wells decreased tremendously (17722 well). The main reason is that the water table going high depth due to electric pumps and digging tube wells. The decreasing no. of wells are uneven. The high (above 5000 wells) no wells are decreased in only Malshiras tahsil due to canal and tube-well irrigation increased. The low (below 5000 wells) no. of wells decreased in Karamala, Madha, Barshi, North Solapur, Sangola and South Solapur tahsil. The no. of wells also increased in some tahsil of district. The high (above 2000) no. of wells increased is in only Pandharpur tahsils and below 2000 wells are increased in Mangalwedha and Akkalkot tahsils.

b. Tube-Well Irrigation

Tube-wells are considered to be an important aspect of Green Revolution. Geological formation is very useful for digging the tube-wells in study region. Tube-wells, as a type of irrigation method, are similar to irrigation by wells. The distribution of tube-wells is varies from tahsil to tahsil. The highest number of tube-wells has been found in Pandharpur, Malshiras, Mohol, and Mangalwedha (above 1300). In Sangola, Madha, Karamala tahsil the tube-wells are found between 1000 to 1300. On the other hand, Barshi, North Solapur and South Solapur having 390 to 943 tube-wells.

3.7. II. Surface Irrigation

Surface water is provided by the flowing rivers or from the still water of tanks, ponds and artificial reservoirs. Irrigation from rivers is mainly through canals, drawn from dams constructed across the rivers. When the dam is high enough to form a large reservoir, the water is available throughout the year. The possibilities of developing the normal flows of rivers into irrigation canals. Tanks are mostly rain fed. They depend for their replenishment on the surrounding drainage area and watersheds.

A characteristic feature of the surface flow in Solapur district there is well defined natural drainage system. It consists of one main drainage systems; The Bhima drainage system, which flows east into the Bay of Bengal. Innumerable small streams flow down the Deccan plateau towards the Bhima river basin which are Man, Sina, Bori, etc. river.

The table 3.6 shows that the 1971, the surface water irrigation in Solapur district was 12100 hectors, while it is increased to 65400 hectors in 2005. The spatial distribution of surface irrigation is varied from tahsil to tahsil in 2005.

The high (above 13 percent) surface irrigation is observed in Pandharpur and Sangola tahsil. The moderate (9 to 13 percent) surface irrigation is depicted in Mohol, Malshiras and Akkalkot tahsil. The low (below 9 percent) area under surface irrigation is

found in Karamala, Barshi, Madha, North Solapur, Mangalwedha and North Solapur tahsil.

Table – 3.6

Solapur District: Area under surface water Irrigation & change (Area in 00 Hect.)

Sr No	Tahsil	1971		2005		Change	
		Area	%	Area	%	Area	%
1	Karmala	07	5.78	47	7.18	+40	+1.4
2	Madha	02	1.65	44	6.72	+42	+5.07
3	Barshi	04	3.30	49	7.49	+45	+4.19
4	N Solapur	17	14.04	44	6.72	+27	-7.32
5	Mohol	02	1.65	63	9.63	+61	+7.98
6	Pandharpur	38	31.40	91	13.91	+53	-17.49
7	Malshiras	21	17.35	61	9.32	+40	-8.03
8	Sangola	15	12.39	108	16.51	+93	+4.12
9	Mangalwedha	12	9.91	33	5.04	+21	-4.87
10	S Solapur	03	2.47	56	8.56	+53	+6.09
11	Akkalkot	NA	NA	60	9.17	-	-
	District	121	100	654	100	+533	-

Source: Socio-economic abstract of Solapur District 1971 and 2004-05.
NA- Not available

The surface irrigation area are not equally increased in whole region. The positive change in surface irrigation is observed in Six tahsil and negative change in four tahsil. The data of surface irrigation is not available in Akkalkot tahsil in 1971. The high (above 5 percent) positive change is observed in South Solapur, Mohol and Madha tahsils and low (below 5 percent) area in Karamala, Barshi and Sangola tahsil. The high (above 10 percent) negative change is lie in only Pandharpur tahsil and low (below 10 percent) in North Solapur, Malshiras and Mangalwedha tahsils.

3.7. III. Man Made Irrigation Sources

After the development of knowledge and technology, the man can create some irrigation projects, canals and lift irrigation schemes. These sources are used where the rainfall is inadequate and scarified. In last two decades man-made irrigation sources play key role in agriculture development of study region.

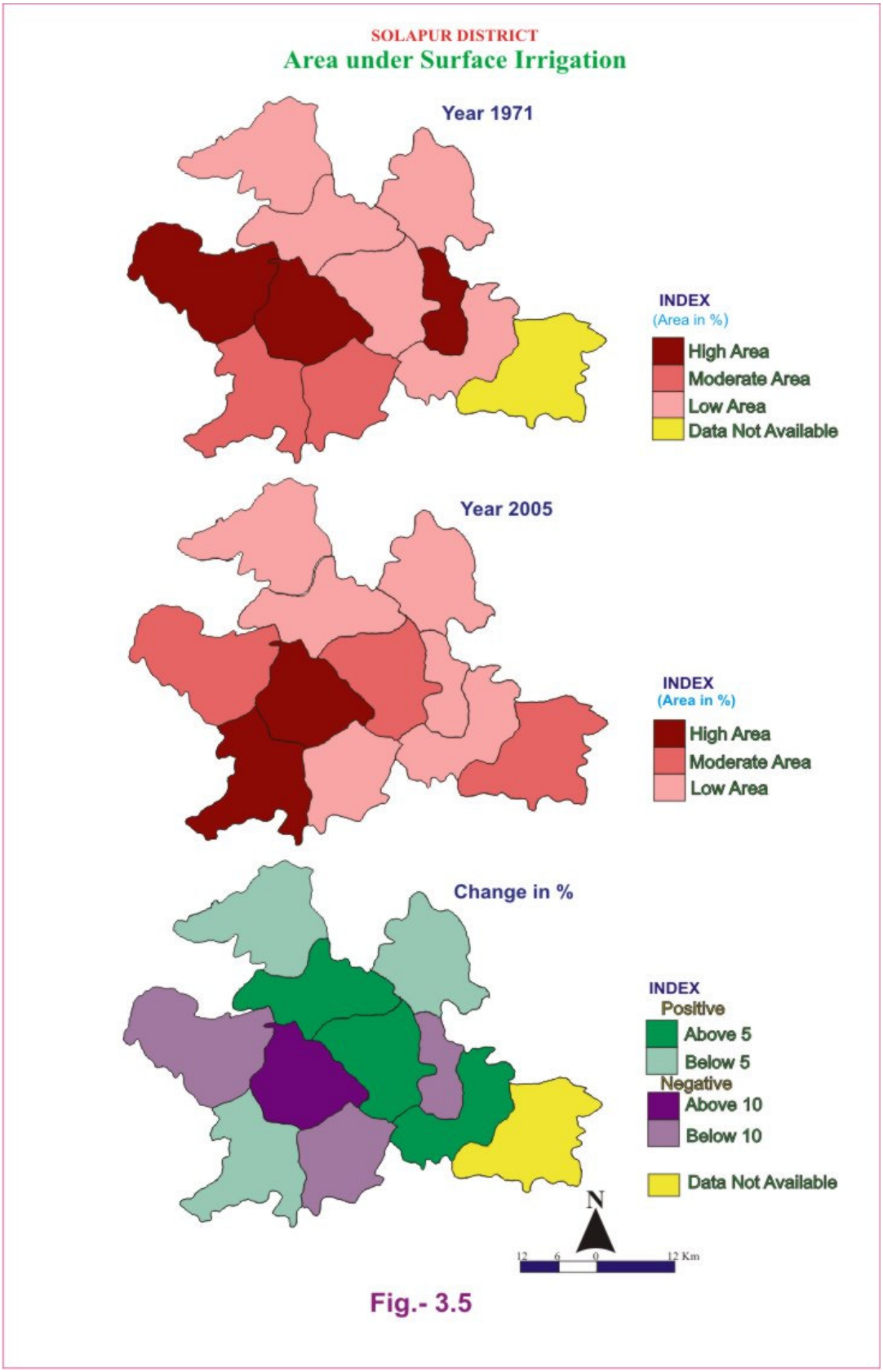
SOLAPUR DISTRICT
Area under Surface Irrigation
Year 1971
INDEX
(Area in %)
High Area
Moderate Area
Low Area
Data Not Available
Year 2005
INDEX
(Area in %)
High Area
Moderate Area
Low Area
Change in %
INDEX
Positive
Above 5
Below 5
Negative
Above 10
Below 10
Data Not Available
N
12 6 0 12 Km

Fig.- 3.5

a. Major Irrigation Projects

A scheme having Culturable Command Area more than 10,000 hectares is a major irrigation scheme. In Solapur district presently three major irrigation projects are available for irrigation. These are following.

(I) Bhima Irrigation Project:

The Ujjani dam is located at Ujjani in Madha taluka in the district, just half a mile upstream of the bridge on Bhima River on Pune- Solapur national highway. The Bhima River, which originates in Bhimashankar of the Western Ghats, and forms the Bhima Valley with its tributary rivers and streams, has twenty-two dams built on it of which the Ujjani Dam is the terminal dam on the river and is the largest in the valley that intercepts a catchment area of 14,858 km2 (5,737 sq. miles) (which includes a free catchment of 9,766 km2 (3,771 sq. miles)). The construction of the dam project including the canal system on both banks was started in 1969 at an initial estimated cost of Rs 400 million and when completed in June 1980 the cost incurred was of the order of Rs 3295.85 million.

Table -3.7
Solapur District : Major irrigation projects and their irrigated area

Sr	Project	Length in km		Irrigated area (Hect.)
		Left canal	Right canal	
1	Bhima irrigation (Ujani)	126	132	147800
2	Nira right Bank canal	-	156	43241
3	Sina Kolegaon project	-	-	3400
	Total			

Source: Socio-economic abstract of Solapur District 1971 and 2004-05.

The reservoir created by the 56.4 m (185 ft) high earth cum concrete gravity dam on the Bhima River has a gross storage capacity of 3.320 km^3 (0.797 cu. miles). The Ujjani Dam commissioned in June 1980 is an earth cum concrete masonry dam, which has created a multipurpose reservoir. The total length of the dam is 2,534 m (8,314 ft). The annual utilization is 2.410 km^3 (0.578 cu. miles). The project provides multipurpose benefits of irrigation, hydroelectric power, drinking and industrial water supply and fisheries development. A pumped storage type powerhouse has been built at the toe of the dam with an installed capacity of 12 M.W. The irrigation supplies benefit 500 km^2 (190 sq. miles) of agricultural land, particularly in the Solapur district.

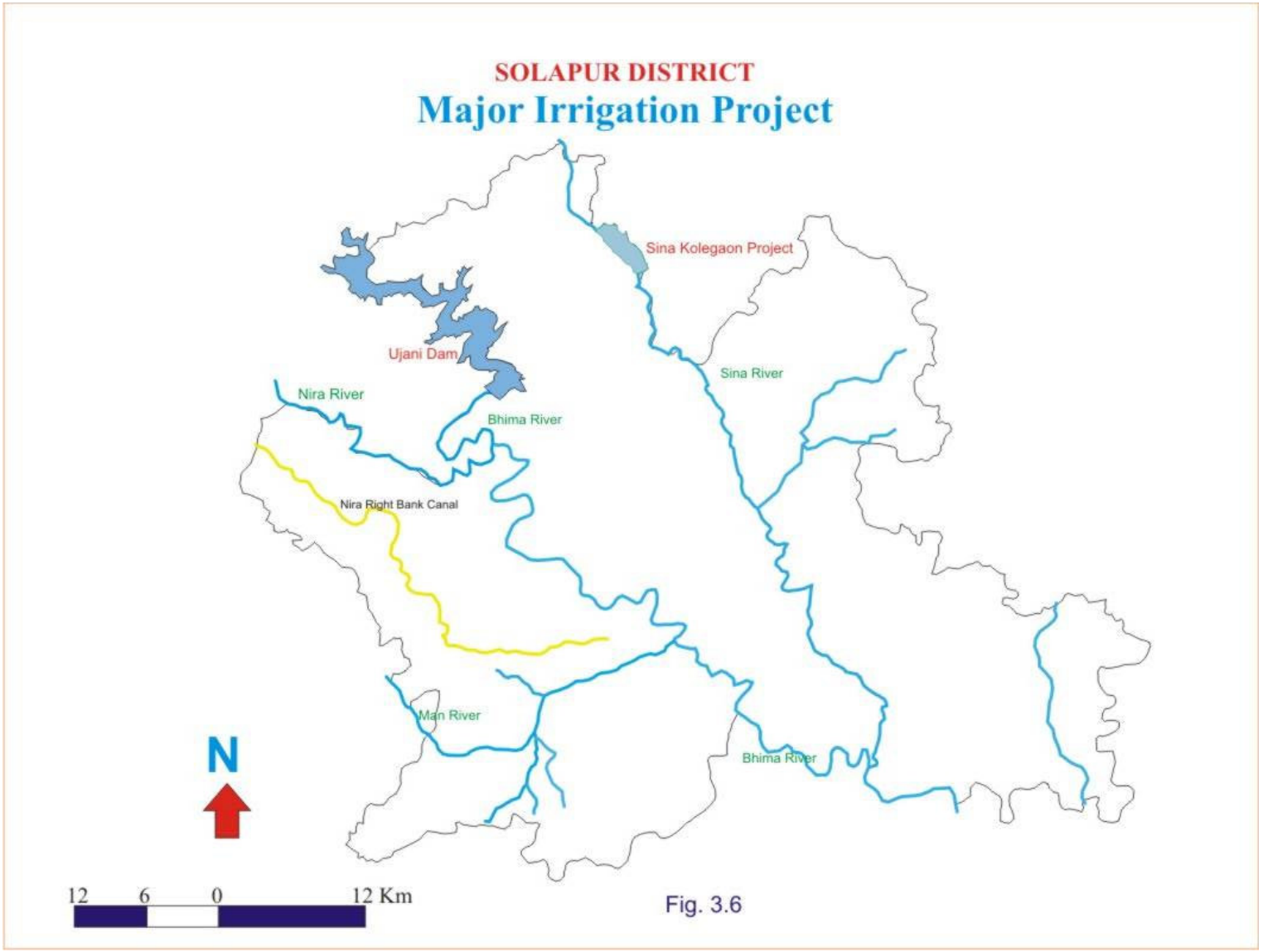
SOLAPUR DISTRICT
Major Irrigation Project
Sina Kolegaon Project
Ujani Dam
Sina River
Nira River
Bhima River
Nira Right Bank Canal
Man River
Bhima River
N
12 6 0 12 Km

Fig. 3.6

Irrigation potential of 1, 66,750 hectares in Pune and an equal potential in Solapur district. Water supplied from the reservoir to irrigate agricultural areas primarily aims to reduce incidence of famines and scarcity during drought conditions. The reservoir operation also lessens threat due floods to cities such as Pandharpur (an important religious pilgrimage center) for the Hindus. As a result of irrigation facilities, some of the important crops grown under irrigated conditions are sugarcane, wheat, millet and cotton.

II). Nira Right Bank Canal:-

The Nira Right Bank Canal system fed by Bhatghar dam in Pune district was put into operation in 1937-38.This canal has a length of 95 miles passing through Solapur and Satara districts. This Canal system now provides irrigation facilities to the Malshiras tahsil and irrigates about 50,000 acres in the district. The proportion of the area irrigated to the net area shown in Malshiras taluka is higher than other talukas in the district, due to this facility. The important crops irrigated by this system are sugarcane, cotton and wheat.

III). Sina- Kolegaon:-

It is a new major irrigation project taken up during the Fifth Plan. It envisages construction of an earthen dam on Sina River, near village Nimgaon in Karamala taluka. It is estimated to store 5.24 T.M.C. of water. The project will benefit Karmala, Barshi and Mohol tahsils in Solapur district and Paranda taluka of Osmanabad district. The estimated cost of this project is Rs. 910 lakhs and the outlay proposed for Fifth Plan is100 lakhs. It will create an irrigation potential of 1, 34,500 hectares.

b. Medium Irrigation Projects

A scheme having Culturable Command Area more than 2,000 hectares and up to 10,000 hectares individually is a medium irrigation scheme. In 1971, the only four medium irrigation (Ekrukh, Hingani, Budhyal and Asti) are available for irrigation in Solapur District. The total water storage capacity was 181.86 million cu.mi. and the total irrigated area was 4889 hectors in 1971. After 35 years, the nine medium irrigation projects are available for irrigation in Solapur district. The total water storage capacity was 248.47 million cu.mi. and the total irrigated area was 33597 hectors in 2005.

1. Ekrukh

Ekrukh dam, is an earth fill dam on Adela river near north Solapur in the state of Maharashtra in India. The height of the dam above lowest foundation is 21.45 m (70.4 ft) while the length is 2,360 m (7,740 ft.). The construction of this dam is completed in 1871. The purpose of this irrigation dam is water supply and irrigation. The left (32 km.)

Table - 3.8

Solapur District: Medium irrigation Projects

Sr	Project	Water storage (Million cu.mi.)	Length in km		Irrigated area (Hect.)
			Left canal	Right canal	
1	Ekrukh	61.16	32	12.87	2610
2	Hingani	31.97	22.70	10.00	5140
3	Jawalgaon	29.19	31	-	4451
4	Budhyal	19.03	26.40	0	4250
5	Mangi	30.53	30.53	9.60	3117
6	Asti	23.01	18.40	16.00	4769
7	Pimpalgaon	9.86	-	30	2400
8	Tisangi	24.47	18.20	-	4050
9	Bori (Kurnur)	19.25	-	-	3750
	Total	244.22			33597

Source: Socio-economic abstract of Solapur District 1971 and 2004-05.

and right (12.87 km.) canal constructed on this dam. The total irrigated area of this dam 2610 Hectors.

2. Hingani

Hingani Dam, also called Pangaon Dam is an earth fill dam on Bhogawati river near Barshi in Solapur district in state of Maharashtra in India. The height of the dam above lowest foundation is 21.87 m (71.8 ft) while the length is 2,193 m (7,195 ft). The actual water storage capacity of this dam is 31.97 million cu. mi. The construction of this dam is completed in 1977. The purpose of this irrigation dam is irrigation. The left (22.70 km.) and right (10 km.) canal are constructed on this dam. The total irrigated area of this dam 5140 Hectors.

3. Jawalgaon

Jawalgaon Dam, is an earth fill dam on Nagzari river near Jawalgaon village in Barshi tahsil of Solapur district. The height of the dam above lowest foundation is 21.71 m (74.50 ft). The gross storage capacity is 29.19 million cu mi. The actual water storage capacity of this dam is 10.88 million cu.mi. The construction of this dam is completed in 1997. The purpose of this dam is irrigation. The total irrigated area of this dam is 4451 Hectors.

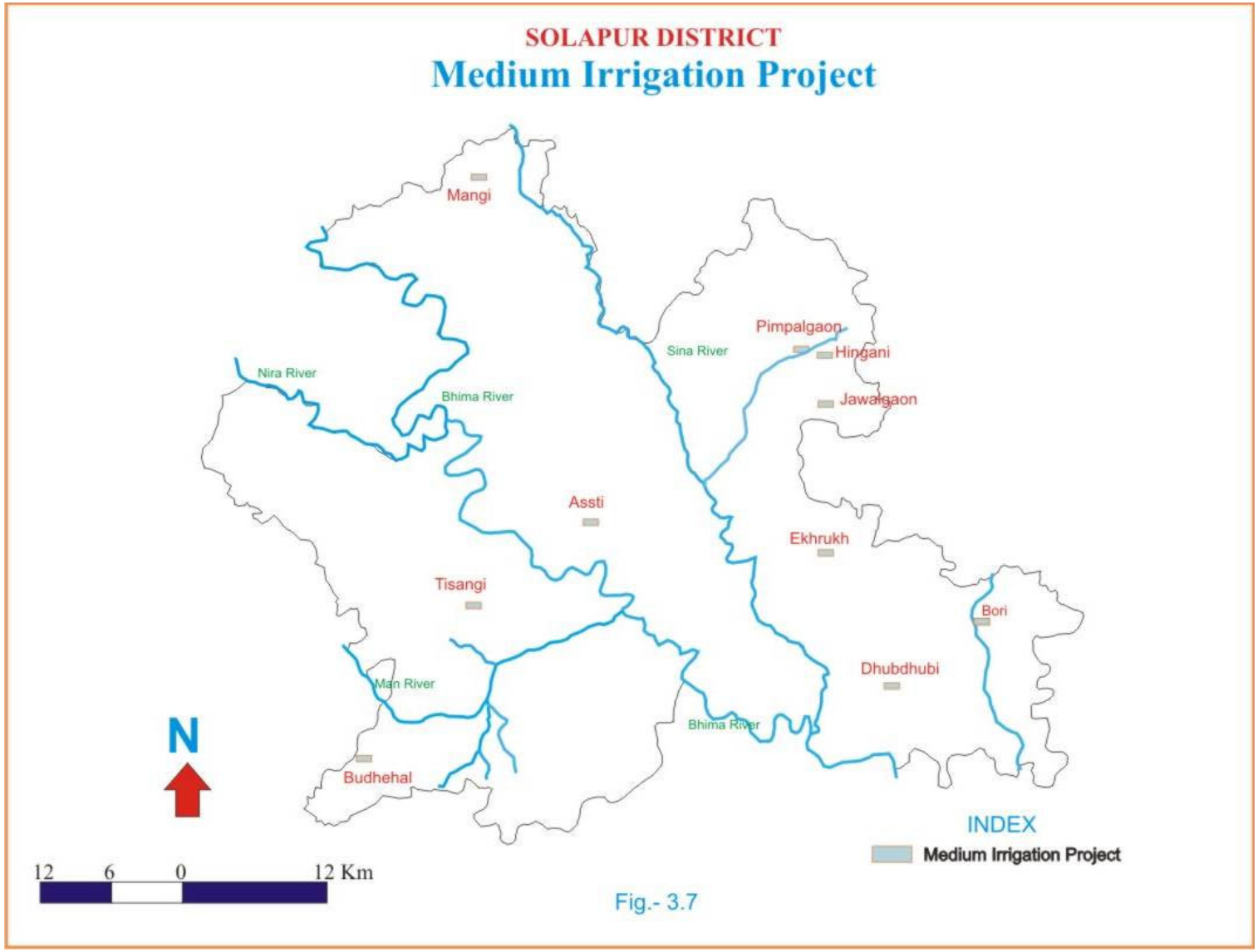
SOLAPUR DISTRICT
Medium Irrigation Project
Mangi
Pimpalgaon
Sina River
Hingani
Nira River
Bhima River
Jawalgaon
Assti
Ekhrukh
Tisangi
Bori
Dhubdhubi
Man River
Bhima River
N
Budhehal
INDEX
Medium Irrigation Project
12 6 0 12 Km

Fig.- 3.7

4. Budhyal

Budhyal Dam is an earth fill dam on Belwan river near Sangola, Solapur district in the state of Maharashtra in India. The height of the dam above lowest foundation is 18.5 m (61 ft) while the length is 2,975 m (9,760 ft). The gross storage capacity is 19.03 cu. mi . The actual water storage capacity of this dam is 19.03 million cu.mi. The construction of this dam is completed in 1966. The purpose of this irrigation dam is irrigation. The left (26.40 km.) canal are constructed on this dam. The total irrigated area of this dam is 4250 hectors.

5. Mangi

Mangi Dam, is an earth fill dam on Kanola river near Karmala, Solapur district in the state of Maharashtra in India. The height of the dam above lowest foundation is 22.95 m (75.3 ft) while the length is 1,475 m (4,839 ft). The actual water storage capacity of this dam is 30.53 million cu.mi. The construction of this dam is completed in 1966. The purpose of this irrigation dam is irrigation. The left (30.53 km.) and right (9.60 km.) canal are constructed on this dam. The total irrigated area of this dam is 3117 hectors.

6. Ashti

Ashti dam is an earth fill dam on Asti river near Mohol, Solapur district in state of Maharashtra in India. The height of the dam above lowest foundation is 17.6 m (58 ft) while the length is 3,871 m (12,700 ft). The gross storage capacity is 40,000.00 km^3. The actual water storage capacity of this dam is 30.53 million cu.mi. The construction of this dam is completed in 1883. The purpose of this dam is irrigation. The left (18.40 km.) and right (16km.) canal are constructed on this dam. The total irrigated area of this dam 4769 hectors.

7. Pimpalgaon

Pimpalgaon Dam, is an earth fill dam on local river in Barshi, Solapur district. The height of the dam above lowest foundation is 18.70 m (61.35 ft). The water storage capacity of this dam is 9.86 million cu.mi. The construction of this dam is completed in 2008. The purpose of this irrigation dam is irrigation. The total irrigated area of this dam 2400 Hectors.

8. Tisangi

Tisangi Dam, is an earth fill dam on local river near Pandharpur, Solapur district in the state of Maharashtra in India. The height of the dam above lowest foundation is 21.87 m (71.8 ft) while the length is 2,193 m (7,195 ft). The actual water storage capacity of this dam is 24.47 million cu.mi. The construction of this dam is completed in 1966. The

purpose of this dam is irrigation. The left (18.20 km.) canal is constructed on this dam. The total irrigated area of this dam 4050 Hectors.

9. Bori (Kurnur)

Bori Dam, is an earth fill dam on Bori river near Akkalkot in Solapur district. The height of the dam above lowest foundation is 15.20 m (49.86 ft). The water storage capacity of this dam is 19.25 million cu.mi. The construction of this dam is completed in 2006. The purpose of this dam is irrigation. The total irrigated area of this dam 3750 hectors.

c. Minor Irrigation Works

A scheme having Culturable Command Area up to 2,000 hectares individually is classified as minor irrigation scheme. The criteria for classification of minor irrigation schemes have been changing from time to time. Since April 1993 all ground water schemes and surface water schemes (both flow and lift) having cultivable command area up to 2000 hectares individually are considered as minor irrigation schemes.

Table – 3.9
Solapur District: Minor irrigation projects area in Hectors

Sr No	Tahsil	1971		2005		Change	
		No of Projects	Irrigated Area	No of Projects	Irrigated Area	No of Projects	Irrigated Area
1	Karmala	04	3918	11	5917	+9	+1999
2	Madha	01	431	03	15224	+2	+14793
3	Barshi	03	980	18	8265	+15	+7285
4	N Solapur	00	00	02	2321	+2	+2321
5	Mohol	00	00	04	5375	+4	+5375
6	Pandharpur	00	00	01	1450	+1	+1450
7	Malshiras	00	00	09	3341	+9	+3341
8	Sangola	03	853	09	2471	+6	+1618
9	Mangalwedha	01	133	10	1968	+9	+1835
10	S Solapur	01	156	06	2318	+5	+2162
11	Akkalkot	00	00	16	3571	+16	+3571
	District	13	6471	109	52221	+96	+45750

Source: Socio-economic abstract of Solapur District 1971 and 2004-05.

SOLAPUR DISTRICT

Area under Minor Irrigation

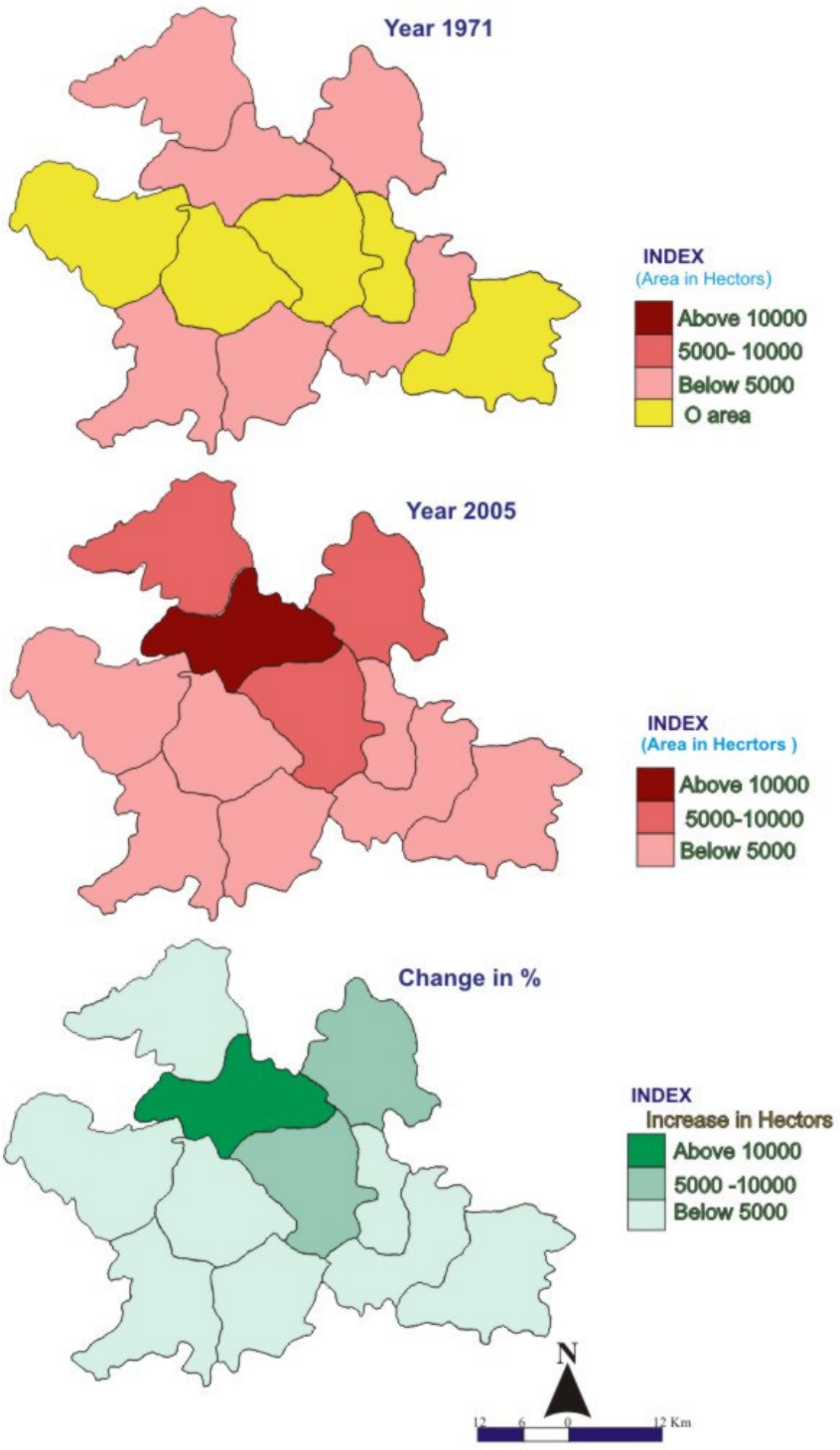

Fig.- 3.8

All minor irrigation schemes that irrigate up to 101.17 hectares (250 acres) are under the administrative charge of the Zilla Parishad. The Zilla Parishad is empowered to take up minor irrigation works costing into Rs. 5 lakhs. It has however been found that projects for irrigation cannot be undertaken within the above-mentioned financial limit by the Government. Naturally the policy of Solapur Zilla Parishad has been to construct percolation tanks and *bandharas*, which help in increasing the water-level in the wells in their vicinity due to the raise of sub-soil water. The Zilla Parishad has so far taken up ten percolation tanks, out of which two were completed during 1967- 68 and 1968-69. There are about fifty proposals for the construction of percolation tanks in the district which are under investigation. The minor irrigation works under Solapur Zilla Parishad which is in progress in the district.

In the 2004-05, the minor irrigation projects are 109 in Solapur district and they irrigated area 52221 hectors. The minor irrigation projects are more (18 projects) in Barshi tahsil, but irrigated area is high (15224 hectors) in Madha tahsil. During the study period, the minor irrigation areas are increased in all tahsils of district. The highest (14793 hect.) area increased and lowest (1450 hect.) in Pandharpur tahsil.

d. Percolation Tanks:

Percolation tanks are the structures for recharging ground water. These are generally constructed across streams and bigger gullies in order to impound a part of the run-off water. This water, in due course, finds its way into subsoil and recharges the found water. This leads to better recuperation of wells in the downstream. The construction of local level percolation tank is indirect irrigation project which helps to increase ground water table. Percolation tanks are very useful for indirect irrigation in drought prone area. More than 1140 percolation tanks are registered in study region. Recently state government provide 100 percent subsidy for the construction of percolation tank in the study region.

The spatial distribution of percolation tanks in study region is uneven. The highest tanks observed in Mohol tahsil (331 tanks), followed by Sangola (117 tanks) and Barshi (113 tanks). The lowest number of percolation tanks is observed Pandharpur (36 tanks).

Table - 3.10
Solapur District: Percolation tanks

Sr No	Tahsil	Year 2005	
		No of tanks	% to total
1	Karamala	67	5.88
2	Madha	82	7.19
3	Barshi	113	9.91
4	N Solapur	57	5.00
5	Mohol	331	29.03
6	Pandharpur	36	3.15
7	Malshiras	98	8.60
8	Sangola	117	10.26
9	Mangalwedha	93	8.15
10	S Solapur	79	6.93
11	Akkalkot	67	5.88
	District	1140	100

Source: Socio-economic abstract of Solapur District 2004-05.

The major percolation tanks was constructed in 1971 to 1973 period because of this period had metrological drought and people need to employment. State Government had started employment guarantee scheme (EGS) and under this scheme in Sangola and Mohol tahsil percolation tanks are constructed.

e. Kolhapur Type Weir (*Bandhara*)

A weir is a barrier across a river designed to alter the flow characteristics. In most cases, weirs take the form of a barrier, smaller than most conventional dams, across a river that causes water to pool behind the structure and allows water to flow over the top. Weirs are commonly used to alter the flow regime of the river, prevent flooding, measure discharge and help render a river navigable.

The construction of local level Kolhapur type *bandhare* has been introduced in study region in the year 1989. The irrigation potential of this Kolhapur Type Bandhare 50 to 100 hectares which are help to increase underground water table of the region. There are 139 K.T.Weirs. observed in study region, mostly K.T. weirs are observed in Barshi, Malshiras, Akkalkot, Sangola and Pandharpur tahsils. Remaining tahsil has observed low number of K.T. Weirs in North Solapur district.

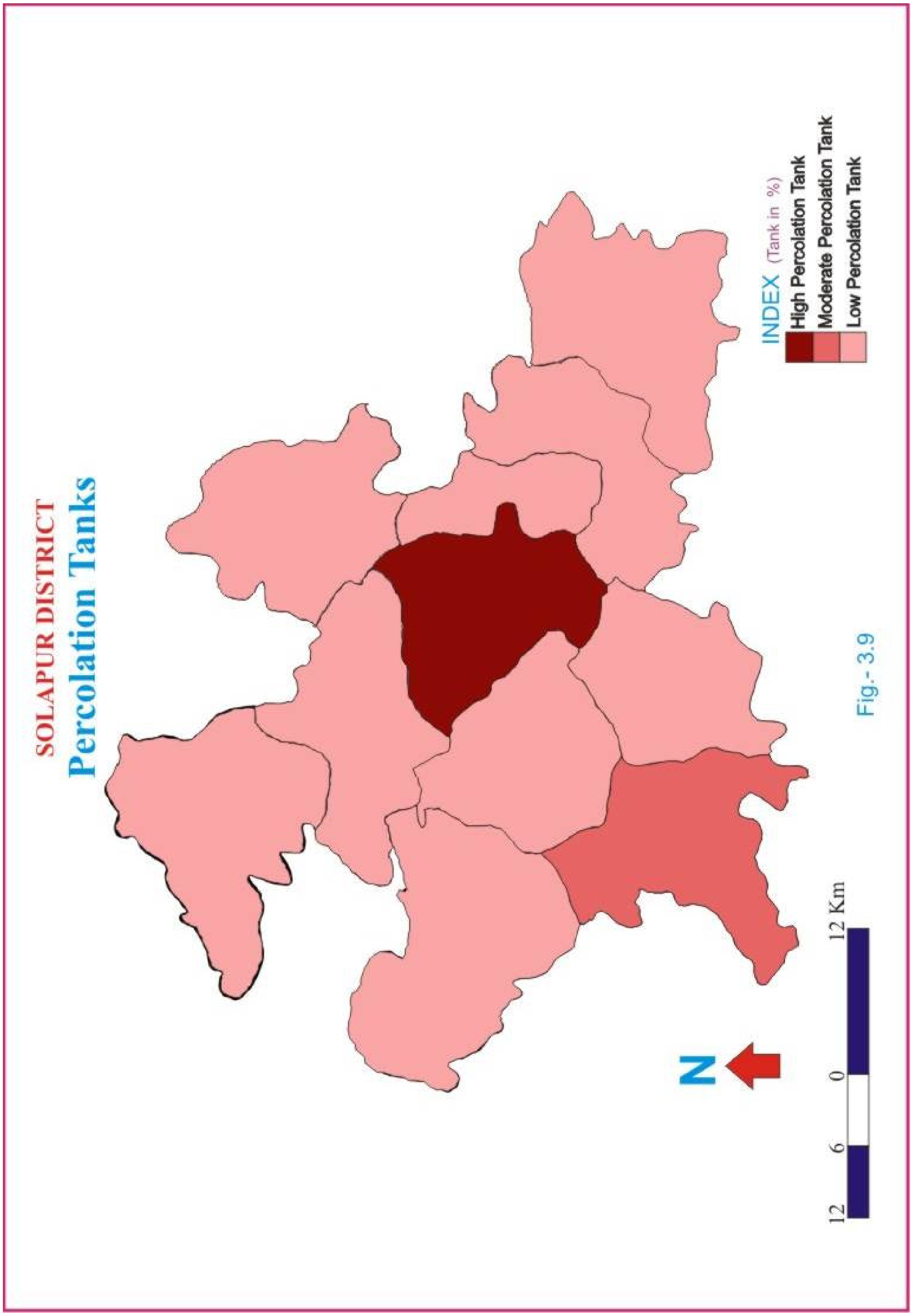
SOLAPUR DISTRICT
Percolation Tanks
INDEX (Tank in %)
High Percolation Tank
Moderate Percolation Tank
Low Percolation Tank
N
12 6 0 12 Km
Fig.- 3.9

Table – 3.11

Solapur District : Kolhapur Type Weir (Bandhare)

Sr No	Tahsil	2005	
		No of Projects	% to total
1	Karmala	04	2.88
2	Madha	12	8.63
3	Barshi	11	7.91
4	N Solapur	04	2.88
5	Mohol	10	7.19
6	Pandharpur	09	6.47
7	Malshiras	20	14.38
8	Sangola	29	20.86
9	Mangalwedha	16	11.51
10	S Solapur	11	7.91
11	Akkalkot	13	9.35
	District	139	100

Source: Socio-economic abstract of Solapur District 2004-05.

f. Lift Irrigation Project

Lift Irrigation scheme is lifted water from lower level to higher level with the help of pumps and other equipment. Construction of dams and canals helped tremendously to increase the irrigated area lying at lower level than the dam level, but scarcity of water remained the problem for higher level areas. So as to bring higher level area under Lift Irrigation Scheme are taken up. The co-operations encourage farmers to form co-operative societies or partnership for the purpose of distribution of water, collection of water charge, arranging supply of input and production, and marketing of produce of the beneficiaries and also for attending of produce of the beneficiaries and also for attending other day to day work for ensuring smooth working of lift irrigation schemes. The lift schemes are installed on seasonal /perennial sources of water like rivers, lakes etc. either by individuals or by groups of farmers in states like Maharashtra, Orrisa etc.. Separate corporations have been established and the commercial banks provide finance for the construction of the lift projects and land development work in the command areas Lift projects should be based on sound technical and economic feasibility. The technical aspects pertain to the source of water on which the lifts are constructed and the designing of the project. It is better to understand these aspects, so that commercial bank will easily grant loans either to the schemes which will benefit individual consumers or group of farmers.

The table no 3.12 shows that the seven lift irrigation scheme is observed in Solapur district. The area under lift irrigation is 100551 hect. in 2005 in Solapur district. These are followings.

Table – 3.12
Solapur District: Lift irrigation Project

Sr	Project		Length in km			Irrigated area (Hect.)
			Main canal	Left canal	Right canal	
1	Dhahigaon	Stage 1	13.56	-	-	10500
		Stage 2	15	8.95	20.31	
2	Bhima- Sina joint canal		26.50 (Tunnel 19.21 km)			20150
3	Sina- Madha canal		22	14.50	28.40	16150
4	Asti		0	26	25.20	9000
5	Barshi	Stage 1	0	12.30	0	15000
		Stage 2	9.6	-	54	
6	Shirapur	Stage 1	11	-	-	9598
		Stage 2	-	16.20	19	
7	Ekharukh	Stage 1	9	-	-	17310
		Stage 2	22.76	-	-	
	Total		1543.20	77.95	146.91	100551

Source: Socio-economic abstract of Solapur District 2004-05.

1. Dhahigaon Lift Irrigation Project

This lift irrigation scheme is constructed on back water of Ujani dam near Dhahigaon village in Karmala tahsil of Solapur district. This project has divided in two stages, i.e. The First and Second stage. The first stage main canal length is 13.56 km. This stage capture area of Dhahigaon and Jeur village. The main canal length of second stage is 15 km. which is flows 8.95km canal on left side and 20.31 km on right side canal. This stage provide water for irrigation in Kumbhej, Khadakwadi, Kondej, Nimbhore, Bhalwani, Sade and Salse village of Karmala tahsil. Area under this lift irrigation project are 10500 hects.

2. Bhima- Sina Joint Canal Irrigation Project

The Bhima-Sina joint tunnel canal is ideal irrigation project in Asia continent. It is approved by planning commission of India in 1994 and actual work started in 1995. It is constructed on Ujani dam back of water near village of Kandar to Kave village on the bank of Sina river in Madha tahsil of Solapur district. The total length of this canal is 26.50 km among them 19.21 km is tunnel which size is 7.8 x 7.3 mtrs. The water recharged in Sina river and they stored in K.T. weirs constructed on this river. The total irrigated area

by this scheme is 20150 hects. This project provide water for irrigation in all villages near of Sina river basin in Madha, Mohol, North Solapur and South Solapur tahsils.

3. Sina- Madha Canal Lift Irrigation Project

This project is constructed in Madha tahsil near the village of Dahivali on the bank of Ujjani dam back water. The total length of main canal is 22 km and this flows on left canal (14.50km) and right canal (28.40 km). The total irrigated area of this project is 16150 hects. It provide water for irrigation in village of Nimgaon, Saptane, Akumbe, Aran, Ghatane, Saptane Bhose, Chincholi, Vittalwadi, Upalavi Kd. and Bk. In Madha tahsil and Wafale village of Mohol tahsil.

4. Ashti Lift Irrigation Project

Asti lift irrigation project is constructed on Asti tank in Pandharpur tahsil. The water is provided to this tank by Ujani left canal. This canal's left bank length is 26 km and flows the area of Modnimb and Aran village. The right bank of canal length is 25.20 km. and provide water for irrigation in Khandali Village and surrounding area of Mohol tahsil. The total irrigated area by project is 9000 hects.

5. Barshi Lift Irrigation Project

Barshi lift irrigation project is constructed on Sina river near Ridhore village of Madha tahsil. Near this village K.T. weir constructed on Sina river and water stored. The water lifted for Barshi tahsil by two stages. The first stage length is 12.30 km on left bank canal and flows area of Sendri village and area. The second stage main canal is 9.60 km and their right canal length is 54 km. This canal useful for irrigation in Pimpalwadi, Shelgaon, Korfal, Anjangaon, etc. villages. The total irrigated area of this project is 15000 hectors.

6. Shirapur Lift Irrigation Project

Shirapur lift irrigation project is depend on the water of Sina river. The K.T. weir is constructed on Sina river near Shirapur village in Mohol tahsil. The water is lifted on the first stage near about 11 km. and then water flows by canal approximately 9.63 km and reach near the village of Nannaj. After the village Nannaj, the water is lifted by Second stage and divided into right and left canal. The right canal length is 19 km and flows in area of Nannaj, Bibidarphal, Kondi villages of North Solapur tahsil. The left canal

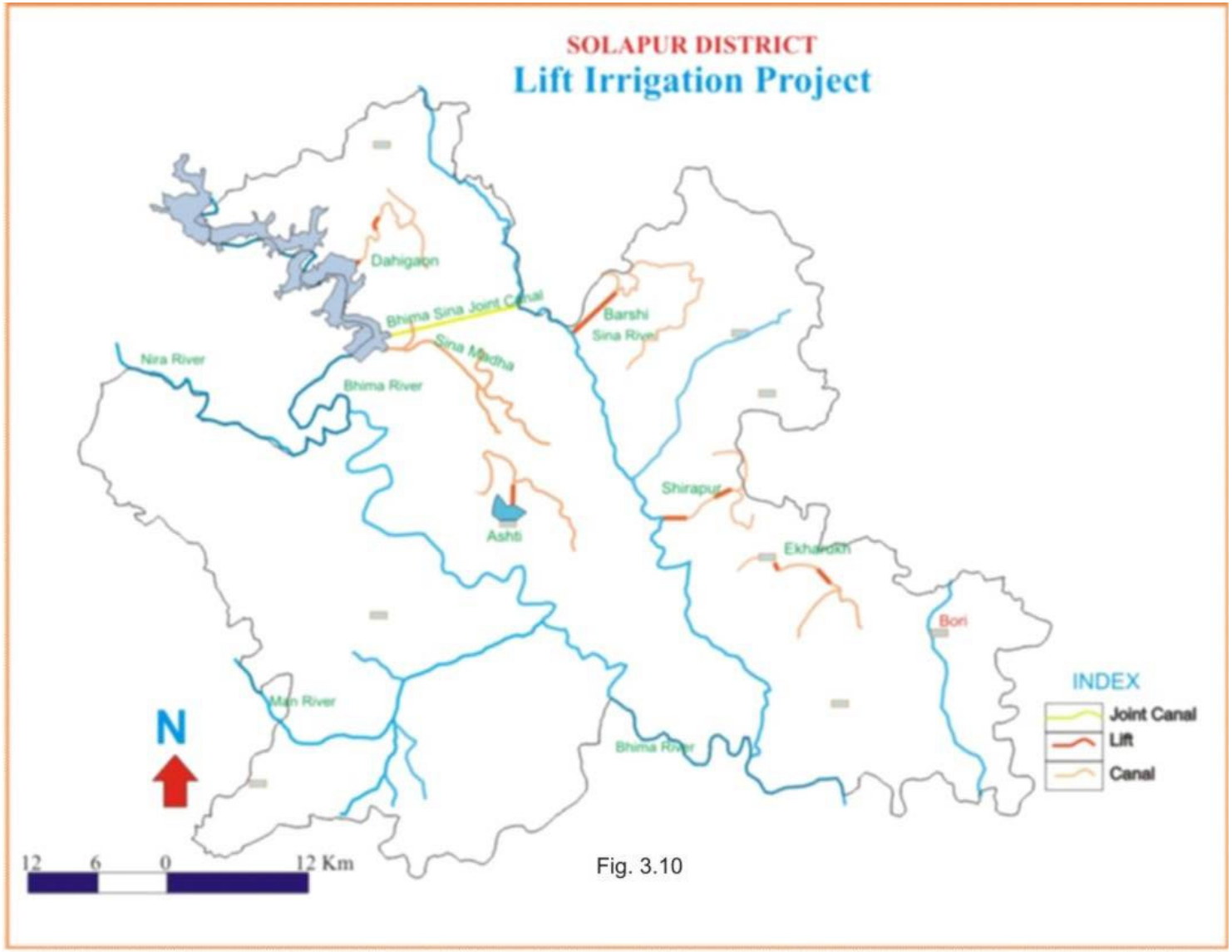
SOLAPUR DISTRICT
Lift Irrigation Project
Dahigaon
Bhima Sina Joint Canal
Barshi
Sina River
Sina Madha
Nira River
Bhima River
Shirapur
Ashti
Ekhardkh
Bori
Man River
Bhima River
N
INDEX
Joint Canal
Lift
Canal
12 6 0 12 Km

Fig. 3.10

length is 16 km and provide water in Wadala, Padsali village. The total irrigated area of this project is 9598 hects.

7. Ekharukh Lift Irrigation Project

Ekhrukh lift irrigation is constructed on Ekharukh tank. The water recharge of this tank from by Honsal, Ule village and Tuljapur tahsil. The water lifted by two stages. The first stage main canal length is 9 km and the second stage distributed in to two bank of canals. The first branch is Darshanhally having length of 18 km. and second branch is Darshanal Kholkhodai having length of 4.76 km. The total irrigated area under this project is 7200 hects.in South Solapur tahsil and 10110 hects. in Akkalkot tahsil.

3.6. Mode of irrigation

There are several mode or method of irrigation observed in study region viz. flood irrigation, drip and sprinkler irrigation. etc. All these mode of irrigation are not useful in all crops as well as all field of agriculture. The ideal method used for conservation of soil moisture and save water which is provided to plants. These are method are followings.

1. Flood Irrigation

Flood irrigation is an irrigation technique in which a field is essentially flooded with water which is allowed to soak into the soil to irrigate the plants. This type of irrigation is one of the oldest techniques known to man, and can be seen in use in some developing nations and in regions where water supplies are ample. There are several different styles of flood irrigation in use, with varying degrees of efficiency. This type of irrigation has been criticized because it can be extremely wasteful when it is not done with care.

One form of flood irrigation is basin irrigation, in which water floods a basin surrounded by berms, usually made from earth. This technique can be useful for crops which need to remain submerged, like rice, and for soil which absorbs slowly.

2. Furrow Irrigation

Furrows are small, parallel channels, made to carry water in order to irrigate the crop. The crop is usually grown on the ridges between the furrows. Furrow irrigation is suitable for a wide range of soil types, crops and land slopes, as indicated below. Furrow irrigation is also suited to the growing of tree crops. In the early stages of tree planting, one furrow alongside the tree row may be sufficient but as the trees develop then two or more furrows can be constructed to provide sufficient water. Sometimes a special zig-zag system

is used to improve the spread of water. In furrow irrigation, the water runs down furrows between rows of crops, reaching the roots as it is absorbed. Surge irrigation involves the use of pulses of water which spurt, soak in, and spurt again.

3. Basin Irrigation

Basin irrigation is a type of surface irrigation where small pound or basins are dug next to crop fields so as to trap water and allow the surrounding soil to absorb it.

4. Drip Irrigation

The drip irrigation techniques have developed after 1980. This irrigation system is a relatively new method of irrigation. It also called trickle irrigation, refers to the application of water at a slow rate drop by drop through perforations in pipes through nozzles or dripper, attached a limited area around the plant. It achievers wetting of even smaller surface area than in case of furrow irrigation in which drip irrigation Water and other nutrients are delivered directly to the root zone according to the plant needs. The drip irrigation system is said to be 50 percent more effective than the conventional irrigation systems. It has been estimated that water loss in conventional irrigation methods is 30-40 percent where as it is hardly 1 or 2 percent in drip system

5. Sprinkler Irrigation

Sprinkler irrigation is a method of applying irrigation water which is similar to natural rainfall. Water is distributed through a system of pipes usually by pumping. It is then sprayed into the air through sprinklers so that it breaks up into small water drops which fall to the ground. The pump supply system, sprinklers and operating conditions must be designed to enable a uniform application of water.

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Chapter - IV

LAND USE PATTERN

4.1 Introduction

The concept of landuse is related to the use of land which is used for certain activity for a given period of time. The land use as 'utilization of all developed and vacant land on a specific point, at a given time and space. Land use is conditioned by the association of two sets of factors. On one side the physical factors which include geology, relief features, climate, soil and vegetation. These factors are very important factors in the role of land use. Land use is a function of four variables that is land, water, air and man. Each plays its own role in composing its life history. The use of land constitutes a major item in national planning and this is especially so in India where more than 80 percent population depend upon land for their livelihood.

4.2 Land Classification

Land classification means dividing the land into different categories according to a single factor or a set of factors. Therefore land classification has been made depending upon the factors as climatic factors, soil characteristics, slope of the land, degree of erosion, water supply, drainage and similar environmental portrays the physical capabilities of land to produce over a long period of time under stated conditions of uses and which can provide land operations with a basis for actual practice on scientific units of land.

Land utilization is also related to 'conservation of land from one major use to another general use'. The concept of land use includes land conservation which means using land to the optimum extent so as not only to get the maximum benefit at the resources but also to preserve it as for as possible in an unhampered efficiency for the prosperity. The use of land for a particular purpose is taken into consideration while classifying the land under heads and subheads. The censes of India has classified the landuse types into nine categories. But for the present study they are grouped into board categories viz.

1. Forest
2. Non-agriculture land
3. Potential land excluding fallow land
4. Fallow land
5. Cultivated area

4.3. General Landuse

The proposes to examine the general land use pattern of the district with the help of the area data from the census handbooks of the district. Land use statistical figurers for the reference period 1970-71 to 2004/05 have been abstracted from the socio-economic review and district statistical abstract, prepared by the Bureau of Economic and statistics, Government of Maharashtra, Mumbai. Tahsil level statistical figurers have been used for analysing the distributional patterns of general land use and changes therein.

4.3.A. Temporal Variation

Due to a lot of variation in rainfall during the investigation period in Solapur district, there is a yearly variation in general landuse pattern of Solapur District. The general landuse of any area undergoes changes in any given period of time. Temporal variation means the change in general landuse pattern in a given period of time. This temporal variation is a result of various changes in inputs factors i.e. rainfall, fertilizers, irrigation, seeds, etc. The temporal variation in landuse pattern of study area has studied for the year 35 years with an objective to find out the trend in general landuse and to identify possible causes responsible for these changes.

Table 4.1
Solapur District ; Temporal Variation in General Landuse (Area in 00 Hect.)

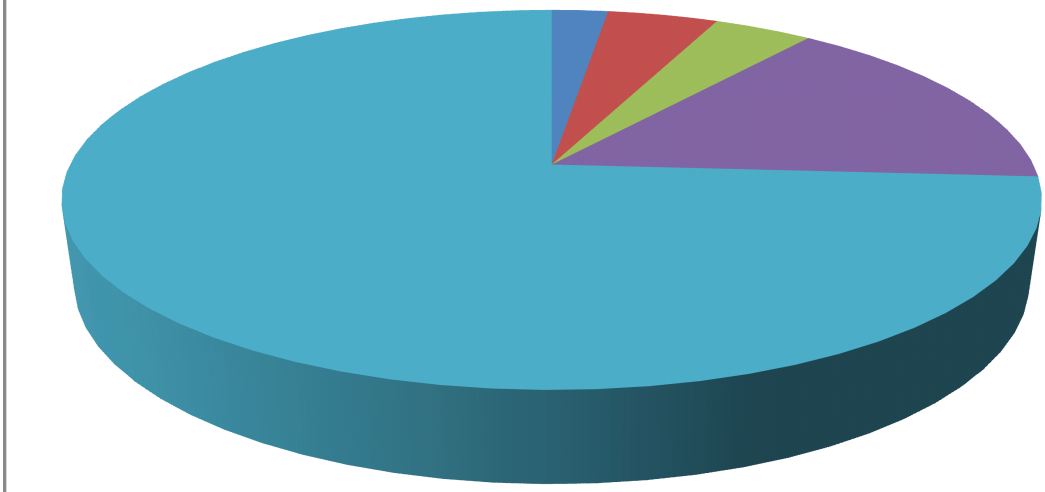
Land / Use / Year	Forest	Non agriculture land	Potential land excluding fallow land	Fallow land	Cultivated area	Total
1971	333	655	584	2333	11105	15010
%	2.23	4.38	3.88	15.58	74.23	100
1981	359	727	1048	2247	10629	15010
%	2.39	4.84	6.98	14.98	70.81	100
1991	269	776	607	1755	11471	14878
%	1.81	5.22	4.08	11.80	77.09	100
2001	319	789	336	1753	11681	14878
%	2.14	5.30	2.26	11.78	78.52	100
2005	319	792	336	2945	10065	14878
%	2.14	5.32	2.25	19.79	67.65	100
Change 1971 to 2005	- 14	+137	-248	+612	-1040	-
%	- 0.09	+0.94	-1.63	+4.21	-6.58	-

Source: Solapur District socioeconomic Abstract 1971 & 2005. Table – 9, Pp-15-19

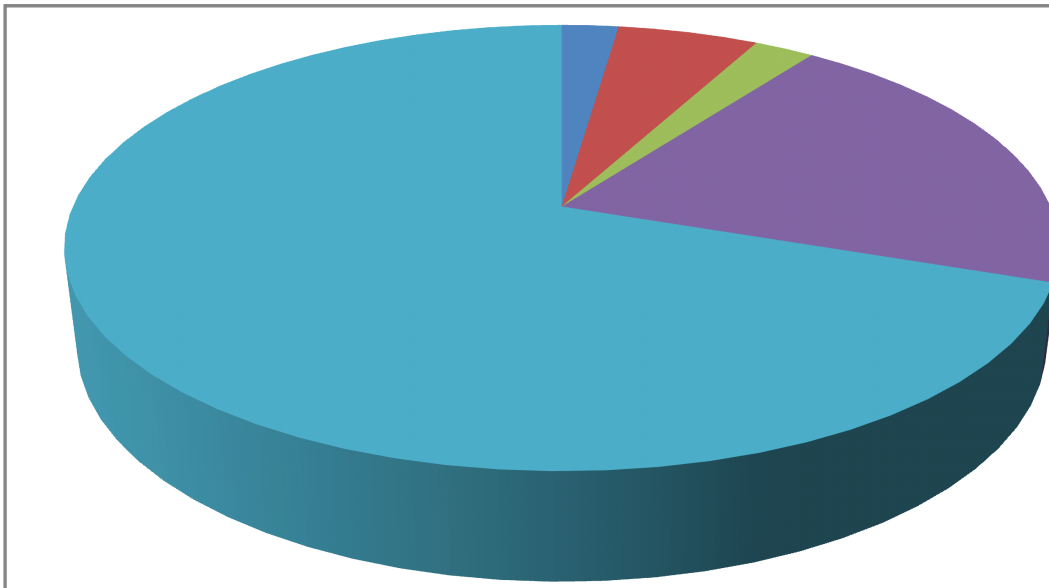
Solapur District

General Landuse

Year 1971



Year 2005



INDEX

- Forest
- Non agriculture land
- Potential land excluding fallow land
- Fallow land
- Cultivated area

Fig No- 4.1

i. Forest

The district has a very limited area under forests , mostly arid and scrub patches are recorded. As per reference year 1971, forest occupy very small proportion (2.23%) in Solapur District. After that 10 years (1981 year) it is increased 2600 hectors and capture share of 2.39 percent of to total geographical area. Although 1980, it is continuously decreasing due to the agriculture development, industrialization, road construction, settlement, over grazing, cutting of trees for domestic fuel and for saw mills. In reference year 2005, forest area depicted only 2.14 percent of geographical area.

ii. Non-Agriculture Land

Non agriculture land includes rocks, disserts, barren and the land put to non agriculture uses. Nearly 65500 hectors (4.38%) of land was not available for cultivation in Solapur district in the reference year 1971. It is slightly increasing due to the development of human activities. During the investigation period (35 years), it is increasing 13700 hectors and it covered 5.32 percent to geographical area.

iii. Potential Land

The land reserved for the purpose of extension of the cultivation can be found only in this category, the land which could be used for cultivation but it has not been cultivated owing to certain reasons. It includes cultural waste, permanent pasture and grazing and under miscelleous trees, crops etc. This category covered 58400 hectors (3.88 %) of study region during 1971, and in 2005 this category covered 33600 hectors (2.25 %) of total geographical area of the study region. It has decreased from 58400 hectors to 33600 hectors between 1971 to 2005.

iv. Fallow Land

Fallow land includes old fallow land and current fallow land. Fallow land is found due to inadequate water supply or excess of moisture supply, extensive holding and heavy clay soils not possible easily filling at a particular time. In the study region shows the land under this category is 294500 hectors (19.79 %) in Solapur District in 2005. During the investigation period the fallow land has increased from 233300 hectors to 294500 hectors.

v. Cultivated Area

Cultivated area means the land which is suitable for cultivation or ploughing. It is the actual area under crops country area sown more than once is the same year only once. Table No 4.1 shows the cultivated area in Solapur District in total geographical

area 74.23 percent in 1971 which decreases in 2005, it remain on 67.65 percent to total geographical area.

3.3.B. Spatial Pattern

There are a lot of differences in physiography of Solapur district, so there is a variation in general landuse pattern of Solapur District. The spatial variation in general landuse of Solapur district is the impact of social, economic, physical, cultural, climatic and other environmental factors. Solapur district shows a tremendous diversity in all factors. In present study, spatial variation in general landuse have studied for net sown area, fallow land, potential land, non agriculture land and forest area.

i. Forest

Forest occupies about 2.14 percent of the total geographical area of the district in 2005. There are remarkable variations at taluka level. The high percentage (above 4%) of forest can be found in Mangalwedha and Pandharpur tahsils and moderate proportion (2 to 4 %) of area under forest can be found in North Solapur and Karamala only. The low proportion under forest (below 2 percent) is in Malshiras, Sangola, Akkalkot, Mohol, Madha, Barshi and South Solapur.

Table 4.2

Solapur District; Area under Forest. (Area in 00 Hect.)

Sr No	Tahsil	1971		2005		Change	
		Area	% to GA	Area	% to GA	Area	% to GA
1	Karmala	62	3.88	59	3.69	-3	-0.19
2	Madha	17	1.11	26	1.70	+9	+0.59
3	Barshi	27	1.63	22	1.44	-5	-0.19
4	N Solapur	12	1.76	21	3.07	+9	+1.31
5	Mohol	39	2.96	16	1.21	-23	-1.75
6	Pandharpur	15	1.15	54	4.17	+39	+3.02
7	Malshiras	59	3.67	03	0.18	-56	-3.49
8	Sangola	70	4.39	07	0.43	-63	-3.96
9	Mangalwedha	08	0.70	71	6.21	+63	+5.51
10	S Solapur	18	1.50	18	1.50	00	00
11	Akkalkot	06	0.42	22	1.57	+16	+1.15
	District	333	2.21	319	2.14	-14	-0.07

Source: Solapur District socioeconomic Abstract 1971 & 2005. Table – 9 Pp-15-19

The large scale variation marked in the pattern, Table No. 4.2 and Fig. No. 4.2 shows that the region has undergone some changes in the forest cover, varying from one percent decrease to 6 percent increase of the total geographical area.

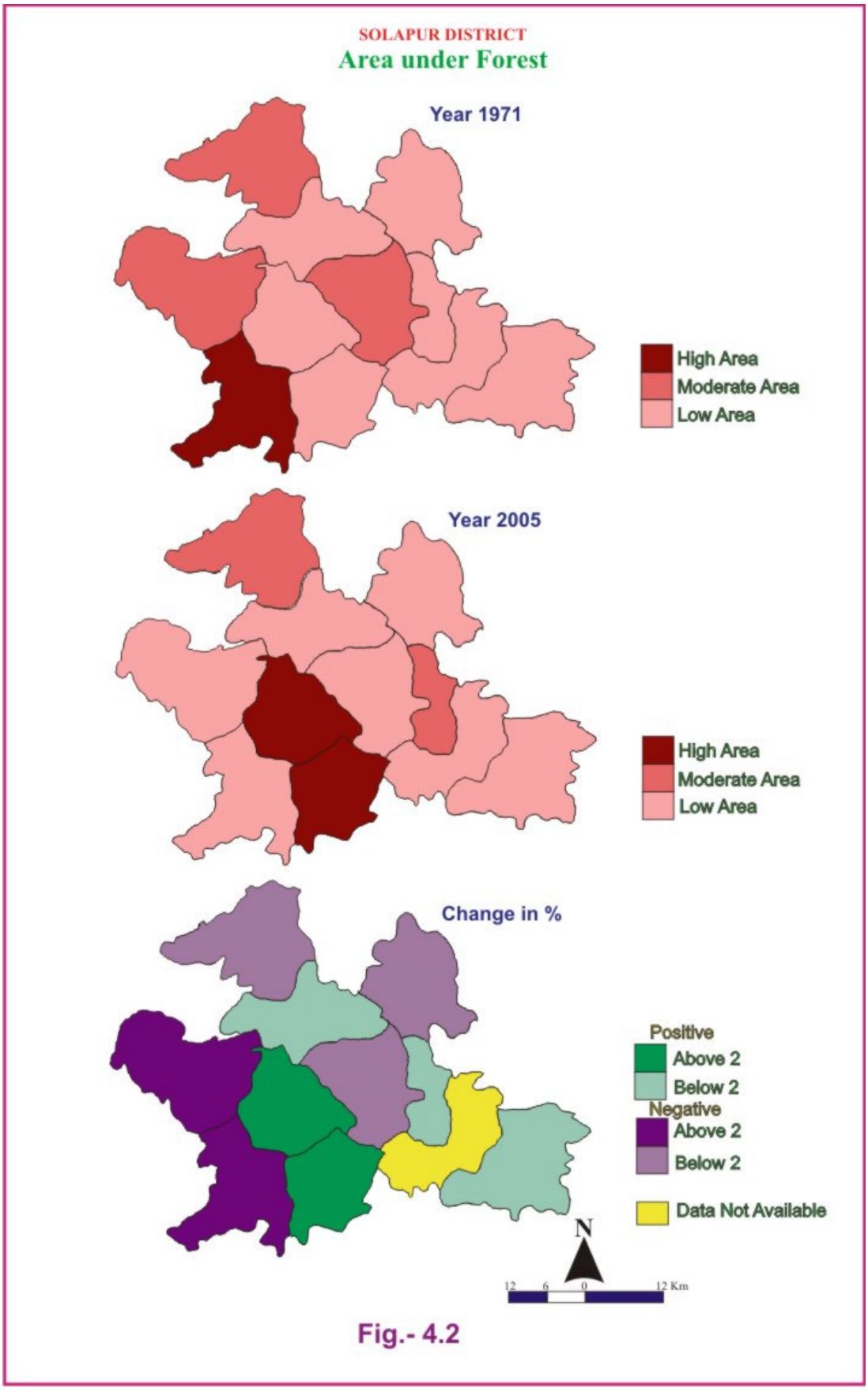

SOLAPUR DISTRICT
Area under Forest
Year 1971
High Area
Moderate Area
Low Area
Year 2005
High Area
Moderate Area
Low Area
Change in %
Positive
Above 2
Below 2
Negative
Above 2
Below 2
Data Not Available
N
12 6 0 12 Km

Fig.- 4.2

The notable (above 5.51 percent) positive change in forest cover has taken place in Mangalwedha and Followed by Pandharpur(3.02 %), North Solapur (1.31) and Madha (0.59 %). High Negative change is observed in Sangola (3.96) and followed by Malshiras (3.49 %). Remaining all tahsils of Solapur District have been found small scale negative change during the investigation period.

i. Non Agriculture Land

As its name implies, it is that land which is not available for cultivation. It is of two types (1). land put to non agricultural uses, such as for constructing settlements, roads, railways, canals, wells, industries establishment, etc. and (2) land which is barren and can not be cultivated due to some natural problems. Land under hills, deserts, lakes, ponds, drainage lines, etc. falls in this sub categories.

Table 4.3
Solapur District; Area under Non Agri. land (Area in 00 Hect.)

Sr No	Tahsil	1971		2005		Change	
		Area	%	Area	%	Area	%
1	Karmala	143	8.95	111	6.95	-32	-02.00
2	Madha	64	4.15	45	2.94	-19	-1.21
3	Barshi	36	2.17	69	4.53	+33	+2.36
4	N Solapur	18	2.63	40	5.85	+22	+3.22
5	Mohol	10	0.75	125	9.49	+115	+8.74
6	Pandharpur	65	5.02	74	5.71	+09	+0.69
7	Malshiras	158	9.82	57	3.54	-101	-6.28
8	Sangola	98	6.14	148	9.28	+50	+3.14
9	Mangalwedha	40	3.50	38	3.32	-02	-0.18
10	S Solapur	12	1.01	46	3.85	+34	+2.84
11	Akkalkot	11	0.78	39	2.78	+28	+2.00
	District	655	4.36	792	5.28	+137	+0.94

Source: Solapur District socioeconomic Abstract 1971 & 2005. Table – 9 Pp-15-19

About 4.36 percent area belongs to this category in the district in 1971. The proportion increase too marginally to 5.32 percent in 2005. It means the whole of increase in the area under this land use categories during the investigation period. Fig. 4.3 and table 4.3 show the regional distribution and the respective changes in non agricultural land during the period under study.

The spatial distribution of non agriculture land in 2005 is uneven. The areas of high proportion of non-agriculture land (above 8 percent) are observed in thasils of Mohol and Sangola.

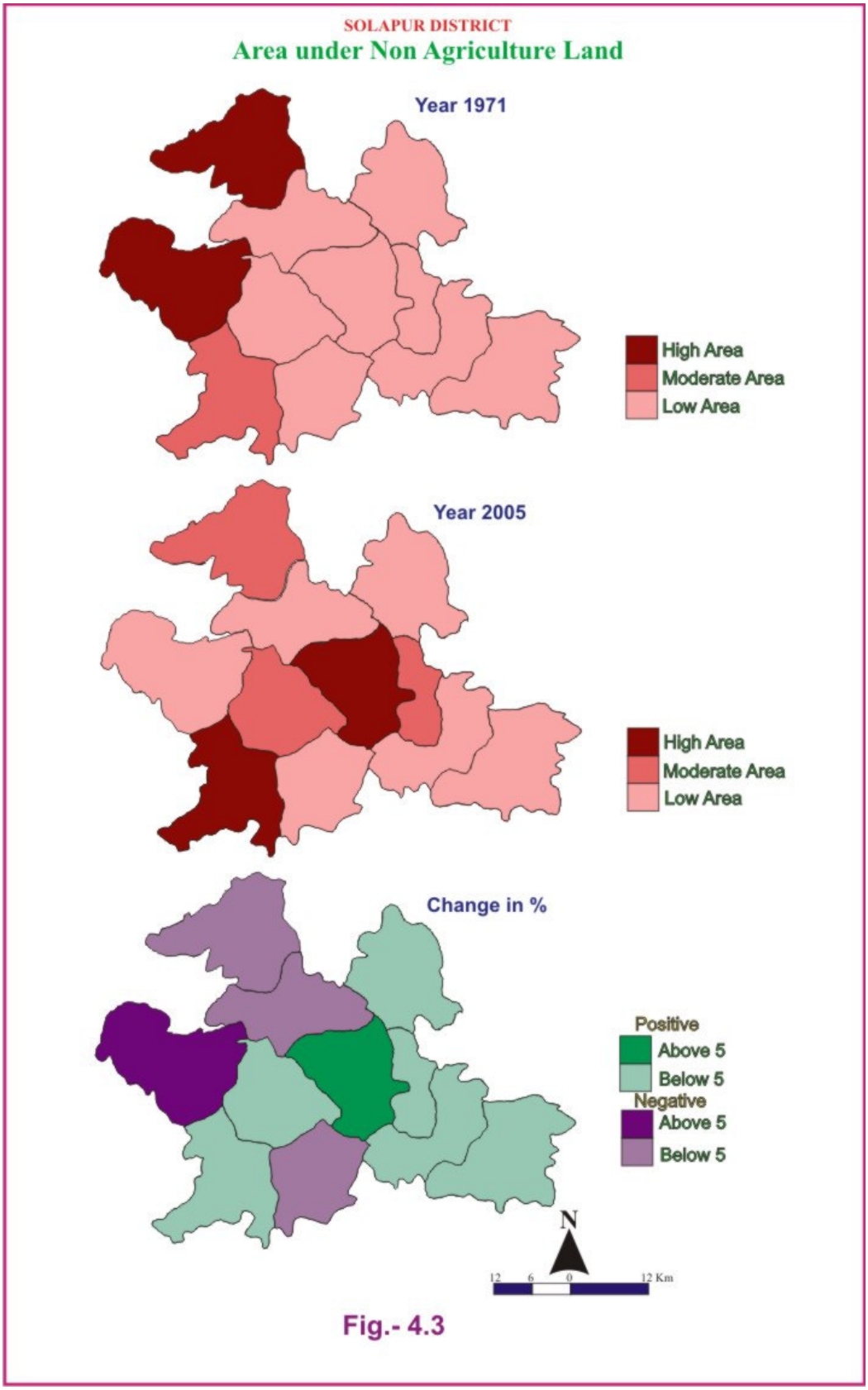

SOLAPUR DISTRICT
Area under Non Agriculture Land
Year 1971
High Area
Moderate Area
Low Area
Year 2005
High Area
Moderate Area
Low Area
Change in %
Positive
Above 5
Below 5
Negative
Above 5
Below 5
N
12 6 0 12 Km

Fig.- 4.3

The moderate proportion i.e. 5 percent to 8 percent prevails in the talukas of Karmala, North Solapur and Pandharpur. The proportion of land under this category is below 5 percent particularly covering densely populated and irrigated tahsils of Madha, Barshi, Malshiras, South Solapur and Akkalkot. The change in the relative position of strength of non agricultural land of talukas is different in fig. 4.3. A tally of percentage points of increase and decreased taken to provide comparative measure of change that occur over period of 1971 to 2005. It is increased from 65500 hect. in 1971 to 79200 hect. in 2005. But there is no uniform pattern in the distribution of area in involved in change in the region. The high increase (above 5 percent) are found in only Mohol tahsil where as the marginal increase (below 5 percent) recorded in the talukas of Barshi, North Solapur, Sangola, South Solapur, Akkalkot and Pandharpur. In the contrast, the decrease in percentage in area involved in change under this category relatively less and confined mostly to the talukas of Malshiras (6.28percent). Respectively, the talukas of Karamala, Madha and Mangalwedha below 5 percent.

ii. Potential Land

It generally consists, cultivable waste land, permanent pasture and grazing land and area miscellaneous trees, crops and groves. The land for the purpose of extension of cultivation can be found only in this category which could be used for cultivation but has not been under cultivation owing to certain reasons.

Table 4.4
Solapur District; Area under Potential Land. (Area in 00 Hect.)

Sr No	Tahsil	1971		2005		Change	
		Area	%	Area	%	Area	%
1	Karmala	71	4.44	07	0.43	-63	-4.01
2	Madha	58	3.80	14	0.91	-44	-2.89
3	Barshi	35	2.12	10	0.65	-25	-1.47
4	N Solapur	25	3.66	11	1.61	-14	-2.05
5	Mohol	24	1.82	NA	NA	NA	NA
6	Pandharpur	41	3.17	31	2.39	-10	-0.78
7	Malshiras	95	5.90	198	12.31	+103	+6.41
8	Sangola	57	3.57	39	2.44	-18	-1.13
9	Mangalwedha	54	4.72	24	2.10	-30	-2.65
10	S Solapur	52	4.35	02	0.16	-50	-4.19
11	Akkalkot	72	5.14	NA	NA	NA	NA
	District	584	3.89	336	2.25	-248	-1.64

Source: Solapur District socioeconomic Abstract 1971 & 2005. Table – 9 Pp-15-19

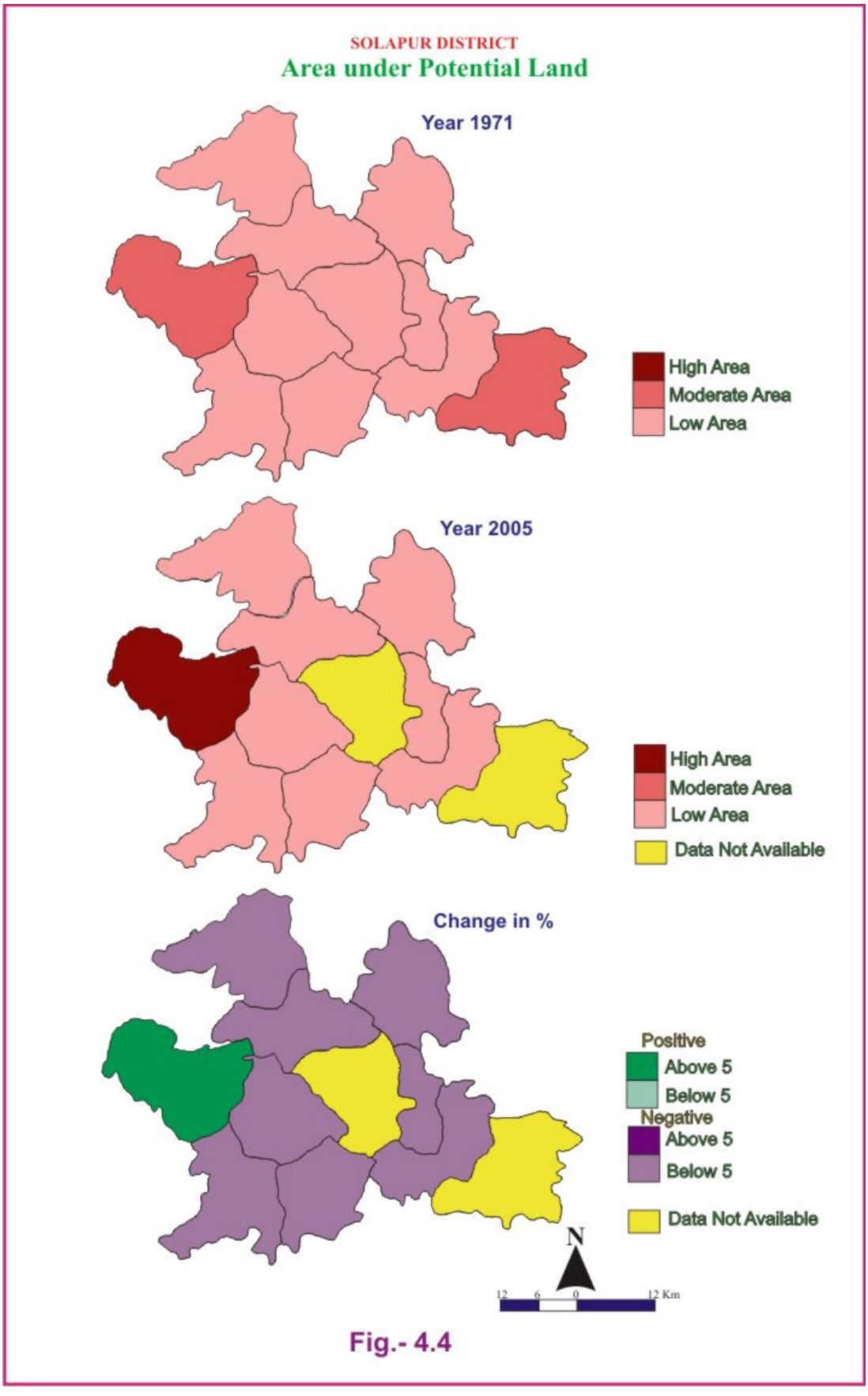

SOLAPUR DISTRICT
Area under Potential Land
Year 1971
High Area
Moderate Area
Low Area
Year 2005
High Area
Moderate Area
Low Area
Data Not Available
Change in %
Positive
Above 5
Below 5
Negative
Above 5
Below 5
Data Not Available
N
12 6 0 12 Km

Fig.- 4.4

In the insuring discussion there are considered together under the heading of penitential agriculture land which is about 2.25 percent of the total geographical area during 2005. The spatial distribution represented in fig. 4.4 varies from under from 0.16 percent to 12.31percent. Significantly very high (over 10 percent) proportion of potential agriculture land embrace is in Malshiras taluka. This is mainly due to adverse climatic conditions and unfavorable physical situation. Coverage of below 5 percent is observed in Madha, Barshi, Mangalwedha, South Solapur, North Solapur, Akkalkot, Mohol, Karamala, Sangola and Pandharpur.

The regional distribution of change in potential agriculture land as depicted in Table 4.4 and fig. 4.4 appears to be uneven. The potential agriculture land slightly decreased from 58400 hect. in 1971 to 33600 hect. in 2005. Sizable increase is confined to Malshiras talukas (6.41 percent). This may be due to the increase in village grazing land, area under fruit tree crops and secondly due to physical hazards. The decrease i.e. under 5 percent is observed in Karmala, Madha, Barshi, North Solapur, Pandharpur, Sangola, Mangalwedha and South Solapur tahsils of the region. This is mainly due to the proportion of potential agriculture land which has gone to non agriculture and agriculture land.

iii. Fallow Land

Fallow land refers to that the part of cultivated area which is kept idle for season or for period extending up to four years.

Table 4.5
Solapur District; Area under Fallow Land. (Area in 00 Hect.)

Sr. No	Tahsil	1971		2005		Change	
		Area	%	Area	%	Area	%
1	Karmala	124	7.77	162	10.15	+38	+2.38
2	Madha	47	3.08	296	19.39	+249	+16.31
3	Barshi	479	28.96	136	8.92	-343	-20.04
4	N Solapur	86	12.59	100	14.64	+14	+2.05
5	Mohol	171	12.98	263	19.96	+92	+6.98
6	Pandharpur	215	16.61	73	5.64	-142	-10.97
7	Malshiras	365	22.69	399	24.81	+34	+2.12
8	Sangola	416	26.10	616	38.64	+200	+12.54
9	Mangalwedha	138	12.08	321	28.10	+183	+16.02
10	S Solapur	170	14.22	193	16.16	+23	+1.94
11	Akkalkot	122	8.71	386	27.55	+264	+18.84
	District	2333	15.54	2945	19.79	+612	+4.25

Source: Solapur District socioeconomic Abstract 1971 & 2005. Table – 9 Pp.-15-19

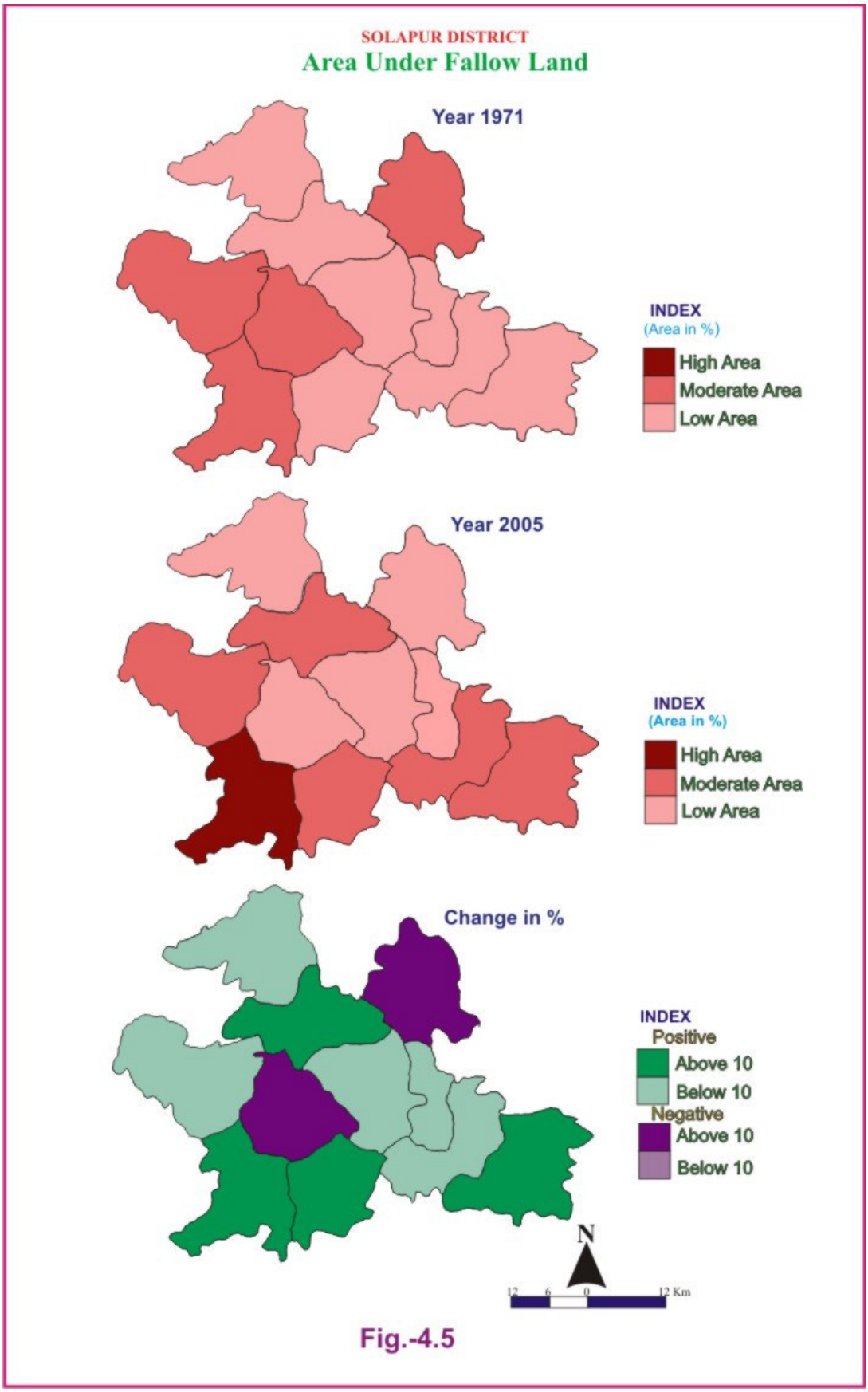

SOLAPUR DISTRICT
Area Under Fallow Land
Year 1971
INDEX
(Area in %)
High Area
Moderate Area
Low Area
Year 2005
INDEX
(Area in %)
High Area
Moderate Area
Low Area
Change in %
INDEX
Positive
Above 10
Below 10
Negative
Above 10
Below 10
N
12 6 0 12 Km

Fig.-4.5

It is of two types 1. Current fallow, 2. Fallow land other than current fallow. The fallow land other than current fallow includes all those areas which have been temporally kept out cultivation due to one reason or the other, for a period of at lest one year but not more than four years.

Solapur District has a substantial proportion of fallow land with an average of 15.54 percent for the reference year 1971 and it largely increased in 19.79 percent the reference year 2005. It is clearly shows that it located in drought prone region. As per the reference year 2005, Sangola tahsil has the highest percentage of fallow land which is more than 30 percent. Area under fallow land between 15 to 30 percent is observed in tahsils of Madha, Mohol, Malshiras, Mangalwedha, South Solapur and Akkalkot. Hence the percentage of fallow land below 15 percent is observed in Karamala, Barshi, North Solapur and Pandharpur.

The fallow land tremendously decreases in Barshi tahsil (20.04 percent) and Pandharpur tahsil (10.97 percent) due to the development of horticulture, irrigation and population pressure. The high increase (above 10 percent) of fallow land is observed in Madha, Sangola, Mangalwedha and Akkalkot and below 10 percent increase is in Karamala, North Solapur, Mohol, Malshiras and South Solapur tahsils. This increase in fallow land earlier years probably due to uncertainty of rainfall and surface level water depth.

Iv. **Cultivated Land**

Cultivated land refers to that part of net area sown on which sowing is actually done at the least once during the year. It does not include double cropped area and in itself constitutes the basic category of agricultural land use. The environmental factors directly affect agriculture land-use or net sown area. Traditionally agriculture is practiced intensively on a large scale. Cultivated land occupies 67.65 percent of the study area in 2005. Fig. 4.6 exhibits the regional variation in share of cultivated area from under 40 percent to 80 percent. The decay of cultivated area in the district has changed over the past 35 years nearly 1110500 hect. during 1971 to decrease about 1006500 hect. during 2005. The highest (above 70 percent) cultivated area is observed in Karamala, Barshi, North Solapur, Pandharpur and South Solapur and followed by 55 to 70 percent cultivated area is in talukas of Mohol, Malshiras, Mangalwedha and Akkalkot. The lowest cultivated area is only in Sangola tahsils due the lack of irrigation facilities.

Table 4.6
Solapur District; Area under Cultivated Land. (Area in 00 Hect.)

Sr No	Tahsil	1971		2005		Change	
		Area	%	Area	%	Area	%
1	Karmala	1196	74.93	1185	74.24	-11	-0.69
2	Madha	1340	87.81	1087	71.23	-253	-16.58
3	Barshi	1077	65.11	1231	80.82	+154	+15.71
4	N Solapur	542	79.35	507	74.23	-35	-5.12
5	Mohol	1073	81.47	911	69.17	-162	-12.30
6	Pandharpur	958	74.03	1063	82.14	+105	+8.11
7	Malshiras	931	57.89	942	58.58	+11	+0.69
8	Sangola	953	59.78	644	40.40	-309	-19.38
9	Mangalwedha	902	78.98	671	58.75	-231	-20.23
10	S Solapur	943	78.91	916	76.71	-27	-2.20
11	Akkalkot	1190	84.93	908	64.81	-282	-20.12
	District	11105	73.98	10065	67.65	-1040	-6.33

Source: Solapur District socioeconomic Abstract 1971 & 2005. Table – 9 Pp-15-19

The high positive (above 10 percent) change are observed in only in Barshi tahsil and low positive (below 10 percent) change found in Pandharpur and Malshiras tahsil. The negative change also observed eight tahsil of district. The large negative change (above 10 percent) is depicted in Madha, Mohol Mangalwedha, Akkalkot and Sangola. Remaining tahsil of Karmala, North Solapur and South Solapur are observed low negative change (below 10 percent).

4.4 . Agriculture Landuse

The term 'Agricultural Landuse' denotes the extent of the gross cropped area during the agricultural year under various crops. Agriculture land-use means land under net sown area, fallow land and uncultivable land excluding fallow land. The cultivated area is known as net sown area, which is also known as agriculture land. In short agriculture land-use means a cropping pattern or the proportion of area under various crops at a point of time. It is the result of the decision made by the farmers regarding the choice of crops and methods for production. Thus, this decision making is based on not only physical constraints and limitations but also on farmer's perception of the total environment. His perception of environment is related to contents and nature of available information, much of which is based on traditional approach. The physical as well as cultural environment affects on crop growth and production.

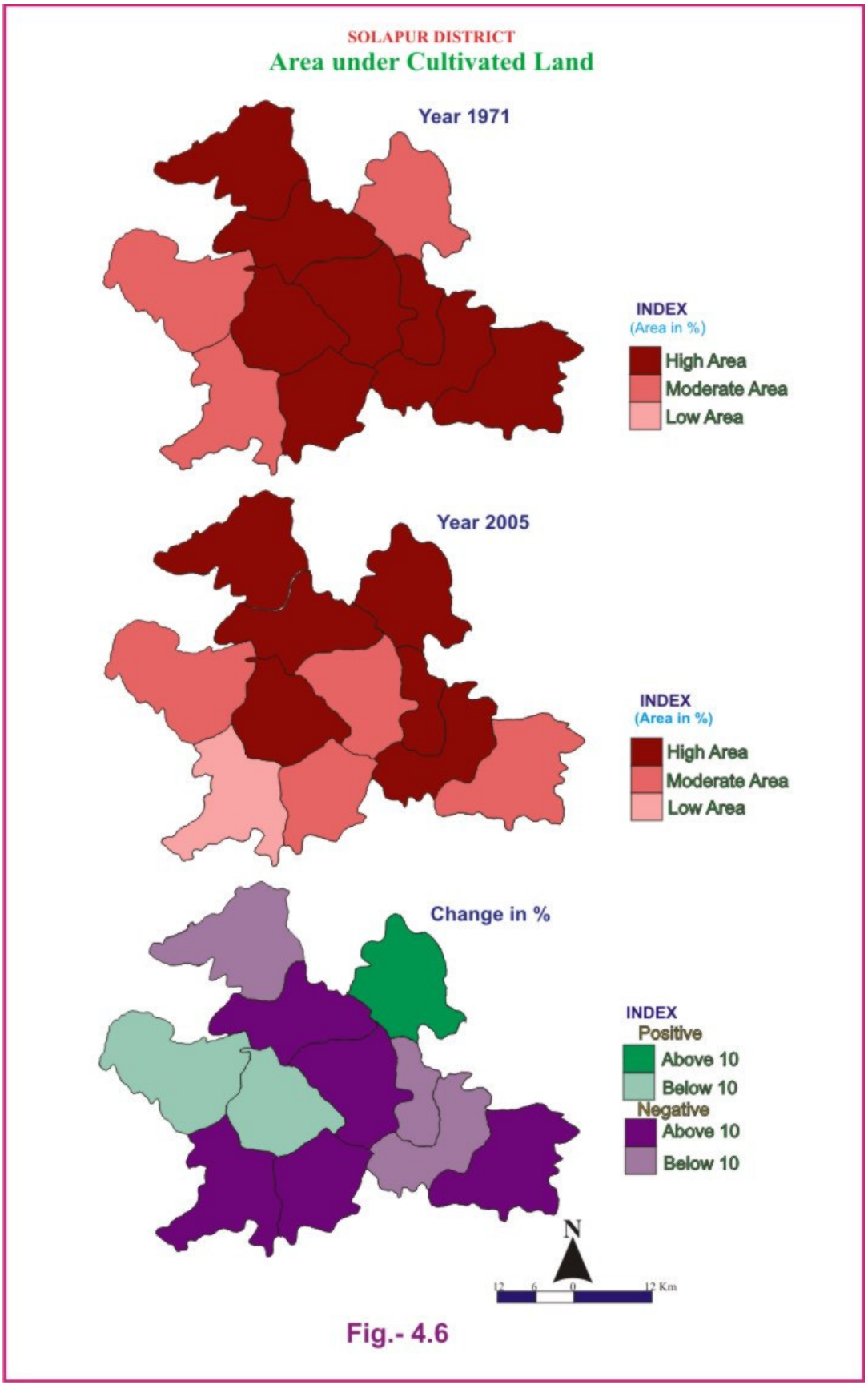

SOLAPUR DISTRICT
Area under Cultivated Land
Year 1971
INDEX
(Area in %)
High Area
Moderate Area
Low Area
Year 2005
INDEX
(Area in %)
High Area
Moderate Area
Low Area
Change in %
INDEX
Positive
Above 10
Below 10
Negative
Above 10
Below 10
N
12 6 0 12 Km

Fig.- 4.6

4.4.A. Temporal variation in Agriculture landuse

The cropping pattern is an important component of any farming system. Cropping pattern means the proportion of area under various crops at a point of time. Any region's cropping pattern always shows variation or change. This change occurs due to variations of rainfall, irrigation, use of high yield varieties, technical knowledge, capital, fertilizers, pesticides, farmers attitude etc.

Table 4.7
Solapur District; Temporal Variation of Agriculture Landuse. (Area in 00 Hect.)

Year	1971		1981		1991		2001		2005	
Crops	Area	%	Area	%	Area	%	Area	%	Area	%
Jawar	6280	56.55	7482	67.0	6921	68.21	7138	63.39	6732	66.88
Bajara	1330	11.97	754	6.82	580	5.71	533	4.73	251	2.49
Maize	109	0.98	142	1.28	139	1.36	291	2.58	271	2.69
Wheat	266	2.39	517	4.67	243	2.39	509	4.52	484	4.80
Rice	74	0.66	59	0.53	34	0.33	16	0.14	05	0.04
Tur	539	4.85	602	5.44	512	5.00	324	2.87	133	1.32
Gram	253	2.28	319	2.88	133	1.30	316	2.80	319	3.16
Moog	69	0.62	66	0.59	26	0.25	51	0.45	20	0.19
Sugarcane	143	1.29	208	1.88	489	4.81	744	6.60	657	6.52
Fruits	84	0.75	76	0.68	80	0.78	155	1.37	490	4.86
Groundnut	762	6.86	311	2.81	217	2.13	218	1.93	59	0.58
Safflower	459	4.13	222	2.00	267	2.63	490	4.35	347	3.44
Cotton	107	0.96	49	0.44	21	0.20	70	0.62	44	0.43
Other	630	5.67	242	2.19	484	4.77	405	3.59	273	2.71
Total	11105	100	11049	100	10146	100	11260	100	10065	100

Source: Solapur District socioeconomic Abstract 1971 & 2005. Table – 12. Pp-27-31

Table No 4.7 and Fig No 4.7 display the temporal variation of major 13 crops in 1970-71 to 2004-05 in study region. Jowar is one of the major crops used as food, fodder, production of alcoholic beverages and bio-fuels. Most varieties of jowar are drought tolerant and heat tolerant and are especially important in arid regions. The total increase of jowar from 1970-71 to 2004-2005 is 10.33 percent (Table- 4.7). It occupies 66.88 percent area in 2004-05. Bajara cultivated 11.97 percent in study region for 1970-71 and it has tremendously decreased by 2.49 percent in 2004-05. Maize is staple fodder crop which is used as food to livestock especially for milk cow. It is occupies 0.98 percent in 1970-71 but in 2004-05 it lies in 2.69 percent to total cultivated area.

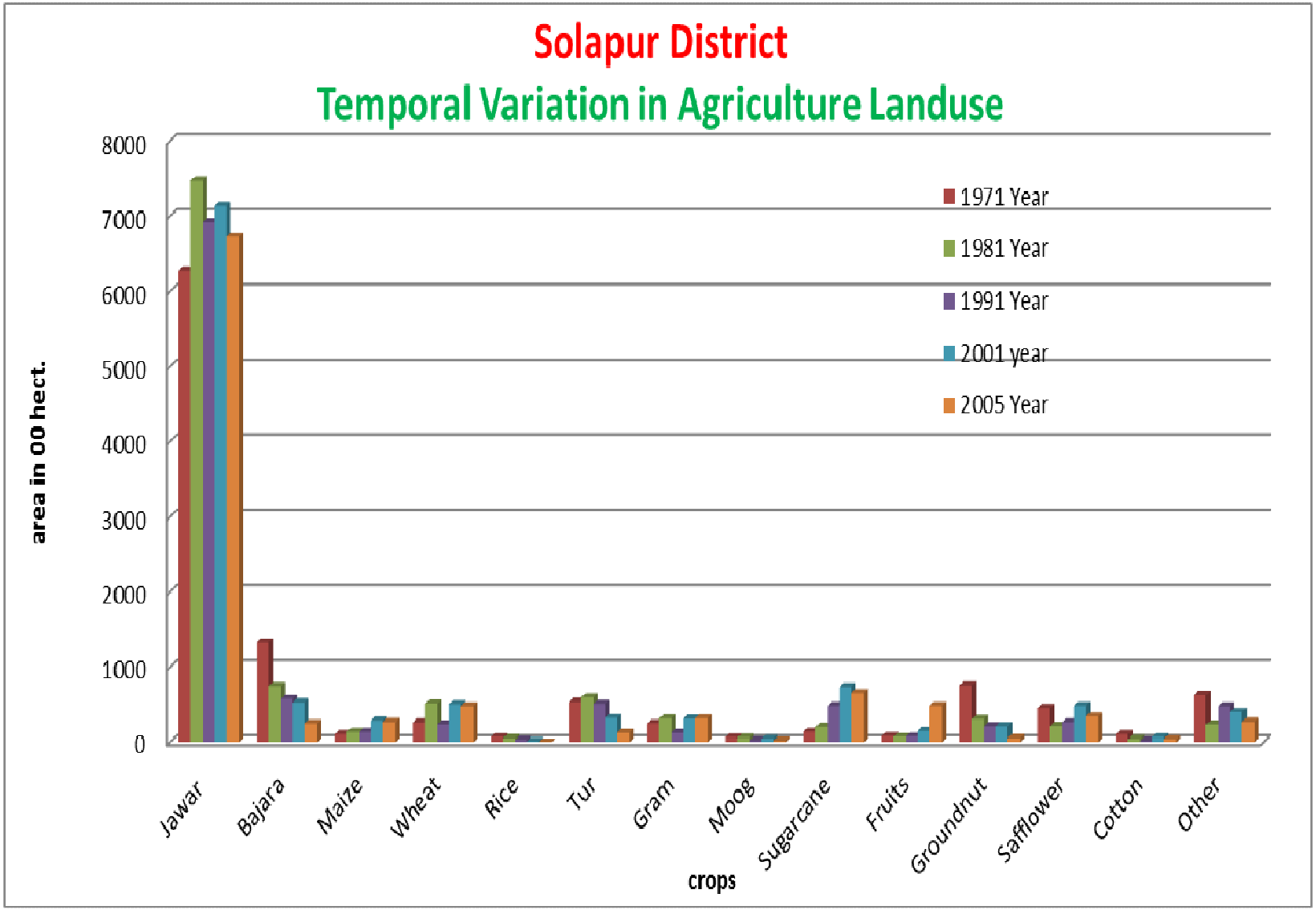

Solapur District
Temporal Variation in Agriculture Landuse
area in 00 hect.
8000
7000
6000
5000
4000
3000
2000
1000
0
1971 Year
1981 Year
1991 Year
2001 year
2005 Year
Jawar
Bajara
Maize
Wheat
Rice
Tur
Gram
Moog
Sugarcane
Fruits
Groundnut
Safflower
Cotton
Other
crops

Fig. 4.7

Wheat is cultivated on 2.39 percent land in 1970-71 while in 2004-05 occupies 4.80 percent land. The total increase of wheat is 2.41 percent from 1970-71 to 2004-05. Sugarcane covers 1.29 percent in 1970-71 in Solapur district. The irrigation facility has increased during study period and therefore sugarcane has increased more than four-fold in study region. It has raised upto 6.52 percent rise in 2004-05. Groundnut was cultivated on 6.86 percent area in 1970-71 and 0.58 percent in 2004-05 having total decrease of 6.28 percent in study region. In study region, safflower was cultivated on 4.13 percent area in 1970-71 and over a period of 35 years, it has decreased to 0.69 percent. Gram was cultivated on 2.28 percent in 1970-71 and it increased 3.16 percent. Fruits and vegetables have increased by 4.11 percent due to increasing demand of fruits and vegetables to mitigate the demand of increasing population. Jowar, Maize, wheat, gram, sugarcane, fruits and vegetables have found increased and whereas bajara, safflower, rice, tur, moog, groundnut and cotton crops area have decreased from 1970-71 to 2004-05 during study period in study region.

4.4B.Spatial pattern

Spatial agriculture landuse pattern is different from tahsil to tahsil in study region. The spatial pattern of landuse and changes there in during 35 years are presented here. Firstly, it attempts to provide a picture of spatial pattern of landuse and cropping by way of tahsil level studies. Secondly, an attempts made to measures the changes in agriculture landuse pattern during the study period.

i. Jawar

The botanical name of Jawar is ***sorghum vulgare***. It is also known as great millet. It is first in importance as a staple food crop in Solapur district. Among all the food grains in the region, it is a staple food crop of the rural population. It is a first ranked crop. Jowar is a leading crop in the study region occupying about 56.55 percent (628000 hectares) in 1971, but it was 68.88 percent (673200 hectares) of the total cultivated area in 2005. It increased by 12.33 percent in the investigated period because of increasing irrigation and population pressure. The main improved varieties grown in the region are C5H5,CH5,M35-1 and local kharif Jowar. Table 4.8 shows the spatial distribution of jowar crop in the study region which vary from tahsil to tahsil during study period. The greater concentration (above 70 %) of jawar is observed in Karamala, Mohol, North Solapur, Mangalwedha, South Solapur and Akkalkot tahsil. In the tahsils

of Barshi and Pandharpur tahsils are 60 to 70 percent. Elsewhere the percentage is below 60 is found in Malshiras, Sangola and Madha tahsil.

Table 4.8
Solapur District; Area under Jawar Crop (Area in 00 Hect.)

Sr No	Tahsil	1971		2005		Change	
		Area	%	Area	%	Area	%
1	Karmala	717	59.94	851	71.81	+134	+11.87
2	Madha	791	59.10	792	72.76	+1	+13.66
3	Barshi	676	62.76	846	68.72	+170	+5.96
4	N Solapur	289	53.32	362	71.45	+73	+18.13
5	Mohol	653	60.86	661	72.55	+8	+11.69
6	Pandharpur	667	69.62	655	61.61	-12	-8.01
7	Malshiras	509	54.67	527	55.94	+18	+1.27
8	Sangola	531	55.72	357	55.43	-174	-0.29
9	Mangalwedha	447	49.55	366	54.54	-81	+4.99
10	S Solapur	484	51.33	677	73.90	+193	+22.57
11	Akkalkot	515	43.27	638	70.26	+123	+26.99
	District	6280	56.55	6732	68.88	+452	+12.33

Source: Solapur District socioeconomic Abstract 1971 & 2005. Table – 12. Pp-27-31

In general, the area of jowar has increased in all the tahsils of district except Pandharpur and Sangola tahsils. The area under jowar has increased by about one percent to 26 percent in the period from 1971 in all over the district. However, the area of this crop high increased (above 20 percent) in South Solapur and Akkalkot tahsil and below 20 percent in Karmala, Madha, North Solapur and Mangalwedha. Mangalwedha is a major producer of ***Maldandi jawar*** in the study region as well as in Maharashtra. The area under jawar crop decreased in Pandharpur (8.01 percent) and Sangola (0.29 percent).

ii. Bajara

Bajara is kind coarse millet. It is raised as a food crop in study region**.** It is the third food grain crop in the study region. It plays a very dominant role in the economy of the study region. It is a staple food of a very large part of the population in the district. It also provides good quality fodder for the livestock. Bajara crop is raised all over the study area to a small extent (below 4 percent), but it is specially concentrated in Sangola (7.29 percent), Mangalwedha (6.55 percent) and Malshiras tahsil (4.56 percent). In 1971, the area under bajara crop was 11.97 percent, which decreased to 2.49 percent of the net sown area in 2005.

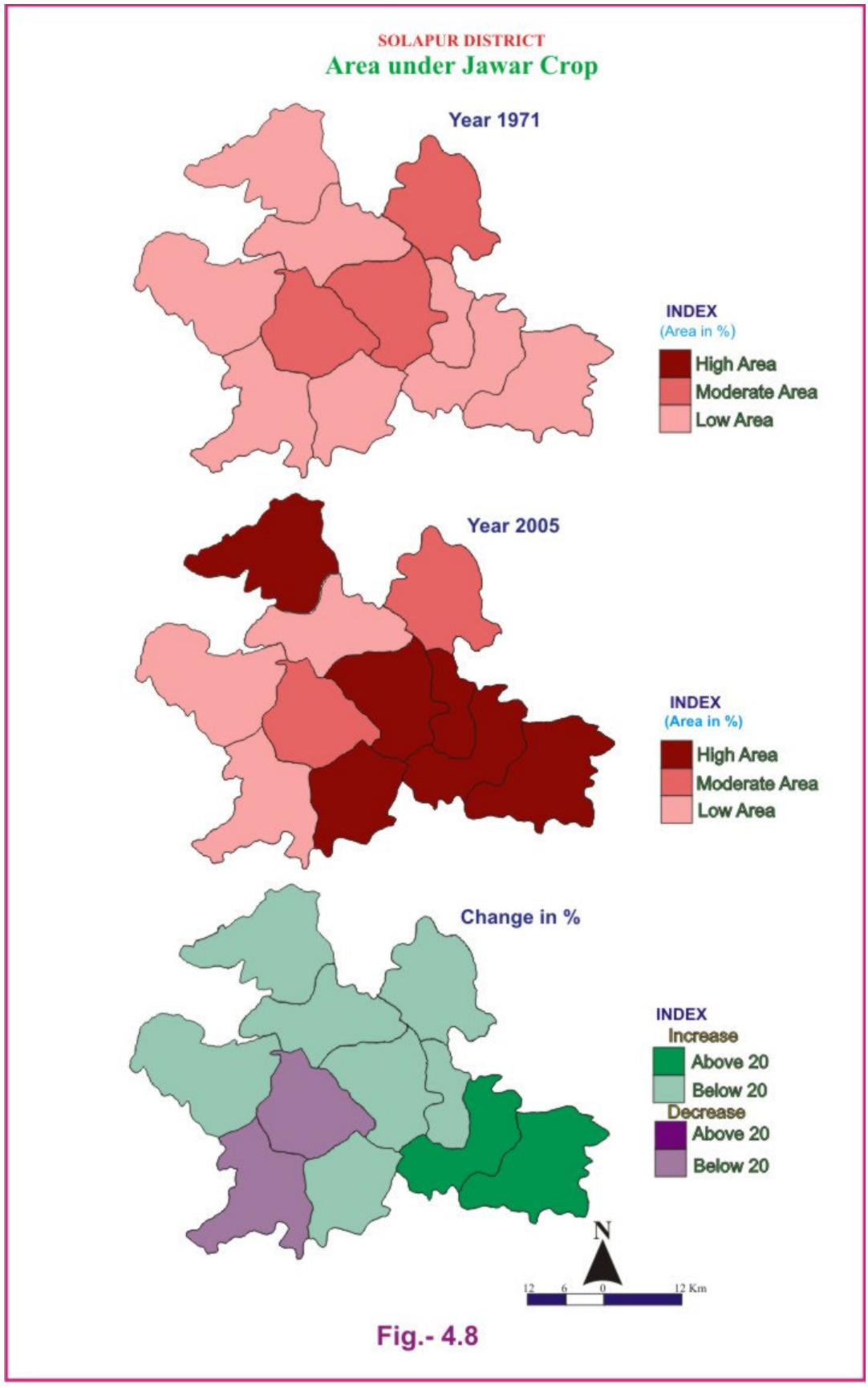

SOLAPUR DISTRICT
Area under Jawar Crop
Year 1971
INDEX
(Area in %)
High Area
Moderate Area
Low Area
Year 2005
INDEX
(Area in %)
High Area
Moderate Area
Low Area
Change in %
INDEX
Increase
Above 20
Below 20
Decrease
Above 20
Below 20
N
12 6 0 12 Km

Fig.- 4.8

The area under bajara crop decreased (above 5 %) in Karamala, Mohol and Pandharpur tahsil. It decreased because the area under pomegranate and ber fruit crops increased largely. Remaining part of the district the area under bajara crop decreased in small scale (below 5 percent).

Table 4.9
Solapur District; Area Under Bajara Crop (Area in 00 Hect.)

Sr No	Tahsil	1971		2005		Change	
		Area	%	Area	%	Area	%
1	Karmala	146	12.20	33	2.78	-110	- 9.42
2	Madha	91	6.79	22	2.02	- 69	- 4.77
3	Barshi	22	2.04	13	1.05	- 9	- 0.99
4	N Solapur	24	4.42	10	1.97	- 14	- 2.45
5	Mohol	68	6.34	07	0.76	- 61	- 5.58
6	Pandharpur	93	9.71	13	1.22	- 80	- 8.49
7	Malshiras	164	1.76	43	4.56	-121	- 2.80
8	Sangola	348	3.65	47	7.29	- 301	- 3.67
9	Mangalwedha	258	2.86	44	6.55	- 214	- 3.69
10	S Solapur	47	4.98	08	0.87	- 39	- 4.11
11	Akkalkot	69	5.80	11	1.21	- 58	- 4.59
	District	1330	11.97	251	2.49	-1079	- 9.48

Source: Solapur District socioeconomic Abstract 1971 & 2005. Table – 12. Pp-27-31

iii. Maize

Maize is the fourth most important food grain in the study area. It is locally called Maka. Farmers grow maize on a small or large scale everywhere in the study area. It increased because it is largely used for livestock or growth of dairy farming.

It covered 0.98 percent of the net sown area in 1971 and 2.69 percent in 2005, it increased by 1.71 percent of the net sown area.The table 4.10 shows the spatial distribution of area under maize crop in 2005. The highest percentage of area under this crop is at Sangola (4.81 percent) Moderate percentage (2 to 4 percent) of maize crop is in North Solapur, Mohol , Pandharpur, Malshiras, Mangalwedha whereas the lowest area (below 2 %) of this crop is observed in Madha, Barshi, South Solapur and Akkalkot tahsil.

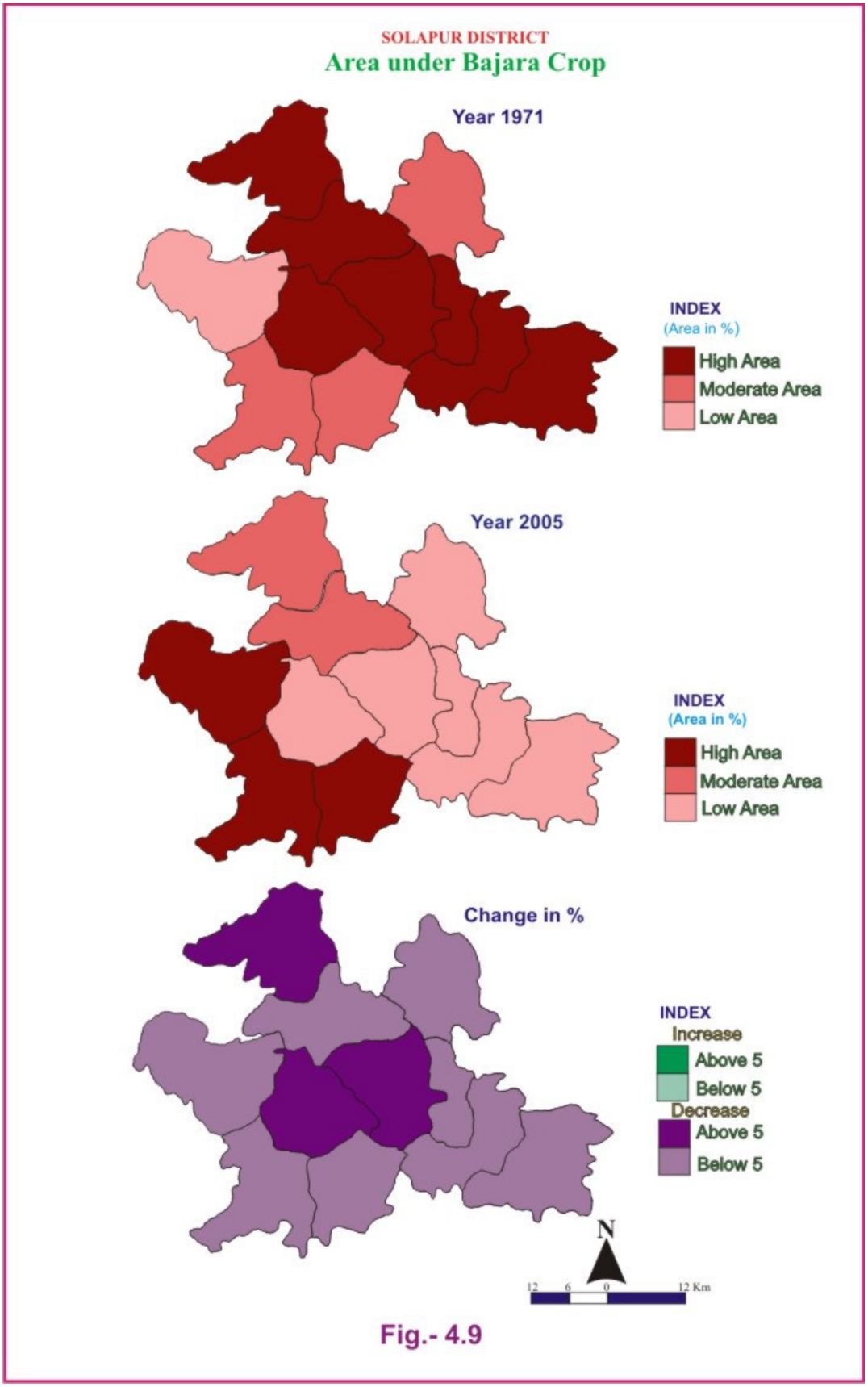

SOLAPUR DISTRICT
Area under Bajara Crop
Year 1971
INDEX
(Area in %)
High Area
Moderate Area
Low Area
Year 2005
INDEX
(Area in %)
High Area
Moderate Area
Low Area
Change in %
INDEX
Increase
Above 5
Below 5
Decrease
Above 5
Below 5
N
12 6 0 12 Km

Fig.- 4.9

Table 4.10
Solapur District; Area under Maize Crop (Area in 00 Hect.)

Sr. No	Tahsil	1971		2005		Change	
		Area	%	Area	%	Area	%
1	Karamala	14	1.17	40	3.37	+ 26	+ 2.20
2	Madha	18	1.34	21	1.93	+ 3	+ 2.59
3	Barshi	08	0.74	24	1.94	+ 16	+ 1.20
4	N Solapur	04	0.74	16	3.15	+ 12	+ 2.41
5	Mohol	25	2.33	27	2.96	+ 2	+ 0.63
6	Pandharpur	10	1.04	39	3.66	+ 29	+ 2.62
7	Malshiras	07	0.75	21	2.22	+ 14	+ 1.47
8	Sangola	07	0.73	31	4.81	+ 24	+ 4.08
9	Mangalwedha	05	0.55	24	3.57	+ 19	+ 3.02
10	S Solapur	06	0.64	13	1.41	+ 7	+ 0.77
11	Akkalkot	05	0.42	15	1.65	+ 10	+ 1.21
	District	109	0.98	271	2.69	+ 162	+ 1.71

Source: Solapur District socioeconomic Abstract 1971 & 2005. Table – 12. Pp-27-31

Fig No 4.10 shows that in 1971 maize occupied about 0.98 percent while in 2005 its area increased by 2.69 percent of the total net sown area of the region. The area under this crop largely (above 3 percent) increased in Sangola and Mangalwedha tahsils whereas it increased to some extent (below 3 percent) in reaming all tahsils of study region because in this area irrigation is well developed.

iv. Wheat

Wheat is the second important food crop in Solapur district. The botanical name of wheat is ***Triticum Satuvum***. Farmers grow wheat on small scale everywhere in the study area. It accounted for 2.39 percent land in 1971, which increased by 4.80 percent of the net sown area in 2005 and in the reference year it increase by 1.02 percent. The area under wheat crop was increasing year by year in the period from 1971 to 2005.

The regional pattern of wheat distribution in table No 4.11 shows that the expansion of this crop in areas where irrigation is more developed as in 2005. The highest percentage of area under wheat is at Pandharpur (7.05 percent) , Malshiras (6.58 percent) and Madha tahsil (6.43 percent). The moderate percentage (4 to 6 % of the net sown area) of wheat crop is observed in North Solapur and Mohol whereas the lowest percent (below 4 %) of the area under wheat crop is in Karamala, Barshi and Sangola tahsils.

Table 4.11
Solapur District; Area Under Wheat Crop (Area in 00 Hect.)

Sr No	Tahsil	1971		2005		Change	
		Area	%	Area	%	Area	%
1	Karmala	32	2.67	29	2.44	- 3	-0.23
2	Madha	27	2.00	70	6.43	+ 43	+ 4.43
3	Barshi	22	2.04	46	3.73	+ 24	+ 1.69
4	N Solapur	12	2.21	30	5.91	+ 18	+ 3.70
5	Mohol	25	2.33	51	5.59	+ 26	+ 3.26
6	Pandharpur	19	1.98	75	7.05	+ 56	+ 5.07
7	Malshiras	32	2.44	62	6.58	+ 30	+ 4.14
8	Sangola	17	1.78	19	2.95	+ 2	+ 1.17
9	Mangalwedha	23	2.55	24	3.57	+ 1	+ 1.02
10	S Solapur	24	2.54	57	6.22	+ 33	+ 3.68
11	Akkalkot	33	2.77	21	2.31	-12	- 0.46
	District	266	2.39	484	4.80	+ 218	+ 2.41

Source: Solapur District socioeconomic Abstract 1971 & 2005. Table – 12. Pp-27-31

It may be observed from Fig No 4.11 that the area under wheat cultivation was 2.39 percent in 1971, which increased to 4.80 percent of the net sown area in 2005. However, it decreases in only Karmala and Akkalkot tahsils of the district. It increased highly (above 4 percent) in Pandharpur, Madha and Malshiras tahsils and also increased to small extent (below 4 percent) in North Solapur, Mohol, Barshi and Sangola tahsil.

v. Tur

Tur is also called as 'tovar' and 'togari'. It has numerous nodules on roots containing Rhizobium bacteria, which fixes atmospheric nitrogen. Tur is the first ranking pulse crop in the study region. It coverers 1.32 percent area of the net sown area in 2005. Tur or red-gram belongs to family and is a protein rich staple food consumed in the form of spilt pulse as dal.

Variation in the distribution of tur is not much and range from under 1 to 2 percent in the region under study. The highest area under tur crop is found in Sangola tahsil and followed by 1 to 2 percent area in Madha, Akkalkot, Mangalwedha, Pandharpur, Barshi, North Solapur, Mohol and Malshiras tahsil. However, the lowest area (below 1 percent) is observed in Karamala and South Solapur tahsil. This is happen due to the farmer's trend towards to commercial fruit farming.

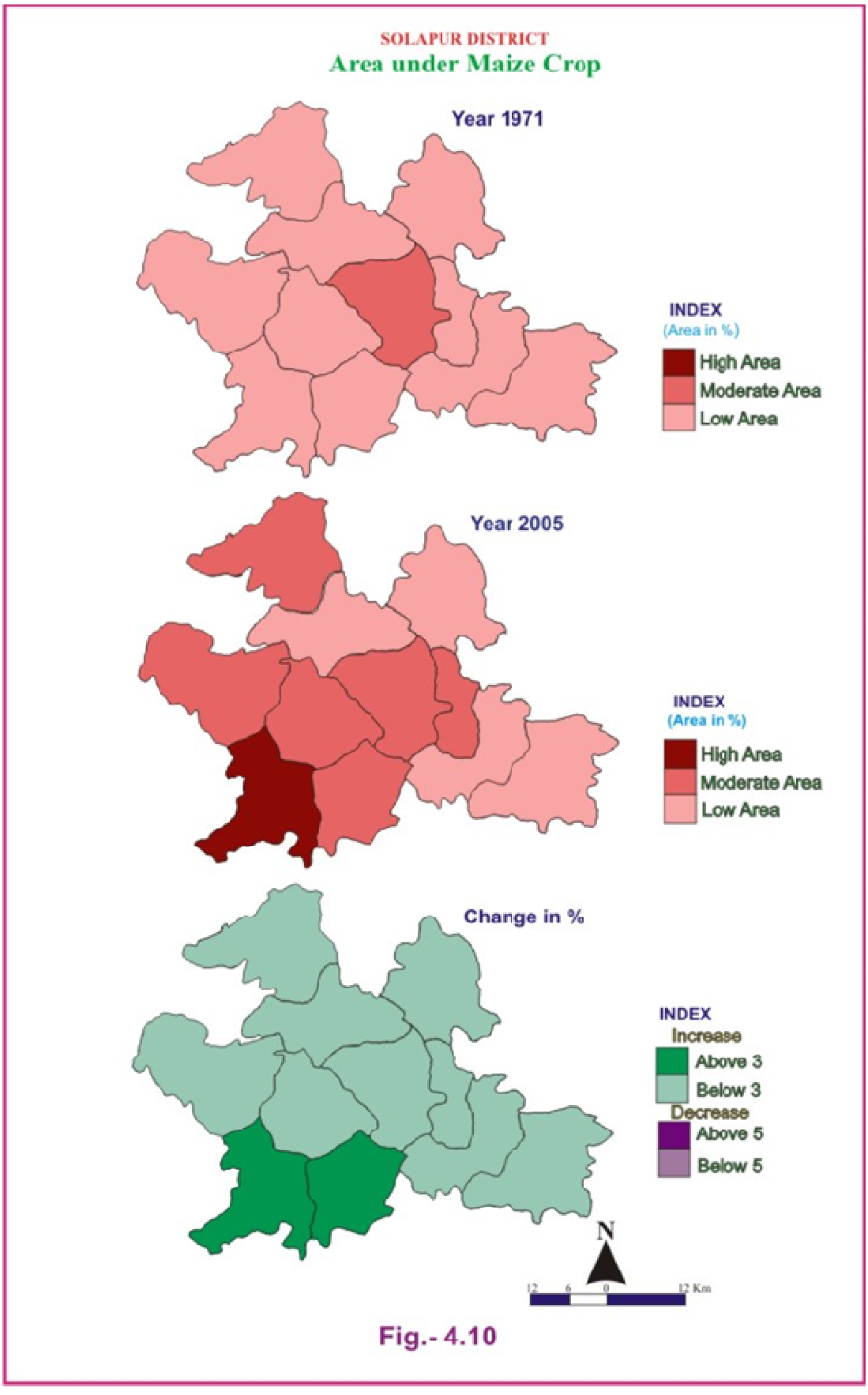

SOLAPUR DISTRICT
Area under Maize Crop
Year 1971
INDEX
(Area in %)
High Area
Moderate Area
Low Area
Year 2005
INDEX
(Area in %)
High Area
Moderate Area
Low Area
Change in %
INDEX
Increase
Above 3
Below 3
Decrease
Above 5
Below 5
N
12 6 0 12 Km

Fig.- 4.10

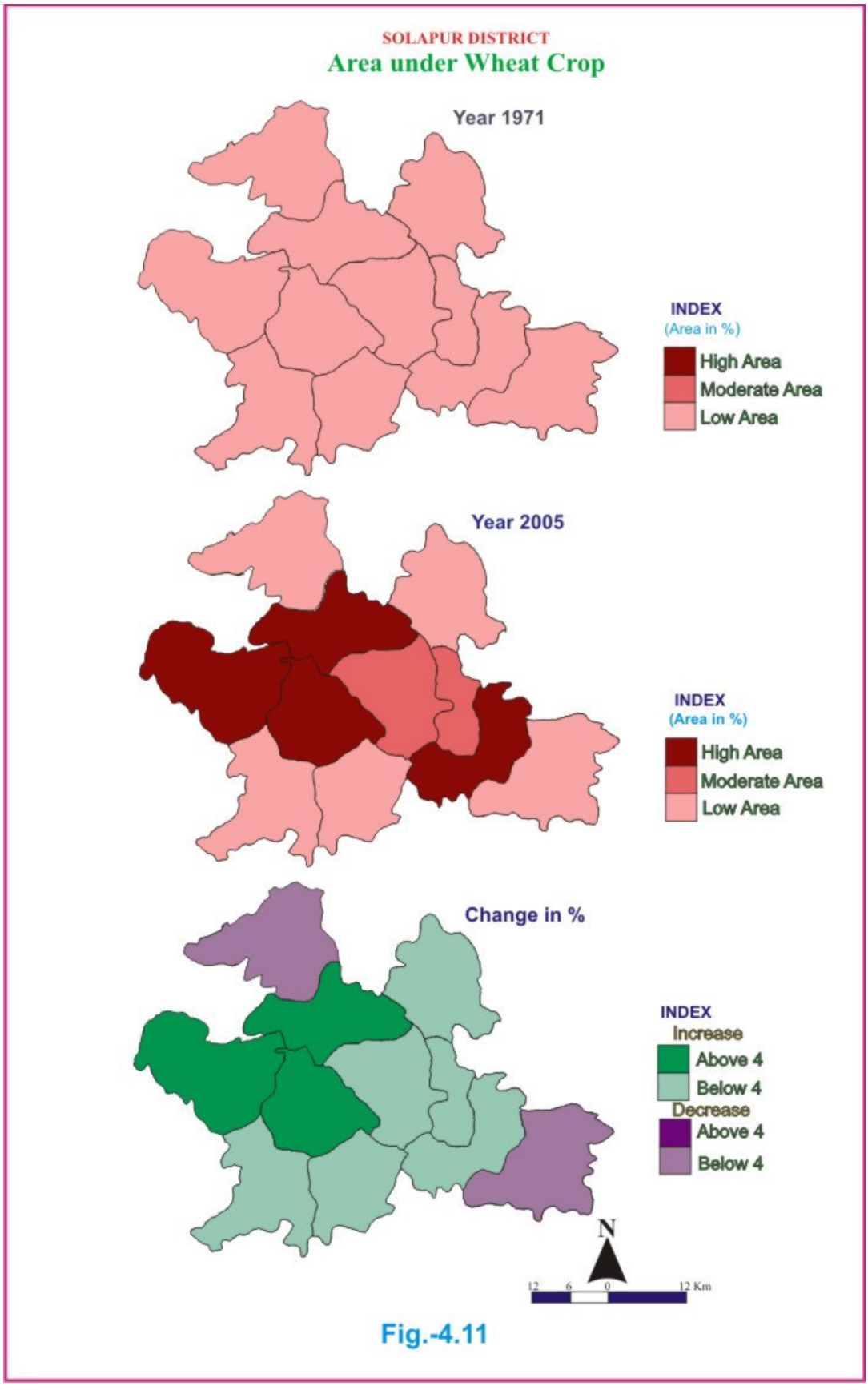

SOLAPUR DISTRICT
Area under Wheat Crop
Year 1971
INDEX
(Area in %)
High Area
Moderate Area
Low Area
Year 2005
INDEX
(Area in %)
High Area
Moderate Area
Low Area
Change in %
INDEX
Increase
Above 4
Below 4
Decrease
Above 4
Below 4
N
12 6 0 12 Km

Fig.-4.11

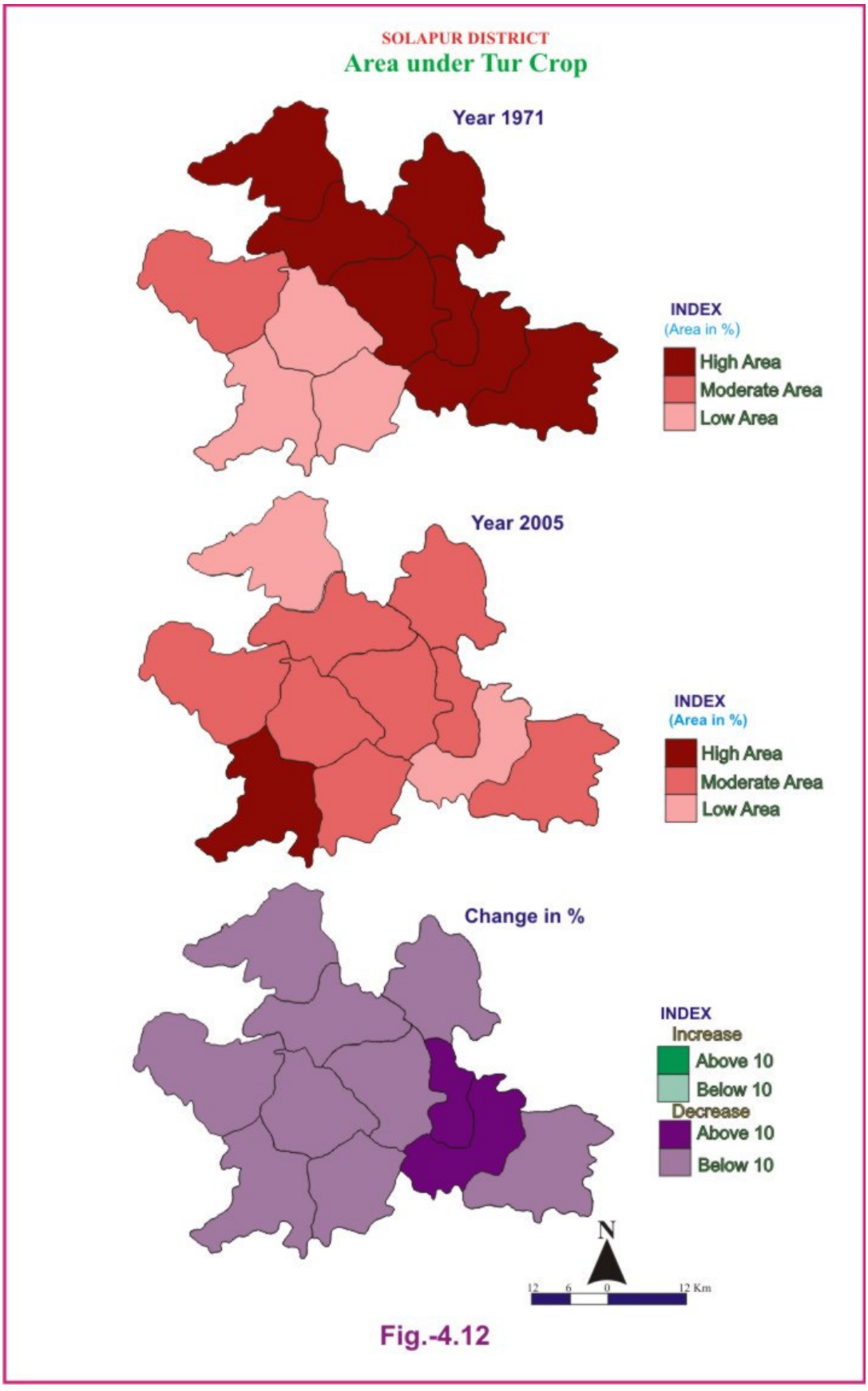

SOLAPUR DISTRICT
Area under Tur Crop
Year 1971
INDEX
(Area in %)
High Area
Moderate Area
Low Area
Year 2005
INDEX
(Area in %)
High Area
Moderate Area
Low Area
Change in %
INDEX
Increase
Above 10
Below 10
Decrease
Above 10
Below 10
N
12 6 0 12 Km

Fig.-4.12

Table 4.12
Solapur District; Area Under Tur Crop (Area in 00 Hect.)

Sr No	Tahsil	1971		2005		Change	
		Area	%	Area	%	Area	%
1	Karmala	47	3.93	09	0.75	-38	- 3.18
2	Madha	48	3.58	13	1.19	-35	- 2.39
3	Barshi	65	6.03	18	1.46	-47	-4.57
4	N Solapur	76	14.02	06	1.18	- 70	- 12.84
5	Mohol	72	6.71	12	1.31	- 60	- 5.40
6	Pandharpur	09	0.94	19	1.78	+ 10	+ 0.84
7	Malshiras	11	1.18	11	1.16	0	-0.02
8	Sangola	05	0.52	14	2.17	+9	+ 1.65
9	Mangalwedha	08	0.89	09	1.34	-1	+0.45
10	S Solapur	57	6.04	06	0.65	-51	- 5.39
11	Akkalkot	141	11.85	16	1.76	-125	- 10.09
	District	539	4.85	133	1.32	-406	- 3.53

Source: Solapur District socioeconomic Abstract 1971 & 2005. Table – 12. Pp-27-31

Map showing the change in tur cultivation, the overall area under tur crop decrease. Only three out of eleven tahsils have shown some increase in areas under tur, but it is not significant. The high area (above 10 percent) decrease in Akkalkot and North Solapur and the remaining tahsils record under 10 percent decrease in area under tur.

vi. Gram

Gram is mainly consumed as a pulse. It is used as food and it helps in increasing the fertility of soil. To some extent gram plays a significant role in the cropping pattern of the area . Gram is a mixed crop and so can be sown singly or with millets and cereals. The area under gram was 2.28 percent in 1971, which increased in 2005 i.e. 3.16 percent of the net sown area.

The area under gram below 2 percent to 4 percent of the net sown area in the study region in 2005 shows in Table No 4.13 and Fig No 4.13. High area (above 3.5 percent) under gram is observed in Barshi , Pandharpur, Malshiras and Sangola tahsil . The moderate area (2.5 to 3.5 percent) is observed Madha, North Solapur, Mohol, Mangalwedha, South Solapur and Akkalkot tahsils. The area under gram is low in Karamala tahsils (Below 2.5 percent) of the net sown area.

Table 4.13
Solapur District; Area Under Gram Crop (Area in 00 Hect.)

Sr No	Tahsil	1971		2005		Change	
		Area	%	Area	%	Area	%
1	Karmala	33	2.76	25	2.10	-8	-0.66
2	Madha	29	2.16	34	3.12	+5	+ 0.96
3	Barshi	29	2.69	48	3.89	+19	+ 1.2
4	N Solapur	10	1.84	15	2.95	+5	+1.11
5	Mohol	22	2.05	27	2.96	+5	+0.91
6	Pandharpur	31	3.23	41	3.85	+10	+0.62
7	Malshiras	19	2.04	36	3.82	+17	+1.78
8	Sangola	07	0.73	23	3.57	+16	+2.84
9	Mangalwedha	29	3.21	19	2.83	-10	-0.38
10	S Solapur	30	3.18	25	2.72	-5	-0.46
11	Akkalkot	14	1.17	26	2.86	+12	+1.69
	District	253	2.28	319	3.16	+66	+0.88

Source: Solapur District socioeconomic Abstract 1971 & 2005. Table – 12. Pp-27-31

The area under gram crop highly increased (above 2 %) in Sangola tahsils between investigations and below 2 percent increasing in Madha, Barshi, North Solapur, Mohol, Pandharpur, Malshiras and Akkalkot tahsil. The area under gram decreased (below 2 percent) in Karamala, Mangalwedha and South Solapur tahsil.

vii. Moog

Moog is an important 'kharif' crop. It is another important pulse crops of the region. It is moderately cultivated dry land farming. The area under Moog was 0.62 percent in 1971, which decreased in 2005 i.e. 0.19 percent of the net sown area.

Table 4.14
Solapur District; Area Under Moog Crop (Area in 00 Hect.)

Sr No	Tahsil	1971		2005		Change	
		Area	%	Area	%	Area	%
1	Karmala	20	1.67	04	0.33	-16	-1.34
2	Madha	09	0.67	00	00	-09	-0.67
3	Barshi	18	1.67	10	0.81	-8	-0.86
4	N Solapur	02	0.67	01	0.19	-1	-0.48
5	Mohol	02	0.19	00	00	-2	- 0.19
6	Pandharpur	01	0.10	00	00	-1	-0.10
7	Malshiras	04	0.43	00	00	-4	-0.43
8	Sangola	01	0.10	01	0.15	0	+0.05

9	Mangalwedha	01	0.11	01	0.14	0	+0.03
10	S Solapur	06	0.64	01	0.10	-5	-0.54
11	Akkalkot	05	0.42	02	0.22	-3	-0.20
	District	69	0.62	20	0.19	-49	-0.43

Source: Solapur District socioeconomic Abstract 1971 & 2005. Table – 12. Pp-27-31

Table No 4.14 and Fig No 4.14 reveals that the area under moog below one percent of the net sown area in the study region in 2005. Madha, Mohol, Pandharpur and Malshiras the under moog crop is uncountable and remaining all tahsils of district the area under moog is very low. During the investigation the area under moog crop decreased slightly (0.43 percent). The area under moog crop increased (below one percent) in Sangola and Mangalwedha tahsils between investigations.

The area under moog highly decreased (1.34 percent) only in Karmala tahsil otherwise the area under moog in Solapur District decreased below 1 percent in the period from 1971 to 2005.

viii. Sugarcane

Sugarcane is locally called 'Oos'. It is an annual crop. It is the main source of sugar in India and a premier cash crop. It is grown mainly in the irrigated area in the study region. It holds the top most position in the economy of the district. It is used for making white sugar. There are 14 co-operative sugar factories and 11 private sugar factories in the study region.

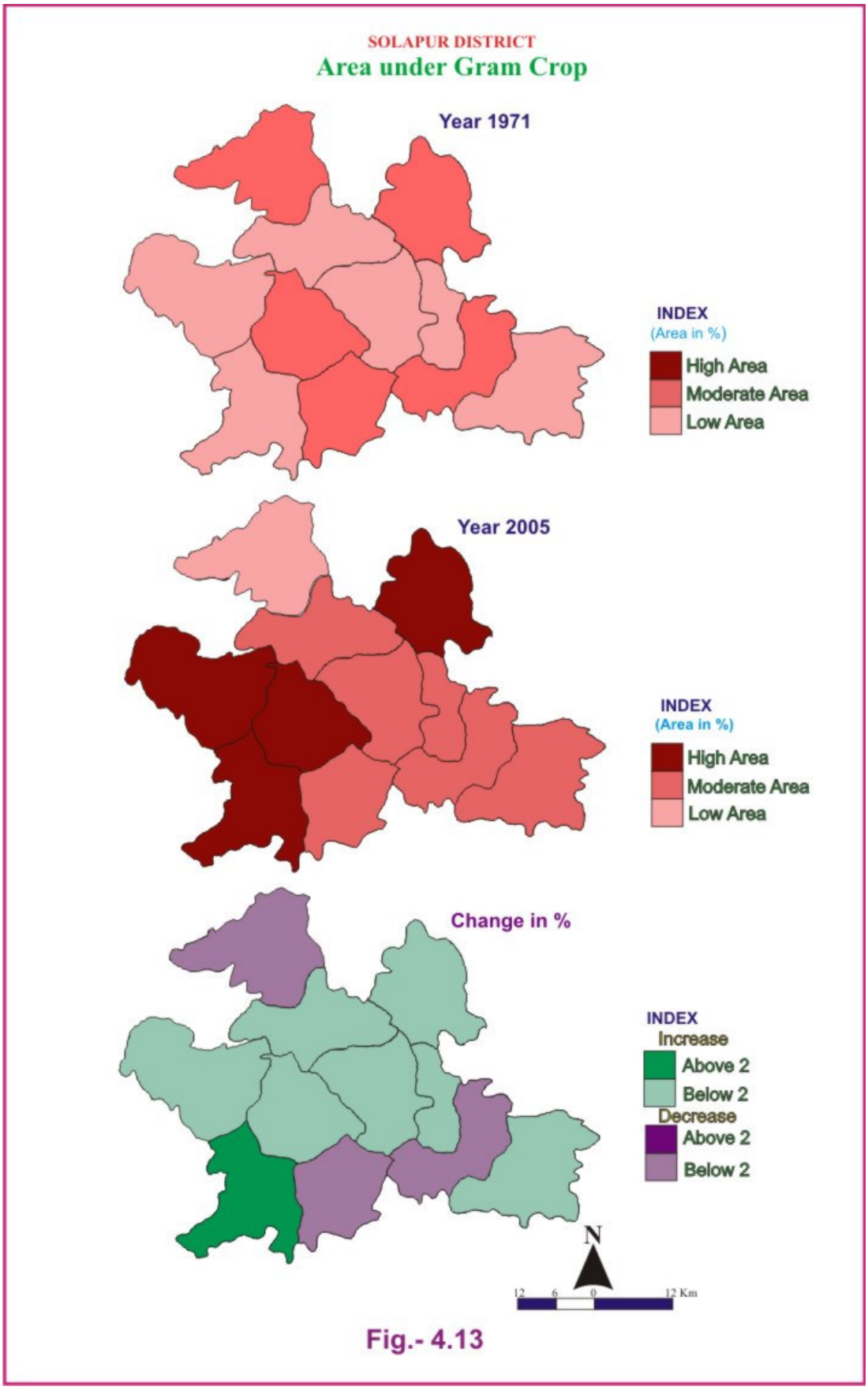

SOLAPUR DISTRICT
Area under Gram Crop
Year 1971
INDEX
(Area in %)
High Area
Moderate Area
Low Area
Year 2005
INDEX
(Area in %)
High Area
Moderate Area
Low Area
Change in %
INDEX
Increase
Above 2
Below 2
Decrease
Above 2
Below 2
N
12 6 0 12 Km

Fig.- 4.13

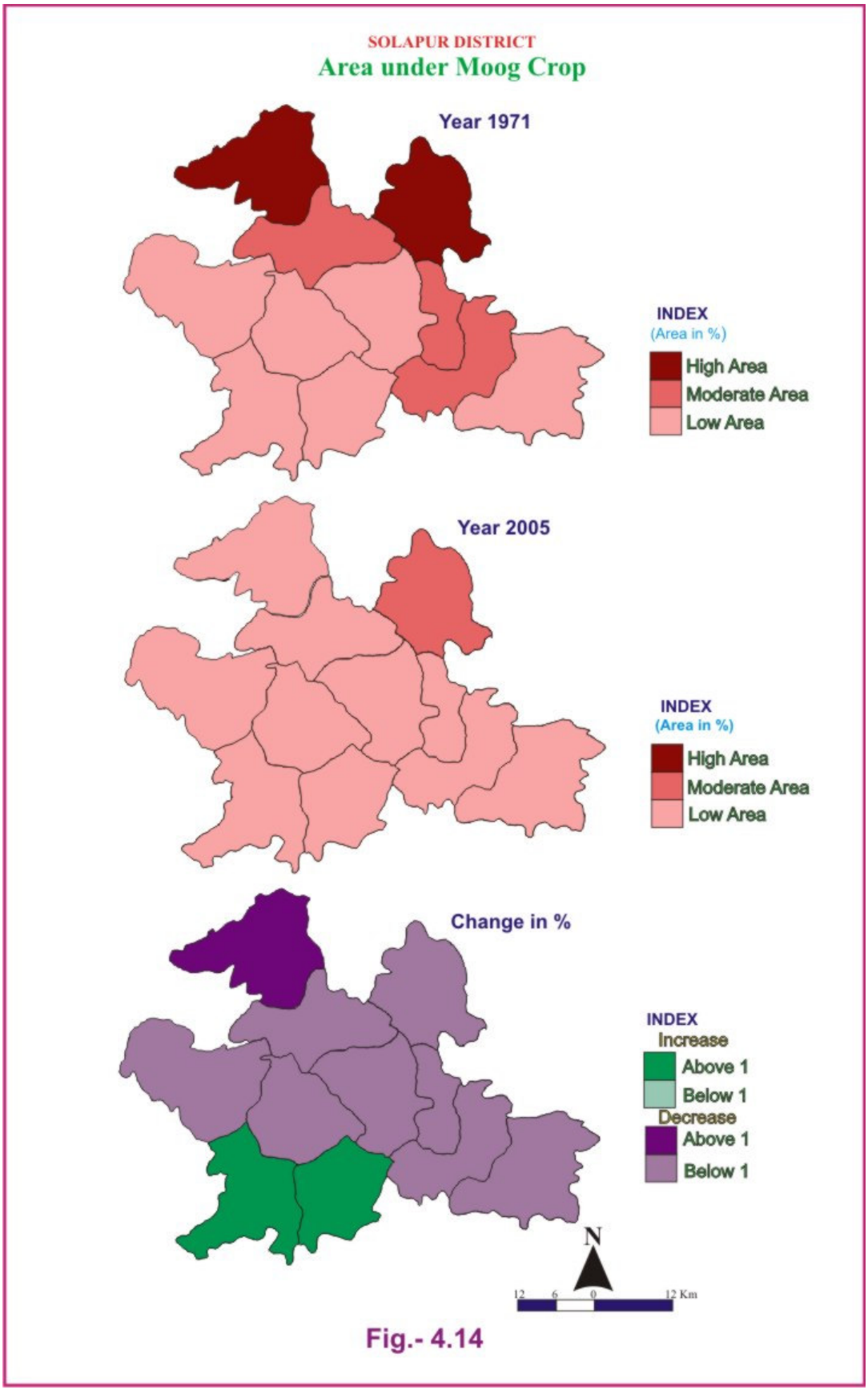

SOLAPUR DISTRICT
Area under Moog Crop
Year 1971
INDEX
(Area in %)
High Area
Moderate Area
Low Area
Year 2005
INDEX
(Area in %)
High Area
Moderate Area
Low Area
Change in %
INDEX
Increase
Above 1
Below 1
Decrease
Above 1
Below 1
N
12 6 0 12 Km

Fig.- 4.14

Table 4.15
Solapur District; Area Under Sugarcane Crop (Area in 00 Hect.)

Sr. No	Tahsil	1971		2005		Change	
		Area	%	Area	%	Area	%
1	Karmala	03	0.25	46	3.88	+43	+3.63
2	Madha	08	0.60	44	4.04	+36	+3.44
3	Barshi	07	0.65	78	6.33	+71	+5.68
4	N Solapur	10	1.84	28	5.52	+18	+3.68
5	Mohol	07	0.65	49	5.37	+42	+4.72
6	Pandharpur	12	1.25	83	7.80	+71	+4.55
7	Malshiras	67	7.19	100	10.61	+33	+3.42
8	Sangola	04	0.42	37	5.74	+33	+5.32
9	Mangalwedha	03	0.33	61	9.09	+58	+8.76
10	S Solapur	08	0.85	36	3.93	+28	+3.08
11	Akkalkot	14	1.18	95	10.46	+81	+9.28
	District	143	1.29	657	6.52	+514	+5.23

Source: Solapur District socioeconomic Abstract 1971 & 2005. Table – 12. Pp-27-31

The distribution of sugarcane in the study area is widespread. Table No 4.15 depicts the regional variation of the area under sugarcane which ranges from 3 to 11 percent. About 6.52 percent of the net sown area of the district was under sugarcane in 2005. The tahsils of Malshiras and Akkalkot record over 10 percent area followed by Mohol, Sangola, Pandharpur, Mangalwedha and North Solapur tahsils with 5 percent to 10 percent area under sugarcane. And the rest of the tahasils have very little proportion (below 5 %) of area the under sugarcane.

Table No 4.15 and Fig. 4.15 shows the regional change in area under sugarcane during the study. The area under sugarcane has been increased significantly during the period under investigation and this is mainly due to the increased irrigation facilities in recent years in all the tahsils of the district. Highest increase is record (above 8 percent) in Akkalkot and Mangalwedha tahsil while Malshiras, Barshi and Mohol tahsils have recorded an increase from 4 to 8 percent. The remaining tahsils have increased the sugarcane area in small extent (below 4 %) due to shallow soil, rough topography and lack of irrigation facility.

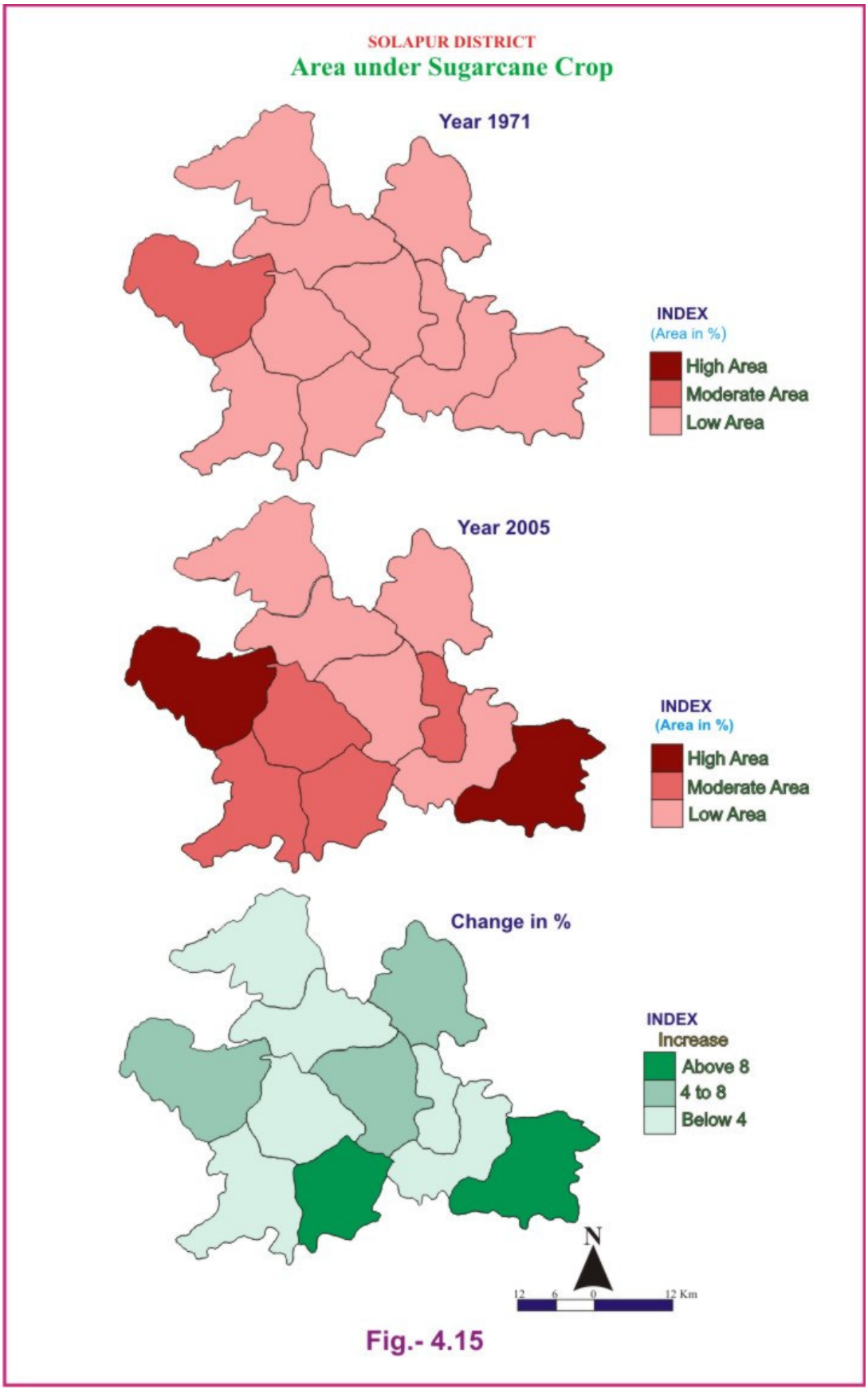

SOLAPUR DISTRICT
Area under Sugarcane Crop
Year 1971
INDEX
(Area in %)
High Area
Moderate Area
Low Area
Year 2005
INDEX
(Area in %)
High Area
Moderate Area
Low Area
Change in %
INDEX
Increase
Above 8
4 to 8
Below 4
N
12 6 0 12 Km

Fig.- 4.15

ix. Fruits

Fruits have undoubtedly been man's oldest food but the development of fruits growing on commercial lines has taken place relatively recently in Solapur district. Fruits include Mango, Grapes, Pomegranate, Ber, Banana, Guava, Fig, Water-melon, Custard Apple, Papaya, Sapodilla, etc. but in the study region Mango, Grapes, Pomegranate, Banana, Lemon, are the important fruit crops. Table No 4.16 reveals that, out of the total net sown area 4.86 percent area is under fruit crops (2005). The spatial distribution of different fruit crops is uneven. All the fruits are not equally planted all over the district as pomegranate is concentrated in Sangola and grape in Pandharpur and north Solapur.

Table 4.16
Solapur District; Area Under Fruit Crops (Area in 00 Hect.)

Sr No	Tahsil	1971		2005		Change	
		Area	%	Area	%	Area	%
1	Karmala	02	0.17	51	4.30	+49	+4.13
2	Madha	06	0.45	47	4.32	+41	+3.87
3	Barshi	07	0.65	51	4.14	+44	+3.49
4	N Solapur	09	1.66	35	6.90	+26	+5.24
5	Mohol	19	1.77	30	3.29	+11	+1.52
6	Pandharpur	06	0.63	54	5.07	+48	+4.44
7	Malshiras	07	0.75	73	7.74	+66	+6.99
8	Sangola	01	0.10	43	6.67	+42	+6.57
9	Mangalwedha	03	0.33	44	6.55	+41	+6.22
10	S Solapur	05	0.53	40	4.36	+35	+3.83
11	Akkalkot	19	1.60	22	2.42	+03	+0.82
	District	84	0.76	490	4.86	+406	+4.10

Source: Solapur District socioeconomic Abstract 1971 & 2005. Table – 12. Pp-27-31

Area where there is dry climate, light soil and irrigated area in North Solapur, Mangalwedha, Sangola and Malshiras which covered above 6 percent under fruit crops of the net sown area. The Moderate area (4 to 6 percent) is found in Karmala, Madha, Barshi, South Solapur and Pandharpur Tahsil. The lowest (Below 4 percent) area under fruit crops in only Mohol and Akkalkot. The area under fruit crops in the investigation period has been increased to a small extent (4.10 percent). The area under fruit crop is highly increased (above 6 percent) in Malshiras, Sangola and Mangalwedha whereas it is increased (4 to 6 percent) in Karamala, North Solapur and Pandharpur to the very small percentage (below 4 percent) in Madha, Barshi, Mohol, South Solapur and Akkalkot tahsils.

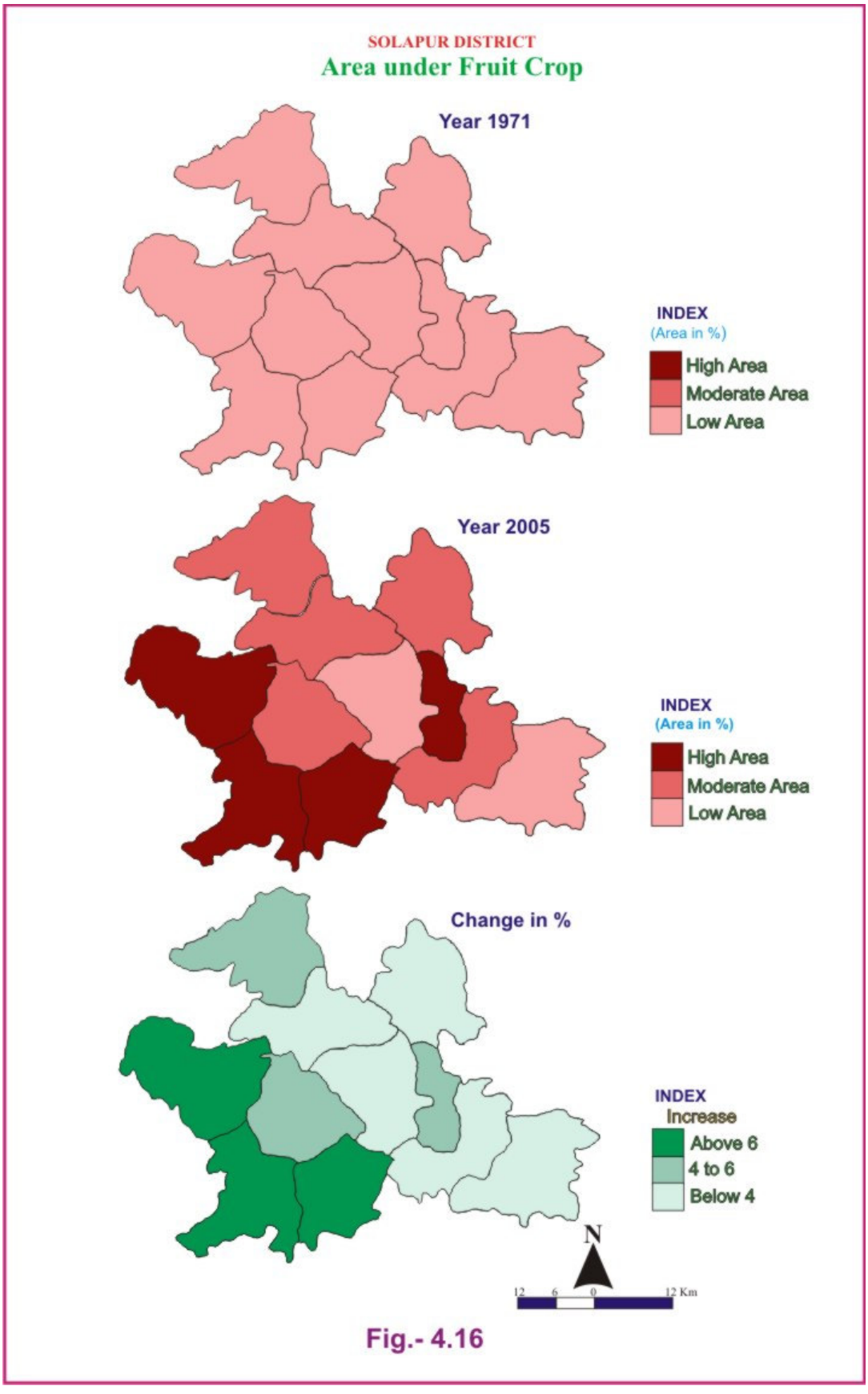

SOLAPUR DISTRICT
Area under Fruit Crop
Year 1971
INDEX
(Area in %)
High Area
Moderate Area
Low Area
Year 2005
INDEX
(Area in %)
High Area
Moderate Area
Low Area
Change in %
INDEX
Increase
Above 6
4 to 6
Below 4
N
12 6 0 12 Km

Fig.- 4.16

x. Groundnut

Groundnut locally called as 'Bhuimoog'. It is most important oilseeds raised in the study region. It is particularly valued for its protein content, which is of high biological value.

Table 4.17
Solapur District; Area Under Groundnut Crop (Area in 00 Hect.)

Sr No	Tahsil	1971		2005		Change	
		Area	%	Area	%	Area	%
1	Karmala	31	2.59	10	0.84	-21	-1.75
2	Madha	50	3.73	07	0.64	-43	-3.09
3	Barshi	161	14.95	08	0.64	- 153	-14.31
4	N Solapur	51	9.41	05	0.98	- 46	-8.43
5	Mohol	36	3.35	04	0.43	- 32	-2.92
6	Pandharpur	19	1.98	03	0.28	- 16	-1.70
7	Malshiras	19	2.04	07	0.74	-12	-1.30
8	Sangola	05	0.52	06	0.93	+ 01	+0.41
9	Mangalwedha	16	1.77	03	0.44	- 13	-1.33
10	S Solapur	116	12.30	02	0.21	-14	-12.09
11	Akkalkot	258	21.68	04	0.44	-254	-21.24
	District	762	6.86	59	0.58	-603	-6.28

Source: Solapur District socioeconomic Abstract 1971 & 2005. Table – 12. Pp-27-31

The Table No 4.17 shows the spatio-temporal distribution of groundnut in study region. It occupied 0.58 percent of the net sown area of the district in 2005. It is decreased 6.28 percent during the study period due to it is replaced by commercial crops and fluxion in rainfall. The highest decrease (above 20 percent) is in Akkalkot tahsil. The 10 to 20 percent decrease is found in Barshi and South Solapur. Remaining part of the district reveals the low decrease (below 10 percent) in area under groundnut.

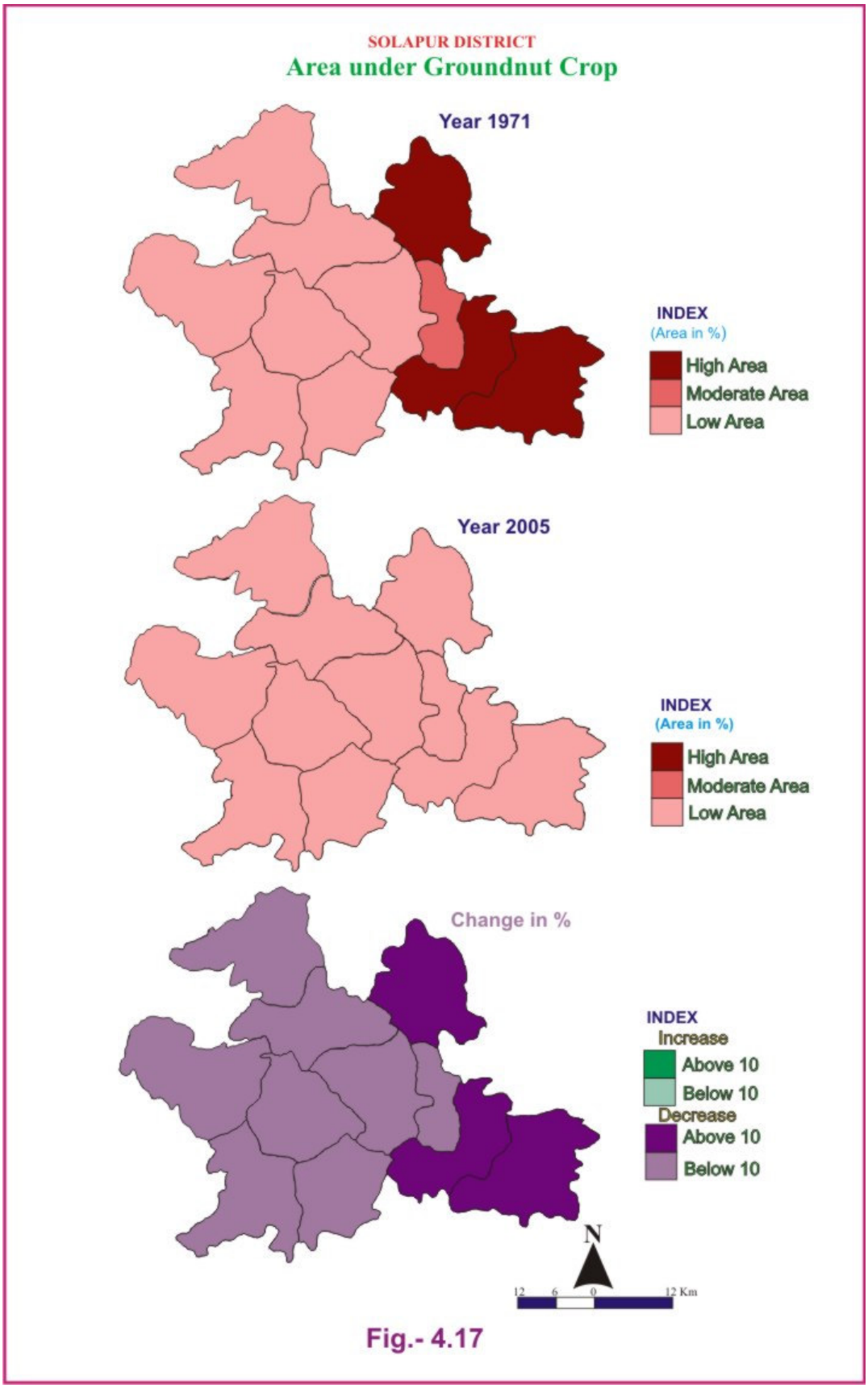

SOLAPUR DISTRICT
Area under Groundnut Crop
Year 1971
INDEX
(Area in %)
High Area
Moderate Area
Low Area
Year 2005
INDEX
(Area in %)
High Area
Moderate Area
Low Area
Change in %
INDEX
Increase
Above 10
Below 10
Decrease
Above 10
Below 10
N
12 6 0 12 Km

Fig.- 4.17

xi. Safflower

Safflower is an important rabi oilseed crop in Solapur district. It is also raised as good management and better irrigation facilities. It covered 3.44 percent area in the reference year 2005.

Table 4.18
Solapur District; Area Under Safflower Crop (Area in 00 Hect.)

Sr No	Tahsil	1971		2005		Change	
		Area	%	Area	%	Area	%
1	Karmala	138	11.54	35	2.95	-103	-8.59
2	Madha	99	7.39	25	2.29	-74	-5.10
3	Barshi	19	1.76	47	3.81	+28	+2.05
4	N Solapur	10	1.84	10	1.97	0	+0.13
5	Mohol	41	3.82	21	2.30	-20	-1.52
6	Pandharpur	46	4.80	28	2.63	-18	-2.17
7	Malshiras	23	2.47	38	4.03	+15	+1.56
8	Sangola	01	0.10	32	4.96	+31	+4.86
9	Mangalwedha	30	3.32	38	5.66	+08	+2.34
10	S Solapur	25	2.65	36	3.93	+11	+1.28
11	Akkalkot	27	2.27	37	4.07	+10	+1.80
	District	459	4.13	347	3.44	-112	-0.69

Source: Solapur District socioeconomic Abstract 1971 & 2005. Table – 12. Pp-27-31

The concentration of safflower (above 4 percent) is in Malshiras, Sangola, and Mangalwedha and Akkalkot tahsils of the district. The 2 to 4 percent area is in remaining all tahsils of the district except North Solapur. The overall sunflower area decreases only 0.69 percent during study period. The high area has decreased in Karamala (8.59 percent) and lowest in Mohol (1.52 percent). The highest area is increased in Sangola (4.86 percent) and lowest in South Solapur tahsil (1.28 percent).

xii. Cotton

Cotton locally named as 'Kapashi' is another important cloth seed in the study region. Cotton is another important cash crop in the study region. The cotton mills are dependent on productivity of cotton in the Solapur district Out of the total gross cropped area, area under cotton is 0.43 percent in 2005.

Table 4.19
Solapur District; Area Under Cotton Crop (Area in 00 Hect.)

Sr No	Tahsil	1971		2005		Change	
		Area	%	Area	%	Area	%
1	Karmala	01	0.08	02	0.16	+1	+0.08
2	Madha	05	0.37	08	0.73	+3	+0.36
3	Barshi	0.50	0.05	01	0.08	+0.50	+0.03
4	N Solapur	0.50	0.09	01	0.19	+0.50	+0.10
5	Mohol	05	0.46	02	0.21	-03	-0.25
6	Pandharpur	07	0.73	07	0.65	00	-0.08
7	Malshiras	49	5.26	01	0.10	-48	-5.16
8	Sangola	09	0.94	13	2.01	+04	+1.07
9	Mangalwedha	05	0.55	07	1.04	+02	+0.49
10	S Solapur	12	1.27	00	00	-12	-1.27
11	Akkalkot	13	1.09	02	0.22	-11	-0.87
	District	107	0.96	44	0.43	-63	-0.53

Source: Solapur District socioeconomic Abstract 1971 & 2005. Table – 12. Pp-27-31

Spatial distribution of the tashils under cotton crop for the reference year 2005 indicates the following aspects. The highest percentage is found in Sangola (2.01 %) and the lowest percentage is in Barshi taluka (0.08 %). Remaining all the talukas of the district cotton is totally below one percent of the net sown area. The six tahsils of district area under cotton crops are increased and rest of five tahsil area under cotton crops decreased.

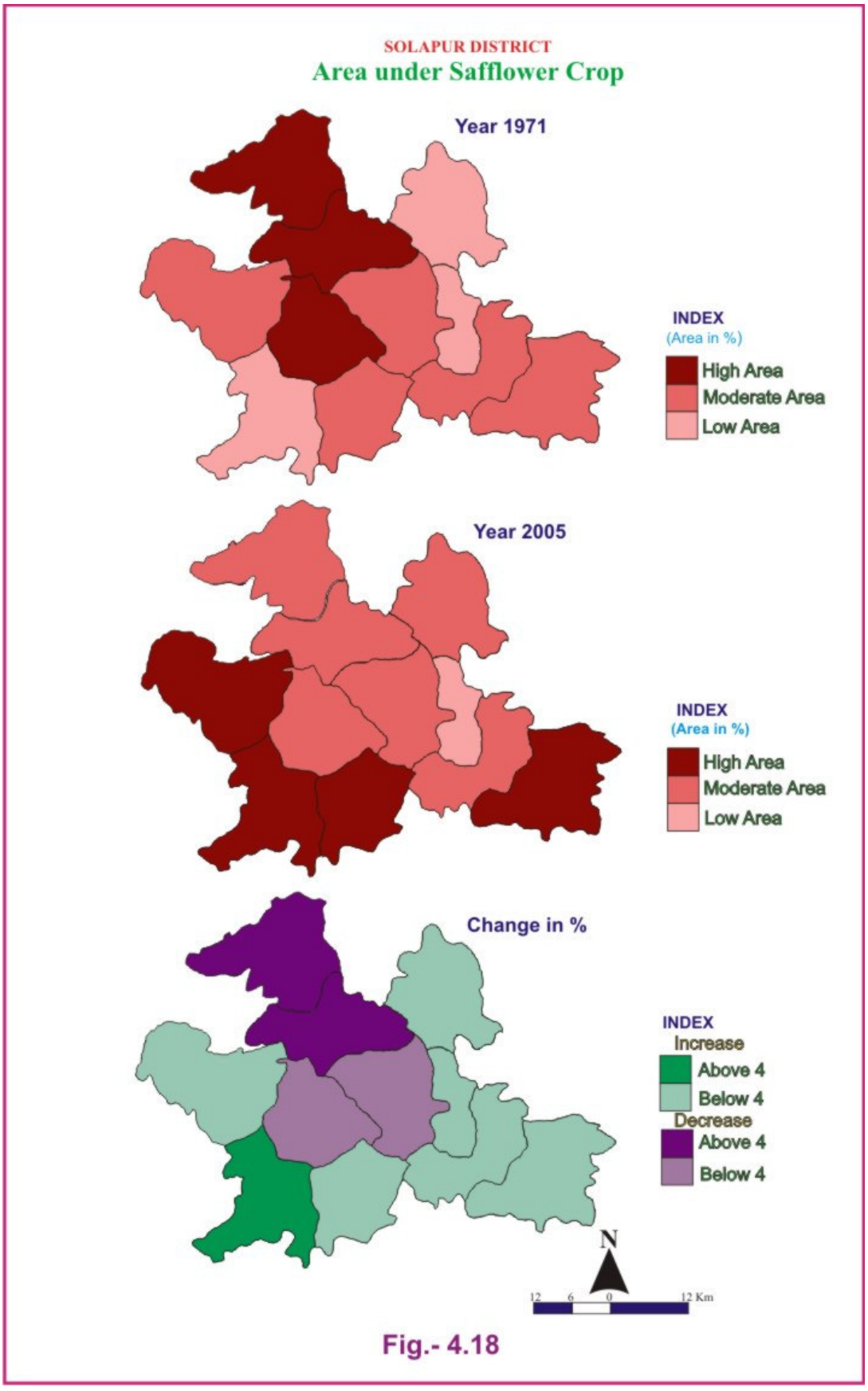

SOLAPUR DISTRICT
Area under Safflower Crop
Year 1971
INDEX
(Area in %)
High Area
Moderate Area
Low Area
Year 2005
INDEX
(Area in %)
High Area
Moderate Area
Low Area
Change in %
INDEX
Increase
Above 4
Below 4
Decrease
Above 4
Below 4
N
12 6 0 12 Km

Fig.- 4.18

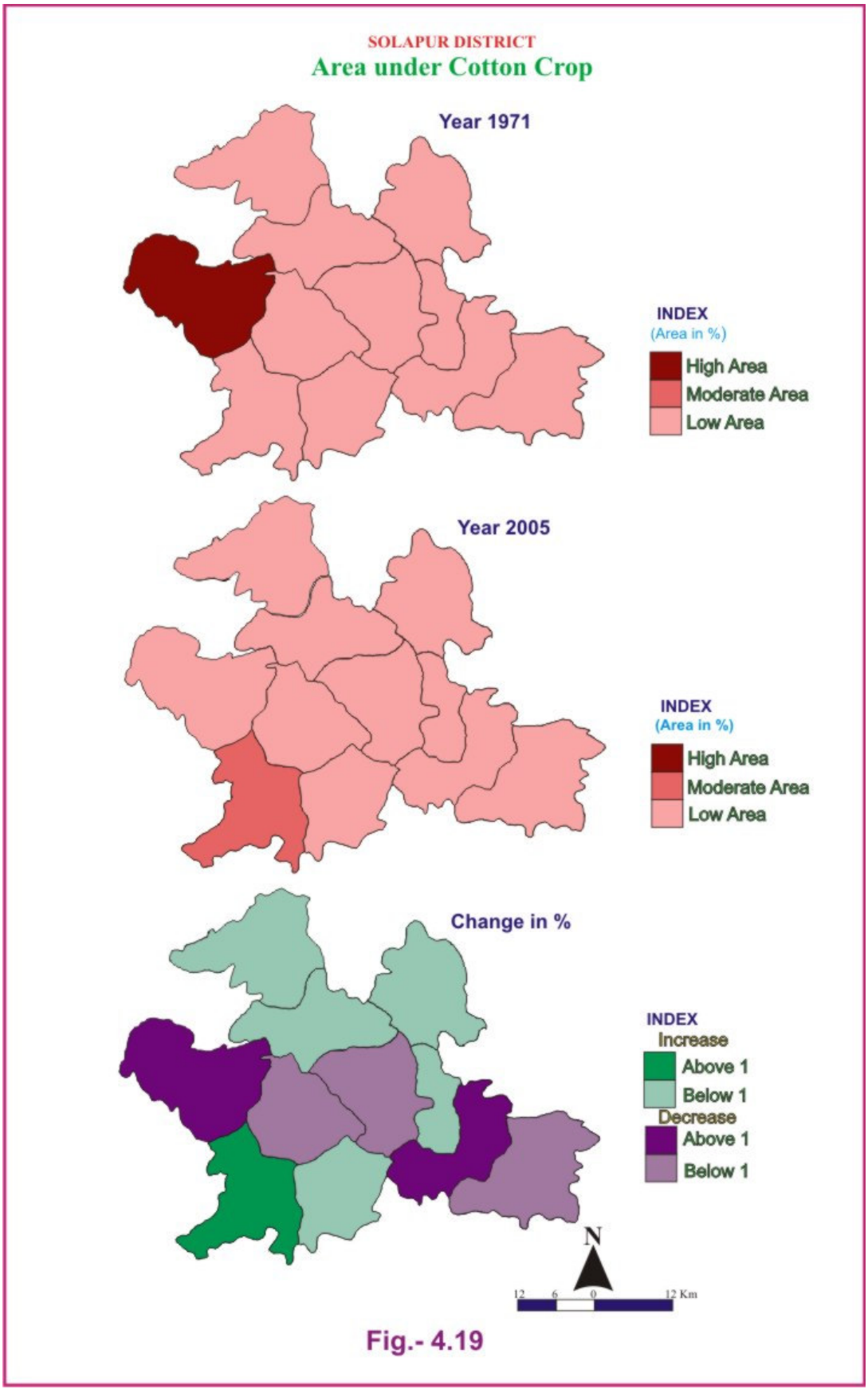

SOLAPUR DISTRICT
Area under Cotton Crop
Year 1971
INDEX
(Area in %)
High Area
Moderate Area
Low Area
Year 2005
INDEX
(Area in %)
High Area
Moderate Area
Low Area
Change in %
INDEX
Increase
Above 1
Below 1
Decrease
Above 1
Below 1
N
12 6 0 12 Km

Fig.- 4.19

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Chapter -V

IRRIGATION & AGRICULTURE

5.1. Introduction

In the previous chapter an attempt has been made to study meaning of landuse, general landuse, agriculture landuse and changes therein. In this chapter the main objectives is to study the index number of irritation and intensity of irrigation index number are calculated by using some statistical equation. The crop ranking, crop combination and crop diversification are also measured in this chapter. The study is high light on irrigation impact on agriculture land use in Solapur district.

5.2. Irrigation intensity

The intensity of irrigation is the proportion of net irrigated area to net shown area of the aerial unit. It is an important indicator to determine the cropping pattern and agricultural productivity. The intensity of irrigation is calculated by using Jasbir Singh (1975). These are followings.

$$Ii = \frac{NI}{NA} X\ 100$$

Where, Ii = Intensity of Irrigation
NI = Net irrigated area
NA= Net Sown area

Table 5.1
Solapur District: Irrigation Intensity and change

Sr No	Tahsil	1971	2005	Change in irrigation intensity
		Irrigation intensity	Irrigation intensity	
1	Karamala	5.06	16.31	+11.27
2	Madha	6.72	17.83	+11.11
3	Barshi	7.98	17.36	+9.38
4	N Solapur	9.12	36.80	+27.68
5	Mohol	8.12	20.48	+12.36
6	Pandharpur	11.30	36.18	+24.88
7	Malshiras	33.75	27.26	-6.49
8	Sangola	15.08	63.63	+48.55
9	Mangalwedha	5.37	16.23	+10.86
10	S Solapur	8.62	26.26	+17.64
11	Akkalkot	6.64	22.33	+15.59
	District	10.25	25.61	+15.36

Source: Compiled by Researcher
Socio-economic abstract of Solapur District 1970-71 and 2004-05.

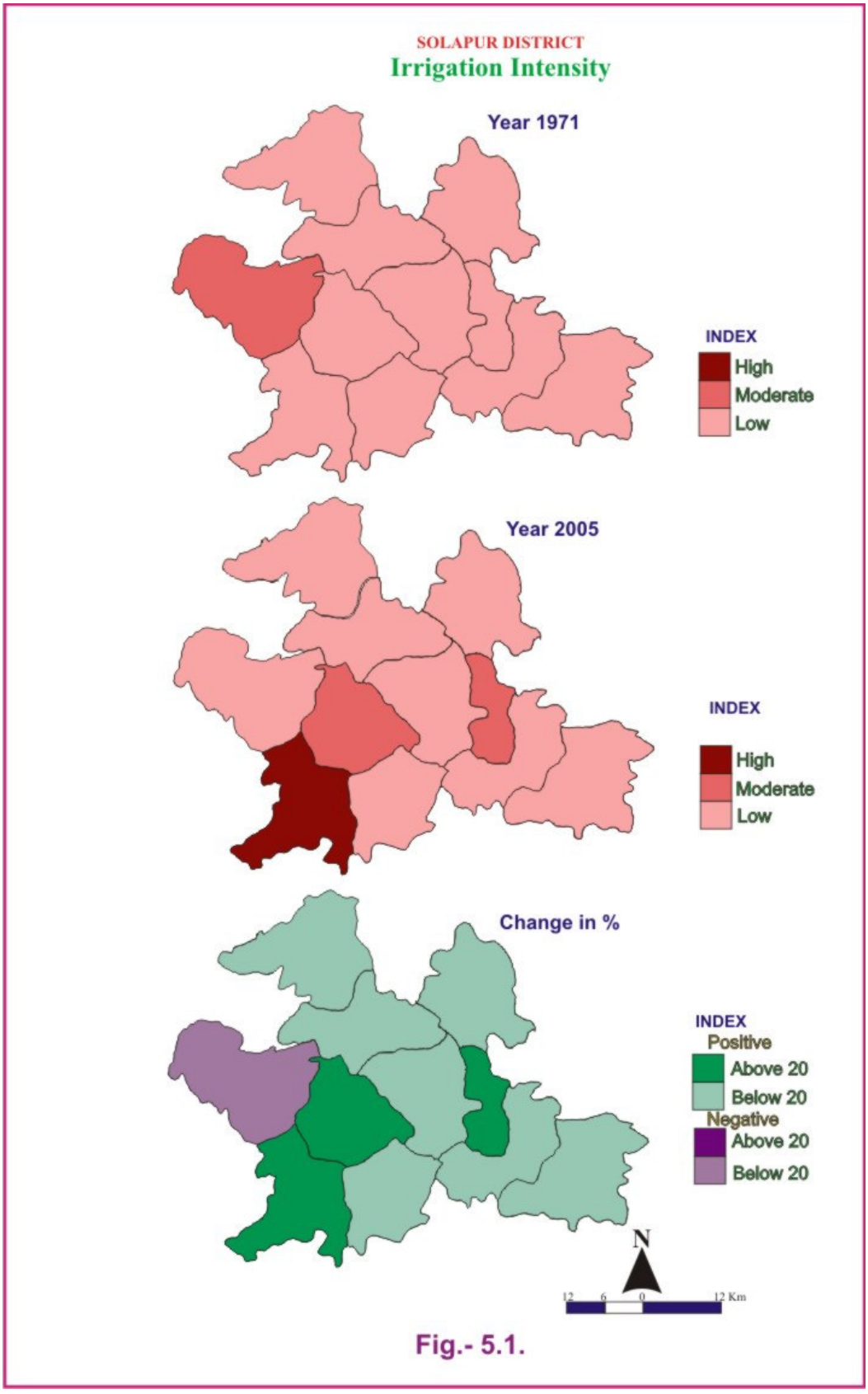
SOLAPUR DISTRICT
Irrigation Intensity
Year 1971
INDEX
High
Moderate
Low
Year 2005
INDEX
High
Moderate
Low
Change in %
INDEX
Positive
Above 20
Below 20
Negative
Above 20
Below 20
N
12 6 0 12 Km

Fig.- 5.1.

The diverse intensity of irrigation in different all tahsils is observed in Solapur district due to the variation of topography, canal and irrigation project, availability of well, bore well, lake and river in tahsils. The spatial pattern of irrigation intensity in Solapur district in 2005 is revealed by Fig No 5.1. High proportion of the intensity of irrigation is observed in Sangola (63.63) taluka , where irrigation has been developed during the last two decades. Moderate (30 to 60) irrigation intensity has been depicted in Pandharpur and North Solapur. Remaining all tahsils of district has been found with low (below 30) irrigation intensity. The intensity of irrigation is very low in Mangalwedha (16.23) and Karamala (16.31).

The intensity of irrigation has been changing over the last thirty-five years (1970-71—2004-05) and the same change has been revealed by Fig No 5.1. The average regional intensity of irrigation is increased by 15.36. The tahsil of Sangola has recorded highest increase of 48.55. However moderate (20-30) irrigation intensity has increased in two tahsils i.e. North Solapur and Pandharpur. The low (below 20) growth of irrigation intensity observed in Karamala, Barshi, Mohol, Madha, Mangalwedha, South Solapur and Akkalkot tahsils. In Malshiras tahsil, the irrigation intensity has decreased during the investigation period.

5.3. Index of Intensive Irrigation

Index of intensive irrigation has been developed to find out whether available water is efficiently used or not. This is calculated by following formula;

$$Iii = \frac{Ti}{Ni} X\ 100$$

Where,

Iii = Index of intensive irrigation
Ti = Total irrigated area
Ni = Net irrigated area

The index of intensive irrigation is calculated for the years 1970-71 and 2004-05. The index of intensive irrigation is divided into five different ranges i.e. below 100.00. 100.00 to 150.00 and Above 150.00 which represented low, medium and high index intensive irrigation .

Table 5.2
Solapur District: Index of Intensive Irrigation and change

Sr No	Tahsil	1971	2005	Change in irrigation intensity
1	Karamala	133.12	131.94	-1.18
2	Madha	139.22	144.50	+4.98
3	Barshi	143.27	164.59	+21.32
4	N Solapur	110.11	72.21	-37.90
5	Mohol	110.23	84.54	+25.69
6	Pandharpur	126.41	69.29	-57.12
7	Malshiras	122.47	122.73	+0.26
8	Sangola	100	76.26	-23.74
9	Mangalwedha	169.86	296.40	+126.54
10	S Solapur	121.38	88.43	-32.95
11	Akkalkot	146.51	123.39	-23.12
	District	122.99	111.32	-11.67

Source: Compiled by Researcher
Socio-economic abstract of Solapur District 1970-71 and 2004-05

The index of intensive irrigation was 122.99 in 1970-71and the index of intensive irrigation was on decrease (11.67) from 1970-71 to 2004-05 respectively. The index of intensive irrigation is different in tahsils of Solapur district which is shown in Table 5.2. The highest index of irrigation intensity is observed in Mangalwedha tahsil and lowest in Pandharpur tahsil in 2004-05. In 2004-05, the low (below 100) index of irrigation intensity observed in North Solapur, Mohol, Pandharpur, Sangola and South Solapur tahsil of Solapur District. The moderate (100 to 150) index of irrigation intensity found in Karamala, Madha, Malshiras and Akkalkot tahsil and remaining tahsil has located in high (above 150) index of irrigation intensity.

During the investigation period of thirty five years, the index of irrigation intensity has seen decreased in district. The index of irrigation intensity is decreased in six tahsils (Karamala, North Solapur, Pandharpur, Sangola, South Solapur and Akkalkot) and increased in five tahsils (Madha, Barshi, Mohol, Malshiras and Sangola). The highest increase is observed in Mangalwedha tahsil (126.54) and lowest in Madha tahsil (4.98) as well as highest decrease is in Pandharpur tahsil (57.12) and lowest is in Karamala tahsil (1.18).

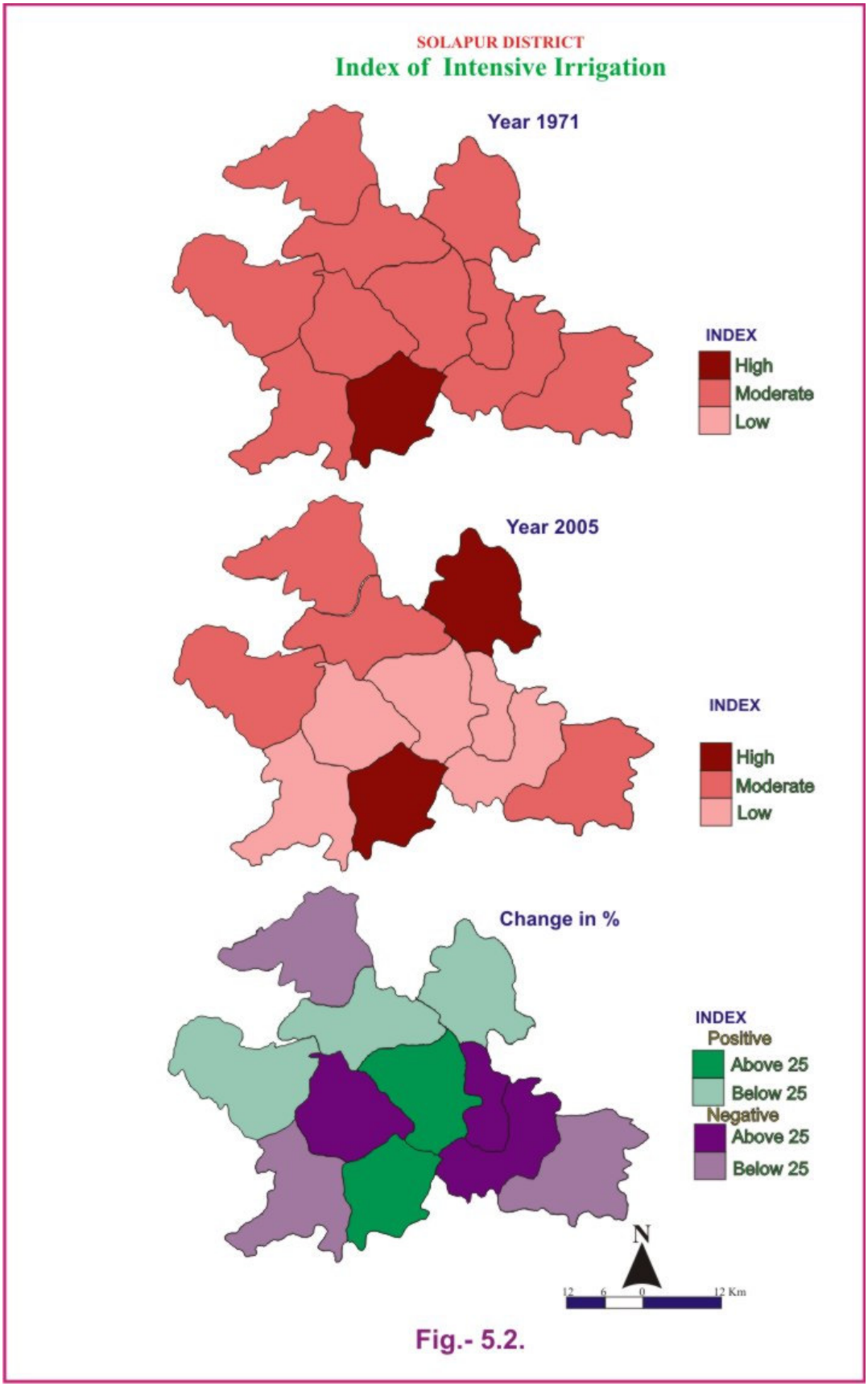
SOLAPUR DISTRICT
Index of Intensive Irrigation
Year 1971
INDEX
High
Moderate
Low
Year 2005
INDEX
High
Moderate
Low
Change in %
INDEX
Positive
Above 25
Below 25
Negative
Above 25
Below 25
N
12 6 0 12 Km

Fig.- 5.2.

5.4. Ranking of Crops

Ranking of crops indicates the nature of enterprise i. e. whether the particular aerial units are of traditional subsistent farmers or commercially market-oriented or partly subsistent and partly market oriented farmers. (Kapadnis.1991). Ranking of crops depends on insight in the geographical reality and cropping structure. The percentage of gross cropped land with the aerial strength of a particular crop reveals the agricultural operation involved, peak period, labours demand and the opportunities of employment to the farmer's families as well as to the labour depending on them.

The relative position of strength among the crops was ascertained by simply ranking them for each tahsil in order of the percentage of total cropped land occupied by each crop; the crop ranks first to eighth ranks have been measured talukawise for the reference years 1970-71 and 2004-05.

Table No 5. 3
Distribution of crops based on crop ranks 1970-71

First Rank	Second Rank
1) Jawar:- Karamala, Madha, Barshi, North Solapur, Mohol, Pandharpur, Malshiras, Sangola, Mangalwedha, South Solapur, Akkalkot	1)Bajara:- Sangola, Karamala, Pandharpur 2) Safflower :- Madha, Mangalwedha 3) Sugarcane :- Malshiras 4)Wheat:-Mohol 5)Groundnut:- Barshi, Akkalkot, S.Solapur
Third Rank	**Fourth Rank**
1) Bajara: - Madha, Mohol 2) Wheat:- Sangola 3) Tur :- Barshi, South Solapur, Akkalkot 4)Gram:- Mangalwedha, 5)Groundnut: North Solapur 6) Safflower: Karamala, Pandharpur, Malshiras	1) Bajara: North Solapur, Mangalwedha, South Solapur, Akkalkot 2) Maize: Sangola 3) Wheat: Malshiras 4) Tur: Karamala 5) Gram: Barshi, Pandharpur, Sangola 6) Groundnut: Madha 7) Safflower: Mohol
Fifth Rank	**Sixth Rank**
1) Bajara: Barshi, 2) Wheat: Barshi, North Solapur, Pandharpur, Mangalwedha, Akkalkot 3) Tur: Madha, Sangola 4) Gram : Karamala, Malshiras, South Solapur, 5) Groundnut: Mohol, Pandharpur, Malshiras, Sangola	1) Bajara: Malshiras, 2) Maize: Mohol, 3) Wheat: Karamala, Mohol, 4) Gram: Madha, North Solapur 5) Sugarcane: North Solapur, Pandharpur, Sangola 6) Safflower: Barshi, South Solapur, Akkalkot

Seventh Rank	Eighth Rank
1) Maize: Pandharpur, 2) Wheat: Madha, South Solapur 3) Tur: Malshiras, Mangalwedha 4) Gram : Mohol, 5) Moog: Barshi , Sangola 6) Fruit : North Solapur, Sangola, Akkalkot 7) Groundnut : Karamala 8) Safflower: Sangola	1) Maize : Madha, Barshi, North Solapur, Malshiras, Mangalwedha 2) Tur: Pandharpur, 3) Moog: Karamala 4) Sugarcane : South Solapur, Akkalkot 5) Fruit : Mohol, Malshiras,

Source: - Compiled by the Researcher

Table No 5. 4

Distribution of crops based on crop ranks 2004-05

First Rank	Second Rank
1) Jawar**:-** Karamala, Madha, Barshi, North Solapur, Mohol, Pandharpur, Malshiras, Sangola, Mangalwedha, South Solapur, Akkalkot	1) Bajara: Sangola 2) Wheat : Madha , Mohol, South Solapur 3) Sugarcane : Barshi, Pandharpur, Malshiras, Mangalwedha, Akkalkot 4) Fruit : Karamala, North Solapur
Third Rank	**Fourth Rank**
1) Bajara : Mangalwedha, 2) Wheat: North Solapur, Pandharpur 3) Sugarcane : Karamala, Mohol, 4) Fruit: Madha, Barshi, Malshiras, Sangola , Mangalwedha 5) Safflower : Akkalkot	1) Maize : Karamala, 2) Wheat: Malshiras, 3) Gram: Barshi, Akkalkot 4) Sugarcane : Madha, North Solapur, Sangola, South Solapur 5) Fruit : Mohol, Pandharpur 6) Safflower: Mangalwedha, South Solapur
Fifth Rank	**Sixth Rank**
1) Bajara: Malshiras 2) Maize : North Solapur , Mohol, Mangalwedha , 3) Wheat: Mangalwedha, 4) Gram : Madha, Mohol, Pandharpur, South Solapur 5) Fruit : Akkalkot 6) Safflower : Karamala, Barshi, Sangola	1) Bajara : Karamala, 2) Maize: Pandharpur, Sangola, South Solapur, 3) Wheat: Barshi, Akkalkot 4) Gram: North Solapur, Mangalwedha 5) Safflower: Madha, Mohol, Malshiras
Seventh Rank	**Eighth Rank**
1) Bajara : Madha, North Solapur, South Solapur 2) Maize: Barshi, 3) Wheat: Karamala, 4) Tur: Mohol, Mangalwedha, Akkalkot 5) Gram: Malshiras, Sangola 6) Safflower : North Solapur, Pandharpur	1) Bajara : Mohol, 2) Maize: Madha, Malshiras, Akkalkot 3) Wheat: Sangola 4) Tur : Barshi, North Solapur, Pandharpur, South Solapur, 5) Gram: Karamala, 6) Groundnut : Mangalwedha

Source :- Compiled by the Researcher

1. First Ranking Crop

With the help of this method the distributional pattern of the first ranking crop has been plotted in table no 5.3 and 5.4. In this method, the first ranking crop, i.e. the crop occupying the highest percentage of the total cropped area in each of the component areal units could be chosen. It may be noticed from Table No 5.3 that Jawar ranks first in all the eleven tahsil of the district in 1970-71. In 2004-05, Jawar also ranks first in all the eleven tahsils of the district. But the total area of jawar is increased in all tahsils of the district compared to year 1970-71.

2 . Second Ranking Crops

Significance of the second rank is that it brings out the second preference of farmers in the determination of the crop pattern. The analysis of the second ranked crops focuses light on the pattern of distribution and changes, which have taken place in giving preference for this rank. The change reflects the development of crop land-use in the area.

The spatial distribution of second the ranked crops viewed for the year 1970-71 is shown in Table No 5.3. Five crops i.e. Safflower, Sugarcane, Wheat, Bajara, and Groundnut are the second ranking crops. It can be seen that Safflower is the second ranking crop in the tahsils of Madha and Mangalwedha. It is among two tahsils of the total tahsils because of the black to medium soil, low rainfall and suitable climate. Sugarcane ranks second in Malshiras because of irrigation facilities. Wheat in Mohol, Bajara in Sangola, Karamala and Pandharpur, and Groundnut in Akkalkot, Barshi and South Solapur are the second ranking crops. Further, the spatial distribution for the year 2004-05 considers changes, which have taken place during period under study. It reveals the four crops ranked second in the district. Groundnut, Safflower, Bajara and wheat crops are replaced by sugarcane and fruits.

3. Third Ranking Crop

The distribution pattern of the third ranking crops is fragmented and diversified. Six crops in the reference year 1970-71 and five crops are in third ranking crops in the study region in the reference year 2004-05. As per reference year 1970-71 , out of total tahsils , Safflower and Tur are in three tahsils each and Bajara is third ranking crops in two taluka. As per reference year 2004-05, five crops in the district are the third ranking crops. Out of total tahsils, fruit crops in five tahsils, Sugarcane and Wheat in two tahsils each and Bajara and Safflower in one tahsils are the third ranking crops.

As compared to 1970-71 as reference year, the changed picture of ranking crops is seen during the reference year 2004-05. The number of talukas under Fruit crops and sugarcane are increased. Groundnut, Bajara and Tur are replaced by Sugarcane and fruit because of the changed tendency of farmers changed as well as irrigation facilities. (Table No 5.4)

4. Fourth Ranking Crops

In 1970-71 reference years have seven crops and six crops in 2004-05, as their fourth ranking crops in the district. But little change is seen in the position of their ranks. As per reference year 1970-71 bajara has four, gram have three talukas each and maize, wheat, tur, safflower and groundnut have one taluka each as their fourth ranking crops. But as per 2004-05 reference year, Sugarcane have four tahsils each, gram, safflower and fruit have two talukas each and maize, wheat has one taluka as their fourth ranking crops in the study region. (Table No 5.3 and 5.4)

5. Fifth Ranking Crops

Fifth ranking crops show different positions in different talukas out of total tahsils. It can be seen that wheat and groundnut are the fifth ranking crop in four tahsils out of eleven tahsils. Groundnut in three tahsils, tur in two tahsils and bajara have one taluka each as their fifth ranking crops during 1970-71 reference year. As per reference year 2004-05 , fruit, maize, wheat, bajara, gram and safflower form fifth ranking crops, in the study region of which gram in four tahsils and maize and safflower have three tahsils each, and bajara, wheat and fruit has one tahsil as their fifth ranking crops. (Table No 5.3 and 5.4)

6. **Sixth Ranking Crops**

As per 1970-71 reference year seven crops and as per 2004-05 reference year five crops in the district are sixth ranked crops. Out of eleven tahsils, , safflower and sugarcane have three tahsil each, gram and wheat in two tahsils each, bajara and maize have one tahsils each as their sixth rank in the reference year 1970-71. But as per reference year 2004-05, out of eleven tahsils have five crops regarded as sixth ranking crops. During the same year , maize and safflower has three tahsils, wheat and gram have two tahsils each , bajara has one tahsils each as their sixth ranking crops.

7. Seventh Ranking Crops

In Solapur District out of eleven talukas, fruit have three tahsils, wheat, tur and moog have two tahsils each, maize, gram, groundnut, safflower in one tahsils each as their seventh ranking crops during the reference year1970-71. But as per the year

2004-05 as reference year five crops are considered as seventh ranking crops. During this year bajara and tur have three tahsils each and groundnut and safflower have two taluka each, maize and wheat crops in one taluka each as their seventh ranking crops.

8. Eighth Ranking crops

According to 1970-71 reference years five crops and 2004-05 reference year six crops are considered as eight ranking crops. During 1970-71 reference year maize have five tahsils, sugarcane and fruit have in two tahsils each, tur and moog have one taluka each as their eighth ranking crops. As per reference year 2004-05, tur in four tahsils, maize in three tahsils, bajara, gram ,wheat and groundnut have one tahsils each as their eighth ranking crops.

5.5. Crop Combination

The study of crop combination regions constitutes an important aspect of Agriculture Geography as it provides a good basis for agriculture regionalization. Crops are generally grown in combination and it is rarely that a particular crop occupies a position of total isolation from other crops in a given aerial unit at a given point of time. In recent years, the concept of crop combination has engaged the attention of geographers and agriculture land-use planners. Any study of crops on the regional scale must take into consideration the combinational analysis and the relative position of the crops. The concept of crop combination is a scientific device to study the existing spatial relationship of crops in association with each other in Agriculture Geography and land utilization.

So crop combination regions are delineated here on the basis of methods advocated by Weaver J.C. (1954). The most important and popular approach is presented by J. C. Weaver for delineating the complex structure of agricultural regions of middle west in the USA in 1954. In this study, he has taken into account the percentage of crop area to total cropped area and has calculated the deviation of real percentage for all the possible combinations in the component areal units against a theoretical standard.

The theoretical curve for standard measurement was employed as follows:-

Monoculture = 100 percent of the total harvested crop land in one crop

2 crop combination = 50 percent in each of two crops

3 crop combination = 33.3 percent in each of three crops

4 crop combination = 25 percent in each of four crops

5 crop combination = 20 percent in each of five crops

10 crop combination = 10 percent in each of ten crops

For the determination of the minimum deviation the standard deviation method was used by using the formula.

$$SD = \frac{\sum d}{n}$$

However, as Weaver pointed out, the relative, not absolute value being significant, square roots were not extracted so, the actual formula used was as follows:-

$$d = \frac{\sum d^2}{n}$$

Where'd' is the difference between the crop percentage in a given country (areal unit) and the appropriate percentage in the theoretical curve and 'n' is the number of crops in a given combination. As a result of the statistical processing by Weaver's deviation method, 10 crop combination regions are identified in Solapur District from main 14crops.

CROP COBINATION ACCORDING TO J. C. WEAVER'S METHOD

The Weaver's method has been admirably accepted for the delineation of crop combination regions as its application result is suitable for combination. The method, however, gives the most unwieldy combination for the units of high crop specification. As a result of the application of the Weaver's method, five crop combination regions emerge out in Solapur district. The talukas falling into different combinations as per reference years 1970-71 and 2004-05 are given in table No 5.5 and 5.6.

Table N0- 5.5
Crop variance according to Weaver's Method 1970-71

Crop comb	Karm.	Mad.	Bars.	North Sola.	Mohol	Pandh.	Malshi.	Sango.	Mang	South Sola	Akkal.
Mono	1605	1673	1387	2179	1532	923	2055	1961	2545	2369	3218
2	1528	1898	1391	1306	1992	2008	1854	2184	2079	1394	847
3	1629			1345			2092		2071	1511	696
4									2038		886
5									2032		
6									2052		

Source:- Compiled by the Researcher

Table No 5.6
Crop Variance according to Weaver's Method 2004-05

Crop comb	Karm.	Mad.	Bars.	North Sola.	Mohol	Pandh.	Malshi.	Sango.	Mang	South Sola	Akkal.
Mono	795	742	978	815	754	1414	1941	1986	2067	681	884
2	2564	2416	2257	2317	2481	1916	1585	1853	1694	2428	1974
3							1682	1877	1755		

Source: - Compiled by the Researcher

Table No 5.7
Crop combination according to Weaver's method 1970-71

Crop combi.	No of talukas	Name of talukas	Name of crops
Mono	05	Madha Barshi Mohol Pandharpur Sangola	Jawar Jawar Jawar Jawar Jawar
2	03	Karamala Malshiras South Solapur	Ja+ Ba Ja + Su Ja+Gr
3	01	Akkalkot	Ja+Gr+Tr
4	-	-	-
5	02	North Solapur Mangalwedha	Ja+Tr+Gr+Ba+Wh Ja+Sa+Gr+Ba+Wh

[Ja-Jawar, Sa-Safflower, Ba-Bajara, Gr-Groundnut, Su-Sugarcane, Wh-Wheat, Tr-Tur,]
Source:- Compiled by the researcher

Table No 5.8
Crop combination according to weaver's method 2004-05

Crop Combination	No of talukas	Name of talukas	Name of crops
Mono	08	Karamala Madha Barshi Mohol Pandharpur North Solapur South Solapur Akkalkot	Jawar Jawar Jawar Jawar Jawar Jawar Jawar Jawar
2	03	Malshiras Sangola Mangalwedha	Ja+Su Ja+Ba Ja+Su

[Ja-Jawar, Ba-Bajara, Su-Sugarcane]
Source:- Compiled by the researcher

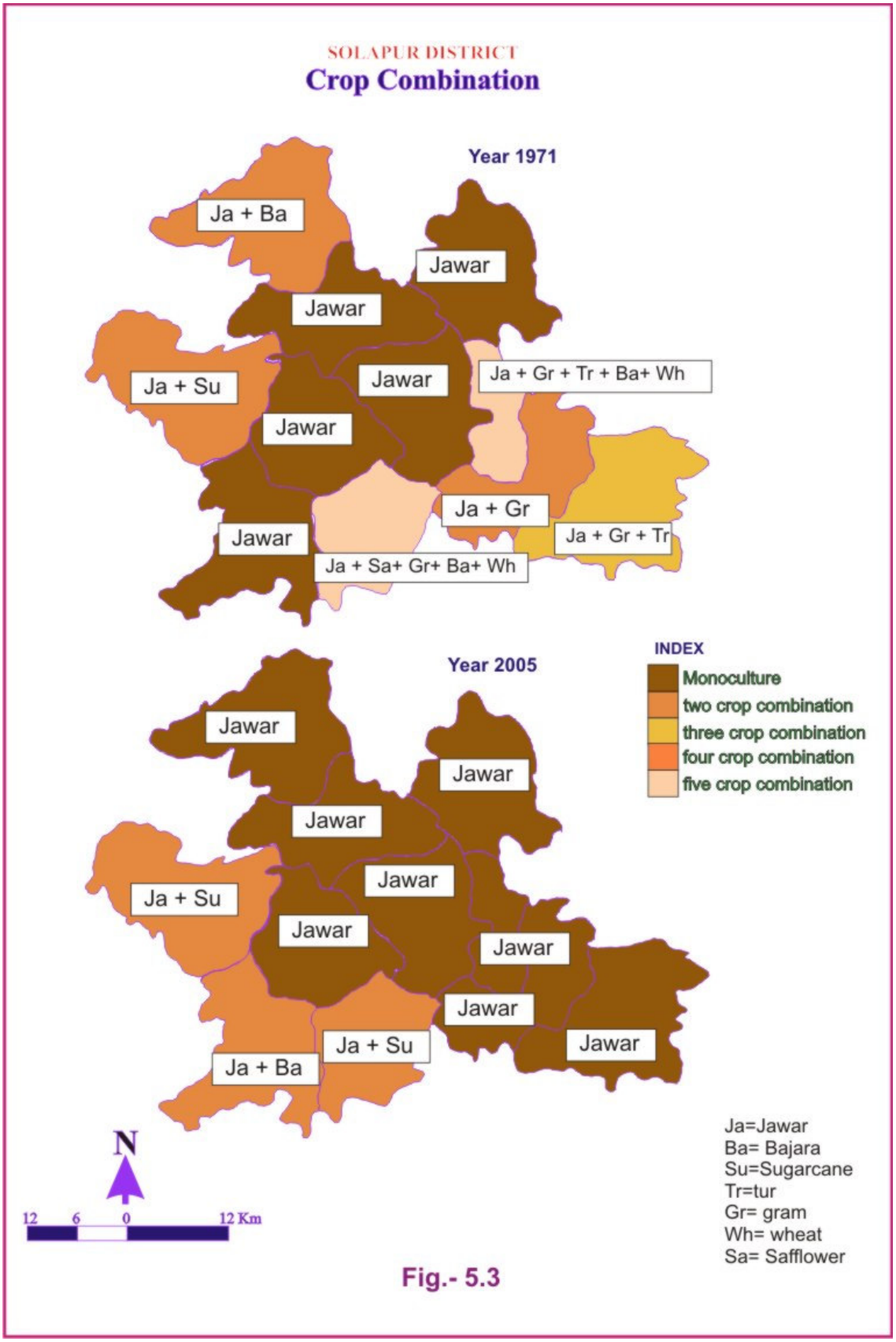
SOLAPUR DISTRICT
Crop Combination
Year 1971
Ja + Ba
Jawar
Jawar
Ja + Su
Jawar
Ja + Gr + Tr + Ba+ Wh
Jawar
Ja + Gr
Jawar
Ja + Gr + Tr
Ja + Sa+ Gr+ Ba+ Wh
Year 2005
Jawar
Jawar
Jawar
Jawar
Ja + Su
Jawar
Jawar
Jawar
Ja + Su
Ja + Ba
INDEX
Monoculture
two crop combination
three crop combination
four crop combination
five crop combination
N
12 6 0 12 Km
Ja=Jawar
Ba= Bajara
Su=Sugarcane
Tr=tur
Gr= gram
Wh= wheat
Sa= Safflower

Fig.- 5.3

1. Monoculture (0ne crop combination)

Five tahsils have the monoculture of Jawar crop covering considerable cultivated area of the region in the reference year 1970-71. The scanty rainfall ,the receptivity of black soil and lack of irrigation facilities have also led to the cultivation of jawar, which is generally drought resistant crop in Sangola, Pandharpur, Mohol, Barshi and Madha tahsils of Solapur district . As per the reference year 2004-05, Jawar crop is the monoculture crop eight tahsils of the region i.e. Karamala, Madha, Barshi, Mohol, Pandharpur, South Solapur, Akkalkot and North Solapur. (Table No 5.8 and Fig No 5.3)

2. Two crop combination

Two crop combinations are observed in both the reference years in three tahsils, but tahsils and crops are different in these years. Two crop combinations are included in three tahsils (Malshiras, Karamala, South Solapur) in the year 1970-71. Malshiras tahsil is situated at the northwestern part of the district, where rainfall varies from 500 mm to 1500 mm. Soil is deep black to curse shallow, Nira right and left canal is available for irrigation. Malshiras tahsil is marked for jawar, sugarcane, bajara and wheat. In the year 2004-05, Malshiras, Sangola and Mangalwedha tahsil are marked two crop combinations in Solapur District. Malshiras and Mangalwedha tahsils have two crop combinations i.e. crops of jawar and sugarcane. Sangola tahsil has two crop combination and these crops are Jawar and bajara crops.

3. Three crop combination:-

This crop combination is observed in Akkalkot tahsil in reference year 1970-71 i.e. jawar, groundnut and tur. This may be due to recent increase in irrigation facilities and improved techniques of dry farming. As per reference year 2004-05, three crop combination is absent. Four crop combination is also absent in the both year in the study region.

4. Five crop combination:-

As per the year 1970-71, North Solapur and Mangalwedha tahsils comes under this crop combination. Hence, jawar, wheat, groundnut, tur and bajara crops have come in this combination in North Solapur tahsil and in Mangalwedha tahsil, Jawar, Safflower, groundnut, bajara and wheat crop combination. There is not a single taluka that comes under the five crop combination as per year 2004-05.

It is evident from the above analysis that jawar is a dominant crop all over the district. But the second leading crop sugarcane is in northwest and central, fruits are in

southeast and middle part, tur is in northeastern and groundnut is in the eastern part crops in the Solapur district.

5.6. Crop Diversification

Diversification according to Fakuda (1976) denotes the separating of farming, horticulture, livestock rising or fishery together. Diversification in cropping pattern means raising a variety of crops in arable land, the keener competition the higher magnitude of diversification. (Hussain 1979). Diversification, for the present investigation is limited to cropping pattern, in other words , it refers to raising a variety of crops involving high competition among field crops for arable land. The techniques of measuring diversification have been developed by various scholars such as Clenn (1930),Tress (1935), Plorene (1942), Rainwald (1949), Bhatiya (1965), Gibbs Martin (1974) and Jasbir Singh (1976). A modified technique by Jasbir Singh has been employed here to examine the magnitude of the diversification in the region.

The formula is --

$$\text{Index of crop Diversification} = \frac{\text{Percentage of total harvested area under 'n' crop}}{\text{Number of 'n' crops}}$$

T

The 'n'crops are those, which occupy individually 5 percent or more of the total harvested area in a given areal unit. The indices, thus obtained with this formula are mapped in Fig No 5.4 on the basis of the degree of diversification of crops five regions have emerged up.

1. Very High Crop Diversification:-

Very high degree of crop diversification are observed in Karamala, Barshi, Mohol, Madha , Akkalkot, North Solapur, South Solapur, tahsils in 1970-71. The irrigation facilities , fertile soil, the farmer's high living standard and Bhima river have led to diversify the nature of crops.

As per reference year 2004-05, this zone includes the tahsils of North Solapur, Mohol, Pandharpur, Malshiras, Sangola, Mangalwedha which have recorded a very high degree of crop diversification. The recent irrigation facilities developed due to Nira canal, Ujani dam system, well and lifts along the river sides have led to the diversified nature of crops. Some food crops and non-food crops are grown twice a year in the irrigated tracts. (Table No 5.9, 5.10 and 5.11)

Table No 5.9
Index value of crop Diversification

Sr. No	Name of taluka	1970-71	2004-05
1	Karamala	27.89	71.81
2	Madha	24.42	39.59
3	Barshi	27.91	37.52
4	North Solapur	25.58	22.44
5	Mohol	24.63	27.83
6	Pandharpur	39.66	20.38
7	Malshiras	30.93	20.21
8	Sangola	55.72	18.78
9	Mangalwedha	49.55	16.47
10	South Solapur	23.22	40.06
11	Akkalkot	20.65	40.36

Source: - Compiled by the Researcher

Table No 5.10
Distribution of talukas on the basis of index value and diversification class in 1970-71

Index value	Diversification class	Name of Talukas
Below 28	Very high	Karamala, Barshi, Mohol, Madha , Akkalkot, North Solapur, South Solapur,
28 - 35	High	Malshiras
35 - 42	Medium	Pandharpur
42 - 49	Low	-
Above 49	Very low	Sangola, Mangalwedha

Source: - Compiled by the Researcher

Table No 5.11
Distribution of talukas on the basis of index value and diversification class in 2004-05

Index value	Diversification class	Name of Talukas
Below 28	Very high	North Solapur, Mohol, Pandharpur, Malshiras, Sangola, Mangalwedha
28 - 35	High	-
35 - 42	Medium	Madha, Barshi, South Solapur, Akkalkot
42 - 49	Low	-
Above 49	Very low	Karamala

Source: - Compiled by the Researcher

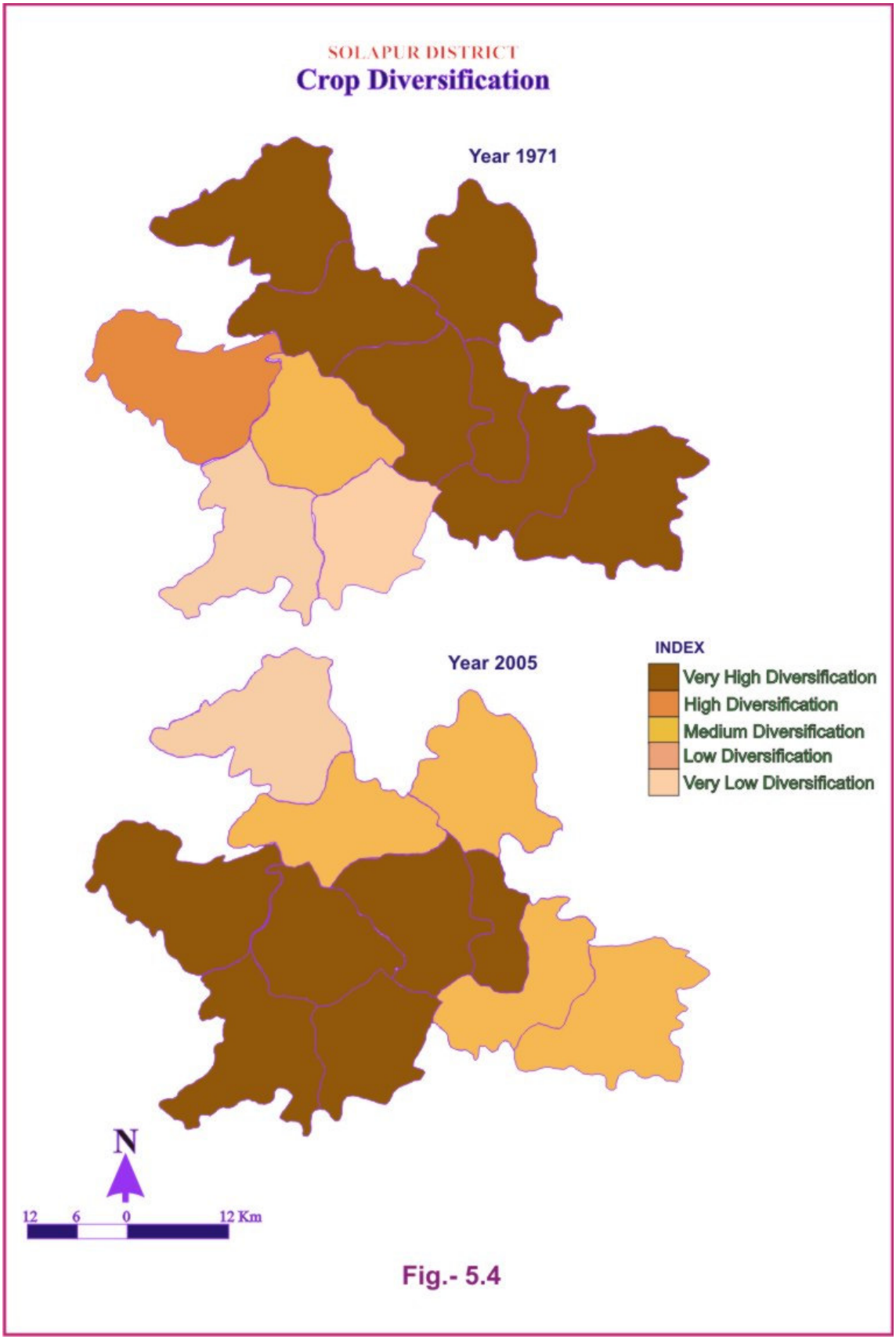
SOLAPUR DISTRICT
Crop Diversification
Year 1971
Year 2005
INDEX
Very High Diversification
High Diversification
Medium Diversification
Low Diversification
Very Low Diversification
N
12 6 0 12 Km

Fig.- 5.4

2. High Crop Diversification:-

This zone includes the tahsils of Malshiras which have recorded a high degree of crop diversification in 1970-71. The fertile soil and suitable irrigation facilities are responsible for the high crop diversification. In 2004-05, the of high degree of crop diversification is absent.

3. Moderate Crop Diversification:-

Pandharpur tahsil had moderate diversification of crops in 1970-71. This may be due to partial irrigation from wells and fertile soil. After the development of advance technology in irrigation (lift, sprinkler irrigation), water storage tank , Kolhapur pattern dam on river and Govt. project ***" Pani adwa ,pani jirwa"*** , ***"Jalsandharan"*** have increased irrigation , so in the year 2004-05, Madha, Barshi, South Solapur and Akkalkot tahsil has moderate diversification.

4. Very Low Crop Diversification:-

Low crop diversification is not observed in both the reference years. But very low crop diversification is observed in Sangola and Mangalwedha tahsils in the reference year 1970-71. The tahsils in this zone have low intensity of irrigation and are characterized by acute scarcity conditions leading to very low crop diversification. Droughts are frequent and have affected the failure of standing crops many times. In the year 2004-05, Karamala tahsil has remained in very low crop diversification in Solapur district.

5.7. Agriculture Change

The change in cropping pattern in a particular span of the time clearly indicates the changes that have taken place in the agricultural change. These changes are brought by the socio-economic influences. The natural factors of physiography, climate soils and water resources will always continue to exert influences on the agricultural land use. A part from this population pressure the ownership of land size of land holding, availability of markets and the farmers capacity and ability play dominant role in deciding the cropping pattern of a particular region.

The cropping pattern changes shifts in area under different crops over a period of time. Investigation pertaining to study of changes occurred in cropping pattern assume special importance in taking to analyse the irrigation impact on agriculture transformation in drought prone area of Solapur district. Farmers always are trying to get maximum benefit from his farm with low investment in short period. They divert the

cultivation of tradition crops and cultivated commercial crops on new methods which is depends on low requirement of water.

Table 5.12
Solapur District; Agriculture Transformation (area in Hect.)

Crops	Change	
	Area (00 hect.)	%
Jawar	+452	+10.33
Bajara	-1079	-9.48
Maize	+162	+1.71
Wheat	+218	+2.41
Rice	-69	-0.62
Tur	-406	-3.53
Gram	+66	+0.88
Moog	-49	-0.43
Sugarcane	+514	+5.23
Fruits	+406	+4.11
Groundnut	-703	-6.28
Safflower	-112	-0.69
Cotton	-63	-0.55

Source: Compiled by Researcher

The agriculture change in Solapur district during the period 1970-71 to 2004-05 is shown in the Table No 5.12. For the purpose of the study, the major thirteen crops are selected. Table No 5.12 shows that the positive and negative change among the crops during the investigation period in study area. Among the food grain crops, the area under four crops are increased and these crops are jawar, maize, gram, and tur and wheat crop. However, the highest positive change is lying in Jawar crop (10.33% to NSA) and lowest lie in gram crop (0.88 % to NSA). However, the negative change in area under food grain crop is recorded in Bajara, rice, moog and Tur crop. The maximum negative is observed in Bajara crop (9.48 % to NSA) and lowest in moog crop (0.53 % to NSA).

The Table No 5.12 also reveals the changes in fruit crops during the study period in Solapur district. The fruit crop area is increased 40600 hect. which consist 4.11 percent to net sown area. The increase of area under fruit crops is noticed among the all fruit crops increased on a large or small scale. The sugarcane crop area also increased (5.23 percent to NSA) in study region. The area under Ground nut (6.28 percent to NSA), Safflower (0.69 percent to NSA), and cotton crop (0.55 percent to NSA) are decreased in Solapur district during the study period.

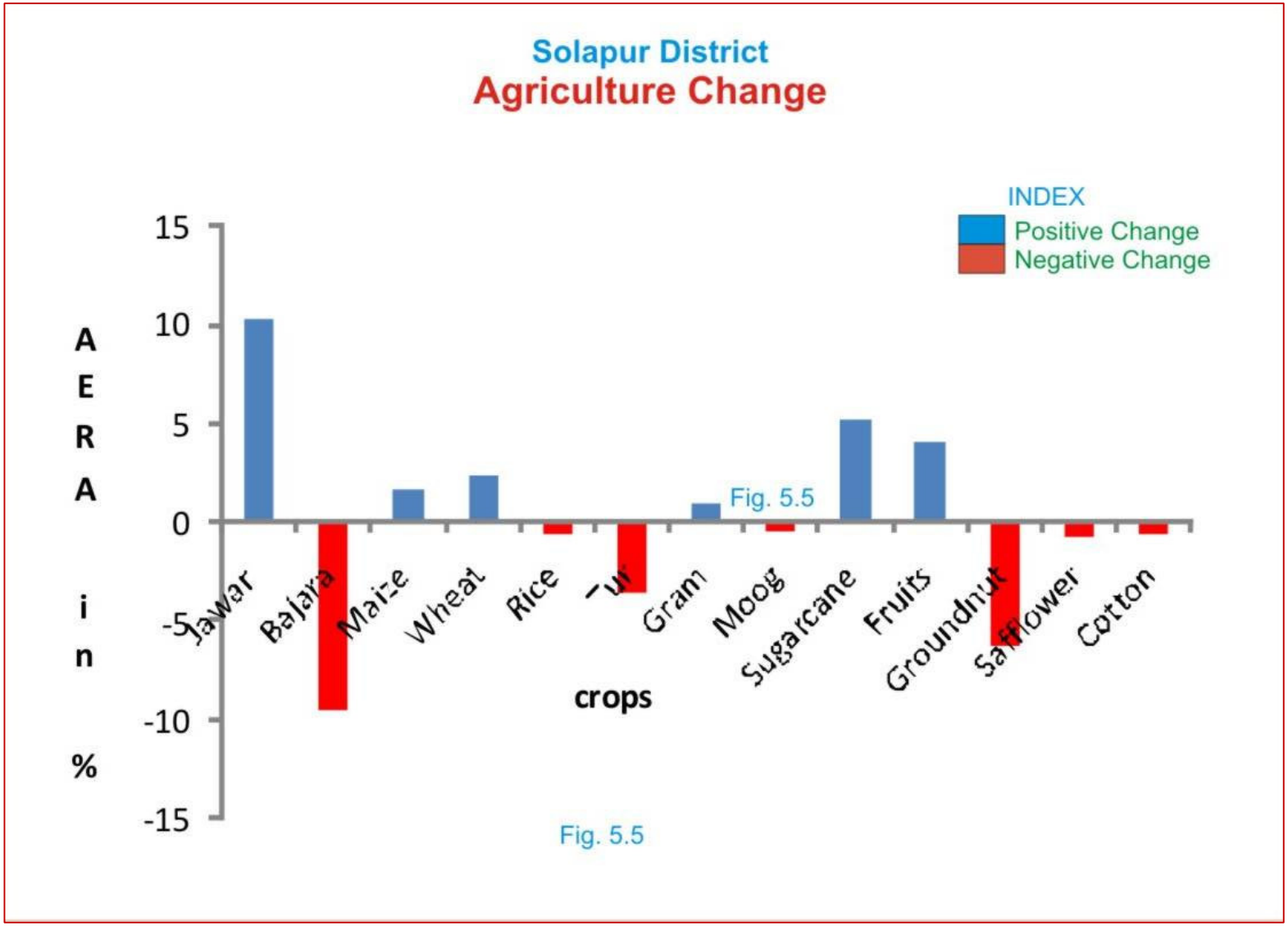
Solapur District
Agriculture Change
INDEX
Positive Change
Negative Change
AERA in %
15
10
5
0
-5
-10
-15
Jawar
Bajara
Maize
Wheat
Rice
Tur
Gram
Moog
Sugarcane
Fruits
Groundnut
Safflower
Cotton
crops
Fig. 5.5

Fig. 5.5

5.8. Irrigation impact on general landuse and agriculture landuse

The correlation coefficient is known as product-moment coefficient of correlation or Pearson's correlation. It is closely related to covariance. Correlation coefficient of 1 means that two numbers are perfectly correlated if one increase so does the other and the change in one is a change in other. Correlation coefficient of -1 means that the numbers are perfectly inverse correlated. If one increases the other falls. The growth in one is a negative multiple of the growth in the other. A correlation coefficient is zero means that two numbers are not related. A non-zero correlation coefficient means that the numbers are related, but unless the coefficient is either 1 or -1 there are other influences and the relationship between the two numbers is not fixed. So if one number is known then other number can be estimated, but not with certainty. The closer the correlation coefficient is to zero the greater the uncertainty and low correlation coefficients means that the relationship is not certain enough to be useful. The above description is of relationship between two variables. It is also possible to calculate correlations between many variables. Adding more variables should increase the correlation; any variables that do not significantly improve the correlation should be excluded. The correlation coefficient has an important physical interpretation. The covariance of two variables is a measure of relationship between them.

In order to understand the irrigation impact on landuse as well as cropping pattern, the correlation coefficient has been computed. The eighteen variables have been carefully selected from the eleven tahsils in the Solapur district. These chosen variables are as follow:

X1= % of irrigation area to net sown area

X2=% of forest area to total geographical area

X3=% of non-agriculture land to total geographical area

X4=% of potential land to total geographical area

X5=% of fallow land to total geographical area

X6=% of agriculture land to total geographical area

X7=% of jawar area to net sown area

X8=% of bajara area to net sown area

X9=% of maize area to net sown area

X10=% of wheat area to net sown area

X11=% of tur area to net sown area

X12=% of gram area to net sown area

X13=% of moog area to net sown area

X14=% of sugarcane area to net sown area

X15=% of fruit area to net sown area

X16=% of groundnut area to net sown area

X17=% of safflower area to net sown area

X18=% of cotton area to net sown area

The degree of correlation has been computed by applying quantitative technique, namely, correlation coefficient for 17x18 matrixes. Pearson product movement correlation was applied. The obtained results are shown in table 6.13. The relationship between variables is summarized as below;

1. Irrigation and Forest

Irrigation plays a dominant role in landuse in drought prone region of Solapur district. Irrigation situation of study region in a particular is depending on rainfall of that year. The co-efficient of co-relation is calculated which comes to 0.41 among irrigation and forest area. This clearly indicates that the positive value of 0.41, though, is not very significant, yet it indicates that the irrigation area as increases, the forest area also increases accordingly. It is also observed that the coefficient of correlation among agriculture land and area under wheat to forest is -0.52. It present that the forest land is used to agriculture land especially for wheat crop in Solapur district. The coefficient of correlation among jawar crop and forest land also negative, means that the jawar area increases the forest area decreases in Solapur district.

2. Irrigation and Non-agriculture Land

Non-agriculture land means land put to non-agricultural uses, such as for constructing settlements, roads, railways, canals, wells, industries establishment, under hills, deserts, lakes, ponds, drainage lines, barren and cannot be cultivated due to some natural problems. The coefficient of correlation value is 0.19 among the irrigation and non-agriculture land which told that low positive correlation among them. The non-agriculture land shows the positive correlation with maize, tur, sugarcane and fruit crops. The coefficient of correlation value is 0.45 among fruit crop and non-agriculture land. This clearly indicate that if the sugarcane, moog and maize crop area increases, the non–agriculture land also increases means the area under settlements, roads, railways, canals, wells, sugarcane industries.

Table 5.13

Correlation matrix of irrigation impact on landuse and cropping pattern in Solapur District

	x1	x2	x3	x4	x5	x6	x7	x8	x9	x10	x11	x12	x13	x14	x15	x16	x17	x18
x1	1																	
x2	0.41	1																
x3	0.19	-0.01	1															
x4	-0.53	-0.46	-0.63	1														
x5	0.38	0.04	-0.01	-0.14	1													
x6	-0.52	-0.06	-0.17	0.21	-0.96	1												
x7	-0.4	0.06	0.26	-0.52	0.40	-0.32	1											
x8	0.13	-0.13	0.07	0.26	-0.04	-0.01	0.09	1										
x9	0.65	0.12	-0.21	-0.10	0.27	-0.34	-0.50	-0.05	1									
x10	-0.52	-0.04	-0.05	0.35	-0.30	0.32	-0.29	0.05	-0.10	1								
x11	0.17	-0.10	-0.40	0.31	-0.04	0.03	-0.80	-0.21	0.48	0.12	1							
x12	-0.01	-0.59	0.08	0.56	0.11	-0.19	-0.19	0.37	0.24	0.02	0.03	1						
x13	0.34	0.14	0.30	0.25	0.36	-0.49	-0.26	0.17	0.29	0.14	0.22	0.41	1					
x14	0.59	0.45	0.15	-0.12	0.36	-0.45	0.11	0.12	0.09	-0.63	-0.05	0.11	0.47	1				
x15	0.21	-0.10	-0.54	0.62	-0.05	0.06	-0.59	0.20	0.64	0.21	0.55	0.11	0.14	-0.25	1			
x16	0.05	-0.13	-0.25	0.29	0.08	-0.09	-0.70	-0.29	0.57	0.30	0.71	-0.05	0.13	-0.38	0.63	1		
x17	0.33	-0.14	0.20	0.33	0.05	-0.16	-0.08	0.64	0.08	-0.08	0.35	0.53	0.67	0.43	0.25	-0.25	1	
x18	0.71	0.37	0.55	-0.80	0.10	-0.26	0.02	-0.16	0.47	-0.29	-0.05	-0.13	0.06	0.24	-0.19	0.04	-0.13	1

Source : Compiled by Authors

The non-agriculture land shows the low negative correlation of coefficient with potential land, agriculture land, bajara, tur, gram, fruit, and groundnut and cotton crop. It means that if the area under these crop increased, the area under non-agriculture land decreases.

3. Irrigation and Potential Land

Potential land means the land for the purpose of extension of cultivation can be found only in this category which could be used for cultivation but has not been under cultivation owing to certain reasons. The coefficient of correlation value among irrigation and potential land is -0.53. This indicates that the correlation among them is significantly negative which means the irrigation has increased, the potential land decreases accordingly. The potential land correlation of coefficient with

4. Irrigation and Fallow Land

Fallow land refers to that part of cultivated area which is kept idle for season or for period extending up to four years. Irrigation has affected on fallow land positive, so the correlation of coefficient value is 0.38. It is observed that the positive correlation of fallow land with Jawar, maize, gram, moog, sugarcane, groundnut, safflower, and cotton crop. The negative correlation of fallow land with forest, non-agriculture land, agriculture land, bajara, wheat, tur, fruit. Among them the correlation coefficient value of fallow and agriculture land strongly negative (-0.96). It means that the agriculture land increased, fallow land decreased on the same way. The agriculture situation is depending on rainfall and irrigation facilities.

5. Irrigation and Agriculture Land

The environmental factors directly affect agriculture land-use or net sown area. Among the environmental factors, rainfall and irrigation are highly influenced the agriculture land in drought prone area. The irrigation and agriculture land, correlation of coefficient value is -0.52. Table noticed that the agriculture land positive correlation with forest, wheat, tur, fruit crops. This table shows that the negative correlation of agriculture land with potential land. It means that the potential land decreased, the agriculture land will be increased.

6. Irrigation and Jawar Crop

Jawar is main staple crop cultivated in rabbi season in study area. Most of the jawar has need of irrigation in Solapur district. The correlation of irrigation and jawar crop is not significantly, but it is low negative. If the irrigation area increased, the jawar crop area decreased on small way. Jawar crop is replaced by cash fruit crops;

however the fruit crop maize, wheat, tur, gram, moog, and groundnut and safflower crops. The positive correlation of jawar crop with forest, fallow land, bajara, sugarcane and cotton crops. This noticed that the jawar area has increased; these crop areas also decreased means the rainfall decreased, sugarcane, jawar, bajara, cotton crop area also decreased. It shows that the jawar is cultivated on rainfall.

7. Irrigation and Bajara Crop

Bajara crop is cultivated in kharif season on monsoon water. However in some areas it needs irrigation. The correlation of coefficient of irrigation and bajara crop is (0.13) slightly positive. It means that the irrigation facilities increased, the bajara area also increased on small scale. The positive correlation of bajara crop with non-agriculture land, potential land, jawar, wheat, gram, moog, sugarcane, fruit crops are observed in study region. It is observed the negative correlation of bajara crop with forest, fallow land, maize, tur, groundnut crop.

8. Irrigation and Maize Crop

Maize is fodder crop cultivated over all year in study region. However it has need of irrigation. The coefficient of correlation value is 0.65 among the irrigation and maize crop. This noticed that the maize crop area increased, where the irrigation facilities also increased. The maize crop has observed negative correlation with non-agriculture land, potential land, jawar and bajara crop. It means that these factors area decreased the area under maize crop increase. Now a days, the farmers trend to jawar and bajara crop replaced by maize crop.

9. Irrigation and Wheat Crop

Wheat crop is cultivated in rabbi season with help of irrigation water in Solapur district. But it is not cultivated on commercial base; however the area under wheat crop is small. The correlation of coefficient value is -0.52 among them irrigation and wheat crop. It means that the irrigation has increased, wheat crop has decreased means the commercial crop increased. The non-agriculture land, fallow land, jawar, maize, sugarcane and safflower crop has negative correlation with wheat crop in Solapur district. It means that the non-agriculture land, fallow land, jawar crop area decreased, wheat crop area increased and sugarcane, safflower area increased, the wheat crop area decreased.

10. Irrigation and Tur Crop

Tur is kharif crop of five months. If the tur crop increased, jawar crop area decreased. It means that the correlation between jawar crop and tur crop is strongly

negative. The irrigation and tur crop correlation of coefficient value is 0.17, but it is not significant. The correlation of sugarcane and tur crop is strong negative and the correlation of fruit crop and groundnut crop is strongly positive due to the tur crop is inter cultivated crop among them, however area under this crop increased, tur crop area also decreased.

11. Irrigation and Gram Crop

Gram is rabbi crop. The correlation of gram crop with irrigation is –0.01. It is not significant. Gram is interring cultivated crop with sugarcane, fruit crop, moog, safflower in study region. However, if the area under these crops (sugarcane, fruit crop, moog, and safflower) increased, the gram crop area also increased. The negative correlation of gram crop with jawar and groundnut crop are observed. It is happen because jawar and groundnut crop cultivated on the same season of gram crop.

12. Irrigation and Moog Crop

Moog crop is cultivated in kharif season with bajara crop. If the area under bajara crop increased, the area under moog crop also increased. This crop has no need of irrigation. The coefficient of correlation among moog crop and irrigation value is 0.34 which is insignificant value. But the strong positive correlation of moog crop with bajara, safflower crop and negative jawar crop are observed in Solapur district.

13. Irrigation and Sugarcane Crop

Sugarcane is major cash crop in study region. It is 14 month crop and it has cultivated insufficiently water availability area. The coefficient of correlation value among irrigation and sugarcane is 0.59. It is strongly positive correlation among these. This noticed that the irrigation area has increased, the area under sugarcane has also increased and irrigation decreased, the area under sugarcane also decreased. The strong negative correlation of sugarcane with tur and fallow land area observed in study region. The strong positive correlation of sugarcane with fruit, groundnut, non-agriculture land is observed. This noticed that the sugarcane area has increased, the sugar factories, road networks, population density increased, so the non-agriculture and irrigation has shown the strong positive correlation.

14. Irrigation and Fruit Crops

Mango, Grapes, Pomegranate, Banana, Lemon, are the important fruit crops in study region. In last two decade, pomegranate, grape and ber are principle fruit crop cultivated in Solapur district. The correlation of coefficient value is 0.21 It is positive, but it is not significant. This shows that the irrigation facilities are increased, the fruit

crop has also increased. It means that fruit crops have need low water compare to sugarcane crop and fruit crop has affected by more disease with heavy rainfall or heavy irrigation. Fruit crop also affected by soil, temperature and humidity. Fruit crop has negative correlation with non-agriculture land, jawar, sugarcane, and cotton crop.

15. Irrigation and Groundnut Crop

Groundnut is most important oilseeds raised in the study region. It is cultivated mostly rabbi and small scale in kharif season. The coefficient of correlation value is 0.05 between irrigation and groundnut crop. But this is not significant. The negative correlation of groundnut crop is observed with jawar, bajara and sugarcane crop. The positive correlation of groundnut crop observed with maize, tur, fruit crop. This noticed that the groundnut area increased with increasing area of tur and fruit crop because of it is increased cultivated with this crop.

16. Irrigation and Safflower Crop

Sunflower is an important rabbi oilseed crop in Solapur district. It was also raised as good management and better irrigation facilities. It has need of irrigation because it is cultivated in rabbi season. The safflower coefficient of correlation value is 0.33 with irrigation. The positive correlation of safflower is observed with bajara, tur, gram, moog, fruit crop and negative correlation with jawar and wheat crop.

17. Irrigation and Cotton Crop

Cotton is another important cash crop in the study region. But it cotton is 0.43 percent to agriculture land in 2005. It is cultivated in summer season. It has need of irrigation for cultivation. So the coefficient of correlation value is 0.71. It shows strongly positive correlation between irrigation and cotton crop. The positive correlation of cotton crop is observed with non-agriculture land and maize crop. The negative correlation of this crop with potential land, wheat, tur, gram, and fruit crop are observed.

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Chapter -VI

A CASE STUDIES OF SAMPLE VILLAGE

6.1 Introduction

Field work or survey work is a universally accepted approach to study of geography, as it is a primary source of data. Analysis of data is essential for a scientific study and for ensuring that the research has all relevant information for making contemplated comparisons and to draw inferences. The collected data through primary method is classified, tabulated and analysed and interpreted. The data by itself can not reveal anything and only by processing and relating the data, the intricacies can be brought to light. In this Chapter survey work has been attempted, to observe personally the situation in the region regarding the irrigation.

6.2 Data Base and Methodology:

To study the irrigation pattern and its impact on agriculture land use and socio-economic condition of farmers with the selected sample. The whole district is systematically divided into three groups on the basis of irrigation intensity. Then 24 villages are selected in each group. The purposive sample techniques used for selection of villages in each tahsil. For this investigation 216 sample fruit growers from 72 villages are selected by systematic purposive sampling method, but they are carefully chosen on the basis of irrigation regimes of the study area.

6.2.1 Sample villages and sample farmers' selection

For the present study, Solapur district is divided three groups; i) low irrigation ii) moderate irrigation iii) high irrigation. Among the low irrigation region, eight tahsil are consisted in this group. These are Karamala, Madha, Barshi, North Solapur, Mohol, Pandharpur, South Solapur and Akkalkot tahsils. The total requirement villages in this category are 24 villages, which are 3 villages in each tahsil are selected. The second region is moderate irrigation region which include only Malshiras tahsil. So the 24 villages are selected in this tahsil. The third group is high irrigation region, Sangola and Mangalwedha came in this group. So the 12 villages are selected in each tahsil.

The total 216 farmers selected for the present investigation. These samples are selected by using purposive sampling method. The 72 farmers are selected in each irrigation and three farmers selected in each village. In this way, total 216 farmers are selected of this sample survey in Solapur district.

Table 6.1
Solapur District: Tahsilwise Sample Villages and Sample farmers

Sr . no.	Name of the region	Name of the tahsils incorporated	Name of the selected villages	No. of sample
1	'A' region (Low irrigation)	Karamala	Aljapur, Kamone, Pomalwadi	09
		Madha	Adhegaon, Hole Kh., Ranzani	09
		Barshi	Agalgaon, Hingani (Pangaon), Pandhari	09
		North Solapur	Akole Kati, Honsal, Pakani	09
		Mohol	Adhegaon, Kamati Bk. , Penur	09
		Pandharpur	Adhiv, Jaloli, Ropale,	09
		South Solapur	Hipparge, Gurde halli, Fatatewadi	09
		Akkalkot	Aktnal, Gudewadi, Mangrul	09
		Village total	24	72
2	'B' region (Moderate irrigation)	Malshiras	Akluj, Bangarde, Borgaon, Dasur, Dulenagar, Falwani, Girzani, Jadhavwadi, Kalamboli, Khandali, Kothale, Londhe Mohitewadi, Malinagar, Mandve, Motewadi, Nitavewadi, Pimpari, Rede, Savatghavaon, Sulewadi, Tarangfal, Umbare dahigaon, Vizori, Zanzewasti	72
		Village total	24	72
3	'C' Region (High irrigation)	Sangola	Achakdani, Badagarwadi, Chopadi, Gavadewadi, Hanmantgaon, Kadlas, Khavaspur, Mahim, Narale, Sangewadi, Sonalwadhi, Waki gheradi	36
		Mangalwedha	Akole, Bhalewadi, Devgaon, Ganeshwadi, Hannur, Karjal, Lavangi, Malewadi, Maroli, Padolkarwadi, Salgar Kh. , Soddi	36
		Village total	24	72
District total			72	216

Source: Compiled by Researcher

6.2.2. Identification Code to sample villages

The selected villages are arranged alphabetically in total Solapur District. The total 72 villages are selected in this study. So it is difficult to write it's name on it's location on the map. For this all the sample villages get the code numbers. They are numerical 1 to 72 and shows in table 6.2. and Fig. -6.1

Table 6.2
Solapur District: Sample Villages Code

Name of Village	Code No.	Name of Village	Code No.	Name of Village	Code No.
Achakdani	1	Hanmantgaon	25	Motewadi	49
Adhegaon(Madha)	2	Hingani(Pangaon)	26	Narale	50
Adhegaon(Mohol)	3	Hipparge	27	Nitvewadi	51
Adhiv	4	Hole k.h.	28	Padalkarwadi	52
Agalgaon	5	Honsal	29	Pandhri	53
Akluj	6	Hunnur	30	Pakani	54
Akole	7	Jadhavwadi	31	Penur	55
Akole kati	8	Jaloli	32	Pimpari	56
Aljapur	9	Kadlas	33	Phatatewadi	57
Aktnal	10	Kalmboli	34	Pomalwadi	58
Bandgarwadi	11	Kamti B.k.	35	Ranzani	59
Bangarde	12	Kamone	36	Rede	60
Bhalewadi	13	Karjal	37	Ropale	61
Borgaon	14	Khandali	38	Sangewadi	62
Chopadi	15	Khavaspur	39	Salgar K.h.	63
Dasur	16	Kothale	40	Savatgavan	64
Devgaon	17	Lavangi	41	Soddi	65
Dhulenagar N.V.	18	Londhe mohitewadi	42	Sonalwadi	66
Falavani	19	Mahim	43	Sulewadi	67
Ganeshwadi	20	Malewadi	44	Tarangphal	68
Gavadewadi	21	Malinagar	45	Umbaredahigaon	69
Girzani	22	Maroli	46	Vizori	70
Gudewadi	23	Mandve	47	Waki gherdi	71
Gurdehalli	24	Mangrul	48	Zanjevasti	72

Source : Compiled by Researcher

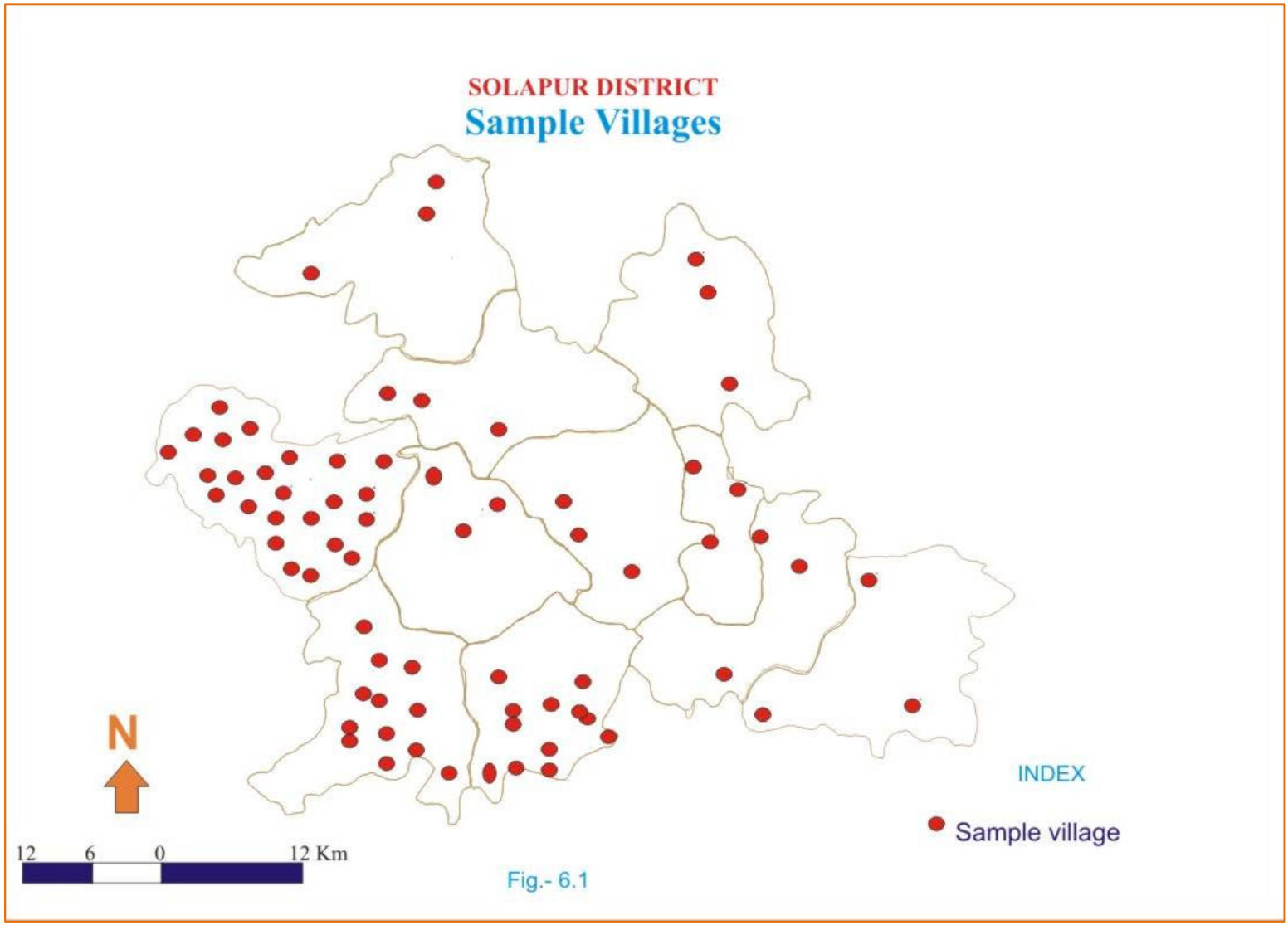
SOLAPUR DISTRICT
Sample Villages
N
INDEX
Sample village
12 6 0 12 Km

Fig.- 6.1

6.3 Information of farmers

It is essential to understand the characteristics of sample farmers who are influenced with Agriculture as well as irrigation development. Data obtained through interview schedule and field work in regards to age of farmers, literacy of farmers, land holding size, occupation, agricultural land use, land holding size, irrigation, sources of irrigation, irrigation system etc. regarding sample farmers is analyzed and represented various cartographic techniques. Following are some of the important characteristics of sample farmers observed in field work.

6.3.1. Age of farmers

The study area also depicts more or less same pattern of young population having a higher proportion to the total population. The young person give more time, energy, accept new changes in cropping pattern, take risk of new farming methods. That's why farmers age group is more important for irrigation development. The following table shows the particulars about age composition of the farmers in the study area.

Table 6.3
Solapur District: Age Group of Sample farmers

Sr	Age group	No farmers	Percentage
1	21 - 40	98	45.37
2	41 - 60	72	33.33
3	Above 60	46	21.30
	Total	216	100

Source: Compiled by Researcher

The table 6.3 shows that elder age people (below 20) are not engaged in the farm work. The working age group comprising 21 - 40 years and 41-60 years constitute 78.70 per cent of the respondents. The empirical evidence shows clearly that young and energetic people who are physically sound are engaged in farm work. The farming involves rigorous and energy sapping works. This is the primary cause for the high proportion of young people to be engaged in agriculture.

6.3.2 Literacy

Educated farm family members, especially those with high school education and above in the age group of 15-59, can contribute more towards the process of mechanization and bio-chemicalzation of farms. The low literacy rate in farmer's class size can explain the difficulties faced by the Extension Service Centers in the propagation of green revolution technology among them. High literacy rate among farmers has brought about a large-scale diffusion of modern farm technology vis-a-vis the latter where traditional methods of farming are in vogue. The grape crop is a very

climate sensitive crop. Literate farmers can take some decision by reading books, newspapers, market reports and others instructions provided by the Govt. and internet website.

Table 6.4
Solapur District: Literacy of Sample Farmers

Sr. No.	Farmers Literacy	Number of farmers	% to total
1	Illiterate	27	12.5
2	Below 5Std.	40	18.52
3	5 to 10Std.	38	17.60
4	10 to 12 Std.	83	38.42
5	Graduate & above	28	12.96
Total		**216**	**100**

Source: Compiled by Researcher

It is proved by Table No 6.4 that the percentage of 10^{th} -12^{th} literate growers is higher than other farmers and the percentage of farmers below 10^{th} Std. is also high in Study region. These farmers can't predict about the rain water harvesting, know knowledge about water saving techniques and they can't invest more money for irrigation development. In Solapur district, the 12 percent farmers are illiterate whose are not accepts new techniques of irrigation. These farmers way of agriculture is traditional which is more problematic to agriculture and irrigation development.

6.3.4 **Farmers occupation**

The whole population of Solapur district is rural in character. Hence it is desirable to study the distribution of man-power for the proper identification of the beneficiaries under various agricultural development programmes.

Table 6.5
Solapur District: Sample Farmers Occupation

Sr. No.	Farmers occupation	Number of farmers	% to total
1	Farmer	172	79.62
2	Service	17	7.87
3	Business	11	5.09
4	Others	16	7.40
Total		**216**	**100**

Source: Compiled by Researcher

Almost 79.62 percent (172) respondents are only cultivators. Whereas only 7.87 percent respondents are service man and 5.09 percent are businessman agriculture. The share of these two categories is very low compare to the group farmers who are only farmers. These farmers can't take any risk of modern agriculture, large investment in irrigation development because they have no guarantee of rainfall, crop production and market price. That's why they can't invest more money in agriculture development. It is clear that the only 13 percent farmers (Service and Businessman) whose second business to agriculture, they can always try to growing now irrigation technology i.e. farm water storage tank, sprinkler irrigation system, water harvesting, etc.

6.3.5 Land Holding Size

Land is the most important constrains which influencing the production of particular marginal and small farmers. It is also an important non-physical parameter, which indirectly influences agriculture production and irrigation. If the farm size is large, these farmers can use modern machines like 18 hp tractors for intercultivation. But it depends on area under grape cultivation. The farmers with large grape field use machinery. Small farmers cannot buy machinery and perhaps they use machineries on hire. Such farmers cannot get machinery when it is essential.

Table 6.6

Solapur District: Sample farmers land holding size

Sr. No.	Farm size	Number of farmers	% to total
1	Small (below 5 acre)	29	13.43
2	Moderate (5- 10 acre)	169	78.24
3	Large (above 10 acre)	18	8.33
Total		**216**	**100**

Source: Compiled by Researcher

The table 6.6 shows the pattern of land holdings in different regions. The study area has been categorized in to three regions according to the area. This table also clearly validates the previously mentioned fact that the average distribution of the land holdings is more or less identical. The average size of holdings in the moderate size is marginally higher in the study area and it has 78.24 percent of sampling farmers. It is followed by the small size with the 13.43 percent of sampling farmers. The only 8.33 percent sample farmers are capturing large size of farms. These large farmers built farm water storage tank.

6.3.6. Landuse

The land use pattern of Solapur district is largely affected by environmental factors. Among them, rainfall is dominant factor influencing on cropping pattern of Solapur district. Solapur district is located in drought prone region of Maharashtra state, however the need of irrigation is intensively required for successful crop cultivation. The crops are selected for cultivation on availability of irrigation facility by farmers.

Table 6.7

Solapur District: Sample farmers Landuse, irrigation and Productivity

Crop	Area in acre	% to total	Irrigated area (acre)	% to total crop area	Productivity In irrigated area (per acre in quintal)	Productivity In non - irrigated area (per are in quintal)
Jawar	1230	57.59	740	60.16	10	04
Bajara	343	7.69	302	88.00	12	04
Maize	872	19.56	872	100	30	-
Wheat	107	2.40	107	100	15	-
Gram	68	1.50	60	88.23	07	02
Moog	52	1.16	00	-	-	03
Tur	43	0.96	00	-	-	04
Groundnut	17	0.38	17	100	20	-
Safflower	09	0.20	09	100	15	-
Sugarcane	937	21.01	937	100	520	-
Fruit	342	7.67	342	100	200	-
Cotton	27	0.60	27	100	15	-
Other	42	0.94	40	95.23	-	-
Fallow land	369	8.27	00	-	-	-
Total	4458	100	3453	77.45	-	-

Source: Compiled by Researcher

The table 6.7 shows the cropping pattern of the farmers. The total 216 sample farmers capture 4458 acre area. It reveals that Jawar is the major crop (57.59 %) cultivated by the sample farmers. This is quite comprehensive because jawar is the major food item and it occupies an important place in the dietary needs of the respondents. It is cultivated in rabbi season and it needs water. On this sample survey 60.16 percent area under jawar crop irrigated. The second important crop by sample farmers is sugarcane which depicted 937 acre (21.01 percent). It is totally cultivated on water of irrigation. It is cash crop and a highly remunerative crop in study region. The

maize is third important food grain crop in study region, however water is required for this crop on the way of irrigation. The bajara, fruits and wheat is also important crops cultivated by farmers of Solapur district. Among them fruits and wheat has cultivated in fixed source of irrigation, however the bajara crop 88. 23 percent cultivated area irrigated by different sources. The gram, tur, groundnut, safflower, cotton are cultivated very few area by the sample farmers in Solapur district. Among these crop, moog and tur are cultivated by rainwater. The 369 acre (8.27 percent) area is fallowed due to ununiformed land, unfertile land, Grazing land, non-irrigated land and farmers conflicted land. It is also reveals that the productivity of crops is highly affected by irrigation. The jawar crop productivity in irrigation area is 10 quintal per acre while it is 04 quintal in no irrigated area. The irrigated bajara crop productivity is 12 quintal per acre and 04 quintal in non-irrigated area. The productivity of gram is also influenced by irrigation. The irrigated gram crop productivity is 07 quintals while 02 quintal in non-irrigated area.

6.3.7. Sources of Irrigation

The sources of irrigation are rough and ununiformed. The natural sources of irrigation are tanks, Bhima, Sina, Man River and its tributaries, Ujani dam, Nira right bank canal, many major and minor irrigation project constructed by Govt., Small water storages tanks, tube-well and wells.

Table 6.8
Solapur District: Sample farmers source of irrigation

Sr.	Well	Bore-well	Canal	Lift	Storage Tank	Tanker	Other	Total
Total	210	319	87 farmers	68 farmers	37	17	05	743
In Use	201	198	87 farmers	65 farmers	37	17	05	610

Source: Compiled by Researcher

The table no 6.8 reveals that the total 216 sample farmers are digging 210 wells by sample farmers but 201 wells are used for irrigation. The 09 wells are dried due to the deflection of ground water. The 319 tube well are construed, however 198 tube wells are provide water and remaining are close due to the absence of water. The 87 sample farmers out of 216 farmers used canal water, 37 farmers water storage tanks, 17 tankers are used by sample farmers. The 68 sample farmers used source of lift irrigation scheme, but 65 farmers lift irrigation scheme are particular in use. It is also find that the level of ground water is very high in depth, that's why farmers used

artificial source of irrigation i.e. vehicle tanker, farm storage tank. It is need to water management and water harvesting to increasing the irrigation is study area.

6.3.8 Types of irrigation

There are useful different methods of irrigation in their own way by sample farmers in Solapur district. This is mainly connected with the plans and agricultural land. It is taking into consideration the lay of the land to be irrigation and eligibility of the soil to absorb and hold water. The method should allow conservation of soil and should also provide enough water to satisfy the needs of plants but not cause waste and damage.

Table 6.9
Solapur District: Sample Farmers irrigation mode

Types of irrigation	Flood (Out of 216)	Drip (Out of 216)	Sprinkler (Out of 216)	Other (Out of 216)
No of farmers	201	113	17	11
%	93.05	52.31	7.87	5.09

Source: Compiled by Researcher

The analysis of field work reveals that the method of flood irrigation is largely used by sample farmers. This system require abundant of water and water wastage on large scale. That's why farmers need to use the sprinkler or drip irrigation system which saves more water. It is also observed that the 52 percent farmers used drip irrigation and 7.87 percent sample farmer used sprinkler irrigation system. It is need to increase this irrigation system by increasing the farmer's awareness, subsidy, bank loan on low interest and Govt. policy.

6.3.9. Water Available For Irrigation

Solapur district is located in drought prone area of Maharashtra state. The amount of average rainfall is low due to this the ground water level is on very high depth. However many well and tube well are dry in summer season or some are parentally dry.

Table 6.10
Solapur District: Water available for Irrigation by Sample Farmer

Sr. No.	**Season**	**No of farmers**	**Percent**
1	Monsoon (Out of 216)	216	100
2	Winter (Out of 216)	203	93.98
3	Summer (Out of 216)	42	19.44

Source: Compiled by Researcher

The Table No 6.10 shows the actual situation of water availability in whole by sample farmers. The analysis reveals that the monsoon season when rainfall comes at average level that time water is available for irrigation by every farmer. But many time monsoon rainfalls are uneven and uncertain. The 203 sample (93.98 %) farmers told that the water is available for irrigation in winter season. However, in the summer season water is not available for irrigation. Among the 216 sample farmers, only 42 farmers (19.44 %) get water for irrigation. This situation reflects the need of irrigation in summer season in Solapur district.

6.3.10. Credit Facilities

Financial support is more important in irrigation and agriculture development. For digging the well, tube wells, lift irrigation, purchase of drip and sprinkler irrigation system, pumps, etc.

Table 6.11
Solapur District: Loan Providing Agency

Sr. No.	Loan Providing Agency	No of farmers (out of 216)	Percent
1	Nationalized Bank	42	19.44
2	Co-Operative Societies	123	56.94
3	Others	12	5.55
Total		177	81.94

Source: Compiled by Researcher

For these famers the loan provided by many co-operative societies, nationalized bank and any other source. In Solapur district, it is observed from sample survey that the only 19 percent farmers take loan for irrigation by nationalized bank which provide loan on low interest. The co-operative societies provide loan to 56 percent sample farmers. Only five percent farmers took loan from private banks.

6.3.11. Area cultivated

Solapur district agriculture is largely affected by rainfall. Rainfall influence on the frequency of crop in year. In which area rainfall is more or source of irrigation is guaranteed or permentally those farmers take three crops in year in one field of agriculture.

Table 6.12

Solapur District: Cultivation in a year by sample farmers

Sr. No.	Cultivation in a year	No of farmers	Percent
1	Ones in year	57	26.38
2	Twice	109	50.46
3	Three	50	23.14
Total		216	100

Source: Compiled by Researcher

The table 6.12 shows that the three crops grown in one year in one farm is only 23 percent sample farmers of Solapur district. It is clearly represent that the irrigation is basic problem of Solapur districts farmer especially in summer season. The 50 percent sample farmers took twice crop and one crop in one year. If the rainfall is not coming on in time, crops are not sown. That time farmers situation become very dangerous.

6.4. Problem of Irrigation

Various farmers were interviewed during the period of field survey, most of the farmers of selected villages told several problems to the researcher. The problems of famers differ from region to region. However, the most important problems being faced in the way of irrigation development are discussed below in brief.

Table 6.13

Solapur District: Sample Farmer faced problem about irrigation

Sr No	Problem	Status (out 216 farmers)	%
1	Less rainfall	151	69.90
2	Low ground water	170	78.70
3	Water management	220	97.22
4	Water shortage	145	67.12
5	Absence of electricity	216	100
6	Lack of irrigation implements	201	93.05
7	Govt. policy	216	100
8	Farmers inadequacy	169	78.24
9	Uncertain frequency of canal water	103	47.68
10	Poor maintenance of canals & tanks	110	50.92

11	Problem of over irrigation	12	7.87
12	Other	25	11.57

Source: Compiled by Researcher

1. Less Rainfall

Solapur district is situated in large drought prone area of Maharashtra state. Therefore the amount of annual average rainfall is very less. The rainfall is scanty, uneven and irregular. The analysis reveals that this problem is faced by 69.90 percent sample farmers in Solapur district.

2. Low Ground Water

The geological structure of Solapur district is a part of Deccan plateau. It is made basalt hard rock which does not percolate water beneath the ground. That's why ground water is very high in depth near above 500 feet in summer which can't provide water for irrigation. Economically it is costly to pick up water from high depth.

3. Water Management

Water management is the activity of planning, developing, distributing and managing the optimum use of water. In this survey, the 97 percent sample farmers no idea about water management. They want some suggestion or training, seminar or workshop about water management in farm level.

4. Water Shortage

Today, agriculture is often unable to compete economically for scarce water. Water shortage is big problem in Indian agriculture. In Solapur district , many sources of irrigation constructed by Govt. i.e. canal, irrigation projects, tanks, dam, etc. However, these sources are dry or not in use due to shortage water. Among these survey, 67.12 percent farmers face the problem of shortage of water.

5. Absence of Electricity

The electricity is used for pumps for getting the water from well, tube well and any other source of irrigation. In Solapur district, the absence of electricity or load shading of electricity is more than 18 to 20hours out of 24 hours. The second problem electricity that it is provide on low power, that's why share of irrigation is decreasing in Solapur district. For these analysis, the hundred percent sample farmers face the problem of electricity in Solapur district.

6. Lack of Irrigation Implements

Irrigation need many types of implements i.e. oil engine, electric pumps, tube-well pumps, sprinkler and drip irrigation sets. It is not available easily and low price. Due to small and poor farmers are exempted from these irrigation implements. In Solapur district, the 93 percent sample farmers face the problem of irrigation implements.

7. Govt. policy

Political pressures often prevent the implementation of apparently sensible and fair reforms for water services. Where water is regarded as a special commodity or has emotional or religious importance, governments are reluctant to charge farmers for irrigation. Policy-makers often find it extremely difficult to raise sufficient revenue to match even their priority needs. The practical effects on traditional public service activities may be harsh. Water has been one of the first sectors to feel the effects of budget-saving efforts and changing resource availability. However, it is unlikely to be treated more austerely than other areas. The irrigation development affected by corruption and non-implementation of policies.

8. Farmers Inadequacy

Farmer's inadequacy means farmers illiteracy, lack of knowledge about irrigation development, economically poor, traditional way of agriculture practice, etc. Among the field survey of 216 sample farmers 169 farmers (78.24%) farmers found inadequate about agriculture and irrigation.

9. Uncertain Frequency of Canal Water

The Ujani right and left bank canal, Nira right canal are provided water for irrigation in Solapur district. These canal provide water by rotation of one month interval, however the rainfall is uncertain, the water is reserved for drinking for people. Many times political interference disturb the canal water rotation. For this time interval of canal water stopped. Due to this crop is destroyed.

10. Poor Maintenance of Canals & Tanks

Due to the lack of financial crises and neglect to agriculture field by Govt. water supply implements like canal do not maintained. These canals have not flows water regularly. Some people objectively broke the canal and receive more water. Canal water flow outside due to growing grass and trees or filled by silt. Fifty percent sample farmers told this problem.

11. Problem of Over Irrigation

The only 12 percent farmers face the problem of over irrigation. This problem creates on these area which is at the river bank, along with canal and exhibit to dam, where there due to the percolation of water and continuously supply of water for irrigation especially in sugarcane crop.

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Chapter VII

Conclusion

And

Suggestions

Conclusion:

In the present research work, an attempt has been made to examine the relationship between irrigation and crop land-use. Especially it is observed that agriculture landuse is highly affected by environmental determinants like soil, rainfall, irrigation facilities, etc. The objectives are to analyse the irrigation and to examine its impact on agriculture landuse. The preceding analysis exhibits the following findings:-

1. The region is divided into three broad relief divisions in which the percentage of plateau is relatively high and hills and ghats are relatively less.
2. The river Bhima is a major river, which drains 60 % area of the region, followed by Man, Sina and Nira river. They are the major source of surface water. The river valleys in the region have typical black soil.
3. Climatically to the region varies spatially and temporally. The temperature in the district remains sufficiently high and conducive to the growth of tropical fruit crops and staple crops. Excluding the period from mid-February to the end of May the day temperature is 25°c - 27°c, which is favorable for grape and pomegranate fruit crops.
4. The region gets rain from southwest monsoon and shows marked spatial differences from west to east. The variability of rainfall is high in the eastern part than the western part of region. The average rainfall is 500mm to 600mm and it falls uncertainly and discontinuously in during the months from June to October.
5. The average rainfall of the region is 585mm. The whole study region depends for its water need on southwest monsoon which is irregular both in space and time.
6. Most of the area of Solapur district is covered by Shallow soil. Very few area (22.96 %) of district is covered by deep soil, in surround of Bhima river and its tributaries. There is very close connection between soil and agriculture development in Solapur district.
7. The population of Solapur district is 3849000 in 2001. During study period, the highest growth of population is noticed in North Solapur and Pandharpur tahsil, while low in Mangalwedha tahsil is shown lowest growth of population.
8. The density of population in the region is 272 persons per km. in 2001. The high population density has in North Solapur (1287 person), Pandharpur (309 person)

and Malshiras tahsil (978 person). The low population density has in Karamala (145 person) and Mangalwedha (149 person) tahsils.

9. Table 2.11 shows the progress of agriculture implements in Solapur district. During the study period, the wooden plough (2737), iron plough (2709), electric pumps (51448), sugarcane crusher (467) and tractors (3514) are increased and carts (13487), oil engines (4672) are decreased.
10. Solapur district is located in drought prone area. So irrigation is essential for agriculture development and better yield. The seven tahsils (Karamala, Madha, Mohol, Pandharpur, Malshiras and South Solapur.) of study region are required high need of irrigation.The moderate need of irrigation is observed in Sangola, Mangalwedha ,Barshi and Akkalkot tahsil and lowest in North Solapur tahsil.
11. In Solapur district the area under irrigation has increased 145974 hectors (15.71 percent to Agri. Land) during the period of 1971 to 2005. The high irrigated area to agriculture land is found in Sangola tahsil (48.52 to Agri. Land) and lowest in Mohol tahsil (17.32 percent to Agriculture land).
12. After the 1971, the irrigation has been continuously increased.The area under irrigation was 53300 hectors (8.48 percent) in 1971, which has been increased in 2005, i.e. 60500 hectors (8.98 percent). The highest area under irrigation is increased 7800 hectors in Malshiras taluka in 2005 and the lowest irrigated area increased in Mohol tahsil (3200 hectors).
13. The area under irrigated of bajara crop was 6500 hectors (4.88 percent) which has been decreased in 2005, i.e. 3600 hectors (14.49 percent).The area under irrigation of Maize crop is 6200 hectors (56.88 percent) in 1971; however it is 8600 hectors (31.87 percent) in 2005.The area under irrigation of wheat crop was 15400 hectors in 1971, which is been become 36100 hectors in 2005.
14. The total irrigated area under gram crop is 3300 hectors in 1971, which is 10200 hectors in 2005.
15. Sugarcane usually occupies the land for about 10 to 18 months and thus necessitates adequate irrigation for realizing its potentials yields.The under irrigation by sugarcane is 139 hectors in 1971 and it is 49300 hectors in 2005.The highest irrigated area under sugarcane crop is observed in 8700 hectors in Akkalkot tahsil and lowest is in 1800 hectors in North Solapur in the year of 2005.

16. The fruit crops like grape, pomegranate. Mango, ber, custard apple, lemon, etc. are cultivated in Solapur district.The total irrigated area under fruit crops is 7100 hectors in 1971, which is 38800 hectors in 2005. The highest irrigated area under fruit crop is 6300 hectors in Malshiras tahsil in 2005 and lowest is 1300 hectors in South Solapur tahsil.
17. The total irrigated area under groundnut crop is 5500 hectors in 1971, which is 3600 hectors in 2005. The highest irrigated area under groundnut crop is 700 hectors in Barshi tahsil in 2005 and lowest is North Solapur, Mohol, Mangalwedha and Akkalkot tahsil. The total irrigated area under safflower crop is 7800 hectors in 1971, which is 10400 hectors in 2005.The highest irrigated area under safflower crop is 2600 hectors in Barshi tahsil in 2005 and lowest is in Pandharpur, Malshiras and Sangola tahsil.
18. Well irrigation is traditional source of irrigation to agriculture since long time in Solapur district. In 1970-71, there were 86272 irrigational wells in district, after 35 years 68550 irrigated wells. It has been decreased due to the depletion of ground water, so many well become dried. The highest wells were used for irrigation in Pandharpur tahsil (12220 wells) and lowest wells were used in Mohol tahsil (3820 wells).
19. Tube-wells are another important source of irrigation in district. The highest number of tube-wells has been found in Pandharpur, Malshiras, Mohol, and Mangalwedha (above 1300). In Sangola, Madha, Karamala tahsil the tube-wells are found between 1000 to 1300. On the other hand, Barshi, North Solapur and South Solapur have 390 to 943 tube-wells.
20. Surface water is provided by the flowing rivers or from the still water of tanks, ponds and artificial reservoirs.The table shows that the 1971, the surface water irrigation in Solapur district was 12100 hectors, while it is increased to 65400 hectors in 2005.The highest surface irrigation is observed in Pandharpur tahsil and lowest in Mangalwedha tahsil in 2005.
21. There are three major irrigation projects in Solapur district. Ujani dam on Bhima river is major source of irrigation in district. The irrigation supplies benefit 500 km2 (190 sq. mi) of agricultural land, particularly in the Solapur district.The Nira Right Bank Canal is another major source of irrigation in district. This Canal system now provides irrigation facilities to the Malshiras taluka and irrigates

about 50,000 acres in the district. Sina-Kolegaonis a new major irrigation project taken up during the Fifth Plan. It envisages construction of an earthen dam on Sina River, near village Nimgaon in Karamala taluka. The project has benefit Karamala, Barshi and Mohol tahsils in Solapur district.

22. The only four medium irrigation (Ekrukh, Hingani, Budhyal and Ashti) were available for irrigation in Solapur District in 1971 and the total irrigated area was 4889 hectors. After 35 years, the nine medium irrigation projects are available for irrigation in Solapur district. The total irrigated area was 33597 hectors in 2005.
23. The minor irrigation projects are 109 in Solapur district and they irrigated area 52221 hectors in 2005. The minor irrigation projects are more (18 projects) in Barshi tahsil, but irrigated area is high (15224 hectors) in Madha tahsil. During the study period, the minor irrigation area are increased in all tahsils of district. The highest (14793 hect.) area increased and lowest (1450 hect.) in Pandharpur tahsil.
24. Percolation tanks are very useful for irrigation in drought prone area.More than 1140 percolation tanks are registered in study region in 2005. The highest tanks observed in Mohol tahsil (331 tanks), followed by Sangola (117 tanks) and Barshi (113 tanks). The lowest number of percolation tanks are observed in Pandharpurtahsil (36 tanks).
25. The construction of local level Kolhapur type weir has been introduced in study region in the year 1989.The irrigation potential of this Kolhapur Type Bandhare 50 to 100 hectares which are help to increase underground water table of the region. There are 139 K.T.W. observed in study region, mostly K.T.W. are observed in Barshi, Malshiras, Akkalkot, Sangola and Pandharpur tahsils. Remaining tahsil has low K.T.W. in Solapur district.
26. Lift Irrigation scheme is lifted water from lower level to higher level with the help of pumps and other equipment. There are seven lift irrigation scheme are observed in district. The area under lift irrigation is 113218 hect. in 2005 in Solapur district.
27. Analysis of the general landuse reveals that over a period of thirty-five years (1970-71 to 2004-05), positive changes are observed in nonagricultural land (0.94 percent), fallow land (4.21 percent) and negative changes are observed in forest (0.09 percent), potential land (1.63 percent) and agricultural land (6.58 percent). It

means that agricultural land of the study area is converted into non-agricultural and potential land.

28. Solapur district has a very limited area under forests which has been decreased in District while it has decreased in Sangola, Malshiras, Karamala, and Barshi tahsil and the rest part of district is increased. The high percentage (above 4%) of forest can be found in Mangalwedha and Pandharpur talukas andlow proportion under forest (below 2 percent) in Malshiras, Sangola, Akkalkot, Mohol, Madha, Barshi and South Solapur tahsil in 2005.
29. The non-agriculture land has been increased (0.94 percent) in Solapur District. It has been increased in Mohol, Barshi, South Solapur, North Solapur, Akkalkot, Sangola and Pandharpur tahsil while it has been decreased in Mangalwedha, Malshiras, Madha and Karamala tahsil of Solapur district. In 2005, the high area (above 8 percent) under non-agriculture land has been observed in Mohol and Sangola tahsil and low (below 5 percent) in Madha, Barshi, Malshiras, South Solapur and Akkalkot tahsils.
30. The potential land has been decreased (1.63 percent) in Solapur district during the thirty five year of study. It has been decreased in all tahsilsexcept Malshiras tahsil. It is clearly indicates that the area under permanent pasture, grazing and under miscelleous trees converted in to agriculture land.
31. During the investigation it has been observed that the4.21 percent of fallow land has been decreased in all tahsils of the district except Pandharpur and Barshi tahsil. The highest fallow land has been noticed in Sangola tahsil (38.64percent) and lowest in Pandharpur tahsil (5.64percent) in 2005.
32. Cultivated area has been decreased (6.33 percent) in Solapur District. The negative change has been recorded in all tahsils of district except Malshiras, Pandharpur and Barshi tahsil. In 2005, the highest cultivated area noticed in Pandharpur (82.14percent) and lowest in Sangola tahsil (40.40 percent). It shows that the irrigation facilities dominantly affected on agriculture land in Solapur District.
33. Jawarhas first importance as a staple food crop in Solapur district. The area under jawar crop has increased in district (12.33 percent) except Sangola and Pandharpur tahsil. Bajara crop is raised all over the study area to a small extent (below 4 percent), but it is specially concentrated in Sangola (7.29 percent), Mangalwedha (6.55 percent) and Malshiras tahsil (4.56 percent). In 1971, the area

under bajara crop was 11.97 percent, which decreased to 2.49 percent of the net sown area in 2005. Maize has been covered 0.98 percent of the net sown area in 1971 and 2.69 percent in 2005; it has increased by 1.71 percent of the net sown area.Wheat has accounted for 2.39 percent land in 1971, which increased by 4.80 percent of the net sown area in 2005.

34. Tur is the first ranking pulse crop in the study region.The highest area under tur crop is found in Sangola tahsil andthe lowest area is observed in Karamala and South Solapur tahsil. The area under gram was 2.28 percent in 1971, which increased in 2005 i.e. 3.16 percent of the net sown area. High area under gram crop is in Barshi and lowest in Karamala tahsil.Moog has another important pulse crops of the region. It is moderately cultivated dryland farming. The area under Moog was 0.62 percent in 1971, which decreased in 2005 i.e. 0.19 percent of the net sown area.
35. Sugarcane is important cash crop in study region. It has occupied 6.52 percent to net sown area in 2005 in Solapur district. It has been increased near about 5 percent to net sown during the study period. In 2005, the highest area under sugarcane is observed in Malshiras tahsil and lowest in Karamala tahsil. Fruit is another important cash crop in study region. Fruits like Mango, Grapes, Pomegranate, Ber, Banana, Guava,custard apple are cultivated in district. In 1971,the area under various fruit was 0.76 percent of net sown area, while it is 4.86 percent to net sown area in 2005. The higher area under fruit crop is in Malshiras and lowest in Akkalkot tahsil.
36. Groundnut is most important oilseeds raised in the study region. It occupied 0.58 percent of the net sown area of the district in 2005. It is decreased 6.28 percent during the study period due to it is replaced by commercial crops. The highest decrease in Akkalkot tahsil and lowest in South Solapur tahsil. Safflower is another important oil seed crop cultivated in district. Itcovered 3.44 percent area in the reference year 2005. During the study period, it has been decreased on small scale (0.69 percent).
37. The intensity of irrigation has been changing over the last thirty-five years (1970-71 to 2004-05). The average regional intensity of irrigation is increased by 15.36.High proportion of the intensity of irrigation is observed in Sangola (63.63) tahsils followed byPandharpur and North Solapur.The intensity of irrigation is very low in Mangalwedha (16.23) and Karamalatahsils (16.31).

38. The index of intensive irrigation was 122.99 in 1970-71and the index of intensive irrigation goes on decrease (11.67) from 1970-71 to 2004-05 respectively. The highest index of irrigation intensity is in Mangalwedha tahsil and lowest in Pandharpur tahsil in 2004-05.
39. Jawar is the first ranking crop in all tahsils of the region. In 1970-71, the safflower and groundnuthave second ranking crops in the many tahsils of the region, but fruit crops replaced them in the 2004-04. Groundnut, fruits, gram and bajara are also major crops in the region.
40. In 1971, Jawar was the monoculture crop in Madha, Barshi, Mohol, Pandharpur and Sangola tahsil while Karamala, Malshiras and South Solapur has been observed two crop combination, three crop combination in Akkalkot , five crop combination in North Solapur and Mangalwedha tahsil. However, in 2005, jawar is monoculture crop in Karamala, Madha, Barshi, Mohol, Pandharpur, North Solapur, South Solapur and Akkalkot tahsil. The two crop combination has been observed in Malshiras, Sangola, Mangalwedha and these crops are jawar, bajara and sugarcane.
41. The Weaver's method is used to find out crop diversification in the region. In 1971, very high and high diversification observed in eight tahsil, moderate in Pandharpur tahsil and very low in Sangola and Mangalwedha tahsil. However, in 2005, the very high diversification in Six tahsils, moderate in four tahsils and very low in Karamala tahsil.
42. The total seventy two villages are selected from whole district.For the present study, Solapur district is divided into three groups on the irrigation intensity; i) low irrigation ii) moderate irrigation iii) high irrigation. Among the low irrigation region, eight tahsil are consisted in this group. These are Karamala, Madha, Barshi, North Solapur, Mohol, Pandharpur, South Solapur and Akkalkot tahsil. Then the 216 farmers are selected on the basis of three farmers in each village.
43. On the basis of the field work, it is observed that 79 percent of farmers belong to middle age group (21-60 age), while 21 percent farmers belonged to old (above 60). Most of the sample farmers (36 percent) are educated to high school level, 38 percent up to 10^{th} to 12^{th} standard, 12 percent up to graduate and above. The farmers of 12 percent are illiterate.
44. On the basis of field survey, almost 79.62 percent (172) respondents are only cultivators. Whereas only 7.87 percent respondents are service man and 5.09

percent are businessman agriculture. Among them 8.33 percent are large farmers (above 10 acre), 78.24 percent are medium (5 to 10 acre) and13.43 percent are small farmers (below 5 acre).

45. The total 216 sample farmers capture 4458 acre area. It reveals that Jawar is the major crop (57.59 %) cultivated by the sample farmers.The bajara, fruits and wheat is also important crops cultivated by sample farmers of Solapur district.
46. It is also reveals that the productivity of crops are highly affected by irrigation. The jawar crop productivity in irrigation areasare 10 quintal per acre while it is 04 quintal in no irrigated area. The irrigated area under bajara crop- productivity is 12 quintal per acre and 04 quintal in non-irrigated area. The productivity of gram is also influenced by irrigation. The irrigated gram crop productivity is 07 quintals while 02 quintal in non-irrigated area.
47. The table No 6.8 reveals that the total 216 sample farmers are digging 210 wells by sample farmers but 201 wells are used for irrigation. The 09 wells are dried due to the deflection of ground water. The 319 tube well are construed, however 198 tube wells are provide water and remaining are close due to the absence of water. The 87 sample farmers out of 216 farmers used canal water, 37 farmers water storage tanks, 17 tankers are used by sample farmers. The 68 sample farmers used source of lift irrigation scheme, but 65 farmers lift irrigation scheme are particular in use.
48. The analysis of field work reveals that the method of flood irrigation is largely (93.05 percent to total) used by sample farmers.It is also observed that the 52 percent farmers used drip irrigation and 7.87 percent sample farmer used sprinkler irrigation system.
49. The analysis reveals that in monsoon season all sample farmers get water for irrigation, but the 203 sample (93.98 %) farmers told that the water is available for irrigation in winter season and only 42 farmers (19.44 %) get water for irrigation in summer season.
50. On the basis of field work, 23 percent sample farmers of Solapur district cultivated three crops in one farm in same year, 50 percent sample farmers cultivated twice crop and 26 farmers cultivated one crop.It is clearly represent that the irrigation is basic problem of Solapur districts farmer especially in summer season.

51. The problems of sample famers differ from region to region. Among them less rainfall, Low ground water, Water management, Water shortage, Absence of electricity, Lack of irrigation implements, Govt. policy, Farmers inadequacy, Uncertain frequency of canal water, Poor maintenance of canals & tanks, Problem of over irrigation , etc. are major problem of sample farmers.

Suggestions:

In view of the findings stated above some useful suggestions for improving irrigated farming and agriculture can made, which follows.

1. Solapur District is located in drought prone area. Water scarcity is a serious problem of agriculture. The farmer should use the mulching techniques for maximum use of available water.
2. Drip irrigation system is most useful in getting good yield during the water scarcity period. Presently well and bore-well irrigation are the much common sources of irrigation. To strengthen these sources, the watersheddevelopmentprograms needs to be implemented on a large scale.
3. The farmers make use of traditional methods of irrigation like flood methods which can waste water on large scale. Therefore it is necessary to use water saving methods of irrigation like drip, sprinkler etc.
4. The surplus water of Bhima and Krishna River should be diverted in to drought prone area of Solapur district. They can be store in small tanks or minor projects which is more beneficial to ground water recharging.
5. The farmers use excess water in canal irrigated area, there is need to create awareness among farmers to optimize the use of water and the problems should be controlled to some extent.
6. It is very essential to inform and create awareness among farmers Governmentproviding about the irrigation facilities and subsidies regarding bore well, well, farm storage tank, sprinkler irrigation and drip irrigation system.
7. There is large number of K.T. weir in Solapur district; therefore it is needed to store water from surplus river by lift irrigation or river joining projects.
8. It is need to meaningful managementof the canal water frequency and regularity of water supply is needed in the study area.
9. For providing the water for agriculture in the summer season, it is needed to construct the farm water storage tank or *shet-tale*in study area.

The above suggestions are to overcome main drawbacks and lacunas of irrigation and agriculture. If these recommendations are adopted by farmers, there will be a bright future for irrigation and agriculture in the region as well as in the drought prone areas of Maharashtra.

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AppendixI

Solapur District: Tahsilwise changes in irrigated area (area in Hect.)

Sr No	Tahsil	1971		2005		Change	
		Irrigated Area	% to Agri. Land	Irrigated Area	% to Agri. Land	Irrigated Area	% to Agri. .Land
1	Karamala	8059	6.73	25506	21.52	+17447	+14.79
2	Madha	12544	9.36	28020	25.77	+15476	+16.41
3	Barshi	12319	11.43	35193	28.58	+22874	+17.15
4	N Solapur	5444	10.04	13476	26.58	+8032	+16.54
5	Mohol	11023	10.27	15777	17.32	+4754	+7.05
6	Pandharpur	13254	13.83	26654	25.07	+1300	+11.24
7	Malshiras	34274	36.81	31527	33.46	-2747	-3.35
8	Sangola	14369	15.07	31253	48.52	+16884	+33.45
9	Mangalwedha	8235	9.13	32281	48.10	+24046	+38.97
10	S Solapur	9870	10.46	21277	23.22	+11407	+12.76
11	Akkalkot	10609	8.90	25029	27.56	+14420	+18.66
	District	140000	12.70	285974	28.41	+145974	+ 15.71
Source : Socio-economic abstract of Solapur District 1971 & 2005							

AppendixII

Solapur District :Cropwise Area under Irrigation (area in00 Hect.)

S.	Crops / Name of Tahsil		Jawar		Bajara		Maize		Wheat		Tur	
			Area	%	Area	%	Area	%	Area	%	Area	%
1	Karmala	1970-71	29	4.04	08	5.47	12	85.71	13	40.62	16	34.04
		2004-05	72	8.44	04	12.50	10	24.62	29	100	00	0.00
		Change	+43	+4.40	-04	+7.03	-02	-61.09	+16	+59.38	-16	-34.04
2	Madha	1970-71	54	6.81	-	-	17	94.44	18	66.66	12	25.00
		2004-05	60	7.58	04	16.68	02	11.28	46	65.72	00	0.00
		Change	+06	+0.77	+04	+16.68	-15	-83.16	+28	-0.94	-12	-25.00
3	Barshi	1970-71	84	12.40	-	-	01	12.50	13	48.14	08	12.30
		2004-05	67	7.91	04	33.04	09	35.52	20	43.19	00	0.00
		Change	-17	-4.49	+04	+33.04	+8	+23.02	+07	-4.95	-08	-12.30
4	North Solapur	1970-71	21	7.26	-	-	02	50.00	05	41.66	07	9.21
		2004-05	37	10.24	01	10.52	02	12.00	29	95.66	00	0.00
		Change	+16	+2.98	+01	+10.52	00	-38.00	+24	+54.00	-07	-9.21
5	Mohol	1970-71	31	4.74	00	0.00	06	24.00	17	68.00	04	5.55
		2004-05	32	4.85	01	17.02	03	12.24	43	85.14	00	0.00
		Change	+01	+0.11	+01	+17.02	-03	-11.76	+26	+17.14	-04	-5.55
6	Pandharpur	1970-71	39	5.84	06	6.45	08	80.00	16	84.21	03	33.33
		2004-05	58	8.88	04	33.57	18	46.30	60	79.37	00	0.00
		Change	+19	+3.04	-02	+27.12	+10	-33.70	+44	-4.94	-03	-33.33
7	Malshiras	1970-71	112	22	36	21.95	06	85.71	30	93.75	03	27.27
		2004-05	78	14.74	04	9.00	08	36.95	46	74.24	00	0.00
		Change	-34	-7.26	-32	-12.95	+02	-48.76	+16	-19.51	-03	-27.27
8	Sangola	1970-71	71	13.37	14	4.02	06	85.71	17	100	01	20.00
		2004-05	42	11.78	04	9.73	15	15.26	13	67.42	00	0.00
		Change	-21	-1.59	-10	+5.71	+09	-70.45	-04	-32.58	-01	-20.00
9	Mangalwedha	1970-71	13	2.90	01	0.38	02	40.00	11	47.82	02	25.00
		2004-05	38	10.39	04	8.80	15	48.16	14	58.71	00	0.00
		Change	+25	+7.49	+03	+8.42	+13	-8.16	+03	+10.89	-02	-25.00
10	South Solapur	1970-71	-	7.64	-	-	01	16.66	05	20.83	08	14.81
		2004-05	61	9.04	02	26.75	02	17.0	41	71.87	00	0.00
		Change	37	+2.90	+02	+26.75	+01	+0.41	+36	+51.04	-08	-14.81
11	Akkalkot	1970-71	42	8.15	-	-	01	20.00	09	27.27	26	18.43
		2004-05	60	9.35	04	29.96	02	14.48	20	95.31	00	0.00
		Change	+18	+1.20	+04	+29.96	+01	-5.52	+11	+68.04	-26	-18.43
	District	1970-71	533	8.48	65	4.88	62	56.88	154	57.89	90	16.69
		2004-05	605	8.98	36	14.49	86	31.87	361	75.57	00	0.00
		Change	+72	+0.50	-29	-9.61	+24	-25.01	+207	+17.68	-90	-16.69

Tables continue. ….

S	Crops / Name of Tahsil		Gram		Moog		Sugarcane		Fruit		Groundnut		Safflowers	
			Area	%	Area	%	Area	%	Area	%	Area	%	Area	%
		1970-71	-	-	07	35.00	03	100	02	100	01	3.22	22	15.94
		2004-05	07	28.65	00	0.00	41	89.13	44	86.27	06	60.00	06	17.14
1	Karmala	Change	+07	+28.65	-07	-35.00	+38	-10.87	+42	-13.73	+05	+56.78	-16	+1.20
		1970-71	-	-	04	44.44	06	75	04	66.66	02	4.00	15	15.15
		2004-05	08	24.45	00	0.00	39	88.63	46	97.87	06	85.71	16	64.00
2	Madha	Change	+08	+24.45	-04	-44.44	+33	+13.63	+42	+31.21	+04	+81.71	+01	+48.85
		1970-71	-	-	05	27.77	07	100	05	71.42	-	-	08	42.10
		2004-05	31	64.43	00	0.00	63	80.76	49	96.07	07	87.50	26	55.31
3	Barshi	Change	+31	+64.43	-05	-27.77	+59	-19.24	+44	24.65	+07	+87.50	+18	+13.21
		1970-71	00	-	01	50.00	10	100	06	66.66	02	3.92	06	60.00
	North Solapur	2004-05	01	6.33	00	0.00	18	64.28	19	54.28	01	20.00	03	30.00
		Change	+01	+6.33	-01	-50.00	+08	-35.72	+13	-12.38	-01	+16.08	-03	-30.00
		1970-71	05	22.72	01	50.00	07	100	17	89.47	02	5.55	07	17.07
5	Mohol	2004-05	02	8.25	00	0.00	22	44.89	20	66.66	01	25.00	04	19.04
		Change	-03	-14.47	-01	-50.00	+15	-55.11	+03	-22.81	-01	+19.45	-03	+1.97
		1970-71	06	19.35	01	100	12	100	06	100	18	94.73	08	17.39
6	Pandhar	2004-05	09	22.06	00	0.00	46	55.42	45	83.33	02	66.66	01	3.57
		Change	+03	+2.71	-01	-100	+34	-44.58	+39	-16.67	-16	-28.07	-07	-13.82
		1970-71	13	68.42	02	50.00	67	100	06	85.71	17	89.47	04	17.39
7	Malshiras	2004-05	12	33.55	00	0.00	49	49.00	63	86.30	05	71.42	01	2.63
		Change	-01	-34.87	-02	-50.00	-18	-51.00	+57	+0.59	-12	-18.05	-03	-14.76
		1970-71	02	28.57	01	100	04	100	01	100	05	100	01	100
		2004-05	01	3.18	00	0.00	34	91.89	34	39.06	04	66.66	01	3.12
8	Sangola	Change	-01	-25.39	-01	-100	+30	-8.11	+33	-60.94	-01	-33.34	00	-96.88
		1970-71	07	24.13	01	100	03	100	03	100	05	31.25	03	10.00
9	Mangal	2004-05	03	16.23	00	0.00	61	100	34	77.27	01	33.33	10	26.31
		Change	-04	-7.90	-01	-100	+58	0.00	+31	-22.73	-04	+2.08	+07	+16.31
		1970-71	-	-	01	16.66	04	50	05	100	02	1.71	02	8.00
10	South Solapur	2004-05	09	35.29	00	0.00	29	80.55	13	32.50	02	100	18	50.00
		Change	+09	+35.29	-01	-16.66	+25	+30.55	+08	-67.50	00	+98.29	+16	+42.00
		1970-71	-	-	01	20.00	14	100	16	84.21	01	0.38	02	7.40
11	Akkalkot	2004-05	19	71.12	00	0.00	87	91.57	21	95.45	01	25.00	18	48.64
		Change	+19	+71.12	-01	-20.00	+73	-8.43	+05	+11.24	00	+24.62	+16	+41.24
		1970-71	33	13.04	25	36.23	139	97.20	71	85.52	55	7.21	78	16.99
	District	2004-05	102	31.96	00	0.00	493	75.03	388	79.18	36	61.01	104	29.97
		Change	+69	+18.92	-25	-36.23	+354	-22.17	+317	-6.34	-19	+53.80	+26	+12.98

Appendix III

Solapur District ; Temporal Variation in General Landuse (Area in 00 Hect.)

Land Use / Year	Forest	Non agriculture land	Potential land excluding fallow land	Fallow land	Cultivated area	Total
1971	333	655	584	2333	11105	15010
%	2.23	4.38	3.88	15.58	74.23	100
1981	359	727	1048	2247	10629	15010
%	2.39	4.84	6.98	14.98	70.81	100
1991	269	776	607	1755	11471	14878
%	1.81	5.22	4.08	11.80	77.09	100
2001	319	789	336	1753	11681	14878
%	2.14	5.30	2.26	11.78	78.52	100
2005	319	792	336	2945	10065	14878
%	2.14	5.32	2.25	19.79	67.65	100
Change 1971 to 2005	- 14	+137	-248	+612	-1040	-
%	- 0.09	+0.94	-1.63	+4.21	-6.58	-

Appendix IV

Solapur District; Temporal Variation of Agriculture Landuse.(Area in 00 Hect.)

Year / Crops	1971		1981		1991		2001		2005	
	Area	%	Area	%	Area	%	Area	%	Area	%
Jawar	6280	56.55	7482	67.0	6921	68.21	7138	63.39	6732	66.88
Bajara	1330	11.97	754	6.82	580	5.71	533	4.73	251	2.49
Maize	109	0.98	142	1.28	139	1.36	291	2.58	271	2.69
Wheat	266	2.39	517	4.67	243	2.39	509	4.52	484	4.80
Rice	74	0.66	59	0.53	34	0.33	16	0.14	05	0.04
Tur	539	4.85	602	5.44	512	5.00	324	2.87	133	1.32
Gram	253	2.28	319	2.88	133	1.30	316	2.80	319	3.16
Moog	69	0.62	66	0.59	26	0.25	51	0.45	20	0.19
Sugarcane	143	1.29	208	1.88	489	4.81	744	6.60	657	6.52
Fruits	84	0.75	76	0.68	80	0.78	155	1.37	490	4.86
Groundnut	762	6.86	311	2.81	217	2.13	218	1.93	59	0.58
Safflower	459	4.13	222	2.00	267	2.63	490	4.35	347	3.44
Cotton	107	0.96	49	0.44	21	0.20	70	0.62	44	0.43
Other	630	5.67	242	2.19	484	4.77	405	3.59	273	2.71
Total	11105	100	11049	100	10146	100	11260	100	10065	100

Interview Schedule

A geographical study of irrigation on agriculture landuse pattern in Solapur District

Dear Farmer

I would like to request you that, I am doing research work on "A geographical study of irrigation in agriculture landuse in Solapur District" for the award of Ph.D. Degree. I would be grateful to you could spare some time to fill the details

Yours faithfully
Shri. B. D. Patil
Dept. of Geography,
Vidnyan Mahavidyalaya Sangola

I. General Information :

1. Name of Farmer…… …….
2. Name of the Village ……Tahsil …….
3. Age ……. Education ……Occupation …….
   Secondary occupation ……
4. Family Information

Sr	Name	Relation to farmer	Education	Age	Sex	Occupation
1						
2						
3						
4						

5. Landuse

Crop	Area in acre	Irrigated area (acre)	Production In irrigated area (quintal)	Production In non -irrigated area (quintal)
Jawar				
Bajara				
Maize				

Wheat				
Gram				
Moog				
Tur				
Groundnut				
Safflower				
Sugarcane				
Fruit ----------				
Cotton				
Other		-	-	-
Fallow land		-	-	-
Total				

6. Sources of irrigation

	Well	Bore-well	Canal	Lift	Tank	Tanker	Other	Total
Total								
In Use								

7. Types of irrigation

Flood	Drip	Sprinkler	Other	Total

8. Bank loan ; Yes/No …….

   Name of Agency/Bank: ……

9. In which season water is available for irrigation?

   1) Monsoon 2) winter 3) summer

10. Use of agriculture implements

Sr No	Implements	Irrigated area	Non irrigated area
1	Bullock Plough		
2	Cart		
3	Chara cutter		
4	Sprayer		
5	Motor sprayer		
6	Tractor		

7	Cultivator		
8	Rota vator		
9	Seed Planter		
10	Disk harrow		
11	Tractor plough		
12	Harrow		
13	Thresher	-	-
14	Other	-	-
	Total		

11. Types of Soil

Shallow	Medium shallow	Deep	Other	Total

12. Livestock

Bullocks	Buffalos	Cows	Sheep's	Hens	Other

13. Due to modern technique of irrigation, agriculture has become more profitable industry: 1. Yes 2. No

14. Do you want irrigation impact on cropping pattern ?

    Yes/no

    why?……..……
    ……..

15. How many times land is cultivated in a year?

    1) One 2) two 3) more than two

    Why ……..
    ……..……..

16. Do you practice "Night irrigation"? 1. Yes 2. No

17. Problem of irrigation

Sr No	Problem	Status
1	Less rainfall	

2	Low ground water	
3	Water management	
4	Water shortage	
5	Absence of electricity	
6	Lack of irrigation implements	
7	Govt. policy	
8	Farmers inadequacy	
9	Uncertain frequency of canal water	
10	Poor maintenance of canals & tanks	
11	Problem of over irrigation	
12	Other	-
	Total	

Date: / / (Signature of the Farmer)